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How Did Stone Walls End Up in the Middle of Forests?

Subject: Environmental Science, biology, ecology
Grade: 11-12
Topic: Succession and Forest Ecology
Time: 13 -40 minute periods

Abstract
The purpose of this unit is to introduce students to the interrelationships of ecosystems and the changes they undergo due to the natural process of succession. The focus will be on forests so that students will understand how a state like Connecticut evolved from being mostly deforested to becoming one of the most densely forested states in the country. This unit will provide a sense of place by increasing student understanding and appreciation of forests which will foster their stewardship of them. While exploring the process of succession, students will learn how areas that are disturbed by natural disasters or human activities can change ecosystems from systems that support a limited number of organisms to climax communities that support a wide diversity of organisms. Students will also learn how crucial the interaction between biotic and abiotic factors in an ecosystem is crucial to its health and sustainability.

Students will learn how to record observations in nature consistent with the scientific method. They will build on these skills by using the data collected through their observations to make predictions about succession and to determine the health of a forest. Students will also develop critical thinking skills and apply data analysis to enable them to reach informed decisions about forest issues in the future.

Objectives:
Students will be able to:

1. Keep a nature journal based on the Grinnell system of nature journaling.
2. Explain the process of succession and its response to natural and human disturbance.
3. Compare and contrast primary and secondary succession and supply examples from existing ecosystems.
4. Describe the effect of living components in the ecosystem on nonliving components during succession.
5. Compare the scientific knowledge of forests and succession to what was known approximately 200 years ago.

6. Describe a forest ecosystem and explain how the biotic components interact with its abiotic environment.
7. Conduct a field study to determine the health of the forest.

Outline:

Forest in a jar: pond succession simulation
Nature journal: Grinnell system of nature journaling
Observing succession: Students will observe a lawn and meadow-like area for comparison.
Succession POGIL: Introduces students to the processes of primary and secondary succession.
A Walk in the Woods: Observation of oak trees
The Succession of Forest Trees: Article by Henry D. Thoreau
Succeeding in Succession: Formative assessment game.
Forest Health: Observations and assessment of biotic and abiotic components of a forest ecosystem.
Summative assessment.

Materials:

Lab notebook
Nature journal
Jar
Dirt
Aquatic plant
Water
String

Student Handouts:

Forest in a Jar
Nature Journal
Succession POGIL
The Succession of Forest Trees
Succeeding in Succession
Forest Health
Summative Assessment and Rubric

Activities

Day 1. (40 minutes unless stated otherwise)

Begin Forest in a Jar, step 1 of the procedure. (See student materials) (10 min)

Nature Journals: Introduce students to nature journaling. (See student materials) (30 min)

Day 2.

Forest in a Jar, step 2 of the procedure. (10 min)

Nature journals: (30 min)
Discuss methods of incorporating images of nature into the journal such as sketches, photographs and rubbings. Practice these techniques using a variety samples from nature such as leaves, pinecones, acorns, feathers and branches.

Students will research the features of plants and animals that are identifying so they know what to look for in their nature journal observations.(homework)

Day 3

Observing succession. (80 minutes)

Materials:
String
Lab notebook
Pencil

Procedure:

1. Working in groups of 3-4, students will obtain a string 4.1 meters long and tie it so it creates a loop measuring 4 meters.

2. Students will go outside and find an area on the school lawn to spread the string out. They will then make observations about the plants and animals enclosed by the string including the numbers and types of species.

3. Students will then go to an area of the school campus that has not been mowed and spread their string out and make observations about the plants and animals in the enclosure.

4. Return to the classroom. Students will compare group data and describe the differences in each location. Students will individually write an explanation for the differences in their notebooks.

Day 4.

Forest in a jar: Record observations.(10 min)

Succession POGIL (See student materials) (30 min; 5 min for video)

Begin by watching a video of the eruption of Mt. St. Helen's on the History site: http://www.history.com/topics/us-states/washington/videos/mount-st-helens-erupts

Students will complete the POGIL activity in small groups of 3-4 students.

Day 5:

Forest in a jar: Add 8 seeds to your jar.(5 min)

A Walk in the Woods (30 min)

The purpose of this activity is to stimulate student thinking about the propagation and distribution of trees in the woods.

Materials:
Lab notebook, pencil

Procedure:

1. Students will walk outside to a wooded area with at least one oak tree.
2. Ask students to look at the tree and make observations about the tree and the area directly under it.
3. Locate a second oak tree if possible and estimate the distance from the original oak.
4. Observe the ground between the trees, or if there isn't a second one, observe the ground between the oak tree and the school building.
5. Return to the classroom and have students share observations, adding to their own.
6. After sharing observations have students answer the following question in their lab notebook:

   How does it happen that when a pine tree is cut down, an oak tree commonly springs up?
   Cite evidence from your observations to support your explanation.

Day 6:

Read The Succession of Forest Trees by Henry D. Thoreau and answer the following in the lab notebook :

1. What are the core ideas presented in this article?
2. How many of these ideas still have relevance and/or value to you?
3. Discuss the answers to the above questions as a class choosing the one quote that best hits the nail on the head, then have students do the following:
   a. Is there anything in your own life that relates to this quote?
   b. In your lab notebook, apply the concept under study to some facet of your own experience.

Day 7:

Forest in a jar: (10 min)
Observe and record the changes in the jar and in a drop of water from the jar.

Succeeding in Succession: (70 min)
Students will play a game and answer questions about it as an formative assessment on succession.

Day 8:

Forest Health: (40 min)

Students will collect data on signs of tree health and abiotic conditions surrounding trees as a means of determining the overall health of a forest plot. This study will lead students to understand the importance of interrelationships in an ecosystem; specifically a forest ecosystem. Students will record their data and observations in their lab notebook.

Day 9:

Forest in a jar: Record observations. (10 min)

Finish Forest Health.(30 min)

Day 10:

Forest in a jar: (10 min)
Add 8 seeds and record observations.

Forest Health: (30 min)
Collect class data on the forest plot studied and come to a conclusion as a class. Did everyone agree on the health of the ecosystem? Why or why not? Record the class conclusion in your lab notebook and whether you agree with it or disagree. Use data to support your position.

Day 11: (80 min)

Summative Assessment

Sources

Burne, Janet, "Getting Real with the Principles of HDT" and "String Journals".

Council for Environmental Education, *Project WILD* (Houston, Texas ©2001)

Focus on Forests, Project Learning Tree
https://www.plt.org/focus-on-forests

Keeping a Naturalist's Field Journal, www.donnallong.com donna@donnallong.com

Thoreau, Henry D., "The Succession of Forest Trees"
http://thoreau.eserver.org/foresttrees.html

Link to Standards

Connecticut State Frameworks
Next Generation Science Standards (NGSS)

Student Handouts:
Forest in a Jar

Students will observe the changes that take place in a simulated pond ecosystem that gradually evolves into a "forest" over a three week period.

Materials:

pint or quart jars or clear two-liter plastic soda bottles (one per small groups of 3-4 students); water; soil; aquatic plants (one per jar); birdseed, lab notebook.

Procedure:

1. Place two inches of soil and three inches of water in a jar to represent a pond. Place the jar at a window, **without a lid**, and allow it to settle overnight.
2. Add the aquatic plant to the jar and 8 seeds. Each week you will be adding 8 seeds to the jar, while not replacing the water that evaporates.. In your lab notebook, predict what will happen to the "pond" over a three week period. Illustrate your prediction and explain your reasoning.
3. Every other day for the next three weeks, you will record your observations of your "pond" and revise your prediction if necessary. Take a drop of water from your pond, place it on a slide and observe it under the microscope. Record these observations, taking note of the number and types of organisms that are present.
4. At the end of the three week period, clean up your "pond" jar by recycling the biotic material, rinsing and recycling the jar.
5. Answer the following questions:
    1. Describe the changes that occurred inside the jar.
    2. Illustrate four stages in pond succession, from open water to climax forest. Use a cross-sectional view.
    3. What would happen if the lid were left on the jar during the experiment? Explain how this closed system would or would not represent pond succession as well as when the lid is left off.
    4. Why must a farm pond be managed if it is to remain a farm pond? What might you have to do to manage a pond successfully?
    5. Identify and classify biotic and abiotic factors in the jar and tell how each affected the plants in the jar.
    6. Explain why the physical and ecological factors influence interactions and interdependence of organisms.

Nature Journal

What is a Nature Journal?

A nature journal is a personal record of observations about the natural environment.

Why should I keep a Nature Journal?

1. You will deepen your relationship with the environment and begin to care more for it than you do now.
2. You'll become more appreciative of nature's beauty and complexity.
3. You'll become more observant and more open to discovery.
4. You'll be inspired to look things up to expand your understanding and appreciation for what you've observed.
5. You'll spot trends that you might not have noticed otherwise (e.g., when the first robins appear in the spring, changes in high and low temperature ranges, changes in rainfall, frequency of the appearance of certain birds or animals).
6. You'll create a record of the plants and animals that exist in a particular time and place that might become the foundation of future scientific studies.
7. You'll begin to see patterns in behaviors, colors, sounds, and smells.
8. You will more fully appreciate others who observe and write about nature and better understand their enthusiasms for nature and concerns about environmental issues.
9. You'll increase your sense of connection with all living things.
10. You'll learn more about yourself by noticing what things you find especially beautiful, interesting, or inspiring.
11. Strengthening your connection with nature through a nature journal is both restful and restorative.

What do I include in a Nature Journal?

There are many ways to keep a nature journal. Scientific observations are separated from personal reflections using the Grinnell System. Although they are all important, data is different and from impressions so the two should be distinct from one another.

We will be using an variation of the Grinnell System which is based on the scientific method and so is designed to aid scientific investigation. It is the method most often used by professional biologists and field naturalists. The method was developed by Joseph Grinnell (1877-1939), a field naturalist, professor and the first director of the University of California's Berkeley Museum of Vertebrate Zoology. It will be used to hone observation skills and increase our appreciation of nature. It is journals like these that

have documented the continuously earlier returns of birds in the spring and fewer days of ice on lakes in the Midwest over time.

Procedure:

Find a location outside that you can visit easily and often.

Every other week, you will visit this spot for a minimum of 20 minutes. Note: You are required to go outside to observe nature for this assignment; Dress appropriately and plan wisely; no whining.

Every other Monday, you will submit a journal entry of 2 to 3 pages (standard 8.5 x 11" single subject notebook is REQUIRED) that is based on reflections made while visiting your location. Some people like to use note cards or smaller notebooks to take notes while making observations and then writing them into their natural journals later, usually within 24 hours of the observations.

Typically, writing is done on the right hand side page of the notebook while pictures, maps, and sketches are on the left side of the notebook. People who are left-handed do the opposite.

Write this observation checklist in the back of your nature journal. Following it can improve your note-taking and develop skills of consistent observation. Every journal entry should contain this information:

- time (use 24-hour clock format; 14:35 for 2:35p.m.)
- date (use international format: 10 September 2013)
- name; sign each observation legibly.
- locality (place, usually the county and the distance from a "permanent" marker of some sort is included (m from a crossroads etc.)
- route (how did you get there)
- weather (temperature, cloud types, wind, precipitation, humidity, etc.)
- habitat (backyard, type of forest, etc.)
- general vegetation type (e.g. Douglas Fir forest)
- smells and sounds
- species seen; describe if you can't identify
- general notes on insects animals, plants, and their interaction-- competition or partnerships?
- sketches, maps, photos, descriptions, information

Rules of Submission:

Journals are due at the start of the period. NO EXCEPTIONS.

Journals must have a proper heading- Entry #, Date submitted, Title.
Any journal lacking this information will lose 10 points from the grade.

Grading

A thoughtful entry that meets all the criteria receives a "B".

An entry that surpasses expectations receives an "A": "surpasses expectations" may mean that you have shown great insights, you were exceptionally creative, you demonstrated a sophisticated style, etc. Please note that writing mediocre material at great length will not result in a higher grade; quality not quantity.

An entry that does not meet expectations will fail. Possible reasons for a failing grade could include: an entry that comes in separated from your Notebook, careless or exceedingly poor grammar, lack of sufficient length, superficial treatment of your subject matter, lack of connection to the experience of being outside and observing nature.

Late entries will lose 10 points a day. "Late" starts as soon as the class begins on the day your journal is due.

Journals will be averaged together at the end of the quarter as a project grade, 10% of the quarter grade.

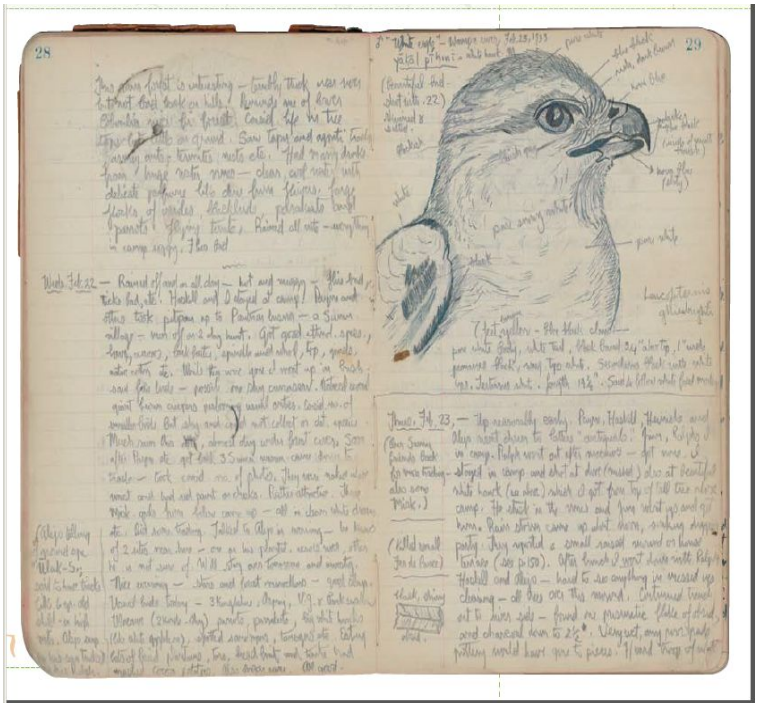
Links to help identify different organisms:

You-Tube Dendrology - Dr. Don Leopold, State University of New York's College of Environmental Science and Forestry professor, has identified a total of 135 tree species on You-Tube. These 2-minute, high definition videos briefly summarize how to identify each tree species, its ecological characteristics and importance, and communicate fun facts. While the list of native and non-native tree species is familiar to Northeastern landscapes, many western U.S. tree species are also covered. These vignettes are also all available for free on i-Tunes.

WildLab Bird - A free app that can be downloaded onto the iPhone, iPod touch, and iPad (try iBird Lite for Android). Use WildLab Bird to learn the basics of bird identification. This application uses audio, photographs, maps, and the process of elimination to help identify over 200 bird species. Sightings can also be entered into a national bird watching database for comparison.

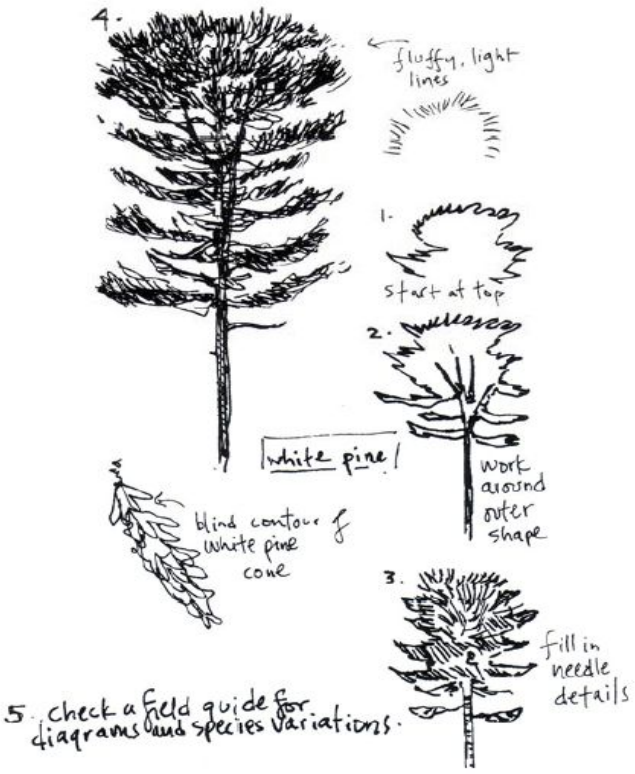
WildObs Observer - A free app that can be downloaded onto the iPhone, iPod touch, iPad, and Android. WildObs Observer allows users to search for and identify thousands of species of mammals, birds, snakes, plants, and more. Log your wildlife encounters for your own calculations or upload them to a national database for comparison.

Leafsnap - A free app that can be downloaded onto the iPhone, iPod touch, and iPad (Andriod version in development). Leafsnap uses visual recognition software to help identify tree species from individual leaf photographs you take in the field. This application contains high-resolution images of bark, flowers, fruit, seeds, and more. Currently Leafsnap specializes in tree species found in the Northeastern United States, but expansion to include all US regions is underway.



(http://www.smithsonianeducation.org/educators/lesson_plans/journals/smithsonian_siyc_fall06.pdf)

http://www.tiaudubon.org/News/Review%20Leslie%20and%20Roth2.pdf



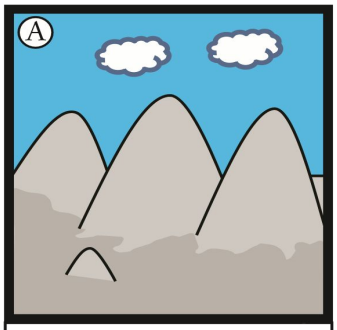
Succession

How do ecosystems develop over time?

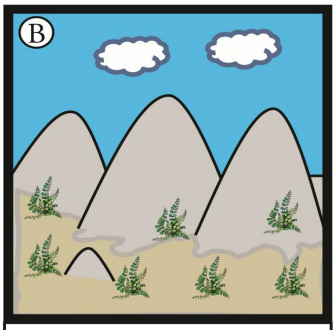
Why?

On May 18, 1980, Mount St. Helens in the state of Washington erupted with the force of a hydrogen bomb. The volcano had been dormant for over 120 years, but now 57 people were dead and forests and lakes were totally destroyed, including nearby Spirit Lake, which became a mud hole. The blast leveled trees in areas over 10 miles from the crater and ash deposits suffocated life on the mountain. However, within weeks, mammals that had taken shelter underground started to reappear in the area, and now, over thirty years later, many areas of the mountain are colonized with a large variety of plant and animal life. How does an area move from a sterile, barren wilderness to one full of life?

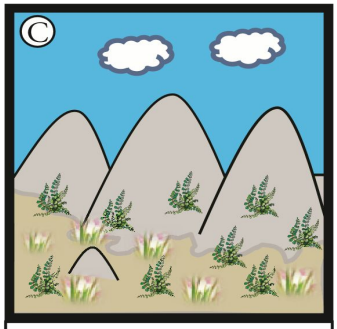
Model 1 – Primary Succession



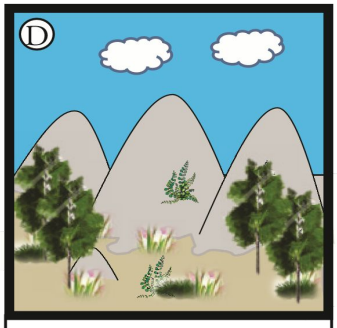
Barren rock from beneath a retreating glacier, or due to a volcanic eruption.



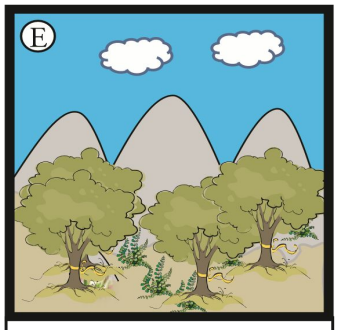
Low-growing plants such as mosses, ferns, and lichens begin to colonize.



Fast-growing grasses, flowering plants, and small shrubs begin to take root. A thin layer of soil develops.



Fast-growing trees such as birch and mountain ash form a low forest and shade out lower plants.



100–200 years since colonization began, large, slow-growing trees, such as an oak, become established.

1. Refer to Model 1.
   a. On what type of land does primary succession first begin to occur?

   b. Does there appear to be any life on the land when primary succession begins?

   c. Why would most plants such as shrubs and trees find it difficult to grow here?

2. Refer to diagram B in Model 1.
   a. What are the first organisms (colonizers) on this land?

   b. Suggest the mechanisms by which the first colonizers arrived on the land.

Read This!

The first colonizers are referred to as the **pioneer community**. These can include lichens, mosses, ferns, and bacteria—all organisms with low nutrient requirements. As they colonize, they break the weathered rock surface, which helps to create the first thin layer of soil. Without soil other plant life cannot be sustained and without plants no animal life can exist.

3. Refer to Model 1.
   a. Which diagram illustrates a pioneer community?

   b. What are some of the features of the pioneer community?

4. Notice the colonizers in diagrams C and D are taller and require more nutrients than those in the pioneer community. Considering what you already know about plants and photosynthesis, why might it be a competitive advantage for a plant to be taller?

5. What happens to the pioneer organisms once the new colonizers become established?

Read This!

As the newer colonizers begin to take over, animals will also begin to appear so they can feed on the more diverse food source. The pioneer plants die and decompose and the animals leave behind manure. Both add to the thin soil layer.

6. What effect will the addition of animal waste and decayed plant matter have on the soil and land?

7. How will grazing animals help plants to become established?

8. How will the grazing animals prevent or control further colonization by other plants?

9. Using the diagrams in Model 1 as a guide to develop a defi nition with your group for the term **primary succession**, as it relates to the colonizing of barren land.

Read This!

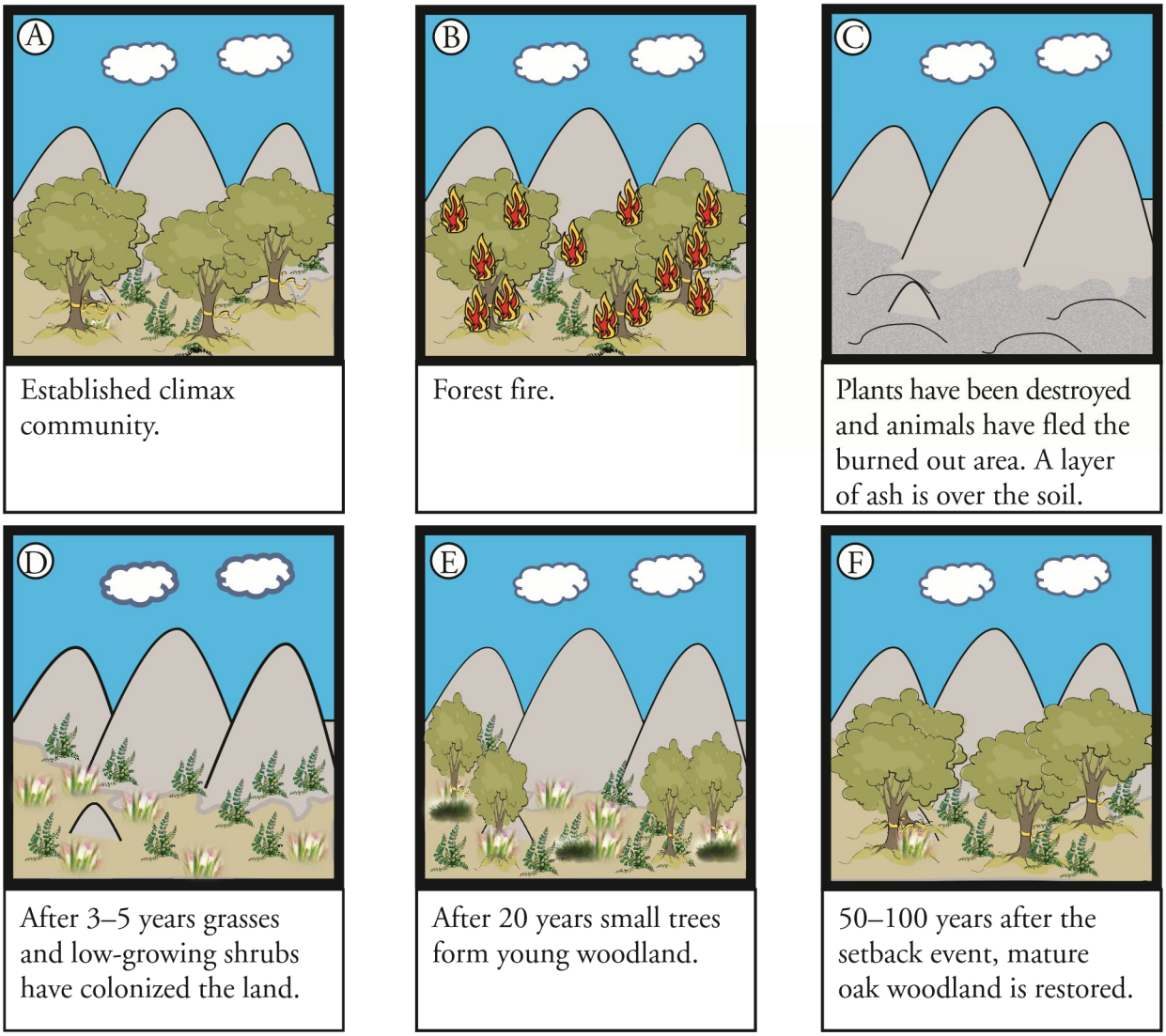
As soil quality and quantity improves, the life forms present in the area undergo a series of changes, each referred to as a **seral stage**. Eventually a stable climax community is formed.

10. Label the pictures in Model 1 as pioneer community, seral stages, and climax community.
11. Most climax communities are mature forests. What features of mature forest species, such as oak trees, make them able to dominate and compete in the ecosystem?

12. What environmental factors may affect the type of climax community that develops in an ecosystem?

STOP

Model 2 – Secondary Succession



13. Refer to the diagrams in Model 2.

    a. What stage of development does diagram A represent?

    b. What appears to have happened in diagram B?

    c. What could be two causes of this event?

    d. What process will begin again after this event has occurred?

14. Can the ecosystem totally recover from this set-back? What evidence is given in Model 2?

15. What effect does an existing soil presence have on the seral stages of secondary succession and the time it takes to return to the climax community compared to primary succession? Give your answer in complete sentences and justify your reasoning.

16. Why is the title of Model 2 **Secondary Succession** rather than Primary Succession?

17. Consider each event below and determine if the recovery process for the environment will happen by primary succession or secondary succession.

    a. Melting, receding glaciers. *b* Logging a wooded area.

    c. Major flooding of a creek bed.

    d. Volcanic eruption with lava fl ow.

18. Are these destructive methods always natural? Explain your answer.

STOP

19. Human activity may alter or "defl ect" the natural course of succession, which leads to a change in the climax community. An example of a human activity that defl ects succession would be grass mowing. The climax community that

develops from a **defl ected succession** is called a **plagioclimax community**. Suggest some other human actions that may lead to plagioclimax communities.

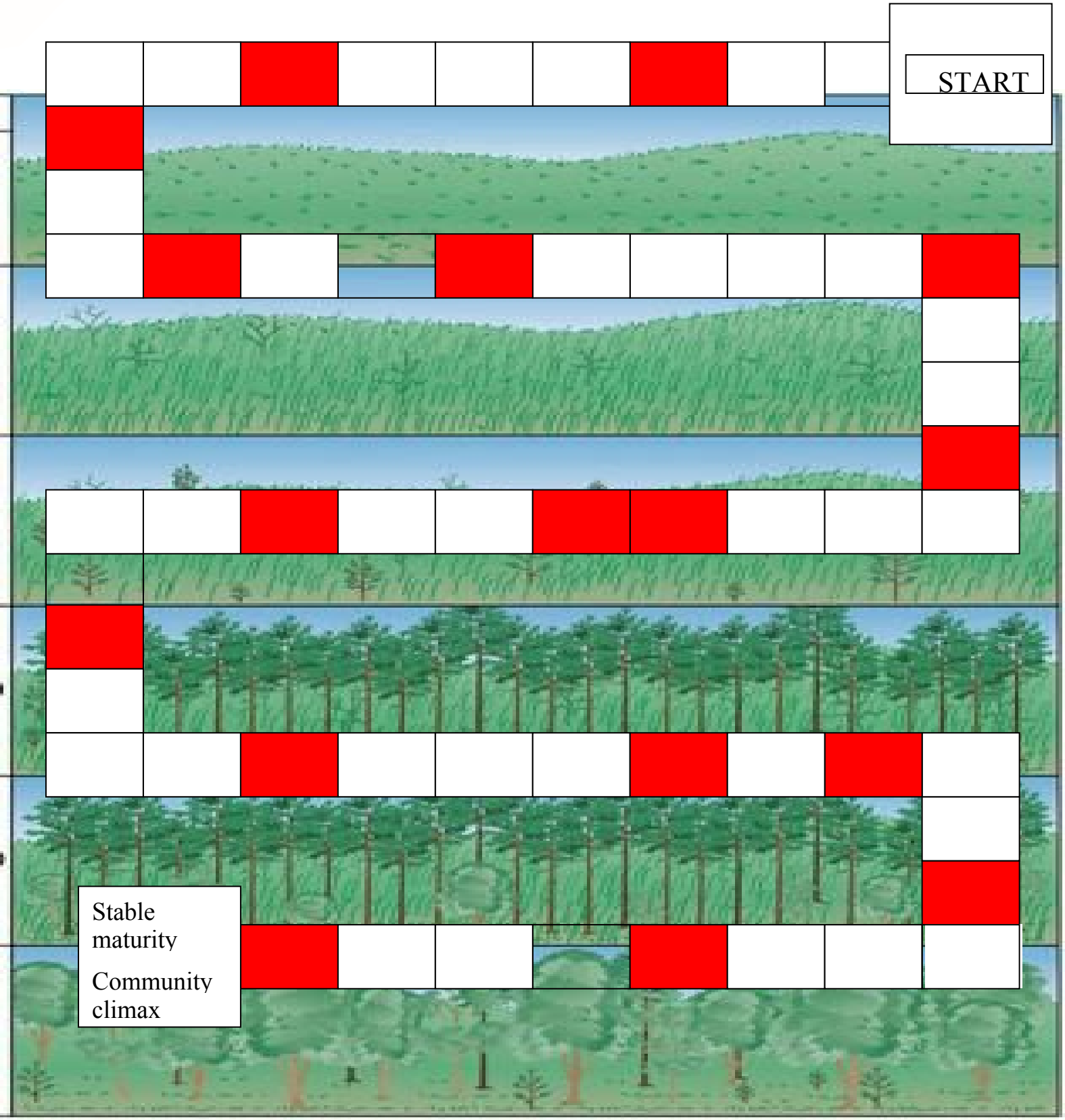
Extension Question

20. Large canopy trees in rainforests reduce light penetration to the forest floor and slow down the growth of tree saplings. In a dense forest, selective logging is often used as a means of conservation, rather than clear cutting large sections of land. Why might selective logging be considered preferable to clear cutting?

Succeeding in Succession Game Rules

Game pieces:

Loblolly Pine (*Pinus taeda*)
Water Hickory (*Carya aquatica*)
Yew Shrub (*Podocarpus macrophylla*)
Japanese barberry (*Berberis thunbergii*)



A volcano covers the area with ash (primary succession) – everyone goes back to start	A broken dam sends a flood through the forest – Japanese barberry move back two spaces
Lightning strikes and causes a fire – *Loblolly pine, Yew shrub* and *Japanese barberry* move back 3 spaces, *Water Hickory* move back one space	A glacier edges through the area scraping down to bare rock. (primary succession) – everyone goes back to start
A harsh winter freezes the ground – *Loblolly pine, Water Hickory* and *Yew shrub* moves back one space	A logging company strips the forest of hard wood trees for lumber – *Water hickory* move back 3 spaces

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A warm fall causes the leaves form the pine and hickory to fall, shading and rotting the understory – *Yew shrub* and *Japanese barberry* move back one, *Water hickory* and *Loblolly pine* move up one	Overcrowding!! The soil has been depleted of nutrients – the person who rolls the highest number gets to thrive, all others perish. Highest roller moves up three spaces, lowest rollers move back two spaces
Overcrowding!! The soil has been depleted of nutrients – the person who rolls the highest number gets to thrive, all others perish. Highest roller moves up three spaces, lowest rollers move back two spaces	A large rodent population depletes the shrubs for nutrients – *Yew shrub* and *Japanese barberry* move back two spaces
The *Japanese barberry* overpopulates and changes the pH in the soil – *Water hickory* moves back two spaces, *Loblolly pine* and *Yew shrub* moves back three spaces, *Japanese barberry* moves up one space	High winds take out the tops of hard wood and soft wood trees. *Water hickory* and *Loblolly pine* move back two spaces
A tornado rips through the forest – *Loblolly pine* and *Japanese barberry* move back 3 spaces	Thousands of locusts migrate through the forest – *Yew shrub* and *Japanese barberry* move back two spaces, *Loblolly pine* and *Water hickory* move back one space
A development company clears the forest to build houses, everyone move back four spaces	Overcrowding!! The soil has been depleted of nutrients – the person who rolls the highest number gets to thrive, all others perish. Highest roller moves up three spaces, lowest rollers move back two spaces
Water hickory thrives as time passes – *Water hickory* move up two spaces	A thriving canopy provides heavy shade for the underbrush – *Yew shrub* move up one space, *Japanese barberry* moves up two spaces
Ceratocystis fimbriata, a	

deadly plant fungus, infected the pollen development of all hard wood trees – *Water hickory* move back 3 spaces	Disease depletes the mammal populations, shrub grazing decreases. *Yew shrub* and *Japanese Barberry* move up 2 spaces
Contaminated run-off water causes severe soil erosion – everyone moves back two spaces	A rare parasite infects the bark of soft wood trees – *Loblolly pines* move back two spaces
Five years after a primary succession event allows shrubs to flourish while trees are still seedlings and immature – Yew shrub and Japanese barberry move up three spaces	Litter from fallen trees enriches the soil for all species. Everyone move up one space

Succession Practice

Give one example based on the cards when the success of one species positively affected the success of another species.(5 points)

_____

_____

_____

Give one example based on the cards when the success of one species negatively affected the success of another species. (5 points)

_____

_____

_____

Reflect on the process of the game by answering all of the following questions:

1. What plant species were you?(1 point)

   _____

2. Was your plant included in the community climax?(Yes or no)(1 point)

   _____

3. Which plants succeeded in succession during your game? (1point)

   _____

4. Do you think all of the plants would have been able to reach community climax, explain why or why not. (2 points)

   _____

   _____

   _____

A very important concept of succession is facilitation, where the successes of one community type change the environment gradually so as to not favor their own (or their children's) continued dominance, but rather favor the success of some new, different community members. Why do you think organisms would facilitate the success of other organisms when it would be at the expense of their own success? (10 points)

Forest Health Indicator: Tree and Crown Condition

Name(s):_____
_____
Location:_____
Date:_____

Damage to trees from disease, weather, and activity by animals, insects, and humans can affect overall forest health. Several of these signs are included in the chart below.

Materials

Paper, pencils, chalk

Method

Count all the trees in the plot, marking the trees with colored chalk to help you keep track. Note trees that have one or more signs of disease or damage (see below). To count it as diseased or damaged, 10 percent or more of the tree should be affected. Calculate the percentage of all trees in the plot that have such signs.

Signs of Disease or Damage	
Sign	**What it may indicate**
Tree has ragged leaves with holes	Insects feeding on the leaves
Black or brown leaves	Stem or leaf disease
Spots or bumps on leaves	Insects and mites
Twisted or malformed leaves	Insects and disease, herbicides
Leaves changing color before fall	Trunk or root damage, drought, pollution
Branch decay	Unhealed wounds
Peeling or broken bark, holes in the bark	Trunk wound, canker disease, or damage caused by humans or animals
Dying branches on one side of crown	Root decay, root injury or internal stem disease, insect attack
Canker (a dead section of a trunk or branch)	Fungal infections
Splits	Broken branches
Hollows	Water entering through old wounds and supporting wood decay by fungi
Fungi or mushrooms growing on tree	Internal decomposition of wood by fungi
Green or brown spots on needles	Air pollution

Results

Total number of trees with signs of disease or damage in plot: _____ (Value A)
Total number of trees in plot: _____ (Value B)
Percentage of trees damaged = (Value A ÷ Value B) x 100 = _____ percent

Rating

Tree and Crown Condition		
Rating	**Description**	**Points**
Good	Less than 25 percent of trees have damage	3

Name(s):_____

Forest Health Indicator: _____

Location:_____

Forest Diversity

Date:_____

A healthy forest includes a variety of different plants and animals. One way to assess this diversity is to determine whether there is a mix of plant species of different sizes and ages, thus creating forest "layers" that provide habitat for many species.

Materials

Pencil, paper, tape measure, chalk, tree identification guide (optional)

Method

Look at the leaves, bark, seed pods, or flowers of the trees in your forest plot to determine whether they are the same or different species. Use the *Tree Species Diversity* chart below to catalog this information. Tree identification guides are helpful with this step, but not necessary. If a tree identification guide is not available, use your observation skills to describe the differences in tree types and include this information in the *Tree Species Diversity* chart below.

Measure (or estimate) the diameter at breast height (DBH) for all trees in the sample plot. Count (or estimate) the number of trees of different size classes using the corresponding DBH size classifications found in the *Size Diversity* chart below and record your findings. To help you, consider using chalk to mark the trees you have already counted.

Assess the presence or absence of different forest layers, using the descriptions found in the *Forest Layer Diversity* chart and record your findings.

Results

Tree Species Diversity		
	Name or Description	**Number found in sample plot**
Species 1		
Species 2		
Species 3		
Species 4		
Species 5		

Tree Size	DBH	Number found in sample plot
Saplings or Poles	4–9 inches (10–24 cm)	
Small	10–14 inches (25–37 cm)	
Medium	15–19 inches (38–49 cm)	
Large	20–29 inches (50–75 cm)	
Giant	30 inches or greater (> 75 cm)	

Forest Layer Diversity

Tree Layer	Description	Present in sample plot? (Yes/ No)
Overstory	Trees whose canopies are fully exposed to the sun	
Understory	Trees growing in the shade of other trees	
Tall shrub	Shrubs (woody plants with several stems arising from the base) greater than 6 feet (1.8 meters) in height	
Short shrub	shrubs less than 6 feet (1.8 meters) in height	
Forb	herbaceous (non-woody) plants such as ferns, wildflowers, and grasses	
Leaf litter	Dead and decaying leaves and other matter on the forest floor	

Forest Health Indicator: Forest Diversity (cont.)

Rating

Size Diversity

Rating	Description	Points

Rating	Description	Points
Good	Five or six layers present	3
Fair	Three or four layers present	2
Poor	One or two layers present	1

***Forest Layer Diversity* rating for sample plot:** (Value C)

Overall Rating

Determine the overall rating by adding up the points shown for the tree species, size, and forest layer diversity ratings; then dividing the total by 3. Round the total to the nearest whole number. (Value A + Value B + Value C) ÷ 3 = _____ (Average point value)

Overall rating for Forest Diversity:
Good: Average point value of 3 *Fair:* Average point value of 2 *Poor:* Average point value of 1

Overall *Forest Diversity* rating for sample plot: _____

Sources

Greenleaf Forestry and Wood Products Inc. 2010. "Forest Health Checklist." http://www.greenleafforestry.com/greenleafservices_006.htm.

Portland State University. 2010. "Protocol: Measuring Tree Diameter, Class Size, and Average Species Diameter." *Ecoplexity*. http://ecoplexity.org/node/236?page=0,4.

Name(s):_____

Forest Health Indicator:

Location:_____

Lichen Abundance

Date:_____

Lichens often grow on trees and shrubs, absorbing nutrients from the atmosphere. Because lichens are very sensitive to air pollution—particularly to sulfur dioxide, fluoride, and ammonia—their presence or absence is an indicator of forest health. The acidity of a tree's bark can also affect lichen abundance.

A lichen is actually two different organisms—either a fungus and an alga, or a fungus and a cyanobacterium—living in a symbiotic relationship. The fungus provides protection and moisture, while the alga or cyanobacterium provides food through photosynthesis.

Materials

String, tape measure, compass, chalk, 100-circle grid transparency

Method

Select 10 trees on your study plot to sample. For each tree, tie a string around the trunk at a standard height (such as diameter at breast height, or DBH). Use a compass to determine north, south, east, and west; then mark the directions with chalk on the tree at the string line.

At each of the 4 directions, place the 100-Circle Grid Transparency against the tree, and count the number of circles in which lichens are showing. That number represents the percentage of lichen coverage. For each tree, find the average lichen coverage by totaling the lichens found within the circles and then dividing the total by 4. Find the total average lichen coverage of the plot.

Results

Trees help support many other living organisms, including these lichens. Far from harming the tree, lichens indicate pollution-free air. Photo by USDA Forest Service - Northeastern Area Archive, USDA Forest Service.

For each tree and direction, record the number of circles that show lichens. This number represents the percentage of lichen coverage.

Forest Health Indicator: Lichen Abundance (cont.)

Lichen Abundance						
	North	**East**	**South**	**West**	**Total**	**Tree Average (%)**
Tree 1:						
Tree 2:						
Tree 3:						
Tree 4:						
Tree 5:						
Tree 6:						
Tree 7:						
Tree 8:						
Tree 9:						
Tree 10:						
Totals:						
Average:						

Add up the tree averages, which will be recorded in the final column in the chart above. Divide this total by the number of trees sampled to get the average lichen coverage for the entire sample plot.

Average Lichen Coverage for sample plot: _____ percent

Rating

Rating	Description	Points
Good	Greater than 5 percent lichen coverage	3
Fair	3–5 percent lichen coverage	2
Poor	0–2 percent lichen coverage	1

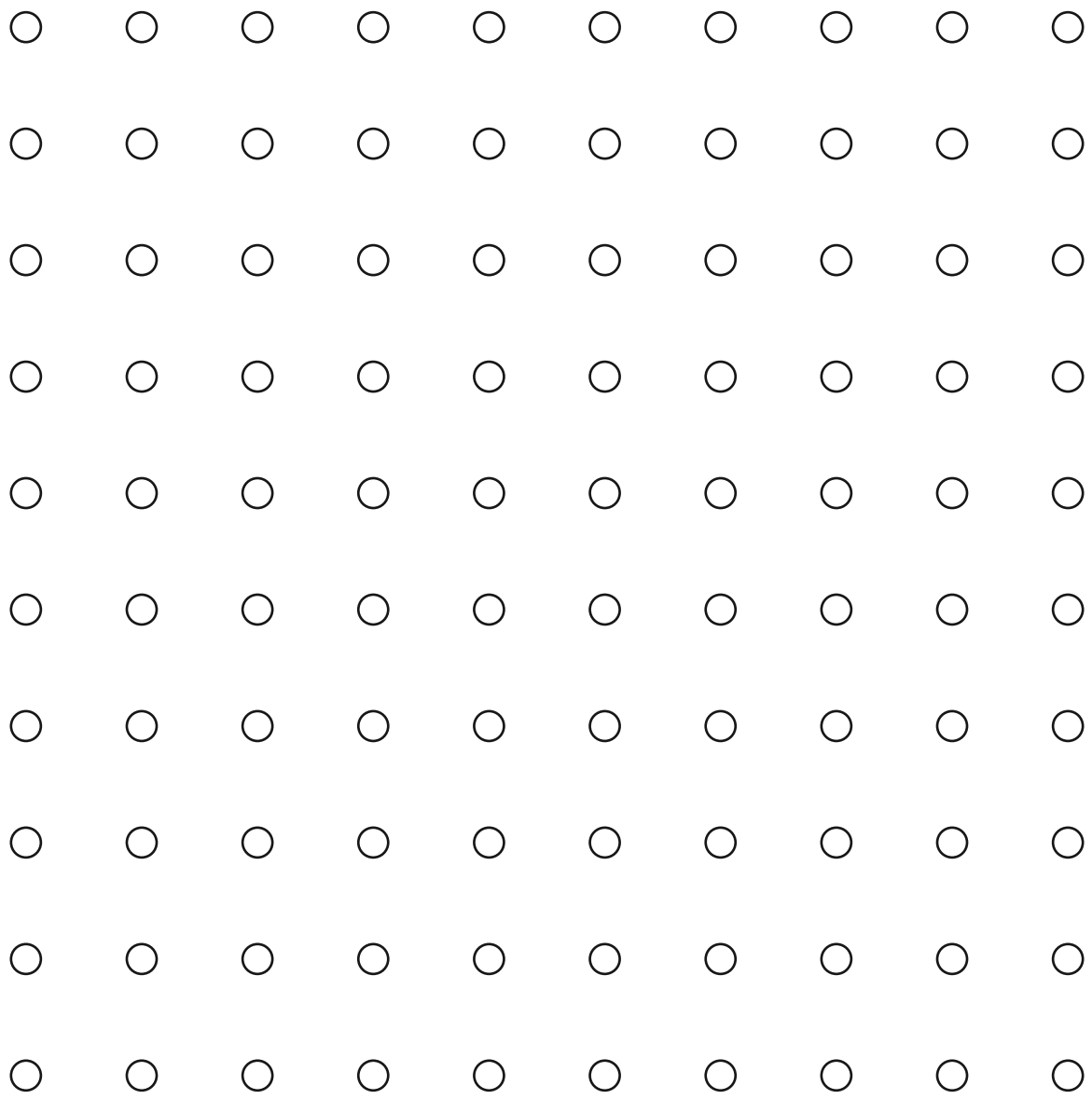
Overall *Lichen Abundance* rating for sample plot:

Sources

Pathfinder Science. 2006. "Sampling Procedure for Lichen Coverage." http://www.pathfinderscience.net/so2/cproto1.cfm.

Smith, Gregory L., and Thomas R. Baker. 2003. "Lichens as Bioindicators." In *The Middle School Science Classroom*, NSTA ScienceScope, 16–19. http://tbaker.com/tbaker/academics/papers/published/sciscope_lichens/released_byNSTA/Lichens%20as%20Bioindicators.pdf.

100-Circle Grid Transparency



Name(s):_____

Forest Health Indicator: _____

Location:_____

Soil Quality

Date:_____

The quality of the soil in a forest is an important indicator of forest health. How well the soil functions directly influences the health of the trees and other forest organisms. An evaluation of soil quality usually involves measuring the soil's physical, chemical, and biological makeup at different depths.

Materials

Spade or trowel, 3 paper cups or plastic bags, distilled water, eyedropper, 3 Petri dishes or plastic containers, pH paper, white paper

Method

Choose a soil sample site that represents the overall forest plot, and measure 1 square foot (0.09 square meters) of ground, marking the corners with sticks or rocks. Within the plot, first remove the leaf litter layer with a spade or trowel. Next, collect soil samples from depths of approximately 3 inches (7.5 cm), 6 inches (15 cm), and 1 foot (30 cm). Use paper cups or plastic bags to store the samples.

Conduct the following assessments for each sample, recording your results in the "Soil Quality Results and Ratings" chart below.

Results

Soil Type

Most soils are a mixture of sand, silt, and clay. The specific content of a given soil influences how well it holds nutrients and water. To find out your soil type, take a small amount of soil (about the size of a marble), and moisten it with a few drops of water. Squeeze it between your thumb and fingers.

Soil Types		
Soil Type	**Squeezed Moist Soil**	**Rating**

SandFeels	gritty and cannot hold ball shape prone to drought	**Poor**—Has few nutrients, holds little water, and is
Sandy	LoamCan be molded into a ball, but ball breaks up retention	**Good**—Has good balance of nutrients and moisture easily
Can be Silt does not	molded into a ball that is easily deformed; **Fair**—Has feel gritty and has silkiness like floursand, but washes	more nutrients and holds more water than away (erodes) easily
Can be Loam	molded into a ball that can be handled quite freely without breakingretention	**Good**—Has good balance of nutrients and moisture
Can be Clay Loam will	formed into a long thin rod or "ribbon" that **Good**—Has break readily, barely sustaining its own weightretention	good balance of nutrients and moisture
Clay	Sticky and can easily be formed into long thin rod or "ribbon"movement of air or water, so doesn't drain well	**Fair**—Holds water very well, but does not allow

Record your results in the "Soil Quality Results and Ratings" chart.

Forest Health Indicator: Soil Quality (cont.)

Soil pH

Soil pH is a measure of how acidic or alkaline the soil is, and it is an indicator of soil quality. Measure 1 tablespoon of soil from each depth, place this amount onto individual Petri dishes or plastic containers, and label the soil samples. Wet each soil sample with 5 drops of distilled water, and allow it to sit for 3 to 5 minutes. Place one piece of pH paper on each soil sample. Determine the approximate pH of your soil.

Soil pH		
Rating	**Description**	**Points**
Good	pH of 5.51–7.2, which is optimum for many plant species	3
Fair	pH of 7.2–8.5 (moderately alkaline) or 4.0–5.5 (moderately acid)	2
Poor	pH of 4.0 and less (acid), or greater than 8.5 (alkaline)	1

Record your results in the "Soil Quality Results and Ratings" chart.

Soil Organisms

The presence of living organisms in the soil is an important indicator of productive soils. Soil organisms aid in nutrient cycling, soil creation, and decomposition of organic matter and dead organisms. Pour the remaining soil sample onto a white piece of paper, and look for the presence of the following organisms. For each type, circle whether it is present or not. (Soil fungi are microscopic cells that grow as long threads or strands in the soil.)

Soil Organisms

Rating	Description	Points
Good	3 or more types of soil organisms present in soil sample	3
Fair	1 or 2 types of organisms present in soil sample	2
Poor	no soil organisms present in soil sample	1

Record your results in the "Soil Quality Results and Ratings" chart.

Forest Health Indicator: Soil Quality (cont.)

Rating

Circle the ratings that apply for each depth and each assessment. Determine the average score for each depth by adding up the points shown for each rating and dividing the total by 3. Find the average of the three "Average Soil Quality at Each Depth" ratings to get the overall soil quality.

Soil Quality Results and Ratings

	3 in (7.5 cm) deep	6 in (15 cm) deep	12 in (30 cm) deep
Soil Type	Type:_____	Type:_____	Type:_____
	Good: 3 points	*Good:* 3 points	*Good:* 3 points
	Fair: 2 points	*Fair:* 2 points	*Fair:* 2 points
	Poor: 1 point	*Poor:* 1 point	*Poor:* 1 point
	Type:_____	Type:_____	Type:_____
	Good: 3 points	*Good:* 3 points	*Good:* 3 points

Soil pH

Fair: 2 points*Fair:* 2 points*Fair:* 2 points
Poor: 1 point*Poor:* 1 point*Poor:* 1 point

Type:_____Type:_____Type:_____

Soil *Good:* 3 points*Good:* 3 points*Good:* 3 points
Organisms*Fair:* 2 points*Fair:* 2 points*Fair:* 2 points
Poor: 1 point*Poor:* 1 point*Poor:* 1 point

Total Points			
Average Soil Quality at Each Depth (rounded to nearest whole number)			
Overall Soil Quality (rounded to nearest whole number)			

Good: Average point value of 3
Fair: Average point value of 2
Poor: Average point value of 1

Overall *Soil Quality* rating for sample plot: _____

Source

USDA Forest Service. 2007. "Soil Vital Signs: Soil Quality Index (SQI) for Assessing Forest Soil Health." http://www.fs.fed.us/rm/pubs/rmrs_rp065.pdf.

Name(s):_____

Forest Health Indicator: _____

Location:_____

Regeneration

Date:_____

Forest regeneration is a good measure of the health of the forest habitat. When a forest can produce enough young trees to replace the canopy trees when they are cut, blown down, or die, such production is an indication that the forest is vibrant and sustainable. An

Rating	Description	Points
Good	More than 66 percent of plot segments have at least one healthy seedling.	3
Fair	33 to 66 percent of plot segments have at least one healthy seedling.	2
Poor	Less than 33 percent of plot segments have at least one healthy seedling.	1

Overall *Regeneration* rating for sample plot:

Source

Forestry Branch, Province of Manitoba. 2010. "Silviculture Surveys: Regeneration Surveys." http://www.gov.mb.ca/conservation/forestry/renewal/surveys.html.

Name(s):_____

Forest Health Indicator: _____

Location:_____

Snags and Coarse Woody Debris

Date:_____

In natural forest ecosystems, snags (standing dead trees) and coarse woody debris (dead logs and large branches on the ground) are important indicators of forest health. Their presence indicates a forest of diverse ages, and the snags and debris provide animal habitat, energy and nutrient cycling, and stable soils.

Note: In parks or near structures, forest managers may remove snags or coarse woody debris to prevent fire and other safety hazards. If your forest plot is in such an area, the presence of snags or debris may not be a relevant forest health indicator.

Materials

Tape measure

Method

Count the number of snags and the number of live trees in your forest plot, and calculate the percentage of standing trees that are snags. Then, count the number of dead logs and downed large branches in your plot that are more than 4 inches (10 cm) in diameter and more than 39 inches (1 m) in length, and calculate their abundance.

Results

Snags

Number of snags in plot: _____

(Value A) Number of live trees in plot:
_____ (Value B)

Total number of standing trees in
plot: Value A + Value B =
_____ (Value C)

Percentage of snags:
(Value A ÷ Value C) x 100 = _____ percent (Value D)

Coarse Woody Debris
Number of logs and downed branches greater than 4 inches (10 cm) in diameter and 39 inches (1 m) in length: _____ (Value E)

Abundance of course woody debris:
(Value E ÷ Value B) x 100 = _____ percent (Value F)

(**Note:** For some forest plots, abundance may be more than 100 percent.)

Forest Health Indicator: Snags and Coarse Woody Debris (cont.)

Rating

Snags		
Rating	**Description**	**Points**
Good	From 10 to 15 percent of standing trees are snags.	3
Fair	From 5 to 10 percent of standing trees are snags.	2
Poor	Fewer than 5 percent of standing trees are snags.	1
	***Snags* rating for sample plot**	points (Value G)

Coarse Woody Debris		
Rating	**Description**	**Points**
Good	More than 15 percent abundance of coarse woody debris.	3
Fair	From 5 to 15 percent abundance of coarse woody debris.	2
Poor	Fewer than 5 percent abundance of coarse woody debris.	1
	***Coarse Woody Debris* rating for sample plot**	points (Value H)

Overall Rating
Determine the overall rating by adding up the points shown for the snag and coarse woody debris ratings, and then divide the total by 2. Round to the nearest whole number.

(Value G + Value H) ÷ 2 = _____

Good: Average point value of 3
Fair: Average point value of 2
Poor: Average point value of 1

Overall *Snags and Coarse Woody Debris* rating for sample plot: _____

Source

National Park Service. 2009. "Forest Health: Course Woody Debris and Snags." Resource Brief, Northeast Temperate Network. http://science.nature.nps.gov/im/units/NETN/Education/Resource%20Briefs/NETN_RB_CWDSnags_FINAL.pdf

Forest Health Indicator: Wildlife

Name(s):_____
_____
Location:_____
Date:_____

The presence of a variety of wildlife is an indicator that a forest is vibrant and healthy. Actually seeing the animals may be difficult, but tracks, droppings, burrows, dens, nests, chewed leaves, and other evidence or "signs" reveal their existence. You are more likely to see or hear the animals if you are quiet, respectful, and patient.

Materials

Pencil, paper, binoculars or magnifying glass (optional)

Method

In your forest plot, look on the ground, under shrubs, and in trees for mammals, birds, reptiles, amphibians, spiders, or insects, or for signs of those animals. Record your observations.

Results

Animal Signs and Sightings		
Animal Class	**Signs**	**Sightings**
Mammals		
Birds		
Reptiles		
Amphibians		
Spiders		
Insects		
Other		

Rating

Wildlife		
Rating	**Description**	**Points**
Good	Signs or sightings of 4 or more different classes of animals	3
Fair	Signs or sightings of 2–3 different classes of animals	2
Poor	Signs or sightings of 0–1 different classes of animals	1
	Overall *Wildlife* rating for sample plot:	

Name(s):_____

Forest Health Summary _____

Location:_____

Date:_____

Use this page to tally the Forest Health Indicator investigations that you have conducted for your forest plot, while noting any key observations. Use the indicators to make an assessment of the forest's overall health.

Forest Health Summary			
Forest Value Indicator(3,	**Overall 2, or 1)or**	**(Good, Poor)**	**Fair, OverallRatingKey Observations Health Point**
Tree and Crown Condition			
Forest Diversity			
Lichen Abundance			
Soil Condition			
Regeneration			
Snags and Coarse Woody Debris			
Wildlife			
Averages / Conclusions			

What is the Overall Health Assessment for your study plot?

Explain your reasoning.

How Did Stone Walls End Up in the Middle of Forests?

Summative-Assessment:

- Your task is to create a mini-history lesson about life in an ecosystem, other than a forest, spanning 100 years., and share this lesson with the rest of the class.
- Working in groups of 3-4 you will research one of the following ecosystems to present:
    - Pond – Primary succession
    - Coral reef – Primary Succession
    - Desert – Secondary succession
    - Swamp – Secondary succession
    - Rain forest – Secondary succession
    - Seashore – Secondary Succession
- Specifics:
    - Research your ecosystem and its communities.
    - Sketch a timeline of the life of the ecosystem and how both biotic and abiotic factors have changed over time.
    - Choose one organism (insect, tree, lichen, etc.) in the community to tell the story of the environmental changes that may take place Use this character as your narrator.
    - Create a comic strip, flipbook, rap, skit, electronic presentation or diorama to tell a possible history of the area. Be sure your changes are realistic.
    - Draw, use clip art or pictures from magazines to illustrate your work.
    - Write a brief paragraph explaining what you found and the length of time it took for the steps in succession to occur that led to a climax community.

CONDUCTING INQUIRY ORIENTED RESEARCH RUBRIC

	Task Definition: What is the problem to be solved? What types of information are needed to solve the problem?	**Information Seeking Strategies**: What are all possible sources of information? Which are	**Location and Access** Where are these sources? Where is the information within each	**Responsible Information Use** What information does the source provide? How can you extract the information you need?

		the best of all the possibilities?	source?	
EXCEEDS STANDARD	The student **thoroughly** identifies a research question or preliminary thesis statement or statement of the assignment	The student develops a**highly effective** research plan to complete the task or answer the research question, or prove or disprove a thesis.	The student is **highly effective** in locating and accessing a source and information within a source	The student **thoroughly** understands responsible information use
MEETS STANDARD	The student **substantially** identifies a research question or preliminary thesis statement or statement of the assignment	The student develops an **effective** research plan to complete the task or answer the research question, or prove or disprove a thesis.	The student is **effective** in locating and accessing a source and information within a source	The student **substantially** understands responsible information use.
APPROACHING STANDARD	The student **partially** identifies a research question or preliminary thesis statement or statement of the assignment	The student develops a **moderately effective** research plan to complete the task or answer the research question, or prove or disprove a thesis.	The student is **moderately effective** in locating and accessing a source and information within a source	The student **partially** understands responsible information use.
BELOW STANDARD	The student demonstrates **difficulty** in identifying an essential question and a preliminary thesis statement or statement of the assignment.	The student develops an **ineffective** research plan to complete the task or answer the research question, or prove or disprove a thesis.	The student is **ineffective** in locating and accessing a source and information within a source	The student **does not** understand responsible information use.

Teacher Comments

Student Goals/Actions