

3- READING THE FOREST LANDSCAPE

Nutshell

In this lesson, students learn how to interpret the disturbance history of a forest by using evidence and applying the ecological principles of change and interconnectivity. Student use a narrative that explores human physiology to visualize how the physical world is interconnected and constantly changing. They discuss how forests change and explore disturbances common in Wisconsin forest ecosystems. They work in small groups to use evidence present in the forest landscape to interpret the disturbance history of their school forest. In conclusion, groups present their findings and work as a class to form a consensus view of their school forest disturbance history.

Big Ideas

Ecosystems are continuously undergoing natural change. This natural change occurs through such processes as long-term evolution of organisms through relatively short-term processes such as succession, in which one plant community gradually supplants another. (sub-concept 13)

Ecosystems are dynamic and altered by natural or human disturbance. Disturbance plays an ongoing role in ecosystem structure and function. (sub-concept 14)

The lumber era shaped Wisconsin's economic, cultural, social, and environmental landscapes. Influences of this time period are still visible in Wisconsin today. (sub-concept 22)

Objectives

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

- Provide examples that illustrate the ecological principles of change and interconnectivity
- Describe the common disturbances that occur in Wisconsin forest ecosystems
- Use evidence in the field to interpret the disturbance history of a forest

Subject Areas

Science, Environmental Education

LEAF 9-12 Lesson Guide Connection

Lesson 2 – A History of Succession

- Provides a comprehensive statewide disturbance history and help students understand how environmental factors and tree characteristics interact to determine forest successional pathways.

Lesson/Activity Time

Total Lesson Time: 105 minutes

Time Breakdown:

Introduction – Visualizing Change (15 minutes)

Activity 1 – Forest Succession (15 minutes)

Activity 2 – Evidence of Disturbance (15 minutes)

Activity 3 – Field Reconnaissance (40 minutes)

Conclusion – A Consensus View (20 minutes)

Teaching Site

Indoor classroom and forested site

Vocabulary

Age-Class Discontinuity – A condition in a forest in which many young and old trees are present but middle-aged trees are absent.

Basal Scar – An opening in the bark of a tree found at the point of ground contact, often taking the shape of an upside down “v.”

Disturbance – an event, either natural or by human-induced, that causes a change in the growth or existing condition of a forest.

Snag – A standing, dead tree.

Succession – the gradual change of an area from one community to another over time, which can be due to natural or human caused disturbance.

Wolf Tree – Wide, low-branching trees that result from growing until maturity in an open environment.

Materials List

For each student

- Student Page , *Forest Disturbance*
- Student Page , *Reading the Forest Landscape*
- Map of the school forest showing aerial view, school forest boundary, and location of research plots (assignment from Lesson 1 – GIS)
- Clipboard
- Pencil

For each student group

- Compass
- Watch

Teacher Preparation

- Practice reading the narrative in the introduction to the lesson. Your voice should be slow and calm to facilitate the visualization exercise.
- Make the copies of Student Page , *Forest Disturbance* and Student Page , *Reading the Forest Landscape* for each student.
- Gather enough clipboards for each student and a compass for each student group.
- Print enough copies of the school forest map (as created in Lesson 1) for each student. Use the map to choose a base camp at the school forest and visualize appropriate reconnaissance routes for groups to use. The base camp should have a whiteboard or butcher paper to facilitate the discussion at the end of the lesson.

Background Information

See Lesson 2 – A History of Succession from the LEAF 9-12 Lesson Guide.

Procedure

Introduction – Visualizing Change (15 minutes)

1. Tell your class that you are going to guide them through a visualization exercise that will help them understand two ecological principles important to understanding how forests change over time.

Have students sit in a comfortable position and close their eyes. Have them take a few deep breaths and then ask them to focus on their breathing. Ask them to breathe in a calm, quiet rhythm. Ask them to remain quiet and focus on the way their body feels. As they are sitting quietly, slowly read the following passage:

Your breath supplies air to your lungs. Your lungs deliver oxygen to your blood. Your heart, as it beats, is delivering vital gases to your cells. Your living cells are growing in size and number. Old cells lose their integrity and die. New cells are differentiating into specialized cells that make up your internal organs and skin. Your skin is alive. Thousands of skin cells are dying and being shed from the body. New skin replaces them. New skin cells make you sensitive to the environment. A warm breeze, a cold drink of water, the light touch of a fly stimulate the millions of nerve endings that connect you to the outside world. The taste of chocolate, the smell of pizza, the warm feel of the sun change the way you feel. Feelings influence your emotions. Joy, fear, excitement, anxiety originate with past experiences, with current feelings, and with the anticipation of things to come. Our emotions influence the way we perceive the world. Our emotions influence the way we communicate with one another. Our emotions influence the way we act. Our physical body changes. The world changes. Our feelings change. Our emotions change.

2. Have students open their eyes and stretch their arms and legs. Proceed in order around the room and have each student say a few words about how they felt and what they were thinking during the exercise. Do not let it turn into a discussion.
3. Once all of the students have spoken, ask them what ideas or concepts they think were being expressed in the visualization. Allow students to ask each other questions and generate discussion. Guide the discussion to the following answers:
 - Everything is always changing (i.e. change is a constant)
 - Everything is connected
4. Tell the students that by visualizing how their body is constantly changing and how their physical bodies and emotions are interrelated and connected to the work around them, they can begin to understand how the natural world works.

Activity 1 – Forest succession (15 minutes)

5. Have the class brainstorm ways that they think forests change through time. The list may include:
 - Trees grow, taking in CO₂ and giving off O₂
 - Trees reproduce

- Fire kills trees and plants
 - Deer eat and kill tree seedlings
 - Diseases like oak wilt or emerald ash borer kill trees
 - Flooding and drought kill trees
 - Forests are cut and turned into human developments, like houses or shopping centers.
 - Trees are harvested for wood
 - Trees are planted by people
6. With the list visible on the board, have students explain how relationships between different parts of the forest influence the changes that occur. For example:
- Environmental conditions and tree characteristics determine whether a tree species survives in a given area. For example, some tree seedlings need shade to survive (like sugar maple), other trees need full sun (like aspen).
 - Property owners can directly determine how a forest changes. For example, a forest can be cut and turned into a parking lot if it is sold for development. Or, it can be managed for timber production.
 - Human actions can indirectly influence how a forest changes. For example, the burning of fossil fuel over the past 100 years has increased the levels of CO₂ in the atmosphere, causing changes in global climate.
7. Once the brainstorm is complete, tell the class that the changes that occur in a forest are called succession. In the next activity, they will learn how to read the forest landscape to determine the changes that occurred in their school forest over the last 100 years.

Activity 2 – Evidence of Disturbance (15 minutes)

8. Tell the class that reading the forest landscape is very similar to interpreting a crime scene. In both instances, you must use the evidence that currently exists to determine prior events. After a car accident, an investigator can use a tire's skid mark to identify the direction and speed a car was traveling. In a forest landscape, you can use fire scars on trees to determine the direction and intensity of a surface fire.

In both instances, the most successful investigators use their knowledge of human motivations and the physical world to interpret the evidence they see.

9. Explain to the class that in the forest landscape, there are 6 major disturbances that can cause change in a forest. Hand each student a copy of Student Page  1, *Forest Disturbance*. Have them read the explanations for each of the disturbances and ask questions as they arise.
10. Once they have reviewed the disturbances, tell them that each disturbance leaves specific evidence on the landscape. The evidence can be used to identify disturbances that caused the forest to change.

Hand each student a copy of Student Page  2, *Reading the Forest Landscape*. Have students turn to the back side and read the descriptions for each piece of evidence.

Answer any questions they may have. Tell the class that they will use the sheet to conduct a field reconnaissance at their school forest.

Activity 3 – Field Reconnaissance (40 minutes)

11. Establish a base camp with the class and make sure each student has a pencil and clipboard with Student Page , *Reading the Forest Landscape* and a map of the school forest. Divide the class into groups of four. Make sure each group has a compass and a watch.

Tell the groups they will have 30 minutes to conduct a reconnaissance of the school forest to look for evidence of historic disturbance. They will use the worksheet to circle the evidence that they find and write any other observations that they have. They can also use a camera to take pictures of the evidence if one is available.

12. Ask them to work as a group to come up with a reconnaissance plan. Their plan should include a route with at least 2 stops where they will set up a small 10' x 10' plot to look for evidence directly on the forest floor (if already established, groups should use the school forest plots). Have them use the school forest map to draw out the route that they will take. The plan must be approved by you.

Make sure that each group is familiar with their route. Make sure that every member of the group is comfortable with the plan and that each group member knows the time to meet back at the base camp. You may wish to work with assistants to keep watch on the progress of each group.

Conclusion – A Consensus View (20 minutes)

13. When all of the groups return to base camp, have each group elect a spokesperson to describe what they saw (i.e., the results of the investigation). Allow each group spokesmen to present, but do not allow other groups to ask questions. Write all of the results on the board.
14. After all of the groups have presented, allow the class to discuss the results listed on the board to determine a consensus disturbance history (i.e. develop a conclusion). If there are disagreements over results and their interpretation that cannot be resolved, have the class decide the process to resolve them. For results in which a consensus view cannot be obtained, a new data collection procedure should be developed and implemented.

Summative Assessment

Have each student write a narrative history that describes the changes that have occurred in the school forest over the last century.

Extension

Invite a subject matter expert (SME) to speak to your class about forest succession. The SME can help your class understand how forest managers predict how the forests have changed through history and will change in the future. Ask the SME to talk about how forest habitat types are used to predict how a forest will change. Also, ask them to talk to your class specifically about your school forest.

Potential experts include, but are not limited to:

- A WDNR forester
- A professor of forestry or forest ecology
- A forest ecology field researcher with the WDNR, US Forest Service, or US Geological Survey
- A graduate student conducting research in forest ecology
- A local naturalist

Recommended Resources

Wessels, Tom. 1999. Reading the Forest Landscape: A Natural History of New England. The Countrymen Press. Woodstock, Vermont.

Web Resources

Primer on Wisconsin Forest Disturbance

<http://basineducation.uwex.edu/woodland/primer/history.htm>

Wisconsin's Forest at the Millennium

<http://www.dnr.state.wi.us/forestry/assessment/WlforestsAtMillennium.htm>

Model Academic Standards

ENVIRONMENTAL EDUCATION A.12.3

Question and Analysis

Evaluate personal investigations* and those of others, critiquing procedures, results, and sources of data and suggest improvements to the investigation* (see *LA Research; MA Process*)

Groups present conclusions from their field reconnaissance to the class. They answer class questions about evidence that supports their conclusions. The class discusses results and works cooperatively to decide which conclusions are reliable and which need to be verified. Students then determine a process of verification.

ENVIRONMENTAL EDUCATION A.12.4

Question and Analysis

State and interpret their results accurately and consider other explanations for their results (see *LA Writing*)

Groups present their field research results and the conclusions they came to. They answer class questions and must defend or re-think their conclusions.

ENVIRONMENTAL EDUCATION B.12.8

Knowledge of Environmental Processes and Systems

Relate the impact of human activities in ecosystems* to the natural process of change, citing examples of succession,* evolution,* and extinction (see *SC Earth and Space Science*)

Students conduct a field reconnaissance to look for evidence of past disturbance in their school forest. They use their observations to interpret how the forest has changed over the last 100 years.

SCIENCE C.12.1

Science Inquiry

When studying science content, ask questions suggested by current social issues, scientific literature, and observations* of phenomena; build hypotheses that might answer some of these questions; design possible investigations*; and describe results that might emerge from such investigations

Students research common forest disturbances and use their knowledge to design a field investigation to determine the recent disturbance history of their school forest. After conducting the research, they formulate conclusions and present them to the class.

SCIENCE C.12.3

Science Inquiry

Evaluate* the data collected during an investigation*, critique the data-collection procedures and results, and suggest ways to make any needed improvements

After presenting their results and conclusions to the class, students must describe their data collection procedures in response to class questions. The class must determine a new data collection procedure to verify any results in question.

SCIENCE D.12.11

Physical Sciences

Using the science themes*, explain* common occurrences in the physical world

Students use results from a field investigation to explain recent successional changes that have occurred in their school forest.

Multiple Intelligences

Verbal-Linguistic

Logical-Mathematical

Visual-Spatial

Interpersonal

Intrapersonal

Naturalistic

Student Page 1, Forest Disturbance

Fire - Fire has occurred periodically in Wisconsin forests for more than 100,000 years. It can occur as slow moving surface fire to an intense crown fire. The effects can range from the death of a few trees to complete stand replacement



Blight – Insects, fungi, and microorganisms can damage and kill trees. Blights are often specific to a single tree species. Dutch elm disease is a common, lethal blight. Black walnut canker (as shown below) is a non-lethal blight that weakens trees and reduces tree value.



Pasturing – Animals such as cows, pigs, and sheep are often grazed in woodlands. They remove many of the plants and shrubs in the understory (as shown below). Over-grazing can result in tree damage and soil compaction.



Beaver activity – Nature's foresters, beavers girdle, fell, and haul trees to build shelter and alter waterways. They can change forest composition by killing specific tree species and by flooding or draining shoreline areas.



Logging – A common historical and current land use, logging can influence the type, age, and form of forest trees. The practice often leaves skid trails as well as large, woody debris on the forest floor (as shown below).



Blowdowns – Extreme lateral and vertical winds can blow down individual trees or large areas of forestland. This can create piles of woody debris (as shown below) as well as a “lumpy” topography known as pillow and cradle.



Student Page 2, *Unlocking the Forest Past*

(Adapted from *Reading the Forest Landscape* by Tom Wessels)

FIRE		PASTURING	
STANDING DEAD TREES	DISCONTINUITY IN AGE CLASS	STONE WALLS	BARBED WIRE
BASAL FIRE SCARS	MULTIPLE-TRUNKED TREES	WOLF TREES	THORNY SHRUBS
CHARCOAL		JUNIPER	WEIRD APPLES

LOGGING		BLOWDOWNS	
MULTIPLE-TRUNKED TREES	CUT STUMPS	PILLOW-AND-CRADLE	DOWNED TREES TOPOGRAPHY
OPPOSING BASAL SCARS		DECAYED NURSE LOGS	

BEAVER ACTIVITY			BLIGHTS
STANDING DEAD SNAGS IN WATER	BEAVER-CUT STUMPS	BEAVER DAMS	SNAGS WITH FUNGUS

Comments:

FIRE

- **Standing dead trees** – Conifers and oaks made rot resistant by heat-killing that stand for many decades; often silvery in appearance.
- **Discontinuity in age class** – Fires often leave the overstory and create a fast-growing understory, but will usually remove the mid-story trees. Logging will not do this; age discontinuity can be observed only in forests with trees larger than two feet in diameter.
- **Basal fire scars** – Triangular scars at the base of trees, on the uphill sides if on a slope. This is where fuel pockets form. If the trees are not on a slope, the scars will be randomly distributed wherever fuel pockets occurred.
- **Multiple-trunked trees** – Many broad-leaved trees send up stump-sprouts after they have been heat-killed.
- **Charcoal** – After ten years, charcoal is not very visible unless you dig in the soil, and even then it may not be found. Also, certain fungi that grow on decaying sugar maple and beech look very much like charcoal but are not, so fire should always be verified by means other than charcoal alone.

PASTURING

- **Stone walls** – Constructed with large stones; the presence of many fist-sized stones indicates past cultivation.
- **Barbed wire** – Barbed wire was first used in the early 1870's. Its presence indicates pastures that were used in the last century.
- **Wolf trees** – Wide, low-branching trees, originally left to shade animals when the woods were cleared.
- **Thorny shrubs** – Hawthorns, barberry, and roses all deter browsing.
- **Juniper** – A slow-growing, unpalatable shrub that is released by the grazing of grass that would otherwise overtop it. The only other environments in which it is common are on rock outcrops and in poor coarse soils where herbaceous vegetation is not able to overtop it in its early years of growth.
- **Weird apple trees** – Apple trees that are highly contorted at their base and often have many basal branches near the ground; a result of heavy browsing pressure.

LOGGING

- **Multiple-trunked trees** – Many broad-leaved trees send up stump-sprouts after they have been cut.
- **Cut stumps** – Stumps that have a visible flat top.
- **Opposing basal scars** – The skidding of logs damages the bases of trees on skidder roads, creating basal scars that face one another and are often triangular in shape.

BLIGHTS

- **Snags with fungus** – Trees killed by blights (insect or fungal) are not rot resistant and quickly develop fungi. The exceptions to this are oaks, which are naturally rot resistant.

BEAVER ACTIVITY

- **Standing dead trees in water** – Flooding kills trees, but the anaerobic conditions created by the flooding preserve the root systems, allowing dead trees to remain standing for decades. These trees are usually conifers and birches.
- **Beaver-cut stumps** – Blond-colored stumps indicate beaver activity within the year; gray stumps were cut more than a year ago; stumps with turkey tail fungi growing on them were cut at least three years ago.
- **Beaver dams** – The first sign of beaver abandonment is a drop in water level below the top of the dam. Herbaceous vegetation growing on the pond side of the dam indicates abandonment at least two months previously. Woody vegetation growing on the pond side indicates abandonment of at least two years.

BLOWDOWNS

- **Downed trees** – Trees all lying in the same direction. Downed trees lying in all directions indicate that dead trees fell over at various times.
- **Pillow-and-cradle topography** – When a live tree is blown over, its upended roots carry a lot of earth, creating a depression, or "cradle." When the tree and root system rot, the earth is dropped as a pile, or "pillow," next to the cradle. Pillow-and-cradle topography lasts for hundreds of years.
- **Decayed nurse logs** – Most often hemlock trees growing in a line with exposed roots tracing the line.