

# Lesson Two

## A Competitive Edge



### CONCEPTS

- ♦ Trees and plants within a forest ecosystem compete for nutrients, sunlight, and energy.
- ♦ The characteristics of a plant or tree determine how competitive it is under certain environmental conditions.
- ♦ Natural disturbances influence plant and tree competition.

### OBJECTIVES

Students will be able to:

- ♦ Name the main types of disturbance that influence forests in Wisconsin.
- ♦ Define forest succession and explain the role that disturbances and tree characteristics play in this process.

### TEACHING SITE

Indoor classroom

### MATERIALS

Day 1 – Overhead projector, pencils, vocabulary list taken from the master vocabulary list, 4 dice, **Disturbance cards**, **Tree Limit Cards** (1 or 2 for each group), **Competition Rules**, and **Forester's Record Worksheets**.

Day 2 – Completed **Forester's Record Sheets**, **Forest Timeline** (must be made), and **Tree Silhouette Cutouts** for all six tree species.

### LESSON TIME

Two 50-minute class periods

### NUTSHELL

Students will play a tree species role-playing game with dice and cards. The trees (students) will compete with each other to establish themselves on abandoned farmland surrounded by forest. Time (role of the dice), disturbances (cards), and the species characteristics assigned to the students will determine who remains in the competition.

### TEACHER PREPARATION

*Day 1* – Read through all of the materials. Make copies of the vocabulary list (optional). Photocopy the species cards to hand out to students (one of each tree species: six total). Obtain four dice. Make a copy of the Forester's Record Sheets. Copy and cut out the disturbance cards.

*Day 2* – Make an overhead transparency of the completed Forester's Record Sheets. Make copies of the tree cutouts. Use butcher paper to draw a timeline that will illustrate the forest succession that occurred throughout the competition (See the Example Timeline attachment).

### VOCABULARY

- ✿ **Tree characteristics** – the identifying traits (physical, biological, or chemical) of a tree.
- ✿ **Disturbance** – a natural or human caused event that causes a forest to change.
- ✿ **Disturbance regime** – the intensity, duration, and frequency of a disturbance.
- ✿ **Tree establishment** – the growing of a tree onto a piece of land.
- ✿ **Tolerance** – a tree's ability to handle natural and/or human influences upon its environment, usually referring to a tree's ability to live in shade.
- ✿ **Germination** – the sprouting of a tree seedling from a seed.
- ✿ **Nutrients** – the elements found in the forest floor and soil that trees require for growth.
- ✿ **Moisture** – the amount of water present.
- ✿ **Competition** – the interactions formed between trees while acquiring their essential needs for growth and reproduction.
- ✿ **Maturity** – a period of time in a tree's life span when growth slows and the tree reaches near maximum size.
- ✿ **Succession** – the change in forest structure and/or composition through time.
- ✿ **Primary succession** – forest establishment that starts on bare rock or any other surface without plant material.

- \* **Secondary succession** – forest establishment that starts from seed beds, roots, or other types of tree reproduction that are already present on the landscape
- \* **Steady-state** – a period of time in forest aging when forest growth slows and changes in composition and structure are minimal. This is the old-growth forest, the last stage of forest succession

*This game is modeled after the AViO forest habitat type suggested by John Kotar et al in The Field Guide to Forest Habitat Types of Northern Wisconsin. All tree information was taken directly from information in The Silvics of North American Trees produced by United States Department of Agriculture.*

## BACKGROUND INFORMATION

### Disturbance and Forest Succession

**Forest succession** is a change in forest composition and structure over time. This change is often influenced by **disturbance**. Fire, clearcutting, wind-throw, insect infestation, animal browsing, and hail damage are all examples of disturbances common throughout Wisconsin.

Different disturbances affect a forest in different ways. Insects may kill the tree species which forms the canopy. As a result, sunlight would be available for all of the suppressed trees. These trees would then form an entirely new and different canopy, resulting in a change in the forest composition and structure.

Intense fires often eliminate all of the trees in the forest. A nutrient-rich layer is formed on top of the soil and the land becomes exposed to direct sunlight. Some trees grow very well in these conditions (especially aspen and jack pine). Intense fire usually results in a forest containing only one tree species, all having the same age. When all of the trees have the same age and the same height, this is called an **even-aged** structure (e.g. red pine plantations and aspen stands).

Wind-throw, the knocking down of trees by intense winds, can have the opposite effect of intense fire. While intense fires reduce the

number of trees and structural layers in the forest, wind-throw can increase both. Wind often knocks down trees in patches. These patches create gaps in the canopy, bringing sunlight to the forest floor. These gaps allow different trees to grow, adding to the diversity of the forest composition and structure. A forest with trees of varying age and height is said to have an **uneven-aged** structure (e.g. mature mixed forests and northern hardwood forests).

### Natural Regeneration

The reestablishment of tree species in a forest is called natural regeneration. **Natural regeneration** occurs when mature trees in a forest are able to establish seedlings and ensure the growth of new trees. This usually happens when the environmental conditions resulting from the disturbance are ideal for the requirements of seedling establishment and growth. For example, eastern hemlock trees have been unable to regenerate naturally in many forests throughout Wisconsin. It has been speculated that white-tailed deer populations are so high that young hemlock seedlings have little to no chance of survival in many forests. It has also been shown that hemlock needles, as they accumulate in the forest floor, create poor conditions for the germination of the hemlock seeds. The lack of many historical disturbances such as fire, and the increase in many recent disturbances such as herbivory by deer, make the natural regeneration of eastern hemlock very difficult.

### Types of Succession

Two types of succession can occur within a forest ecosystem – primary and secondary succession. **Primary succession** is the establishment of forest in an environment (bare rock) with no biological influence. Primary succession occurs after lava flows, severe fire, glaciation, or any event that eliminates all reproductive sources of plants. **Secondary succession** is forest establishment influenced by preexisting biological influences when a disturbance does not remove all of the plant reproductive sources. These sources can be seedbeds, root suckers (aspen), seedlings, saplings, or any live flora remaining after the disturbance.

Disturbances that can cause secondary succession include fire, clearcutting, insect infestations, animal browsing, and flooding.

Succession also occurs in the absence of major disturbances. These changes are influenced by the characteristics of the trees present. For example, certain trees can tolerate shade better than others. This makes them better suited for surviving under a canopy of dense trees. As the trees in the canopy grow old and die, the trees that survived in their shade will most likely be the next trees to form the canopy layer. Certain trees also live much longer than other trees. These trees will outlive the other trees, competing with them for sunlight and soil nutrients and will most likely become the dominant trees. Trees differ in their abilities to reproduce, disperse seed, grow tall, grow old, absorb nutrients, and tolerate shade. These differences determine how a forest will change over time.

### The Stages of Succession

Forests are always changing. Old trees die and new trees grow in their place. These changes are reflected in a series of stages that lead to an equilibrium or steady state. These

stages (seres) include the pioneer, successional, mature and steady state stages.

The **pioneer stage** starts with bare ground after a disturbance. Seeds that find their way to the soil or root shoots that extend from underground invade and colonize the area. These plants reorganize a pattern of vegetation on the landscape and begin the accumulation of organic matter (biodegrading plant material) necessary for forest establishment.

The **successional stage** is recognized by the rapid growth and accumulation of living plant material (biomass). These forests change relatively quickly in composition and structure due to increased availability of nutrients, rapid growth spurts, and susceptibility to disturbances.

The **mature stage** is achieved when the tree accumulation rates begin to decline and tree composition and structure stabilize.

The **steady-state stage** is reached when a forest's plant mass, composition, and structure remain relatively constant through time. This is the old-growth or climax stage of a forest.

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## ACTIVITIES

### 1) A Competitive Edge (50 minutes)

In this lesson you will be introducing the concept of competition in forest communities and how disturbances can alter the composition of a forest. Start by telling the students that you would like them to think about a football or softball team. Ask them to tell you what makes up a football or softball team. Guide their answers to individual players and the positions they play. Remind the students that in the last lesson they learned about the structure and composition of the forest. Ask students to recite the layers of the forest. *Leaf litter, forb, shrub, understory, & canopy.* Ask the students if they see any comparison to a football or softball team. *Positions on the team are like the layers.* Ask the students if they can define what the composition of a forest is. *The species of trees present in a given area.* Tell them that the composition of a football or softball team is made up of a variety of different players.



Ask the students how someone gets to be chosen to play a position on a team. *They have to try out for the position.* Ask if everyone who tries out gets to play. *No because they only need so many of a particular position.* Ask how two people trying out for the same position are related. *They are competitors.* Ask what would happen if the best player broke a leg. *Someone else would have to replace him or her in that position.*

Tell the students that the composition of the forest is determined by the ability of trees and other plants to grow and compete with other species. Like the football or softball team, what trees are present in the different layers is determined by their ability to play the same game or coexist together and out-compete other species. Tell the students that just like the composition of the team is changed by player injuries, the composition of the forest is altered by disturbances. Ask the students if they can think of possible disturbances that alter a forest. *Wind, fire, harvest of trees, animal browsing, insects, and disease.*

Tell the students that today they will be playing a game to see how the composition of a forest changes over time. They will work as teams of tree species. The trees that are present during the game will be determined by the disturbances that take place and the ability of the trees to survive a disturbance and compete with the other trees. Relate to the students that this process of the forest changing over time in response to aging and disturbances is called succession.

### COMPETITION BACKGROUND FOR STUDENTS

*(Read the following to the class)*

"It is the early 1900's and many farmers are moving to the great Northwoods of Wisconsin. The soil is fertile but the land is full of large rocks left by glaciers and large tree stumps left from logging. Many farmers are having a very difficult time making a living and many fields are being left unplanted. A local farmer has come upon hard times and left his land unworked. The bare soil that you are standing on will not be farmed again and will be left as property of the state. The field will be unmanaged and left to turn into forest. The trees around the edge of the forest are going to compete for the space, nutrients, water, and sunlight available in the field. You are those trees. Each of you is one of six different tree species: black cherry, white ash, paper birch, sugar maple, American basswood, and eastern hemlock. You will need all of your strengths and resources to compete against each other and establish yourself. You will also work against the forces of nature and time. The field is very fertile and has enough moisture and nutrients to allow you to reach your maximum age and height if you can win the competition. A forester from the Wisconsin Department of Natural Resources will record all of the changes in the field through time."

### GAME SETUP

2) Select one student to serve as Mother Nature and one to serve as Father Time. Explain that Father Time will control how much time passes by rolling the number of years that pass on four dice and that Mother Nature will control natural events such as fires and storms by handing out disturbance cards. Divide the remaining students into six groups. Tell each group what tree species they are and hand them their **Tree Characteristic Sheets**. Explain the tree characteristic sheets to them. Tell them that the top half of the sheet describes their characteristics and gives background about their strengths and weaknesses. Tell them that the box at the bottom of the sheet lists the events that limit how they play the game.



To explain how these limits work, go through some examples by asking each group to tell the class 1) when they can enter the game, 2) what disturbances eliminate them from the game, and 3) how long they can live.

Ask them to turn over their tree game sheets and put them down on their desks. Put the competition rules on an overhead projector for all of the class to see. Go through each rule individually, using the groups and specific students as examples to illustrate the rules.

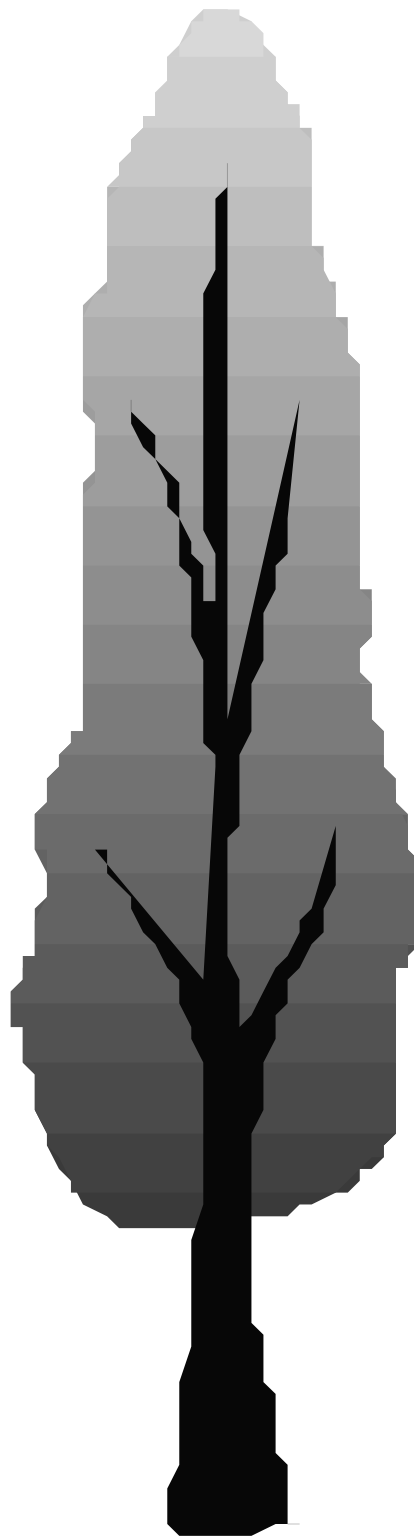
Explain to them that you are the forester. Your job is to keep track of what is happening throughout the game by making sure that the players are following their tree rules. To do this, stop the game after each dice roll. Tell the students how many years have elapsed. Ask the trees to raise their hands when they have determined how old they are. Help the trees that don't know. Some trees may die of old age, so they must compare their age to their tree's age limit. If they are older than their age limit, they are eliminated. Then ask Mother Nature to pull a disturbance card and announce it. Have the trees look at their limits and figure out if they can tolerate the disturbance. If they can, they stay in the game. If not, they are eliminated. Ask the groups if any of them can enter the game now. If they are not breaking any limits, let them into the game.

Before beginning the next round, record the species present after the disturbance by putting a **P** for those species present in the preceding round, **N** for those trees that just entered the game this round, and **A** for those trees absent from the game. Also record the elapsed time and disturbance type from the previous round. Once you have completed entering this data, Father Time can again roll the dice.

Complete the game in this fashion. There are 12 disturbance cards. Each will represent one round of the game. You will play 100 more years after the last disturbance card has been drawn. Father Time will continue to roll dice and trees will compete without disturbance cards for 100 years. After 100 years pass, decide the final stand composition and the ages of the trees and declare the winning groups.

*The Forester's Record:* There are two record sheets. Each must be completed by you (the teacher) as the game progresses. The first one outlines the forest's composition change during the periods of disturbance, and the second one outlines the forest's composition change after the disturbances run out. These records will be the basis for the next activity.

*Notes to Mother Nature:* Mother Nature plays a large part in directing the game. Make sure that she can properly keep track of the ages on the disturbance cards that require ages. Make sure that she announces and explains each disturbance. She must also announce when the pests (deer, fungus, etc.) leave the game.



### AFTER THE GAME (30-40 MINUTES)

3) Roll out the piece of butcher paper on which you have already drawn a timeline (see Example Timeline attachment) and attach it to your classroom wall. With the completed Forester's Record on the overhead for the students to review, help them locate the points along the timeline where disturbances occurred. Mark these points on the timeline for the students by drawing a line from the timeline to the top of the paper. Label these lines with the disturbance that occurred.

Hand out the tree cutout pages to each group. Each page has small and large pictures of the same tree. There is a specific tree page for all six different tree species. Have the students cut apart the small and large trees on their page. A representative of each tree group will bring up their tree when called upon and tape it in the appropriate location. *The small trees will be placed on the timeline at the point where the trees initially entered or re-enter the game (at the beginning or after a disturbance, etc.). The large trees will be used for any other point in time that the tree remained in the game.*

Start at the beginning of the timeline. Ask all tree groups to come up that had trees present at the first round of the game. Once they have taped up their trees, ask each group why their tree was present. Ask those trees not present, why they were not. Discuss with the students what the disturbance was. Ask students to come up whose trees remained after the disturbance and add their tree pictures to the timeline. Ask why their trees were still present. Ask if there are any new trees that can join the forest after the disturbance and have those tree representatives add that tree picture to the timeline. Continue the discussion and timeline development until it is completed.

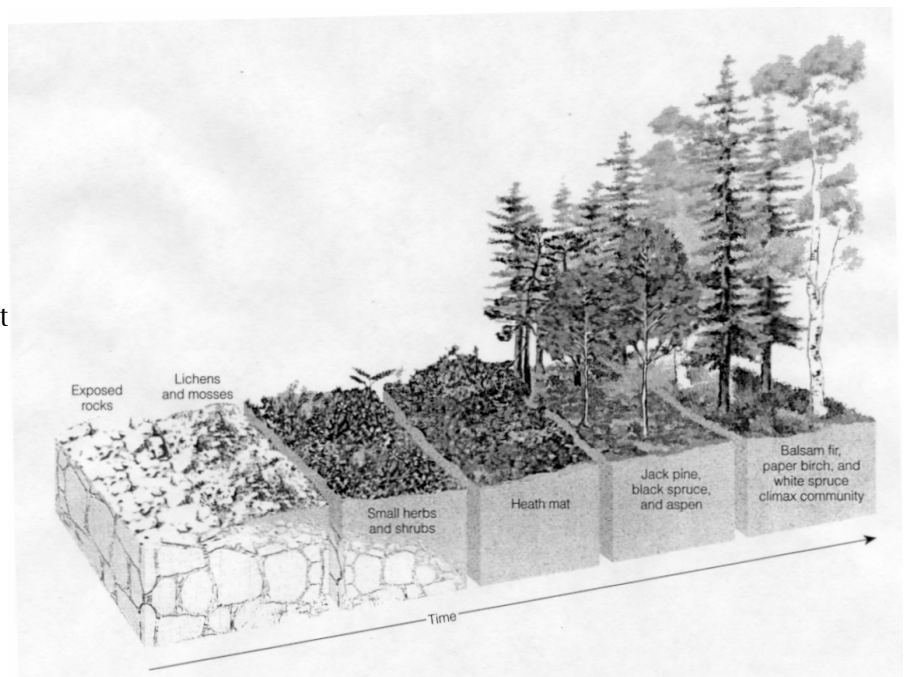
### CONCLUSION (10-15 MINUTES)

4) After you have completed the timeline, tell your students that they have just participated in a process that all natural systems go through. Ask the students how the random role of the dice might represent the real world. *Disturbances and natural events like fire, flooding, drought, etc. are unpredictable. We have no way to predict if and when they might happen.* Ask if anyone can remember what the process is called where the composition and structure of a forest is changed over time or changed by a disturbance. *Succession.*

Tell the students that there are two types of succession that can occur within a forest ecosystem. They are called primary and secondary succession.

Ask the students to again think of a football or softball team. Would it take longer to start a team if you don't have any equipment and people that know how to play, or if you already have the equipment and people that know how to play? *Starting a team from scratch would be much harder and take longer.*

Tell the students that **primary succession** is like starting that team from scratch. Primary succession is the establishment of a forest in an



environment (bare rock) with no topsoil and seeds present. Primary succession occurs after lava flows, severe fire, glaciation, or any event that removes topsoil and plant seeds, root shoot, or other means of a new plant starting. Tell the students that like starting a ball team when you have the equipment and people, **secondary succession** takes place much faster.

Secondary succession takes place where there is already soil developed and where the disturbance has not removed all seed beds, root suckers, seedlings, or other living plants. Disturbances that cause secondary succession include fire, clearcutting, insect infestations, animal browsing, and flooding.

Ask your students how a human changes as it ages. Have them start with a baby and give you characteristics until older age. Tell your students that just like a human goes through a variety of stages during their life, so too succession in a forest goes through several stages. When a forest starts in a new area, this is called the pioneer stage. This stage is characterized by the first plants to arrive on the site, much like the pioneers were the first Americans to settle the land. Tell them that as succession continues it goes through a rapid growth stage, just like children grow during their teenage years. As time progress, the forest reaches a maturity stage similar to the slowing in growth that humans experience before age 30. During this time, the forest composition doesn't change much and trees grow slowly. Eventually, given enough time and no disturbance, a forest reaches its final stage called the steady-state stage. During this stage, the trees grow very slowly and only very minor changes occur. Steady-state or 'old growth' forest are usually have an uneven-aged structure with a variety of different tree species with different ages. These forests are dominated by the climax tree species. These are the trees that win the competition and grow to great size and age.



Direct the students attention back at the timeline from the game. Ask the students which trees were present during the pioneer stage. How did the trees/forest react to disturbances? What did the disturbances do to the succession of the forest? *The disturbances kept the forest young and constantly changed the trees that were in the competition.* Ask the students what happened after the last disturbance card was drawn. *The forest was allowed to mature and eventually reached the steady-state stage. The forest was dominated by very large, old eastern hemlock and sugar maple trees.*

Tell the students that our forests are typed or given a name based on the dominant species of trees that are present or will be present during the steady-state stage. Ask the students what they think the name of the forest type is in the competition. *Most likely it will be hemlock/sugar maple.* Tell the students that in the next lesson they will be learning the different types of forests in Wisconsin and looking at the reasons why specific forest types are found where they are.

## STUDENT LOG BOOK

Using the information on the timeline, have students write a short autobiography of the life of their tree in their daily log. Each autobiography should include observations of how the forest changed, the effects of disturbances on them, effects of time, and the strengths and weaknesses of their specific tree species.

Have students compare the time it took for the forest in the competition to mature (the time during the competition when the sugar maple and hemlock trees reached maturity) to the time it takes a person to mature. Use the timeline to help the class find their age, their parents age, grandparents and so on. Have them research their family history throughout the life of this forest (this could be as far back as 300+ years). Ask them to comment on how the time that it takes a forest to grow and mature might affect the way that people view the forest. If you plant a tree will you ever get to see it grow very big?

## Web Links

U.S. Forest Service, North Central Forest Experiment Station—<http://www.ncfes.umn.edu>

Forest management company in British Columbia has developed a computer model to show a forest after logging – [www.forestnet.com/forest\\_management.htm](http://www.forestnet.com/forest_management.htm)

US Forest Service: Silvics of North American Trees on line—  
[http://willow.ncfes.umn.edu/silvics\\_manual/Table\\_of\\_contents.htm](http://willow.ncfes.umn.edu/silvics_manual/Table_of_contents.htm)

## References

American Forest Foundation. 1996. The Changing Forest: Forest Ecology. Project Learning Tree. Washington, D.C.

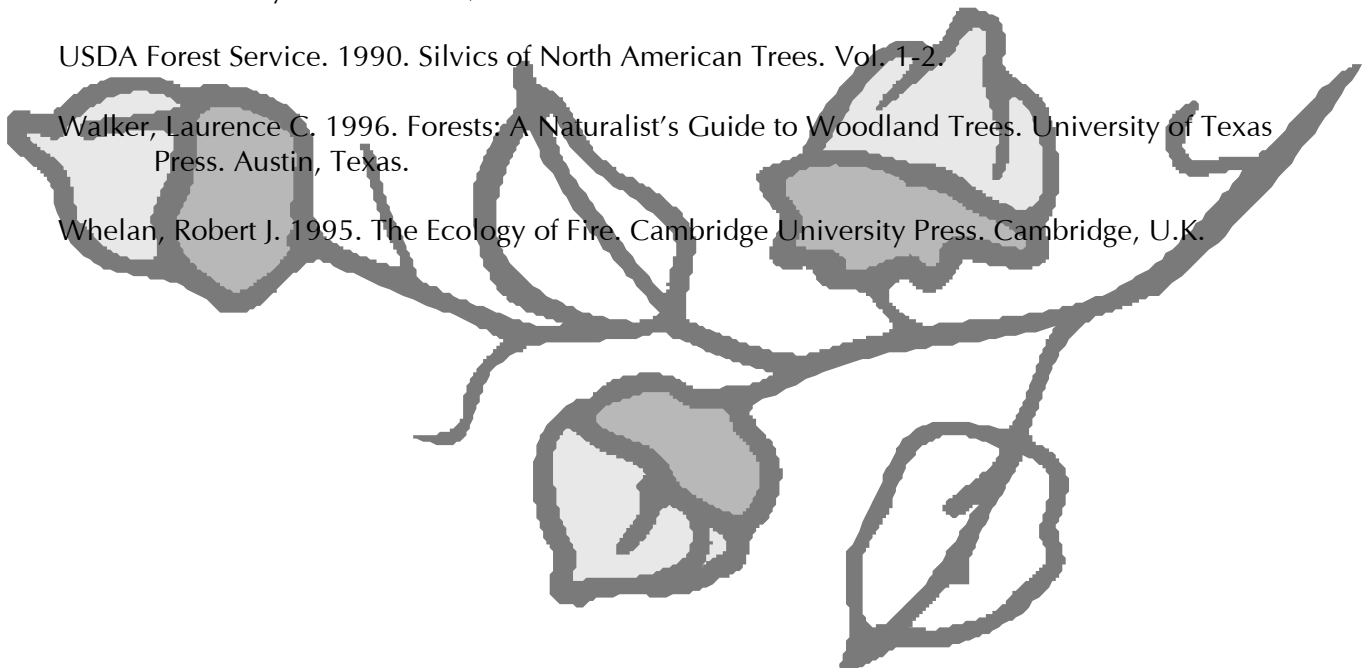
Kotar, John. 1984. Habitat Types of Northern Wisconsin. Dept. of Forestry Pub. Madison, Wisconsin.

Kotar, John. 1996. A Guide to Forest Communities and Habitat Types of Southern Wisconsin. Dept of Forestry Pub. Madison, Wisconsin.

USDA Forest Service. 1990. Silvics of North American Trees. Vol. 1-2.

Walker, Laurence C. 1996. Forests: A Naturalist's Guide to Woodland Trees. University of Texas Press. Austin, Texas.

Whelan, Robert J. 1995. The Ecology of Fire. Cambridge University Press. Cambridge, U.K.





# RULES OF THE COMPETITION

- ✿ Read all of the rules carefully.
- ✿ All the trees in one tree species group work as a team against all other trees. Help each other throughout the game.
- ✿ You may not talk to any other tree species group.
- ✿ No tree is ever permanently eliminated from the competition.
- ✿ You must follow all of the limits given to you on your card.
- ✿ You must keep track of your own age.
- ✿ You can enter the competition at the beginning, immediately after disturbances, or after the roll of the dice if there are no disturbances.
- ✿ The time is controlled by Father Time and only Father Time.
- ✿ The Disturbance Cards are controlled by Mother Nature and only Mother Nature.
- ✿ Pests will stay in the game as long as is stated on the disturbance card. Once they are gone, if all other conditions are right, you may re-enter the game.
- ✿ All trees must obey the forester or they will be cut down.
- ✿ The competition ends 100 years after the last disturbance card is drawn.
- ✿ Any and all tree species left in the competition at the end win the competition.
- ✿ If you need to ask a question, RAISE YOUR HAND, and the forester will stop the game to answer you.

# DISTURBANCE CARDS

<p>Low Intensity Ground Fire</p>	<p>High Intensity Fire</p>	<p>Windstorm</p>
<p>50 Year Storm!! Extreme Flooding &amp; Extreme Winds</p>	<p>The Dam Broke!! Flash Flooding</p>	<p>Black Knot of Cherry Fungus Kills All Living Cherry Trees</p>
<p>White-Tailed Deer Populations Expand and Remain for 20 Years</p> <div style="border: 1px solid black; width: 100%; height: 20px; margin-top: 10px;"></div>	<p>Porcupine Population Invades and Remains for 20 Years</p> <div style="border: 1px solid black; width: 100%; height: 20px; margin-top: 10px;"></div>	<p>Rabbit Populations Expand and Remain for 20 Years</p> <div style="border: 1px solid black; width: 100%; height: 20px; margin-top: 10px;"></div>
<p>Tent Caterpillars Are Introduced and Remain for 20 years</p> <div style="border: 1px solid black; width: 100%; height: 20px; margin-top: 10px;"></div>	<p>The Gypsy Moth Is Introduced and Remains for 20 years</p> <div style="border: 1px solid black; width: 100%; height: 20px; margin-top: 10px;"></div>	<p>Bronze Birch- Borer Beetle Invades for 20 years</p> <div style="border: 1px solid black; width: 100%; height: 20px; margin-top: 10px;"></div>
<p>σ For the animals and insects use the boxes below the names to keep track of the time that they remain in the game. (Each box represents one year. Once the boxes are full, the pest is gone from the game)</p>		

**EASTERN HEMLOCK**  
(*Tsuga canadensis*)

**Max age:** 400 years

**Max height:** 100 feet

**Maturity:** 300 years

**Growth:** Extremely slow



**Reproduction:** Hemlock seeds require shade and a decomposing leaf layer on the forest floor in order to germinate. One or more trees must form a canopy for at least 30 years until the climate and forest floor conditions are right. Hemlock trees only grow from seeds.

**Shade tolerance:** Hemlocks are a very shade tolerant tree species and can remain in shade for any length of time at any stage in growth.

**Tolerance to disturbance:** Hemlocks are resistant to wind at young ages, but as they grow taller, wind can topple some trees. Hemlocks are tolerant of fire when old BUT even then will be killed by intense fire. Flooding will damage their roots and encourage disease.

**Damaging agents:** Root rot affects the ability of the tree's roots to absorb soil nutrients and usually causes death soon after flooding. White-tailed deer mice and voles eat young hemlock saplings and seedlings. If any two of these animals are present while the tree is young, it will be impossible for it to grow new branches and collect enough sunlight for food.

**Competitive edge:** Hemlock's extreme tolerance of shade and remarkably long life span give them a competitive edge. As a hemlock, you will most likely be one of the final contestants in the competition.

**Your limits during the game:**

1. You may not enter the game until at least one tree has lived 30 years.
2. After you are killed by a disturbance you may only re-enter the game if there is at least one tree that is 30 years old.
3. Fire will eliminate you if you are younger than 100.
4. If you are younger than 100 and deer are present, you will be eliminated.
5. Intense fire will immediately eliminate you.
6. You will die of root rot 10 years after a flood event.
7. You will be 100 feet tall at 300 years of age.
8. You will die at 400 years of age.

**\* Use the side of this sheet to keep track of your age**

<b>*Age Tally</b>	
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## WHITE ASH

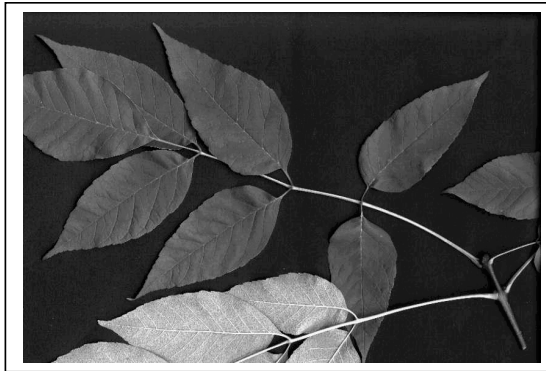
(*Fraxinus americana*)

**Max age:** 110 years

**Max height:** 100 feet

**Maturity:** 80 years

**Growth:** Average growth rate, which slows down as the tree ages.



**Reproduction:** White ash are pioneer species whose seeds grow readily in full sunlight. After establishment, white ash are usually overtopped by other pioneer species. Ash require partial sunlight from gaps formed in the canopy, and will not survive if the canopy remains closed for long periods of time. Ash have the ability to sprout new trees from their own roots, but can only sprout successfully in full sunlight.

**Shade tolerance:** Ash are somewhat shade tolerant but this tolerance decreases with age. After their initial surge of growth ash will not survive long in complete shade.

**Tolerance to disturbance:** Ash have a deep root system and are resistant to wind. Ash are killed by fire at all ages and die immediately. Ash are tolerant of most flooding and remain unaffected unless flooding is severe.

**Damaging agents:** The tent caterpillar and white-tailed deer use ash buds and leaves as a food source. This reduces the tree's ability to sprout new branches and produce food. Porcupines will also girdle (remove a strip of bark from) ash tree trunks. Combinations of these agents weaken the tree's natural defense systems and eventually kill it.

**Competitive edge:** Resistance to wind and flood damage allow ash trees to get established in areas where other tree species have died.

### Your limits during the game:

1. You may only enter the game if less than 2 tree species are in the competition.
2. At 40 years of age, if more than 2 tree species are older than you are, you will be eliminated.
3. You will die at 80 years of age if any tree is taller than you are.
4. If both tent caterpillars and porcupines are present at the same time, you will be eliminated.
5. All fire events will eliminate you.
6. You will be 100 feet tall at 80 years of age.
7. You will die at 110 years of age.

\*Use the side of this sheet to keep track of your age

### \*Age Tally

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## AMERICAN BASSWOOD

(*Tilia americana*)

**Max age:** 180 years

**Max height:** 140 feet

**Maturity:** 100 years

**Growth:** Average, but basswood grow very quickly in canopy gaps created by the death of other trees.



**Reproduction:** Basswood produce seeds every year. These seeds germinate poorly. In order for basswood seeds to germinate, they must remain dormant in a cool forest floor for approximately 20 years. After dormancy, the seedlings require warmth and light for at least ten years in order to grow. Once established, basswood trees have the ability to sprout new trees from their roots and will return to the forest immediately after most disturbances.

**Shade tolerance:** Tolerant of shade at all ages except during the first 10 years of life.

**Tolerance to disturbance:** Basswoods have extensive root systems that allow the tree to survive strong winds. Basswoods are affected by fire at all ages and will eventually die. They can not tolerate wet soil and are killed by flooding.

**Damaging agents:** Most pests do not affect basswoods, but they are prime habitat for gypsy moths. If gypsy moths are present the tree will be weakened and may eventually die.

**Competitive edge:** Basswood's ability to tolerate shade and sprout from roots give them a competitive edge. If your seeds can establish themselves in the stand and possibly reestablish themselves after a flood, you will survive until the end of the competition.

### Your limits:

1. In order for you to get into the competition at the beginning of the game and after flooding events, at least one tree must die that is older than 20 years of age.
2. You can return to the competition immediately after a disturbance except after a flooding event.
3. You will be eliminated by all fire events.
4. If the gypsy moth is present at the same time as you, you will be eliminated.
5. You will be 140 feet tall at 100 years of age.
6. You will die at 180 years of age.

**\*Use the side of this sheet to keep track of your age**

### \*Age Tally

Round	Age
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**PAPER BIRCH**  
(*Betula papyrifera*)

**Max age:** 120 years

**Max height:** 90 feet

**Maturity:** 65 years

**Growth:** Fast until 65 years of age. At this age they become overtopped by other trees.



**Reproduction:** Birch seeds can grow under a canopy or in direct sun and have no requirements for germination. They can also sprout new trees from roots and stumps and can even grow through black cherry seedbeds. After a young tree reaches the age of ten years, they require full sunlight. After this age if the tree is under the canopy or overtopped by another tree they will die.

**Shade tolerance:** Birch trees cannot grow in shade.

**Tolerance to disturbance:** Birches have shallow roots, so they are vulnerable to strong winds. Birch bark is extremely flammable and catches fire easily. Birch roots don't do well in water and the tree will die shortly after a flood.

**Damaging agents:** The bronze birch borer feeds on the birch tree's bark for food and weakens the tree. The gypsy moth, tent caterpillar, and white-tailed deer eat birch leaves and buds, reducing the tree's ability to produce food and grow new branches. Porcupines can girdle (remove the bark from around) birch trunks and kill them.

**Competitive edge:** A birch's ability to sprout new trees immediately after disturbances gives them a competitive edge. This allows birch to successfully compete with newly growing black cherry trees and other pioneer species.

**Your limits:**

1. You may enter immediately at the beginning of the competition.
2. You may only enter the competition twice while other tree species are present and all of those species must die within 10 years or you will be eliminated.
3. After you turn 65, if any tree is taller than you are, you will be eliminated.
4. All fire, flood, and wind events will eliminate you.
5. If 2 or more of the following are present you will be eliminated: gypsy moth, tent caterpillar, white-tailed deer, and bronze birch borer.
6. You will be 90 feet tall at 65 years of age.
7. You will die at 120 years of age.

**\*Use the side of this sheet to keep track of your age**

**\*Age Tally**

Round	Age
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**SUGAR MAPLE**  
(*Acer saccharum*)



**Max age:** 350 years

**Max height:** 120 feet

**Maturity:** 150 years

**Growth:** Slow at all stages.

**Reproduction:** Sugar maple seeds need moist soil to germinate. A well established tree canopy provides the most favorable forest floor conditions for their growth. Their seedlings also require partial shade in order to survive. This shade helps to limit the competition of other tree seedlings.

**Shade tolerance:** Very shade tolerant. Sugar maple can tolerate shade at all ages.

**Tolerance to disturbance:** Sugar maples have a well developed root system and are resistant to wind at all ages. Flooding weakens the root system and eventually causes death. They are tolerant of fire only if they have grown into the upper canopy. Intense fires will usually spread through the canopy and kill the tree.

**Damaging agents:** Sugar maples are resistant to insects, but their seedlings provide food for both rabbits and deer.

**Competitive edge:** Shade tolerance, wind resistance, and a long life span give sugar maples a competitive advantage. This allows sugar maples to outlive most other trees and often become the dominant tree species.

**Your limits:**

1. You may only enter the competition if another tree is 20 years old or older.
2. After entering the competition, if all other tree species die before you turn 15, you will be eliminated.
3. All flood events will eliminate you.
4. You can tolerate fire if you are older than 40, but severe fires will eliminate you at any age.
5. If both rabbits and white-tailed deer are present you can not enter the game.
6. You will be 120 feet tall at 150 years of age.
7. You will die at 350 years of age.

**\*Use the side of this sheet to keep track of your age**

**\*Age Tally**

Round	Age
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**BLACK CHERRY**  
(*Prunus serotina*)



**Max age:** 100 years

**Max height:** 100 feet

**Maturity:** 60 years

**Growth:** Extremely fast until maturity.

**Reproduction:** Black cherry seeds do not compete well with seeds from other trees. They require shade and moisture to grow. They usually store large amounts of seeds in the ground to better compete. Black cherry can sprout new trees from roots and stumps.

**Shade tolerance:** Black cherry trees are shade intolerant. The seeds need shade to grow but the saplings need partial light to survive. Gaps in the tree canopy must form (other trees must die) for the saplings to live. Black cherry trees are extremely intolerant of shade after maturity. If other trees overtop the tree by this age they will die.

**Tolerance to disturbance:** Shallow roots make black cherry extremely vulnerable to wind events. Their bark is vulnerable to all fire events. They are sensitive to drought and flooding.

**Damaging agents:** Deer, mice, and moles eat black cherry leaves, twigs, fruit and bark. Tent caterpillars use the leaves for food. These damaging agents weaken the tree's health.

**Competitive edge:** Black cherry are very good at storing large amounts of seeds in the ground. Because they can sprout new trees from the stumps of dead ones, they are able to compete well with other pioneer species.

**Your limits:**

1. You can only enter the game if one and only one tree species is present.
2. After 60 years of age you will be eliminated if any trees are older than you are.
3. Any wind, fire, or flooding events will eliminate you.
4. If deer are present at the same time as you, you will be eliminated.
5. You will be 100 feet tall at 60 years of age.
6. You will die at 100 years of age.

**\*Use the side of this sheet to keep track of your age**

**\*Age Tally**

Round	Age
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# Forester's Record With Disturbances

	First Trees Present Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8	Round 9	Round 10	Round 11	Round 12	Round 13
Black Cherry													
Eastern Hemlock													
White Ash													
American Basswood													
Paper Birch													
Sugar Maple													
Time Elapsed													
Disturbance													

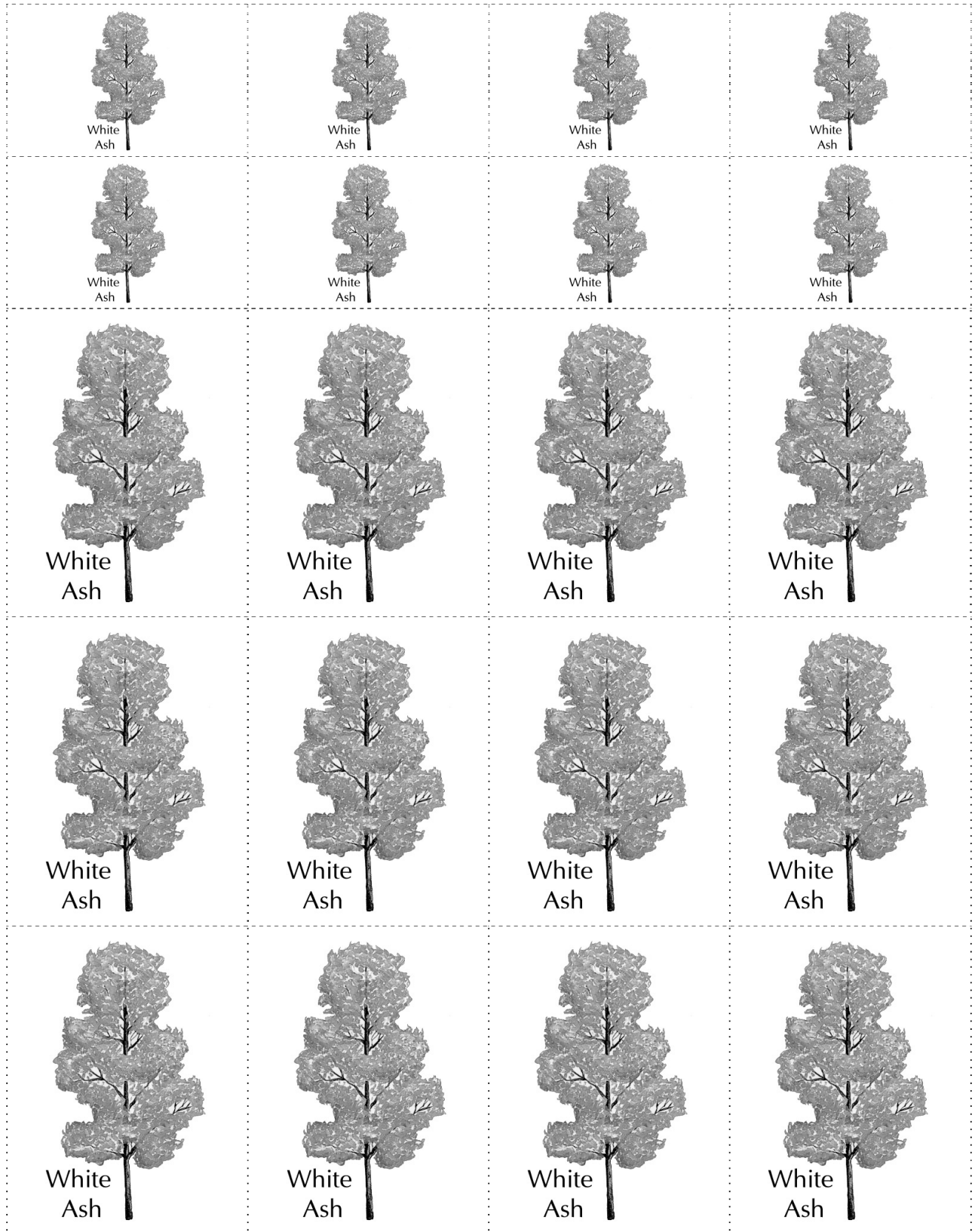
In the tree boxes, label them as **N** for new trees present, **P** for trees that were present the round before, and **A** for trees absent that round.

# Forester's Record Without Disturbances

	Round 14	Round 15	Round 16	Round 17	Round 18	Round 19	Round 20	Round 21	Round 22	Round 23	Round 24	Round 25
Black Cherry												
Eastern Hemlock												
White Ash												
American Basswood												
Paper Birch												
Sugar Maple												
Time Elapsed												

In the tree boxes, label them as **N** for new trees present, **P** for trees that were present the round before, and **A** for trees absent that round.

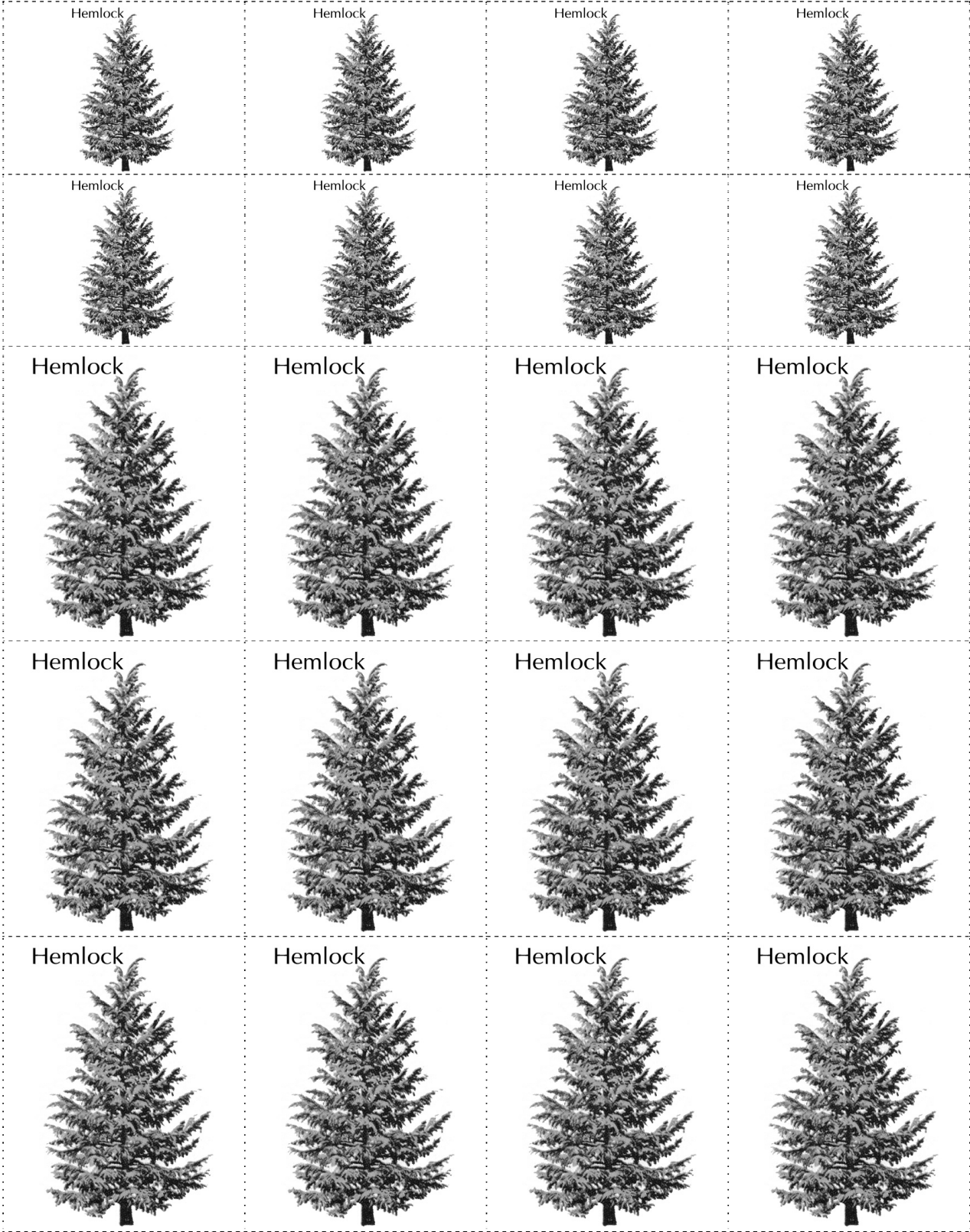
# WHITE ASH



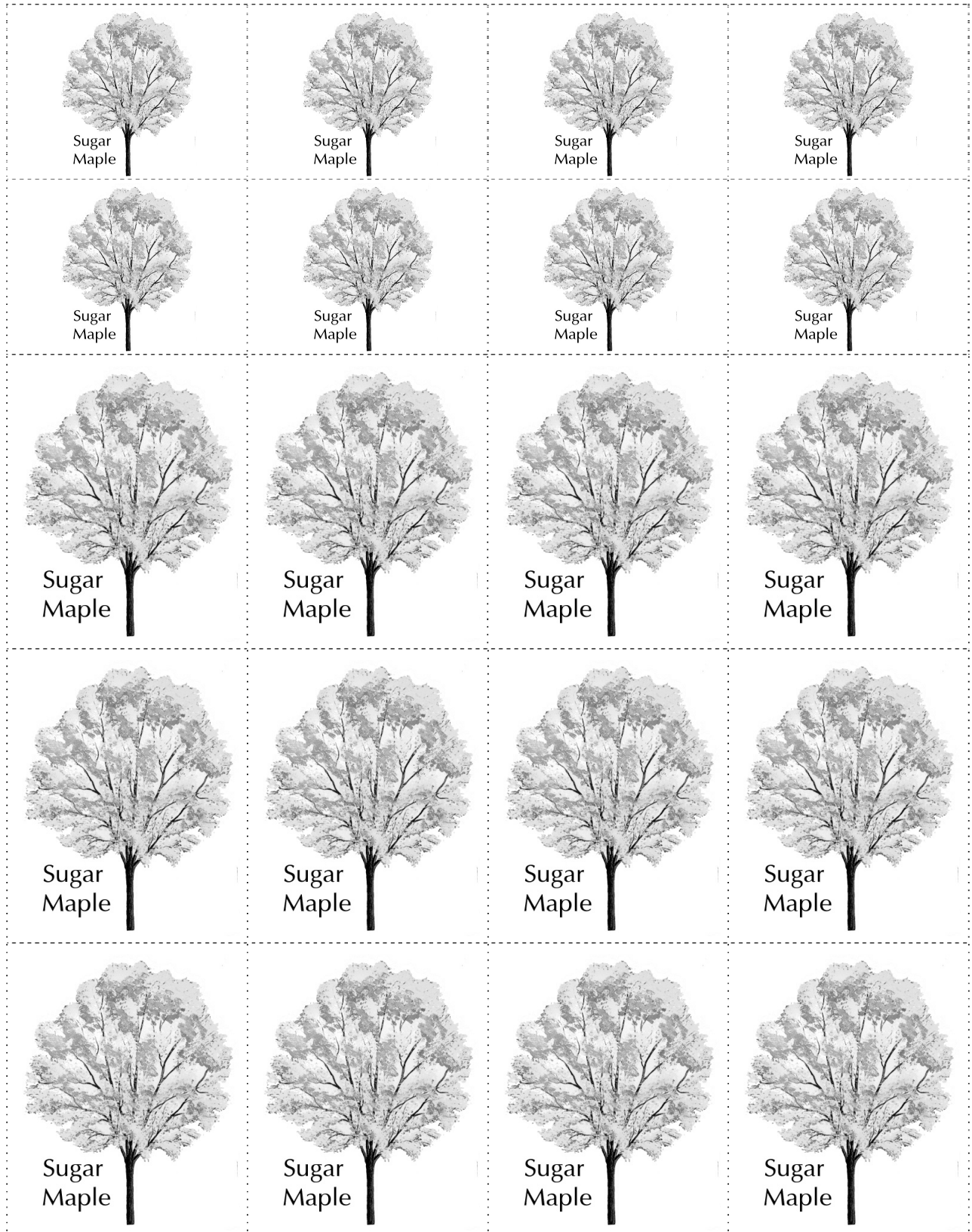
















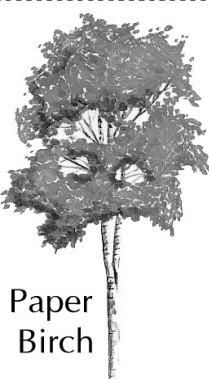

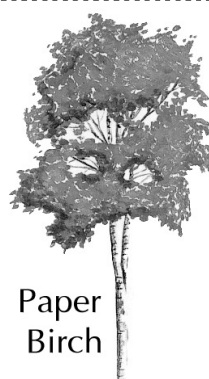
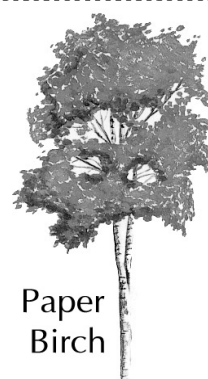
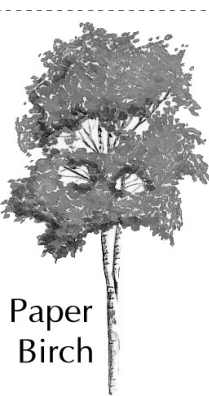

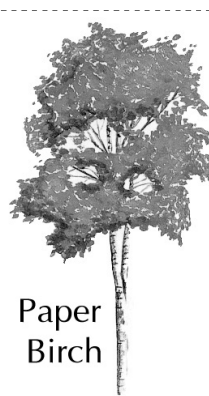

# Hemlock



# SUGAR MAPLE



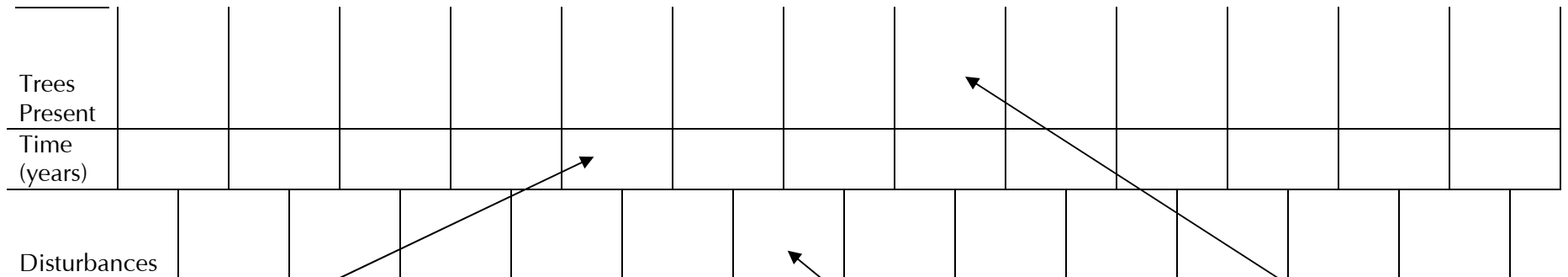
# PAPER BIRCH

 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>
 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>
 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>
 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>
 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>	 <p>Paper Birch</p>



# Example Timeline

## Forest Succession with Disturbances (first 12 rounds)

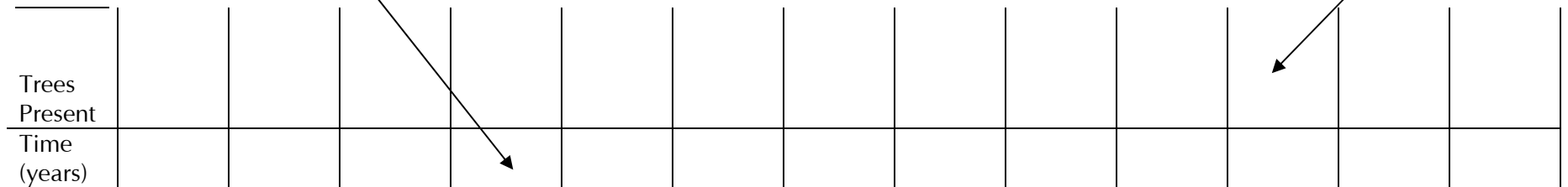


Write the time that passed between rounds inside of these boxes. It may be helpful to record both the number of years that passed between rounds and the total number of years that passed.

Write the disturbances that occurred during the competition in these boxes. The disturbance cards were drawn after each of the first 12 rolls of the dice. These disturbances caused the forest to change.

Have students place the tree cutouts in these boxes. These represent the trees that remained after each round.

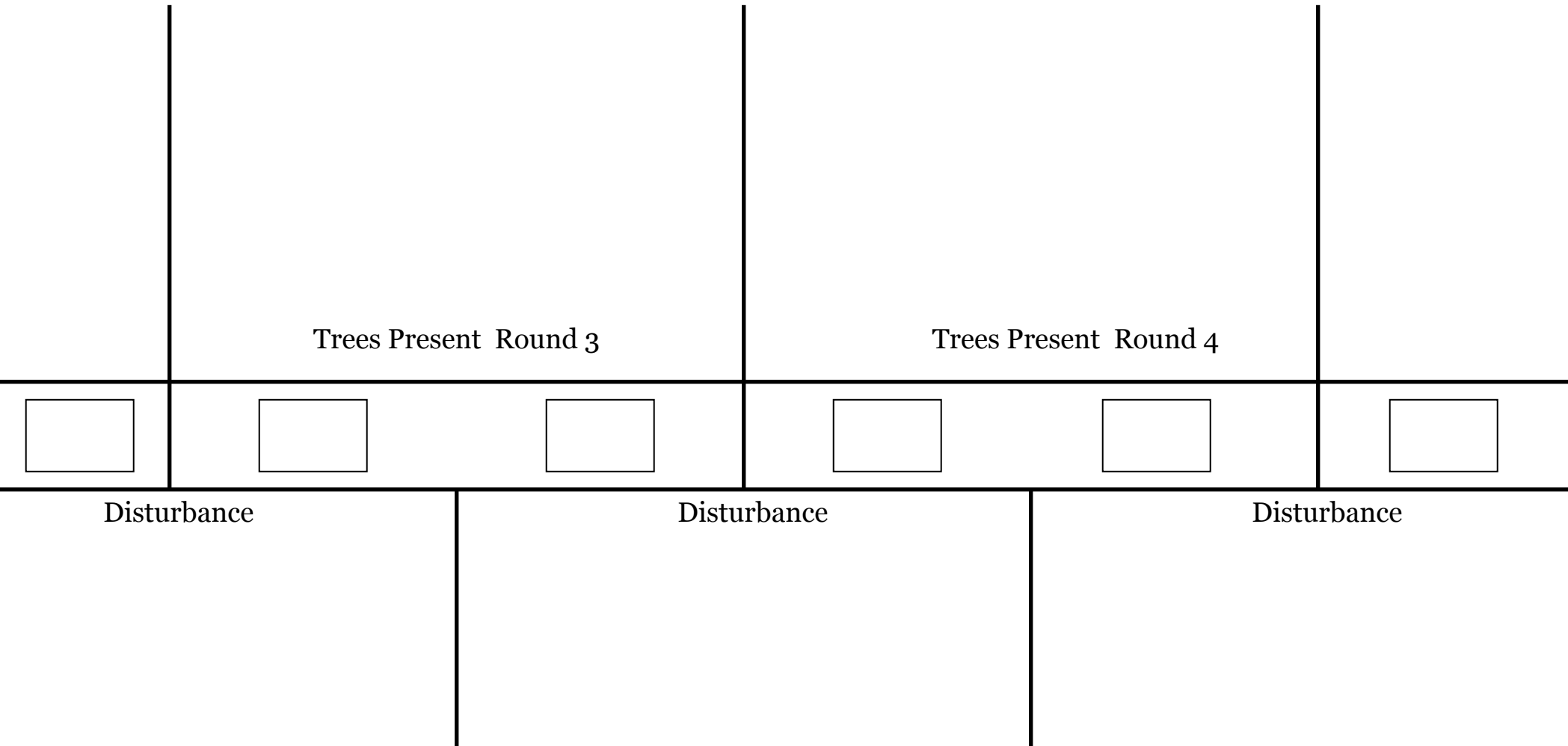
## Forest Succession without Disturbances (last 100 years of the competition)



## Helpful hints for playing *A Competitive Edge* Lesson 2

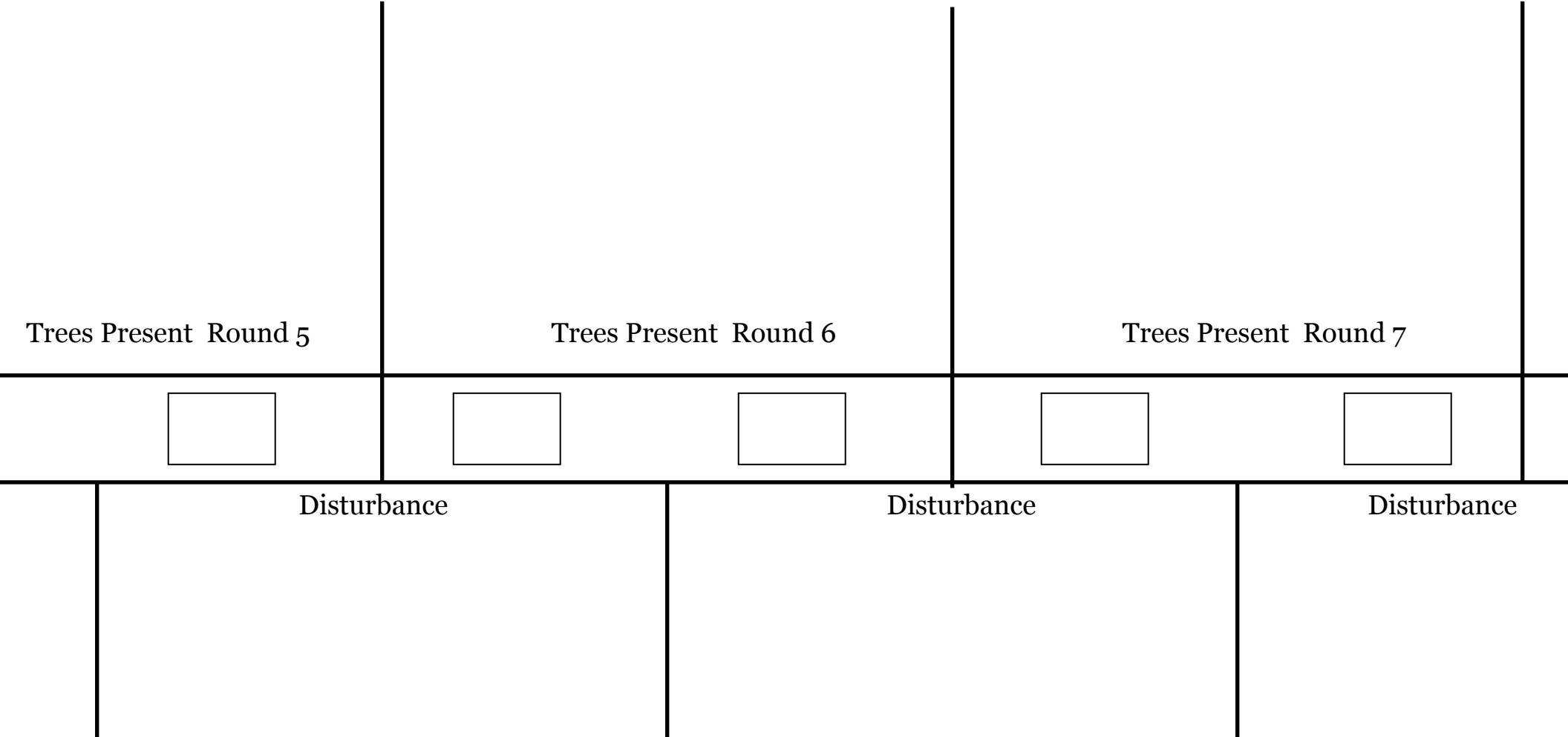
- Make sure each tree group is familiar with all of their limits before starting the game. Students may have a tendency to focus on one or two limits and not realize that more than one disturbance or action of another tree group affects them.
- With a large class allow extra time for explaining rules. It is vital to the game that each tree group understands how to play before beginning the game. If one group doesn't understand the rules their mistakes can influence the actions of all the other tree groups.
- Make the roles of Mother Nature and Father Time fun with hats, props, or costumes. These roles can seem daunting because these students have to wait for each round to pass while the tree groups decided their fate for the round.
- Follow a pattern for allowing when trees can enter the game or leave the game.
  1. The dice are rolled. Who can enter?
  2. Disturbance card pulled. Who must leave?
  3. Who is left?
  4. Can anyone new enter? They enter at the age of the last roll of the dice.
  5. (This is because in X number of years a disturbance eliminated one tree which allowed another to grow. It is impossible to say how many years one tree was living before the disturbance knocked it out and how many of the X years it took for the new tree to establish.)
  6. The dice are rolled. Who can enter?
  7. etc.
- If a pest disturbance card expires in the middle of a round (for example, 12 is rolled and there were only 4 years left on a disturbance card) trees that can enter if that pest is not present can enter with the remaining number of years left. For example, sugar maple limit number 5 says *If both rabbits and white-tailed deer are present you can not enter the game.* If both rabbits and white-tailed deer were present and the rabbit card expired after 4 of the 12 years rolled on the dice, the sugar maple can now enter at 8 years old (assuming all other limits are followed).

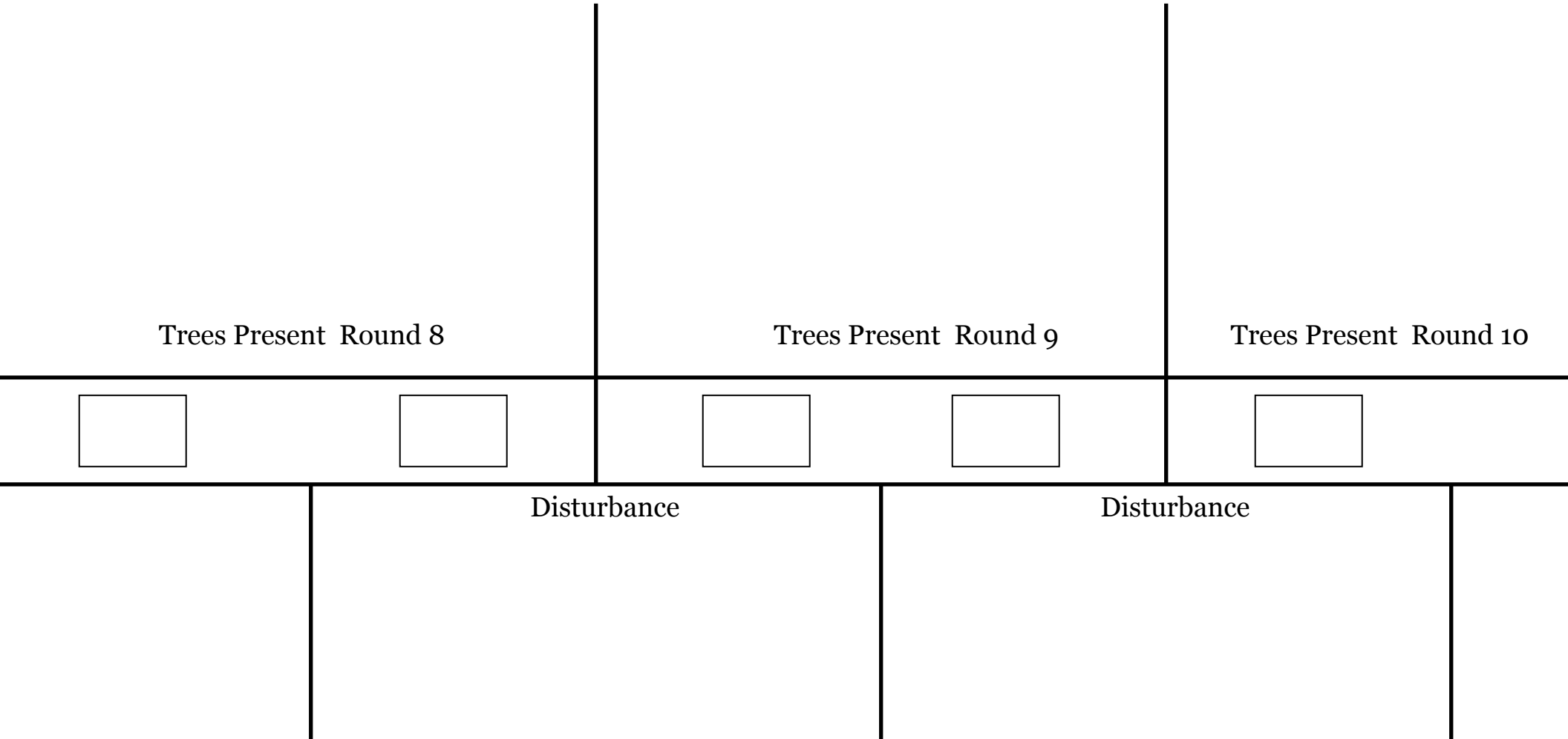
Trees Present Beginning	Trees Present Round 1	Trees Present Round 2		
Time passed this round <input data-bbox="245 1161 392 1258" type="text"/>	Total number of years passed <input data-bbox="625 1161 772 1258" type="text"/>	<input data-bbox="936 1161 1083 1258" type="text"/>	<input data-bbox="1295 1161 1442 1258" type="text"/>	<input data-bbox="1703 1161 1850 1258" type="text"/>
	Disturbance	Disturbance		

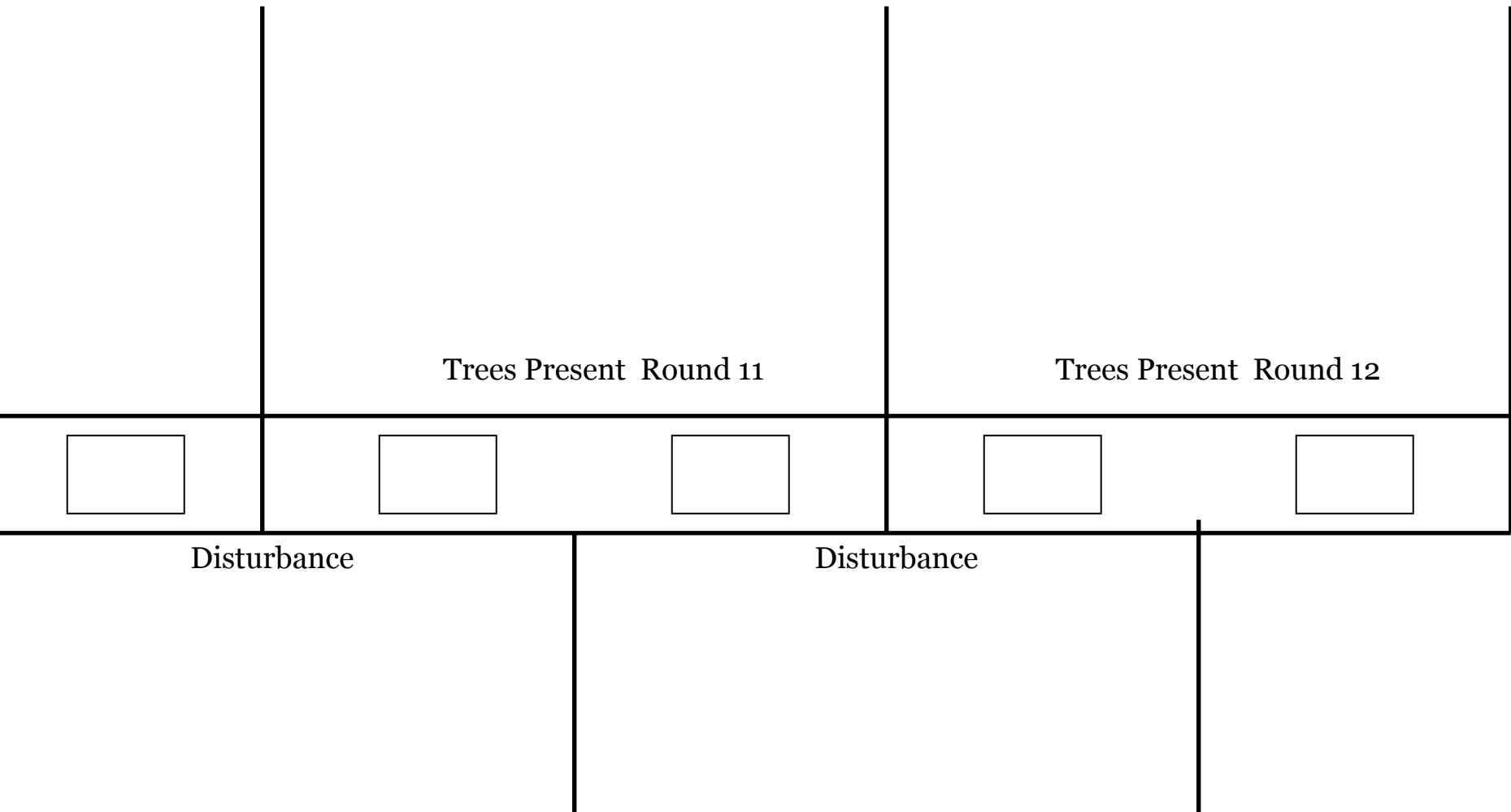


# Forest Succession with Disturbances Timeline

*(first twelve rounds)*





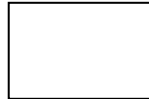
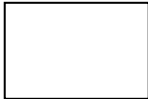
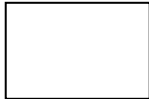
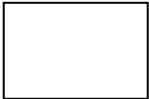


Trees Present Round 13		Trees Present Round 14		Trees Present Round 15	
Time passed this round	<input type="text"/>	Total number of years passed	<input type="text"/>	<input type="text"/>	<input type="text"/>



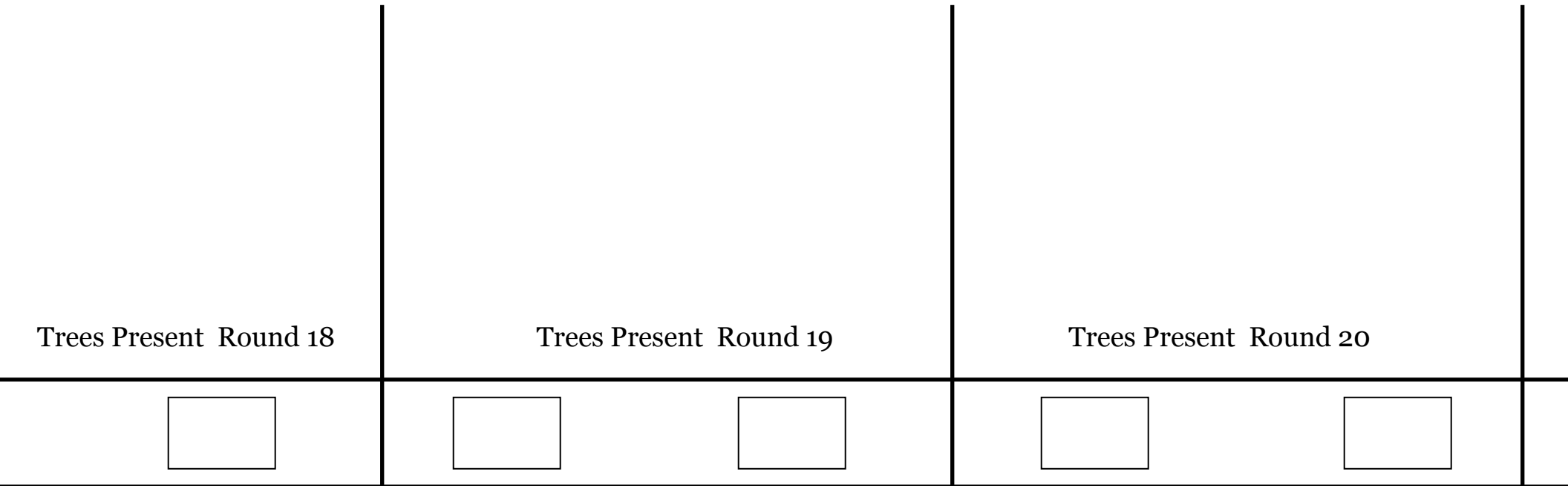
Trees Present Round 16

Trees Present Round 17



# Forest Succession without Disturbances Timeline

*(last 100 years of competition)*



Trees Present Round 21

Trees Present Round 22

Trees Present Round 23

