LESSON 2
A History of Succession

BIG IDEAS
- Forests differ in composition and structure. These are both affected by biotic (e.g., animals, plants, humans) and abiotic (e.g., soil, moisture, sunlight, climate) factors. (Subconcept 2)
- Ecosystems are continually 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. (Subconcept 13)
- Ecosystems are dynamic and altered by natural or human disturbance. Disturbance plays an ongoing role in ecosystem structure and function. (Subconcept 14)

OBJECTIVES
Upon completion of this lesson, students will be able to:
- Describe the process of forest succession using the terms "change," "primary succession," "secondary succession," "composition," "structure," "disturbance," "events," and "large-scale forces."
- List some of the major causes of forest ecosystem change in Wisconsin over the last 64 million years.
- Describe, in general, the natural features and current land use patterns in Wisconsin.
- Explain why the distribution of specific tree species in Wisconsin has increased and decreased throughout history.
- Identify and describe the current causes of forest ecosystem change in Wisconsin.

SUBJECT AREAS
Language Arts, Social Studies (Geography, History)

NUTSHELL
In this lesson, students work in small groups to create a descriptive timeline that illustrates how Wisconsin's forests have changed throughout history in response to disturbance. To gather information for the timeline, students listen to a short presentation on Wisconsin's natural history, read passages dealing with Native American relationships with the forest, and watch a video about influences on forests since European settlement. Groups then use a Wisconsin Land Cover Map to discuss the changes that have occurred in land use since European settlement. Students use the timeline and tree characteristics to deduce changes in the distribution of certain tree species. In conclusion, students discuss current causes of change in Wisconsin's forests and discuss how the causes fit into the context of the forests' disturbance history.

PROCESS SKILLS
Essay writing, Map interpretation, Multimedia interpretation, Timeline development

LESSON/ACTIVITY TIME
- Total Lesson Time: 275 minutes
- Time Breakdown:

Introduction	45 minutes
Activity 1	30 minutes
Activity 2	30 minutes
Activity 3	50 minutes
Activity 4	40 minutes
Activity 5	30 minutes
Activity 6	25 minutes
Conclusion	25 minutes

TEACHING SITE
Classroom

MATERIALS LIST

FOR EACH GROUP (5 TOTAL)

- Copy of either Student Page **2A**, *Tree Profile Card - Red Pine* OR **2B**, *Tree Profile Card - Jack Pine* OR **2C**, *Tree Profile Card - Quaking Aspen* OR **2D**, *Tree Profile Card - Black Ash* OR **2E**, *Tree Profile Card - Sugar Maple*

FOR EVERY 2 STUDENTS

- Copy of Student Pages **1A-B**, *Native American Land Use*

FOR THE CLASS

- Several pieces of poster paper
- Markers
- Scissors
- *Forest Story* video (DVD provided by LEAF)
- Chalk/marker board
- Ten sheets of 8.5" X 11" paper
- Tape
- Rulers
- Assorted colored pencils
- Five small, irregularly shaped objects
- Five copies of Student Page **3**, *Example Tree Profile - White Pine*
- *Wisconsin Land Cover Map* poster (provided by LEAF)

FOR THE TEACHER

- Overhead of Teacher Page **1**, *Primary Succession Diagram*
- Overhead of Teacher Page **2**, *Secondary Succession Flow Chart*
- Copy of Teacher Page **3**, *Pre-human Influences*
- Overhead of Teacher Page **4**, *Before the Ice Age*
- Overhead of Teacher Page **5**, *The Ice Age*
- Overhead of Teacher Page **6**, *The Glaciers Recede*
- Overhead of Teacher Page **7**, *Native American Settlement*
- Overhead of Teacher Page **8**, *Forest Disturbance Timeline*
- Overhead of Teacher Page **9**, *Example Disturbance Timeline (White Pine)*
- Copy of Teacher Page **10**, *White Pine History*
- Copy of Teacher Page **11**, *Tree Histories*
- Overhead of Teacher Page **12**, *Snapshots of Change*

TEACHER PREPARATION

Become familiar with the information on Teacher Page **3**, *Pre-human Influences*.

VOCABULARY

Composition: The species that constitute a plant community.

Disturbance: A natural or human action that causes change in forest ecosystems by damaging or killing some existing plants (e.g., fire, flooding, logging, insect infestation, wind).

Events: Social or environmental influences that affect disturbance patterns and cause regional changes (e.g., glacial advance, human migrations, social policies).

Forest Regeneration: The process of renewing forest cover through natural or human establishment of trees.

Glacial Outwash: Rock material composed mostly of sand-sized particles; transported by a glacier and deposited by meltwater as the glacier retreated.

Glacial Till: Rock material composed of larger rocks and boulders; transported by a glacier and deposited directly by the ice.

Glaciation: The advance over land of large ice masses from the poles of Earth; occurs in cycles as global temperatures cool.

Ice Age: The last geologic period, the Quaternary Period, which started 1.8 million years ago and is characterized by the cyclical advance and retreat of glaciers in North America.

Large-scale Forces: Broad social trends or environmental forces that shape events and cause widespread change on the landscape (e.g., climate change, mountain formation, evolution, industrialization, human population growth and expansion).

Primary Succession: The establishment of vegetation in an area that lacks biologic communities, soil, and immediate sources for plant reproduction.

Secondary Succession: The establishment of vegetation in an area that has some plant remnants capable of reproduction.

Stress: An environmental factor that gradually weakens organisms (e.g., air pollution, water pollution).

Structure: The horizontal and vertical distribution of layers in a forest, including height, diameter, and species present.

Succession: The change from one biologic community to another over time.

BACKGROUND INFORMATION

FOREST SUCCESSION

Daniel Botkin, in his 1990 book Discordant Harmonies: A New Ecology for the 21st Century, wrote that, “change now appears to be intrinsic and natural at many scales of time and place in the biosphere.” This statement summarizes the shift in thinking that ecologists have introduced to forestry. Forests across the landscape have changed throughout history, are changing today, and will continue to change.

Changes that forests undergo are part of a process called forest **succession**. Succession is a change in forest **composition** and **structure** over time and is often defined as a transition from one biologic community to another.

Change in forests can be caused by the natural aging and dying of plants or can be caused by **disturbances**. Disturbances are forces that affect the structure and composition of a forest.

They include fire, wind, logging, floods, drought, insect infestation, disease, animal browsing, etc. Disturbances can be influenced by other natural and/or human **events**.

Large-scale forces, both social and environmental, are exerted over large areas for long periods of time and shape events and ultimately, disturbances. These forces include things such as climate change, evolution, plate tectonics, human population growth and expansion, industrialization, and more recently, globalization. Natural and social events occur in response to these forces and ultimately shape the disturbance patterns in forests. Natural events include things such as volcanic eruptions, glaciation, earthquakes, and extreme weather patterns. Human events include things such as war, social movements, migrations, and settlement.

To understand why forests change, it is necessary to understand the relationship between social and environmental forces, events, and disturbances. To understand how forests change, it is necessary to understand how trees, plants, animals, and other organisms respond to different disturbances.

Two types of succession can occur within a forest ecosystem – primary and secondary succession. **Primary succession** is the establishment of vegetation in an environment that lacks biologic communities, soil, and immediate sources for plant reproduction. Primary succession occurs after lava flows, glaciation, or any event that eliminates all reproductive sources of plants.

Secondary succession occurs on sites that have some plant and animal remnants. It takes place when a given disturbance or set of disturbances affects forest structure and/or composition, but does not remove all of the plant reproductive sources. These sources can be seedbeds, tubers, root suckers, live plants, etc.

Common disturbances that can cause secondary succession include fire, logging, insect infestations, animal browsing, wind, and flooding.

Secondary succession also occurs in the absence of major disturbances. Time is a major factor in succession, and as forests age, the environmental conditions within them change. This can include amount of shade, density of the understory, soil conditions, and moisture levels. When old trees die, it is likely that the tree that grows into its place in the canopy will be of a different species – a species more adapted to the conditions present at that time. In this way, forests can change even without major disturbances.

The changes that take place in both primary and secondary succession depend on the characteristics of the trees, plants, animals, and other organisms present. Using trees as an example, some trees are tolerant of shade (e.g., sugar maple, eastern hemlock, beech) and some trees need full sunlight to grow (e.g., aspen, birch, jack pine, red pine, cherry). As shade conditions change in forests, the trees present will change. This is true for all of the conditions in the forest, including moisture, soil type, disturbances, climate, diseases, etc.

DISTURBANCE REGIMES

A disturbance regime is defined as the type, intensity, frequency, and distribution of disturbances in a specific area. As you will see, disturbance regimes are at the center of the controversy over forest use, but are rarely mentioned as the issues are reported.

Some environmental groups stress our need to protect or preserve areas of forest as they are. Certain types of forests, typically old forests, are scarce due to human use, and these groups attempt to protect the ecosystems from human intervention, most notably from logging.

Other groups, sometimes called wise-use groups, argue that forests are to be used. They say that forests are always changing and benefit from logging. They stress that any attempt at preservation is delaying the inevitable death of the trees and, at the same time, keeping them from being used by humans.

Though each of these two types of groups claims to be concerned with the health and sustainability of forests, they are often driven by other, broad goals. Environmental groups attempt to draw attention to the rapid consumption of forest resources created by a pro-growth, consumer culture. In their larger battle, they often lose sight of the current needs of forests and the local communities that depend on them. Wise-use groups are most often funded by industry and related groups that are concerned with making money from increased access to protected lands. In their effort to turn a profit, the groups lose sight of the needs of the forest ecosystem and the long-term needs of society.

The controversy over forest use often focuses on the arguments of these two groups, each of whom has a valid point to make. A key point of environmental groups is that to sustain forests and the many services they provide, certain forest areas (forests that harbor endangered species, forests that protect key water and soil resources, forests with cultural value, etc.) need to be protected. The wise-use groups make the point that both forests and people can benefit from forest management.

A debate about forest protection could center on these two points and, for each forest ecosystem, answer the following questions: How has this forest developed throughout history? What types of disturbances has this forest undergone and how did it react? What type, intensity, and frequency of disturbance is beneficial for this forest and what intensity and frequency is harmful? How have disturbance patterns changed and how has this forest been affected? What types of disturbances or management techniques are needed to sustain this forest ecosystem?

The answer to each of these questions will be different for different forests and different regions. They are dependent on a detailed understanding of the historic and current disturbance regimes and how those regimes will continue to change.

PROCEDURE

INTRODUCTION – Succession Overview

1. Tell students that during the next few class periods they will look closely at how both natural events and human actions have influenced Wisconsin forests throughout history. They will begin millions of years in the past, before humans arrived in Wisconsin, and finish in the present.

   Ask students when they think plants first appeared on the landscape. *(The earliest plant fossils are about 400 million years old.)* Ask students which came first, herbaceous plants or trees (plants with a woody stem)? *(Herbaceous plants came first. Trees evolved from herbaceous plants as a result of competition for sunlight. The presence of cellulose, or wood, allowed the earliest trees to grow tall and capture more sunlight.)* Tell students that the earliest fossils of conifer trees (gymnosperms) are 250 million years old, and the earliest fossils of deciduous trees (angiosperms – or flower bearing trees) are 100 million years old.

Ask students if they think the trees have changed (or evolved) since then. *(Yes, trees have adapted to changing conditions and many more species of trees are present today.)* Ask students if they think that forests have changed since then. *(Yes they have, dramatically.)* Ask the students how forests may have changed. *(Forests have spread across the landscape and can now be found from coastlines to mountains, deserts to rainy climates, and bordering each of our polar ice caps. Many new species have evolved and many plants, animals, insects, fungi, and microorganisms have adapted to live in forest ecosystems.)*

2. Tell students that forests change because they have the ability to regenerate or renew themselves after plants, animals, and other organisms die. Have students work in pairs to identify forces, actions or events that they think cause trees and other organisms to be injured and/or die and subsequently cause forests to change. Have each pair present an idea and list them on the board. *(The list may include the following: fire, severe winds, floods, drought, climate, animal populations [herbivory], insects, disease, soil erosion and deposition, glaciers, logging, land development [urbanization], agriculture, introduction or removal of species, air pollution and smog, water pollution, competition from other plants, dams and wetland draining, solid waste pollution.)*

   Tell students that specific actions (natural, biologic, human) that cause immediate injury or death to plants are called disturbances. Have students identify ideas on the list that they think are disturbances. *(Fire, wind, floods, drought, logging, insects, disease, herbivory, and soil erosion/deposition.)* Label the new list "disturbances."

3. Tell students that many environmental conditions may not immediately damage or kill trees, but may cause **stress** and weaken them over time. Have students identify ideas from the brainstorm that could be stresses. *(Ideas should include the following: air pollution, water pollution, solid waste pollution, gradual changes in temperature or moisture, competition.)* Write this list next to the list of disturbance and label it "stresses."

4. Once students have the disturbances and stresses identified, ask them what causes disturbances and stresses. Use a few examples from the list above to pose the following questions. What causes logging? *(A need for building supplies, a need for paper, etc.)* What causes severe winds? *(Climate patterns.)*

   Place the following definitions on the board to help students differentiate between the causes of forest change.

   - **Disturbances:** Cause immediate death or injury to plants (e.g., fire, logging).
   - **Stresses:** Cause the weakening of plants over a relatively short time period (e.g., water pollution, air pollution).
   - **Events:** Social or environmental influences that affect disturbance patterns and cause regional changes (e.g., human migrations, technology, social policies).
   - **Large-scale Forces:** Broad social trends or environmental forces that shape events and cause widespread change on the landscape (e.g., climate change, mountain formation, evolution, industrialization, human population growth and expansion).

Tell students that large-scale forces shape events which cause forest disturbances. Have them give an example or provide one similar to the following: Nearly two million years ago, cooling global weather patterns (large-scale environmental force) caused the accumulation of ice and formation of glaciers in the northern latitudes of the planet (natural event). The glaciers advanced into Wisconsin and removed trees and topsoil (disturbance).

5. Once students understand the relationship between the three causes, ask them if they know what the process of forest change is called. *(Succession.)* Tell the class that succession is generally defined as "the process of change from one biologic community to another in a given area over time."

   Tell the class that there are two types of succession – primary and secondary. Place Teacher Page **1**, *Primary Succession Diagram*, on the overhead projector. Tell students that primary succession is the establishment of vegetation in an area that is devoid of plant life. Have students look at each of the stages and discuss the important natural processes that occur in each. The stages are:

   - Colonization
   - Accumulation of biomass
   - Establishment of plant and animal communities
   - Increased soil formation

6. Once students are comfortable with the idea of primary succession, explain that secondary succession occurs in areas where plant and animal life are still present. The way in which the plant and animal communities change is different because seed sources and plant roots remain, allowing seeds to germinate and/or grow above ground from their roots.

   Tell the class that, in secondary succession, the type of change is controlled in large part by the following three factors and list them on the board:

   - The species of trees present (and their characteristics)
   - The types and patterns of disturbance
   - Time

7. Ask students to identify some disturbances that they think would eliminate all the plants and reproductive sources in an area (cause primary succession). Use the list on the board and highlight the disturbances. *(These may include volcanic activity, glaciers, urban development, landslides.)* Discuss each of the disturbances and how they might eliminate plants and their reproductive sources.

   Next, read each of the remaining disturbances on the board. Have students discuss how each of the disturbances might leave behind some plants and reproductive sources. Tell students that these disturbances cause secondary succession.

8. Place Teacher Page **2**, *Secondary Succession Flow Chart*, on the overhead projector. Tell the class that the flow chart shows how a specific type of forest will change when certain disturbances are present. Point out that this diagram focuses primarily on the role of fire as a force of change.

   Tell the class that any of the three forests described in a bottom box is a forest that currently exists on a dry site in southern Wisconsin. To use the chart, they should begin at a bottom box and follow an arrow to the next box. They can then use the information associated with the boxes to describe how the forest changed after the disturbance (represented by the arrow).

The flow chart provides a variety of different scenarios, allowing for a number of different "forest histories" depending on the trees present and the type of disturbance that occurs.

First, start at the bottom and have students identify that there are three different forests with different species of trees present in each listed on the flow chart. Ask the class if they think the different trees react differently to disturbances. *(Yes, each species has certain requirements to grow and reproduce. Some are tolerant of shade, others are not. Some can survive fire, others cannot. Some can withstand floods, others cannot. Trees are resistant to different diseases and pests. Animals utilize different species of trees for food and shelter.)*

Second, ask students to find the different points where disturbances take place in the flow chart. Start at the bottom and discuss each disturbance and how it affected the type of forest that was present. Discuss why they think this happened, and be sure that students understand that the disturbance created conditions more suitable for the reproduction and growth of the types of trees that compose the post-disturbance forest.

Third, direct students to the top two forest types and ask them to identify the disturbance that separates them. *(No fire or management.)* Ask students what happens to the forest if neither of these disturbances occurs. *(It stays the same.)* Explain to students that as time passes, trees get old and die, and different trees grow in their place. In this forest (unlike the aspen forest), the composition stays the same because the trees present are adapted to the environmental conditions in the forest. Only disturbances or stresses will cause the forest composition to change.

9. Once the students have seen how the flow chart is used, ask a volunteer to choose a portion of the chart and explain how the forest changed. Have another volunteer explain how the forest changed using a different disturbance.

   In summary, tell the class that they are going to use their knowledge of primary and secondary succession to create a timeline of how Wisconsin forests have changed throughout history.

ACTIVITY 1 – Pre-human Influences

1. Ask the class to take notes for the next 10 minutes while you discuss some of the major influences on Wisconsin's forests before humans arrived. Ask them to record the time period, large-scale forces, natural events, and forest disturbances or stresses that were caused. Have them title their page of notes "Pre-human Influences."

   NOTE: You may wish to provide students with a notetaking format similar to the one shown below.

Time Period	Large-scale Forces	Events	Disturbances and Stresses

2. Place Teacher Page **4**, *Before the Ice Age* on the overhead projector. Show the map to the class and use Section 1 of the talking points on Teacher Page **3**, *Pre-human Influences* to detail how the Midwestern landscape changed as a result of the formation of the Rocky Mountains 60 million years ago. Go through the talking points slowly so students have time to take notes. Allow a short time for questions once you've finished. **NOTE:** You may want to hand out a copy of Teacher Page **3**, *Pre-human Influences* to each student for reference.

3. Place Teacher Page **5**, *The Ice Age* on the overhead projector and point out the map details. Use Section 2 of Teacher Page **3**, *Pre-human Influences* to explain how glaciers influenced Wisconsin's forests throughout the Quaternary Period (the last 1.8 million years) – particularly in the most recent glacial advance which reached into Wisconsin from 26,000 to 18,000 years ago. Allow students to ask questions once you have finished.

4. To finish the presentation on pre-human influences, place Teacher Page **6**, *The Glaciers Recede* on the overhead projector and point out the map details. Use the third and final section of Teacher Page **3**, *Pre-human Influences* to present how forests reestablished themselves after glaciers receded from 18,000 to 10,000 years ago and how forests reacted to the disturbances prevalent at that time.

5. After all of the presentations are done, have students work in small groups to form a chronological list of influences, events, and disturbances on a piece of poster paper. The list should be similar to their notes.

   As a class, discuss the disturbances, how they affected forests, and their relationships with the large-scale forces and events. Tell students that they will expand on the timeline in the next activities.

ACTIVITY 2 – Native American Influences

1. Ask students if they know the names of some of the Native American tribes that were present in Wisconsin as Europeans arrived. *(Ojibwa [or Chippewa], Sioux, Sauk, Fox [or Musquakie], Oneida, Menominee, Dakota, Ottawa, Potawatomi, and Ho-Chunk [or Winnebago].)*

   Tell students that Native American tribes arrived at different times; some migrated into the area as the glaciers receded (18,000 to 10,000 years ago), and others were forced into the area as settlers moved west. Tell students that, in general, there are four distinct periods of Native American settlement in the state. Each of the periods is characterized by different ways of life.

   Place the following periods, dates, and lifestyles on the board:

   - **Paleo-Indians** (12,000 to 9,000 years ago)**:** nomadic hunters
   - **Archaic Period** (9,000 to 3,500 years ago)**:** hunters and gatherers
   - **Woodland Period** (3,500 to 1,000 years ago)**:** settlement, agriculture, and hunting
   - **Mississippi Period** (1,000 to 400 years ago)**:** large settlements, advanced agriculture, and hunting

   Ask student if they see a pattern in how the Native American populations changed through time. *(Tribes gradually began to make permanent or semi-permanent settlements, practice agriculture, and hunt and fish around the settlements.)* Tell students that as Native Americans began to settle in one location, farm, and manage for wildlife, their populations began to grow.

2. Tell students the names of Native American tribes that we know are from the last period, the Mississippi Period. Further explore students' knowledge by asking if any of them know in which regions of Wisconsin the tribes were living when Europeans arrived. The regions are as follows:

   - **North:** Ojibwa
   - **Northeast and Central:** Menominee
   - **Southwest:** Ho-Chunk, Dakota, and Potawatomi
   - **Southeast:** Ottawa and Potawatomi

   Once students have had time to answer, place Teacher Page **7**, *Native American Settlement* on the overhead projector. Show students the different areas that tribes inhabited and ask students to describe the type of landscapes that were associated with each area. Brief descriptions should be as follows:

   - **North:** rolling, forested landscape with many lakes and wetlands
   - **Central:** flat, sandy landscape with mixed forest, barrens and savannas
   - **Southwest:** mixed forest and prairie landscape with tall ridges and steep valleys
   - **Southeast:** rolling, prairie landscape with areas of savanna and forest

3. Once students are familiar with how the tribes were distributed across the state, ask the class if they think the tribes interacted with nature in different ways. *(Yes, since the tribes lived in different landscapes, they had to rely on different plants, animals, hunting, agriculture, and other land management techniques to survive.)*

   Tell students that the Native Americans of each period interacted with the environment in different ways, and the different tribes interacted with nature in different ways.

4. Hand a copy of Student Pages **1A-B**, *Native American Land Use* to each student pair. Tell the class that the readings are from a variety of different books written about Wisconsin's indigenous people. Go around the room and have students from each pair read the different quotes. Once each quote is read, discuss the action taken and how the disturbance may have affected forests.

   Have the student pairs write the time period 12,000 years ago to 400 years ago on their chronological list. Have them list any large-scale forces, events, and disturbances caused by Native American tribes.

5. Once the list is formed, ask students if they think Native American tribes had a small, moderate, big, or very big influence on Wisconsin's forests. As the discussion progresses, provide the students with the following information:

   - It is obvious that the tribal people of Wisconsin used natural resources to survive and even used fire, agriculture, and wildlife management to manipulate ecosystems.
   - It is generally understood by historians, archaeologists, and living tribal spokesmen, that the Native American tribes that lived in Wisconsin had a deep respect for nature and, in living so closely with the natural world, were very conscious of their dependence on natural resources. In spite of this, there is some evidence that Native American populations heavily used some plants and animals, and severely reduced their populations.
   - The native peoples of Wisconsin did not have an industrial society; therefore, could not consume resources as fast as modern societies or from as far away. They used local, natural materials for clothes, shelter, and transportation before the arrival of Europeans.

- In the year 1500, the total Native American population in Wisconsin was about 60,000 (715,000 in the entire northeastern U.S.). Today, there are currently 5.4 million people living in Wisconsin.

NOTE: As a homework assignment, you may wish to have your students research the relationships that different tribes had with the environment.

ACTIVITY 3 – European Settlement and Forest Conservation

1. Tell students that they have looked at Wisconsin's history through the Ice Age and the inhabitation by Native American tribes. Ask students if they know who Jean Nicolet was and why he is famous. *(Jean Nicolet was a French explorer who, in 1634, became the first European to discover the Wisconsin region. Although when he landed near Green Bay, he thought he was in China!)* Tell students that the discovery opened the Wisconsin region to inhabitation and exploitation that occurred as Europeans came to trap and trade fur, cut timber, and farm.

2. Ask students what they know about Wisconsin in the late 1800s. They may be aware of lumberjacks, Paul Bunyan, etc. Tell students that they are about to watch a video called *Forest Story* that shows how humans have influenced Wisconsin's forests since European settlement.

   Have students take notes on the different events, the disturbances they produced, and the large-scale forces that shaped them. Let them know that they do not have to write down all the information, but hopefully, as a class, they will be able to form a chronological list once the movie has finished.

3. Play the 25-minute video and leave some dim lighting on so that students can take notes. Once the video is finished, lead a short discussion allowing students to express how they felt about the movie. Ask them if they learned anything about how the relationship between European settlers and forests changed over time.

   Place emphasis on the fact that there are two distinct stages of forest use after Europeans arrived in Wisconsin. The first stage was settlement and exploitation. The second stage was forest conservation. Place these two headings on the board and have students list the events and dates that they feel belong under each. The list may include the following events:

SETTLEMENT AND EXPLOITATION
- Jean Nicolet "discovers" Wisconsin (1634)
- First sawmill built on Fox River (1809)
- First lumber mill built on Wisconsin River (1831)
- Creation of Wisconsin territory (1836)
- Wisconsin statehood (1848)
- Large increase in European immigrants (1850s)
- The cutover (1850-1920s)
- Railroads access new forested areas (1890s)
- Intense wildfires and soil erosion (1870-1920s)
- Land clearing and agriculture (1890-1920)
- Farms abandoned in the cutover (1920s)

FOREST CONSERVATION
- Forest problems survey (1880)
- State Forestry Department created (1903)
- First state forester (1904)
- State reforestation fund (1906)
- First Wisconsin tree nursery (1911)
- State given power to restore forest land (1924)
- National forests established (1925)
- Forest Crop Law – tax breaks for forest land (1927)
- Property tax to pay for reforestation (1930)
- County forests made from tax delinquent lands (mid 1930s)
- Civilian Conservation Corps created by Franklin Delano Roosevelt and used to replant forests (1933)

4. Discuss the lists with students and have them identify the disturbance that each of the events helped cause. *(Examples: Settlement and Exploration – sawmills led to the cutting of trees, increases of immigrants led to farming and land clearing; Forest Conservation – national forest establishment protected large areas of forest land cover.)* You may also want to help them make some generalizations about the social and environmental forces that caused the change from exploitation to forest conservation.

   Tell students that progress is still being made on conserving Wisconsin forests. Write the following more recent accomplishments on the board and have students record them in their notes:

   - Wisconsin is the #1 papermaking state (1953-present)
   - Many conservation laws and land management plans were developed (1970 to present). These include: Clean Air, Clean Water, and Endangered Species Laws passed (1970), Strategic Plan for Wisconsin Forests (1983), Wisconsin's Forestry Best Management Practices for Water Quality (1995), Wisconsin Forest Management Guidelines (2003), Forest certification for state forests (2004)

ACTIVITY 4 – Forest Timeline Creation

1. Divide the class into five groups. The groups will make a timeline of Wisconsin forest disturbances by using the lists they have compiled over the last few class periods. Hand each group two 8.5" X 11" sheets of paper. Have them tape the short ends together to form one long piece. Be sure each group has a ruler, pencil, and if available, a variety of markers to help them differentiate disturbances.

2. Place Teacher Page **8**, *Forest Disturbance Timeline* on the overhead projector. Have the groups reproduce the timeline on their long sheet of paper. Point out that there are three sections on the timeline: large-scale forces, events, and disturbances. Explain that the abbreviation "mya" stands for "million years ago" and "tya" stands for "thousand years ago."

   Tell students that the timeline cannot be to scale because the pre-human influences lasted millions of years, while the conservation period has not even lasted a century. Tell students to make the long time periods relatively larger, but to leave enough space in each section to add the events and disturbances. In addition, have students leave some space below the timeline (one to two inches) to add more information in later activities.

   Tell students that when filling in their timeline, they should start by listing the large-scale forces, then label the events, and finally label the disturbances. By doing this, students will see how long-term, moderate, and rapid causes of change are interrelated.

3. As students work on their timelines, walk around the room and be sure that they have created the timeline correctly and are placing the large-scale forces, events, and disturbances in the appropriate place and time period.

   Once the timelines are complete, have a few volunteers showcase different parts of their timeline. Use examples from the timeline to help students identify how the large-scale forces, events, and disturbances are related.

ACTIVITY 5 – Tree Profiles

1. Hand each group a copy of either Student Page **2A**, *Tree Profile Card - Red Pine* OR **2B**, *Tree Profile Card - Jack Pine* OR **2C**, *Tree Profile Card - Quaking Aspen* OR **2D**, *Tree Profile Card - Black Ash* OR **2E**, *Tree Profile Card - Sugar Maple*. Be sure that each group has a different species and that all students in a group have the same card.

   Tell students there are five different tree profiles and have them identify which tree species profile their group was given. Go over the different sections of the cards and give students time to read the information. Explain to the groups that they will use their timeline and tree profile card to tell the story of their tree species throughout Wisconsin's history.

2. Tell the groups to cut out the tree stamps that border their tree profile. They need to use the information on the timeline and profile to determine when the historical conditions allowed their tree to expand its distribution on the Wisconsin landscape. When they determine the points in time where their tree was flourishing, they should tape the tree stamps without "X's" on them at those points in the timeline.

   They must also look for points in time when their tree would have died and decreased its distribution. They should place the tree stamps with "X's" on them at these locations on the timeline. Once their timeline is complete, each student must write a short history of their tree in the Wisconsin landscape, explaining what happened at the different points in time.

3. Hand a copy of Student Page **3**, *Example Tree Profile - White Pine* to each group and tell them that they will use the tree species white pine as an example. Give them time to read the information. Place Teacher Page **9**, *Example Disturbance Timeline (White Pine)* on the overhead projector. Show students the times at which you determined that white pine was flourishing. Use Teacher Page **10**, *White Pine History* to explain to students how you determined when the conditions were good for white pine and when they weren't.

4. Answer student questions and have the groups begin developing their timeline and history. Monitor group discussions and help them stay on the right track. Use Teacher Page **11**, *Tree Histories* as a general guideline.

   Once students are finished, have groups select a representative to present their timeline and story. Encourage students to ask questions. In the discussions, emphasize the following points:

   - Tree characteristics and environmental factors (disturbances and stresses) determine if a tree population will survive and flourish or die and diminish.
   - Different trees have different characteristics and react differently to disturbance; trees compete with each other for survival.
   - In many instances, large-scale forces shape events which create disturbance patterns and ultimately affect which trees will survive and flourish and which trees will die and diminish.
   - Often, disturbances do not occur across the entire landscape, leaving patches of undisturbed forest that serve as refuge for animals, trees, plants, and seeds that could not survive in the disturbed areas.
   - Disturbances may affect forest composition by eliminating some species and creating ideal conditions for others. Disturbances may also influence forest structure by altering the layers in a forest or the distribution of trees across the landscape.
   - Forests are constantly changing, whether by natural or human influences. Forests are adapted to change, but disturbances that are too frequent or intense can negatively influence the regeneration of trees and ultimately the renewal of the forest.

ACTIVITY 6 – Forest Maps

1. After groups have created, presented, and discussed their disturbance timelines, place the *Wisconsin Land Cover Map* poster on a table in the center of the room. Point out that the map symbols represent land cover and land use types. Give a specific example from the map. You may wish to choose the location of your school, use the map to describe the major land use type, and have students give examples from in and around the area.

2. Pass out a piece of candy or other small, irregularly shaped object to a student representative from each group. Have the group representatives toss the object on the map one at a time and identify and describe the land cover type where it lands. Have the students work in their groups to answer the following questions:

   - What type of benefits do we currently get from this type of land use?
   - How might the region have changed since before European settlement?
   - Why may it have changed?
   - How might the region change in the future?

3. Once all of the groups have answered the questions, have them present their ideas to the rest of the class. Allow the class to discuss the answers and agree or come up with other ideas.

CONCLUSION – Current Challenges

1. Ask the class if they think that Wisconsin's forests are continuing to change today. *(Yes, Wisconsin's forests are undergoing rapid change due to a variety of factors.)*

   Place Teacher Page **12**, *Snapshots of Change* on the overhead projector and give students a few seconds to look at the pictures. Have a few volunteers describe what the pictures are showing. *(A road through a forest, a canker on a tree, the logo on the side of the gypsy moth spray plane, house construction, aerial photo of a city, a forest fire.)*

   Ask students to identify the different causes of change portrayed in the images and write them in their notes. Have a few volunteers identify the causes of change and list them on the board. *(The list should include the following: fragmentation, introduced species, urban expansion, disease, increased consumption and use, wildfire and fire suppression.)*

2. Once the influences are listed, have students compare and contrast the differences they feel exist between disturbances now and disturbances during European settlement. Use the following statistics and statements to help students make conclusions about how forests are currently changing.

   - **Globalization:** With the invention and mass production of trains, planes, automobiles, and ships, the interchange of people and organisms has increased dramatically. This has increased due to our current capacity to trade with and travel to other nations around the globe.
   - **Population and consumption:** In 1890, 1.6 billion people inhabited Earth, about 2.1 million of whom were in Wisconsin. In 2004, 6.4 billion people inhabited Earth, 5.4 million of whom were in Wisconsin. Per capita consumer demand in modern society is much higher than at the turn of the century.

- **Property and social trends:** More people are competing for land to satisfy their wants and needs. People's need to "escape to the woods" is putting pressure on forests. Each year 3,400 new parcels are divided out of Wisconsin's forest land base.
- **Climate change:** The global climate is warming. Though some debate whether this is caused by the mass release of carbon dioxide and other greenhouse gasses from industrialization, there is widespread scientific consensus that Earth's atmospheric, surface, and oceanic temperatures are rising. Global warming is causing changes in weather patterns which affect the health of forest communities and the distribution of tree species. This becomes very important to modern society, since we depend so heavily on forest resources.

NOTE: You may wish to collect a variety of newspaper columns, magazine articles, books, etc. that students can look at to help them understand that the issues above are widely discussed and prevalent throughout many aspects of society.

SUMMATIVE ASSESSMENT

Have students find a variety of news reports, newspaper articles, magazine articles, books, or research papers that discuss a specific, current influence that is causing change in Wisconsin's forests. Have them write a short summary describing the influence and putting it in the context of Wisconsin's disturbance history.

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RECOMMENDED RESOURCES

●●● BOOKS ●●●

Discordant Harmonies: A New Ecology for the 21st Century by Daniel Botkin. (Oxford Press. 1990.) Though many ecology texts now incorporate a dynamic conceptualization of ecosystems, this text is comprehensive and provides many good examples of the process of change in terrestrial ecosystems.

The Vegetation of Wisconsin: An Ordination of Plant Communities by John T. Curtis. (University of Wisconsin Press. 1959.) This book is widely considered a must-have text when studying Wisconsin's plant communities. It is quite technical in parts, but offers a host of information on the physical, biological, and cultural history and makeup of Wisconsin's landscape.

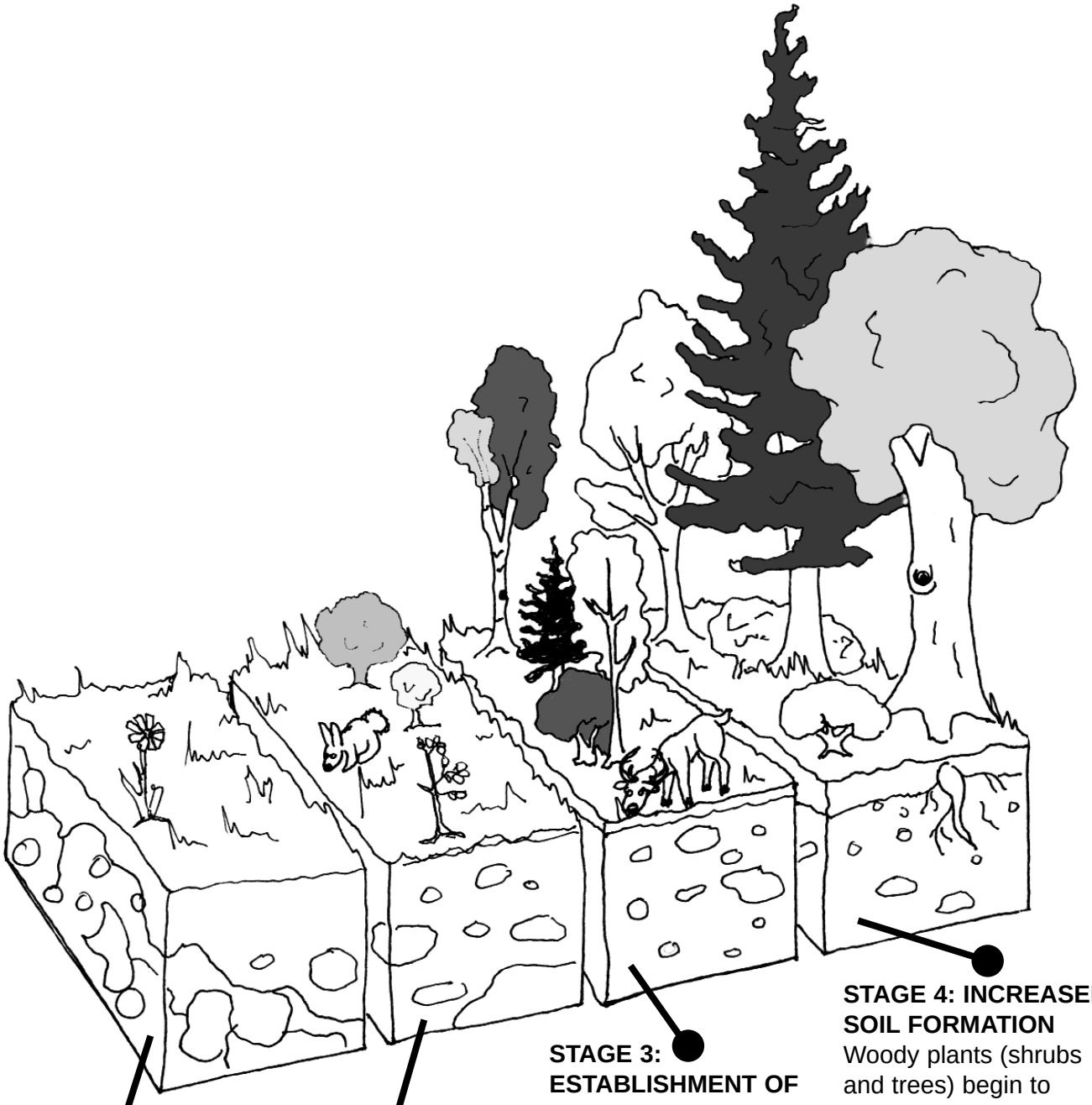
Roadside Geology of Wisconsin by Robert H. Dott, Jr. and John W. Attig. (Mountain Press Publishing, Co. 2004.) A great book for the amateur geologist or anyone interested in the geologic history of the state, or even the area just outside your classroom.

The Ecological Indian by Shepard Krech III. (W. W. Norton and Company, Inc. 1999.) This is a groundbreaking book that attempts to demystify the Native American relationship with the environment. It presents historical information on indigenous relationships with both the forests and grasslands of the upper Midwest and the rest of the continent.

●●● POSTER ●●●

Wisconsin Land Cover Map
Page size version available for purchase from the Wisconsin State Cartographers Office:
http://sco.wisc.edu/maps/state/php

PRIMARY SUCCESSION DIAGRAM



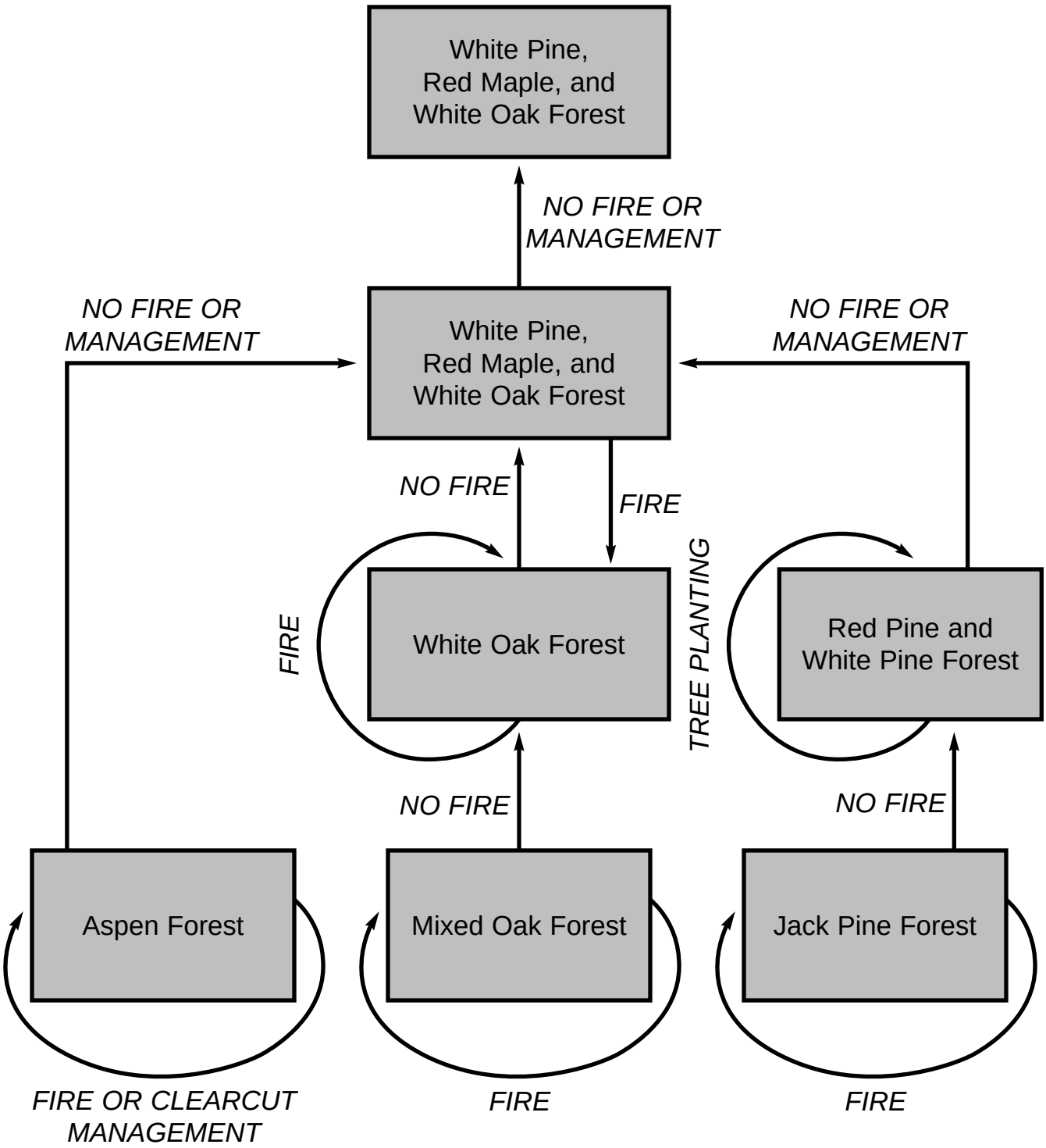
STAGE 1: COLONIZATION
A small number of plants, animals, and fungi that can survive in desolate, sunny conditions begin to move into the area.

STAGE 2: ACCUMULATION OF BIOMASS
Plants, animals, and other organisms live and die in the area; organic material begins to build up and retain moisture.

STAGE 3: ESTABLISHMENT OF PLANT AND ANIMAL COMMUNITIES
A greater variety and density of plants and animals move into the area and successfully survive and reproduce.

STAGE 4: INCREASED SOIL FORMATION
Woody plants (shrubs and trees) begin to dominate the area and further the process of soil formation by breaking up surface rocks with their roots and adding wood fiber to the decomposing plant and animal matter.

SECONDARY SUCCESSION FLOW CHART
(FOR DRY SITES IN CENTRAL WISCONSIN)



3 PRE-HUMAN INFLUENCES (TALKING POINTS)

SECTION 1 – BEFORE THE ICE AGE (65 MYA TO 1.8 MYA)

(Teacher Page 4, Before the Ice Age)

The Wisconsin landscape has been through such a wide variety of changes that even the most open-minded of us would be surprised. Since the formation of the Earth 4.6 billion years ago, Wisconsin:

- has been covered with mountains similar to the Alps (1.85 bya)
- was the center of a giant magma uprising; a vast volcanic event that nearly split the North American continent in two (1.1 bya)
- and was covered by a vast ocean (450 mya)

The forests and animals that live here have been constantly changing. In the last geologic age from 65 mya to present, a few major geologic events on the continent have caused change in Wisconsin's forests. The formation of the Rocky Mountains in the western U.S. 60 mya caused a major change in climate patterns across the continent. The weather patterns that brought rain from west to east were disrupted and a drought settled over much of the Midwestern landscape. Forests gave way to the grasslands of the Great Plains and the prairies of the Midwest.

As the regional weather patterns settled, much of the southern and western part of Wisconsin did not receive enough rainfall to support temperate forests. Grasslands, savannas, and barrens covered these areas.

NOTE: Not much is known about the plants and animals that lived in Wisconsin at this time because the geologic record from this age is characterized by large-scale erosion and no fossil record remains.

SECTION 2 – THE ICE AGE (1.8 MYA TO 12,000 YEARS AGO)

(Teacher Page 5, The Ice Age)

For nearly two million years, glaciers have repeatedly advanced onto and receded from the Great Lakes landscape. The Ice Age, as it is known, was characterized by periods of global cooling where glaciers advanced toward the equator from the North and South Poles and intermittent warm periods where glaciers receded back toward the poles.

In North America, the last glacial cycle in The Ice Age was called the Wisconsin **Glaciation** and lasted from 100,000 years ago to 10,000 years ago. The most recent glacial advance in Wisconsin was from 26,000 years ago to 18,000 years ago. Glacial lobes advanced over much of Wisconsin, scraping away the forests and topsoil and depressing the landscape under their immense weight. The glacial lobes were such a powerful erosive force that they helped to carve out much of what we know today as Lake Michigan, Green Bay, and Lake Superior.

SECTION 3 – THE GLACIERS RECEDE (18,000 TO 10,000 YEARS AGO)

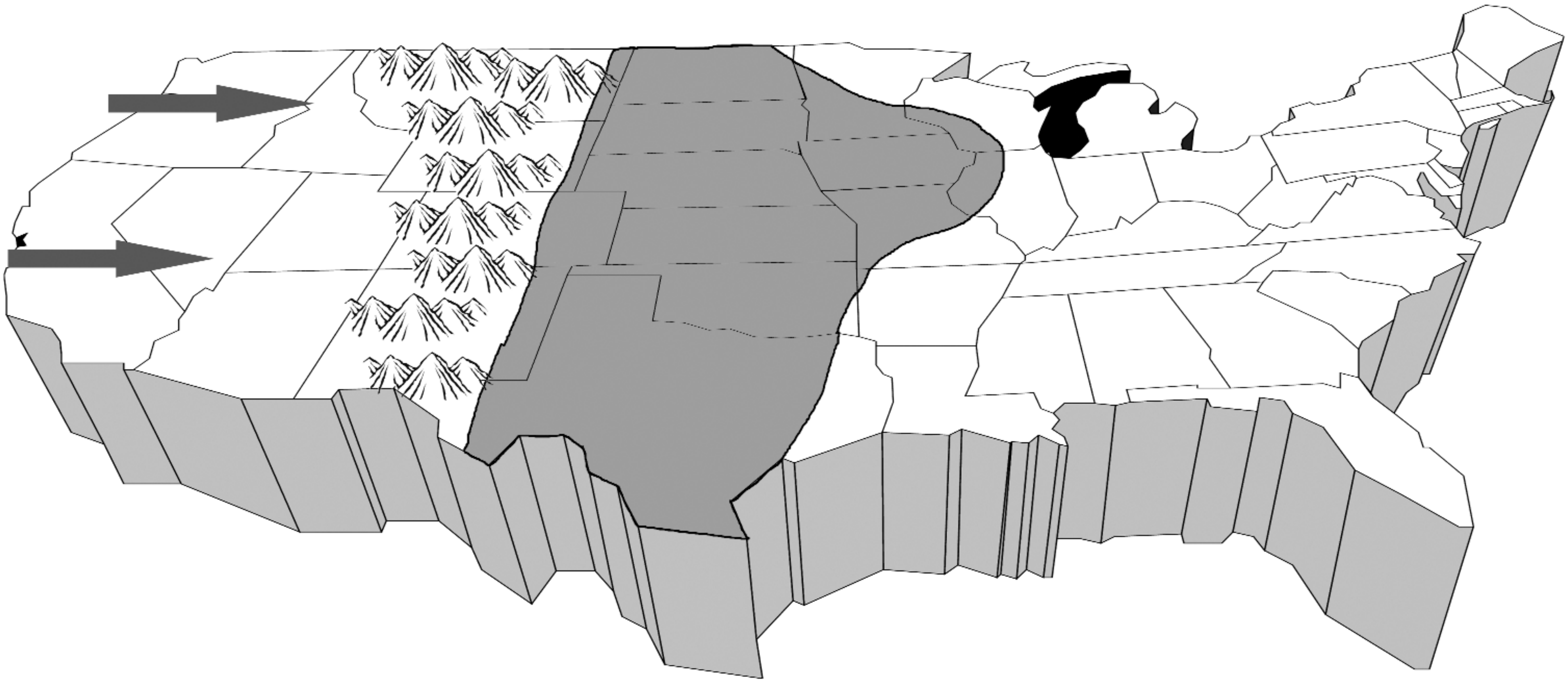
(Teacher Page 6, The Glaciers Recede)

The last glaciers were at their furthest extent 18,000 years ago when the global climate began to warm again. As the last glaciers receded, they changed the landscape in a variety of ways; leaving gravel deposits, sand deposits, and creating rivers and lakes with their meltwater. The soils and surface water patterns in Wisconsin were greatly changed by the:

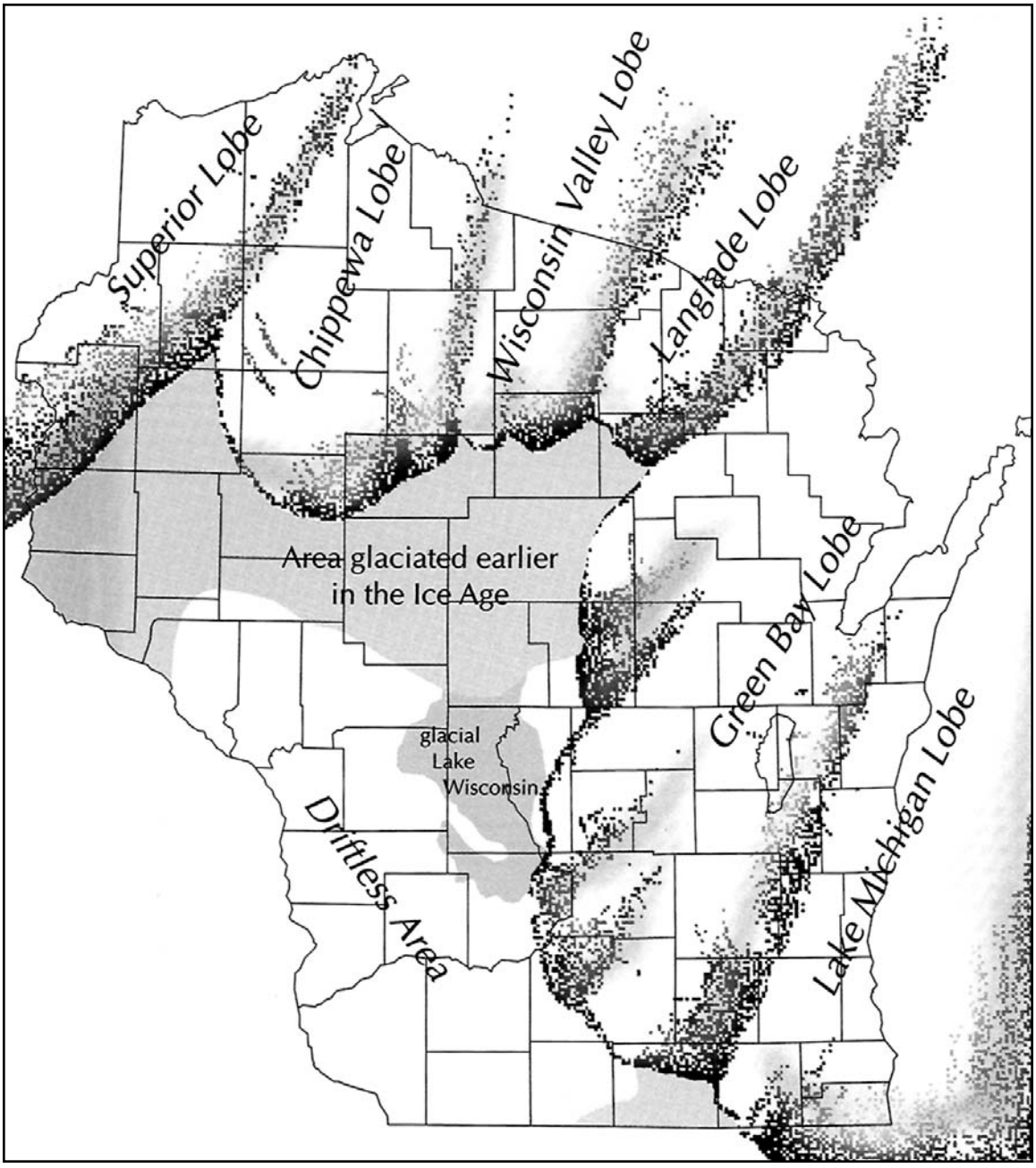
- extended mounds of large rocks called moraine till that were deposited at the glacier's edges
- rolling landscapes of other **glacial till** (large and medium-sized rocks) that were left as glaciers receded
- large plains of sand and gravel deposits, known as **glacial outwash**, deposited by streams and rivers as the glaciers melted, many of which were pitted by large ice blocks that have turned into the lakes we know today
- flat, sandy areas that were once the bottom of large reservoirs of glacial meltwater

At the end of the Ice Age, many mammal species had become extinct. Reasons for the widespread extinctions include influences from both climate change and hunting by Paleo-Indians.

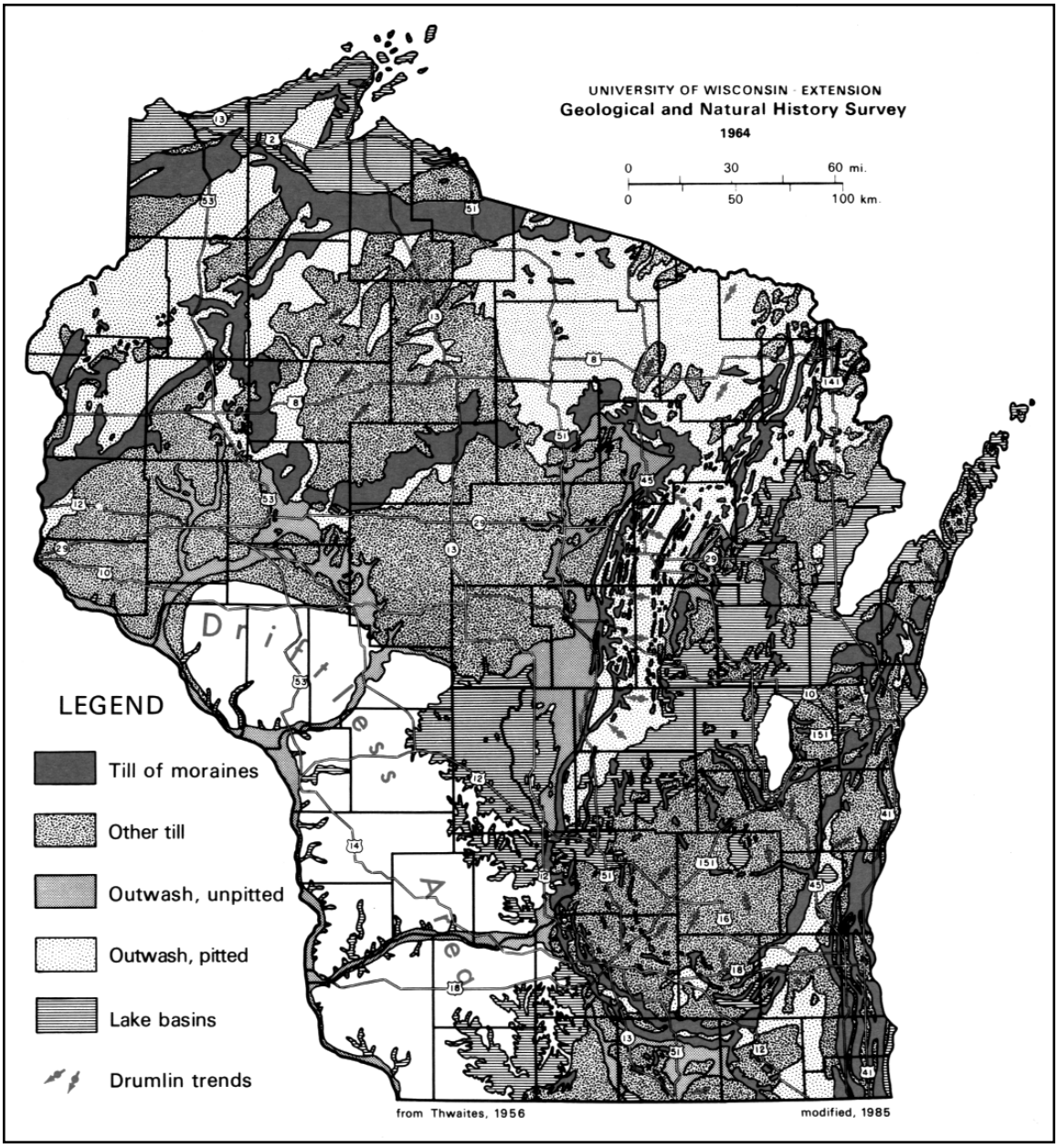
BEFORE THE ICE AGE
(THE ROCKY MOUNTAINS)



THE ICE AGE
(GLACIAL LOBES)



THE GLACIERS RECEDE
(ICE AGE DEPOSITS)



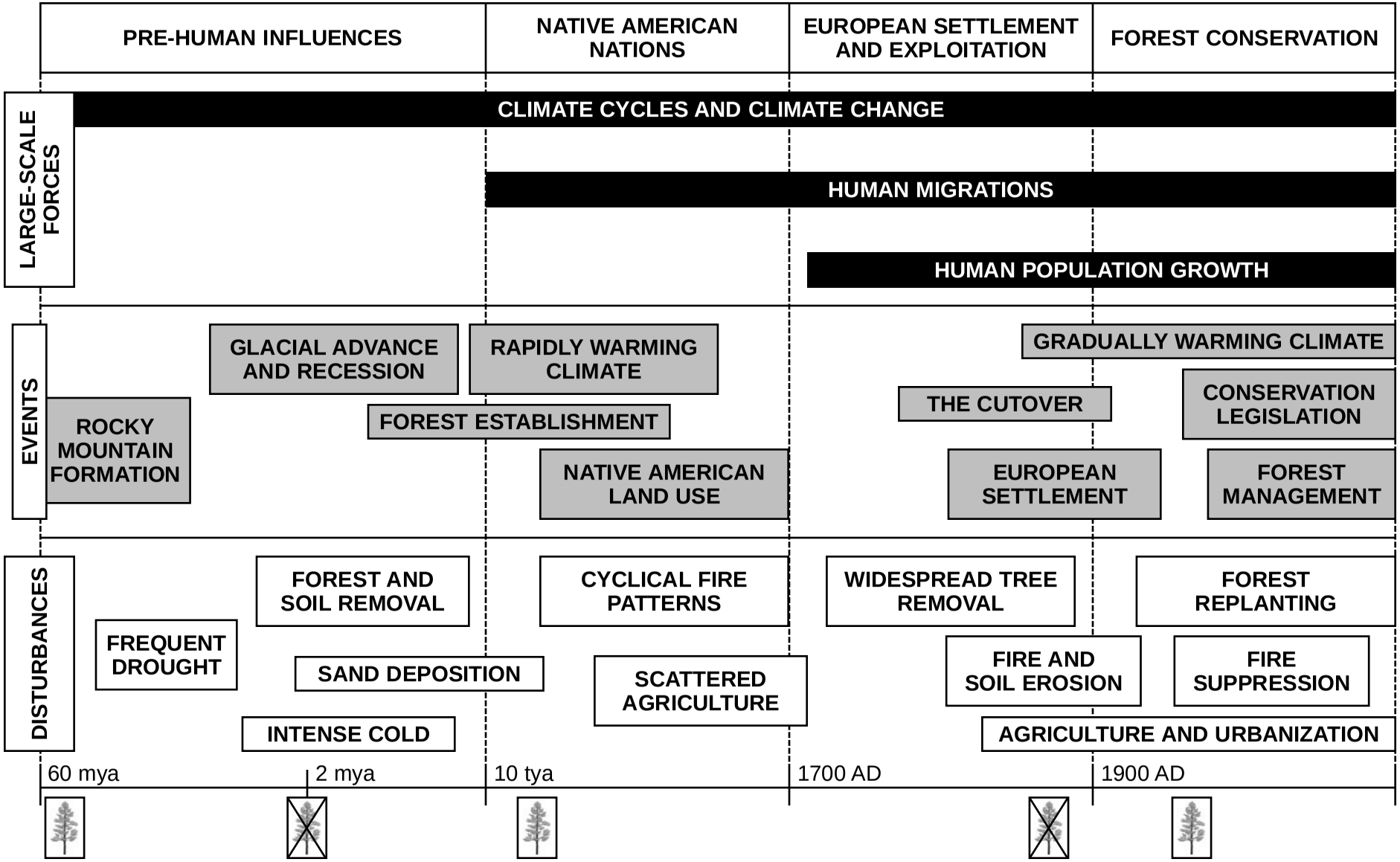
NATIVE AMERICAN SETTLEMENT
(TRIBAL DISTRIBUTION)

FOREST DISTURBANCE TIMELINE

	PRE-HUMAN INFLUENCES	NATIVE AMERICAN NATIONS	EUROPEAN SETTLEMENT AND EXPLOITATION	FOREST CONSERVATION
LARGE-SCALE FORCES				
EVENTS				
DISTURBANCES				

60 mya — 2 mya — 10 tya — 1700 AD — 1900 AD

EXAMPLE DISTURBANCE TIMELINE (WHITE PINE)



WHITE PINE HISTORY

White pine trees were present on the Wisconsin landscape before the Ice Age, but were mostly limited to scattered areas with both a cool, moist climate and sandy soil. As climates cooled throughout the region, white pine expanded, but was removed from most of the landscape as glaciers consumed both forests and topsoil.

As the glaciers began to retreat 18,000 years ago, large deposits of gravel and sand were left across the landscape. The large areas of sand were a good indication that white pine would come to dominate the landscape. White pine is particularly adapted to sandy soils and can out-compete most other tree species in this habitat. Beginning approximately 9,000 years ago, trees began to reestablish themselves on the landscape, and soils began to form, white pine came to dominate much of Wisconsin's post-glacial landscape.

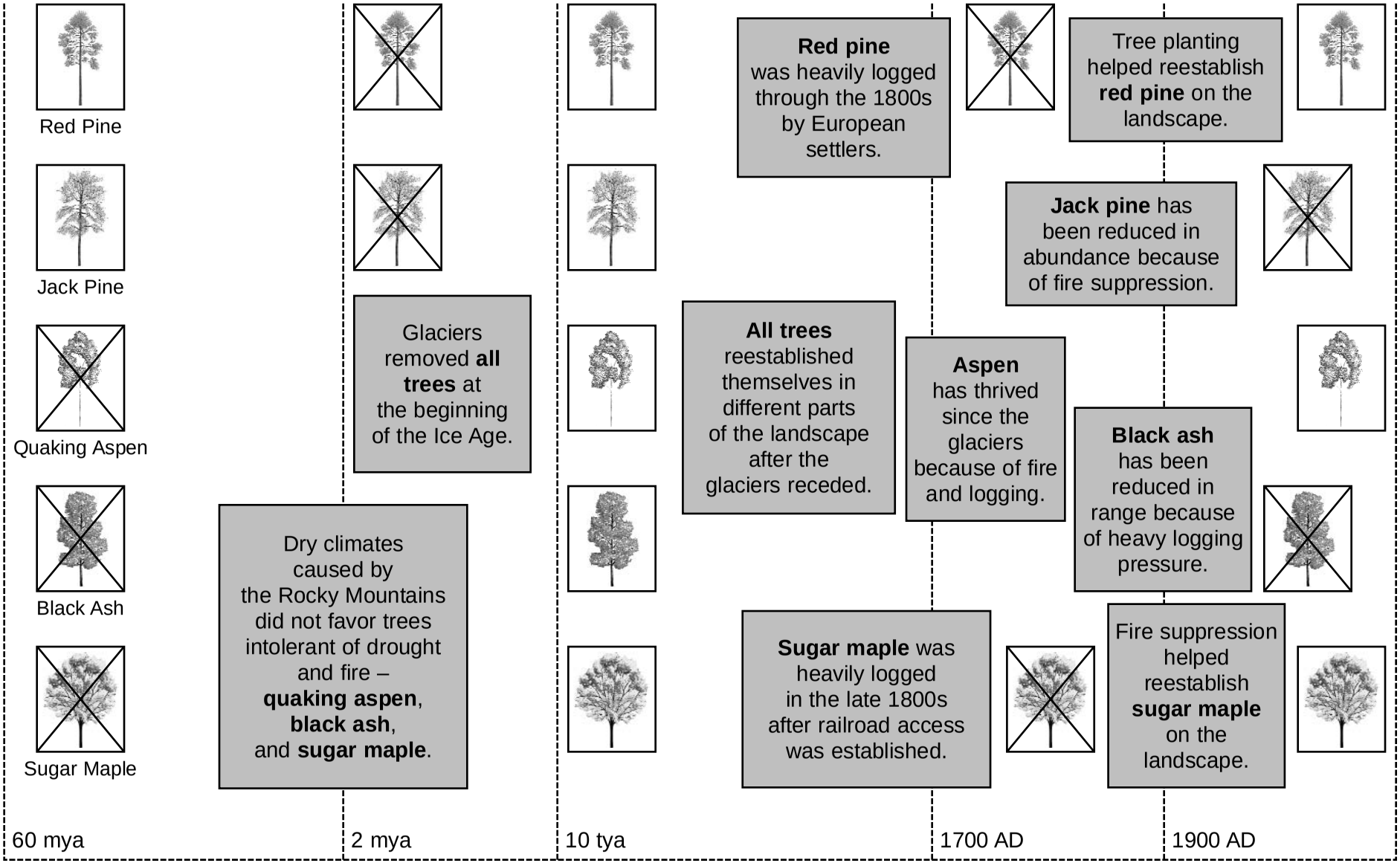
In the new landscape, natural fire cycles and fire management by some Native American tribes limited white pine expansion in some areas. Before the arrival of European settlers, many forests contained an astounding number of very large white pine trees.

When European settlers arrived, they began to cut the white pine first because of their size, excellent lumber, and natural buoyancy in rivers. By the late 1800s, the vast majority of white pine had been logged. In some areas, the logging was followed by intense fires, which killed many of the white pine seed sources. Erosion and land conversion also negatively affected white pine, and it has taken some time for it to become established once again in the landscape.

As the conservation era began in Wisconsin in the early 1900s, Wisconsin's citizens and government began to protect and replant white pine by passing conservation laws; establishing state, county, and federal forests; creating the Civilian Conservation Corps; creating and encouraging tree nurseries; and providing incentives for landowners to plant and manage forests.

By all accounts, white pine has made an amazing comeback on the Wisconsin landscape, but many challenges still exist. Possibly the two biggest challenges are: 1) the huge deer population that consumes white pine seedlings and 2) introduced organisms (including plants, insects, and diseases) that invade white pine habitat and injure and weaken trees.

TREE HISTORIES



SNAPSHOTS OF CHANGE

1A

NATIVE AMERICAN LAND USE

"From the earliest times Indians had used fire, stone tools, and other implements in order to survive and to enjoy the world. Until approximately eight thousand years ago, Indian hunters relied primarily on the killing of large animals such as mammoth, musk-ox, and long-horned bison...These Stone Age hunters left little trace of themselves on the terrain and apparently had minimal settlement structures."
American Indian Environments (1980)

"Undeniably, some Paleo-Indians may have been deliberate or opportunistic hunters of the megafauna that became extinct [during the Ice Age], but others were probably hunters of caribou, deer, beaver, and small animals. In the tundra, parklands, and mixed forest environments, Indians killed many caribou and some mastodons. But in forested regions, they also exploited species like tortoises – which also disappeared – and other small animals."
The Ecological Indian (1999)

"During the Archaic period...Indians traveled in set patterns, moving from place to place to take advantage of food sources available seasonally. They developed utensils associated with vegetable food production...worked with axes, adzes, gouges, and for the first time, bows and arrows. At the same time they domesticated dogs and encouraged the growth of certain edible wild plants."
American Indian Environments (1980)

"Wildland fire, as opposed to mankind's more domesticated variants, allowed early man to begin shaping the larger physical environment to fit his needs rather than merely to adapt by strict natural selection to the existing landscape. Broadcast fire made man almost instantaneously capable of wholesale modification of his environment. As a practical and intellectual problem, the discovery of fire by early man can only be compared in modern times with the discovery of the atom. With implements of stone and bone, man could improve his chances for survival; with fire he had power."
Fire in America (1982)

"There are five main ways by which the Indians influenced the nature of the vegetation. These are mostly related to their methods for obtaining food. The hunting tribes could affect the plant communities directly through the use of fire and indirectly through their influence on populations of large mammals. The food-gathering activities could have been of direct importance in influencing populations of some of the species harvested. The agricultural tribes exerted a direct destructive effect on the vegetation of the areas uses as fields. The fifth influence was that of plant introduction, both intentional and accidental."
Vegetation of Wisconsin (1959)

"Indians developed 155 species of domesticated plants used for food, tools, clothing, medicine, and other uses, but they did not domesticate large numbers of animals. Indians possessed no draft animals, no plows, and no use of wheels in subsistence technology."
American Indian Environments (1980)

NATIVE AMERICAN LAND USE

“The Menominee Indians are direct woodland descendants; the Potawatomi and the [Ojibwa] belong to branches of the woodlands. The most distinctive branch of the woodland Indians was the effigy mound group, building elaborate burial mounds in the shape of animals and birds, enclosing in them artifacts of a distinctive culture...by the time the white settlers established themselves in the state, descendants of the early Indians had given up mound building. They lived in semi-permanent villages, in lodges made of bark, saplings and rushes. They practiced agriculture, growing corn, beans, squash and tobacco. They hunted and fished and made clothes of fur...”
Handbook on Wisconsin Indians (1966)

“Let’s pretend that we can travel backwards in time... and visit a typical Indian family of that period. As we arrive on the scene the tribe is preparing to set up a new camp. The women are busy unpacking their household gear, including reed mats used to cover the outsides of the wigwam... While the women unpack, the men enter the woods to cut poles for the framework of the wigwams and collect birch bark for the roofs...we can see why this particular spot has been chosen as the campsite. A small lake and several springs are only a short distance away, but the most important reason for camping here at this season is a large grove of sugar maple trees...March is the proper time to tap the trees for their sap.”
The Indians in Wisconsin’s History (1954)

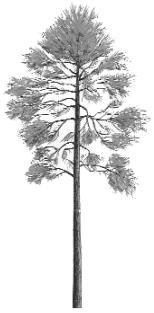
“Indians used fire to improve subsistence more than for any other end. Across the continent, they deployed fire to improve their access to animals, to improve or eliminate forage for the animals they depended on for food, and to drive and encircle animals.”
The Ecological Indian (1999)

“Many foodstuffs available for annual gathering or domestication, such as acorns, berries, and beans, appeared along the burned edges of forests and grasslands. So did game birds, some of which, like the turkey, could be domesticated. The importance of this relationship of early man to a grassland environment is that grasslands are maintained by fire. Through the manipulation of fire, man could adapt the area to his needs; he could readily accommodate himself to and disperse himself across areas; and he could greatly expand the natural distribution of grasslands as a vegetation cover type.”
Fire in America (1982)

“No conclusive proof exists that any Indian ever introduced any species into Wisconsin, but circumstantial evidence both here and elsewhere strongly supports the contention that such actions did take place. One interesting example is the Kentucky coffeetree. The large, hard seeds of this species were used in a sort of dice game by various tribes. As a result, they were carried about when the tribe moved its headquarters. At present, the species has a very local distribution in Wisconsin, with each locality at or near the site of an Indian village.”
Vegetation of Wisconsin (1959)

“Some indigenous people lived in scattered communities relatively small in size. Other lived in densely settled circumstances...But were population size and density great enough anywhere to constitute significant pressure on the environment? Given the relatively low impact technology of these pre-industrial people, it may be that except in a few notable cases, their few numbers trod so lightly as to leave bounty for European eyes almost everywhere.”
The Ecological Indian (1999)

TREE PROFILE CARD - RED PINE



RED PINE

(Pinus resinosa)

AVERAGE AGE OF MATURITY: 50 years old

MAXIMUM AGE: 300 years old

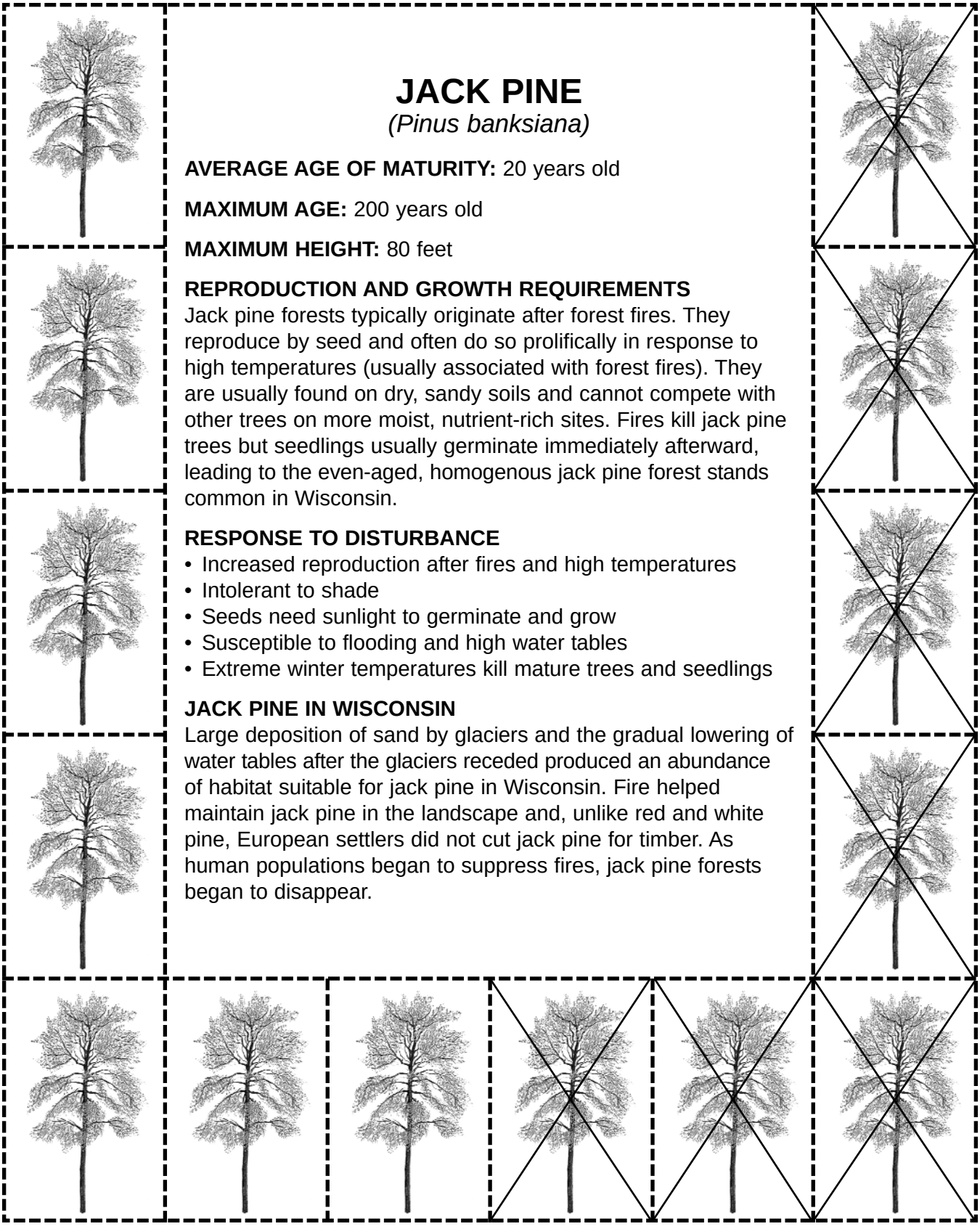
MAXIMUM HEIGHT: 150 feet

REPRODUCTION AND GROWTH REQUIREMENTS
Red pines become established by seed, usually following a fire. Fire is the only natural agent capable of providing most of the conditions they require. Surface fires can provide a satisfactory seedbed, kill back some competing tree species, reduce insect populations, and produce an open overstory. Very intense fires kill both red pine trees and seeds, and hurt red pine reproduction.

RESPONSE TO DISTURBANCE
- Reproduces after fire, but intense fires kill trees and seeds
- Intolerant to shade and needs sunlight to reproduce and grow
- Very susceptible to flooding and high water tables
- Extreme winter temperatures, ice, and wind damage kill mature and seedling trees

RED PINE IN WISCONSIN
In the absence of fire or other events that clear stands of trees, red pine forests change into white pine and mixed hardwood forests. Red pines were heavily cut during European settlement. The remaining red pine forests disappeared as human populations suppressed wildfires, but red pine became a popular tree for wood production so red pine plantations were planted across the landscape. Prescribed fires and plantation management currently keep the red pine widespread in Wisconsin.

TREE PROFILE CARD - JACK PINE



JACK PINE

(Pinus banksiana)

AVERAGE AGE OF MATURITY: 20 years old

MAXIMUM AGE: 200 years old

MAXIMUM HEIGHT: 80 feet

REPRODUCTION AND GROWTH REQUIREMENTS

Jack pine forests typically originate after forest fires. They reproduce by seed and often do so prolifically in response to high temperatures (usually associated with forest fires). They are usually found on dry, sandy soils and cannot compete with other trees on more moist, nutrient-rich sites. Fires kill jack pine trees but seedlings usually germinate immediately afterward, leading to the even-aged, homogenous jack pine forest stands common in Wisconsin.

RESPONSE TO DISTURBANCE

- Increased reproduction after fires and high temperatures
- Intolerant to shade
- Seeds need sunlight to germinate and grow
- Susceptible to flooding and high water tables
- Extreme winter temperatures kill mature trees and seedlings

JACK PINE IN WISCONSIN

Large deposition of sand by glaciers and the gradual lowering of water tables after the glaciers receded produced an abundance of habitat suitable for jack pine in Wisconsin. Fire helped maintain jack pine in the landscape and, unlike red and white pine, European settlers did not cut jack pine for timber. As human populations began to suppress fires, jack pine forests began to disappear.

TREE PROFILE CARD - QUAKING ASPEN

QUAKING ASPEN

(Populus tremuloides)

AVERAGE AGE OF MATURITY: 10 years old

MAXIMUM AGE: 200 years old

MAXIMUM HEIGHT: 100 feet

REPRODUCTION AND GROWTH REQUIREMENTS

Quaking aspen is the most widely distributed tree in North America. It grows on many soil types and is quick to grow in disturbed sites where there is bare soil. This fast-growing tree is short-lived, and stands are gradually replaced by slower-growing species. Aspen reproduces by seeds or root sprouts. It requires full sunlight and little competition from other plants. Fire and land clearing provide near ideal conditions for aspen growth.

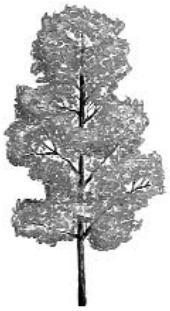
RESPONSE TO DISTURBANCE

- Reproduces and grows rapidly after fires or land clearing
- Very intolerant to shade
- Sensitive to drought
- Susceptible to a wide variety of native and exotic pests

QUAKING ASPEN IN WISCONSIN

Throughout Wisconsin's history, aspen has acted as a pioneer species colonizing disturbed areas and beginning the transition from bare ground and small plants to forested landscapes. Aspen's range was most likely reduced before the Ice Age as drier climates began to prevail over the Midwest. After glaciation, it colonized areas but was again reduced as it was replaced by other shade-tolerant trees. Some areas of aspen were maintained by natural and human-induced fire before human settlement, but the large-scale cutting of trees for lumber by European settlers caused a large increase in aspen across the state. Today the acreage of aspen forest is decreasing as forests mature.

TREE PROFILE CARD - BLACK ASH



BLACK ASH

(Fraxinus nigra)

AVERAGE AGE OF MATURITY: 30 years old

MAXIMUM AGE: 200 years old

MAXIMUM HEIGHT: 80 feet

REPRODUCTION AND GROWTH REQUIREMENTS

Black ash is a slow-growing, northern tree that is typically found in bogs, along streams, or in seasonally flooded areas. It is adapted to wet conditions for reproduction and growth, and does not compete well with other trees on drier sites.

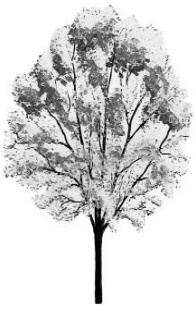
RESPONSE TO DISTURBANCE

- Reproduces and grows in wet soil conditions
- Reproduces and grows in open conditions caused by fire or other disturbances
- Susceptible to drought
- Eaten heavily by deer

BLACK ASH IN WISCONSIN

The presence of black ash on the Wisconsin landscape has changed as the topography, and ultimately, the groundwater and surface water conditions change. As glaciers receded and water tables were high, black ash was widespread in marshy and seasonally wet areas. As water tables lowered, black ash was restricted to fewer areas but remained widespread. The cutover during European settlement had little effect on black ash since mostly large coniferous and upland deciduous trees were cut, but as the landscape was settled and farmed, wetlands were drained for their nutrient-rich peat. Wetlands have been disappearing at a fast rate for the last century and, because black ash produces a very valuable wood, logging pressure has been high.

TREE PROFILE CARD - SUGAR MAPLE



SUGAR MAPLE

(Acer saccharum)

AVERAGE AGE OF MATURITY: 70 years old

MAXIMUM AGE: 400 years old

MAXIMUM HEIGHT: 120 feet

REPRODUCTION AND GROWTH REQUIREMENTS

Sugar maple is found in regions with cool, moist climates. It can grow on a wide variety of soils, but is dominant on nutrient-rich soils. Sugar maple does not readily reproduce in open, sunny conditions and requires shaded, moist areas. It is known as a late successional species that comes to dominate older, long-established forests.

RESPONSE TO DISTURBANCE

- Very shade-tolerant
- Reproduces in moist, shady forested areas
- Very susceptible to both fires and floods
- Eaten heavily by deer

SUGAR MAPLE IN WISCONSIN

After the glaciers receded, pioneer plants and trees added organic matter to the sandy soils, creating rich soils and forested conditions ideal for sugar maple. Sugar maple began to establish itself as the climax species in many older forests. Fires, wind, disease, drought, and flooding created a patchwork of younger forests, interspersed with undisturbed forests dominated by sugar maple. With the arrival of railroads, hardwood trees such as sugar maple that do not float, could be effectively logged. Most large trees were removed from the landscape. The widespread logging and fires created conditions unsuitable for sugar maple reproduction and growth, and it has taken the better part of the last century to reestablish itself. Currently sugar maple is expanding its dominance on the landscape as more lands are managed for mature timber.

EXAMPLE TREE PROFILE - WHITE PINE

EASTERN WHITE PINE

(Pinus strobus)

AVERAGE AGE OF MATURITY: 40 years old

MAXIMUM AGE: 450 years old

MAXIMUM HEIGHT: 150 feet

REPRODUCTION AND GROWTH REQUIREMENTS

White pine grows in cool, moist climates on nearly all soils within its range, but generally competes best on sandy soils. Sandy soils permit fair growth of white pine, but many hardwoods have a hard time establishing in them. On these sites, white pine regenerates naturally, competes easily, and dominates the older forest canopy.

RESPONSE TO DISTURBANCE

- Reproduces in both sunny and shady conditions
- Low tolerance of fire when young and will not establish itself in areas with short fire cycles
- Susceptible to many native and exotic insects
- Eaten heavily by deer

WHITE PINE IN WISCONSIN

The glacial retreat provided white pine with the sandy soil conditions necessary to effectively establish itself without the competition from other tree species. Natural fire rotations limited white pine expansion in some areas, but before the arrival of European settlers, many forests contained an astounding number of very large white pine trees. By the late 1800s, most of those vast stands had been logged. The intense fires killed many of the white pine seed sources, and it has taken some time for it to become reestablished in the landscape. During the conservation era, white pine was widely planted and its growth encouraged, but deer populations have limited its expansion.