INSIDE OREGON'S FORESTS

A high school forestry curriculum

ENVIRONMENTAL IMPORTANCE OF OREGON'S FORESTS

1: Forests and Drinking Water
2: Watershed Survey
3: Forests as Habitat
4: Habitat Edges
5: Forests and Carbon

Oregon Forest Resources Institute

Introduction

Inside Oregon's Forests is a high school curriculum developed by the Oregon Forest Resources Institute (OFRI) to help students build a deep understanding of Oregon's forests. The seven modules are loosely organized around topics and concepts from the *Oregon Forest Literacy Plan*, a forest-education conceptual framework developed by OFRI and available at learnforests.org.

Curriculum Goals and Objectives

The overall goal of this curriculum is to provide engaging, standards-based lessons that help high school students understand the environmental, economic and social importance of Oregon's forests, as well as the principles behind forest management. Through the lessons, students will be able to:

- explain basic tree biology
- identify the forest types in Oregon
- describe the environmental, economic and social benefits Oregon's forests provide
- explain scientific and economic principles involved in managing Oregon's forests
- describe current issues facing Oregon's forests
- identify actions they can take to help ensure the sustainability of our forests

Curriculum Overview

Following is a description, as well as a suggested sequence and time frame, for each of the seven modules in the curriculum.

Sequence & Time Frame	Module	Description
Weeks 1-2	Oregon's Forest Heritage	Students are introduced to Oregon forests and their history, and examine some changes in our state's forestland over time.
Week 3	Forest Basics	Students gain an understanding of both tree biology and the forest types in Oregon, and practice identifying and measuring trees.
Weeks 4-5	Environmental Importance of Oregon's Forests	Students explore the environmental importance of forests: for example, how they protect our water resources, provide habitat and store carbon.
Week 6	Economic Importance of Oregon's Forests	Students examine Oregon's forest economy, including the products, energy and jobs that come from forests.

Weeks 7-9	Forest Management	Students learn about forest management and practice forest management skills, such as surveying a forest tract, analyzing forest soil and developing a management plan.
Weeks 10-11	Forest Management Issues	Students explore the impacts of fire, forest pests and climate change on Oregon's forests, and conduct an opinion survey related to a forest management issue.
Week 12-13	Our Responsibility to Oregon's Forests	Students learn about certification as a way to achieve forest sustainability, and plan and carry out a service-learning project.

How to Use the Curriculum

The curriculum is designed to be flexible. Teachers may select modules or lessons that fit their educational goals, as each lesson can either stand alone or build on prior lessons. This curriculum may be used:

- as the basis for a 13-week or semester-long course on forestry
- to teach a single unit on forestry within other high school courses, such as agricultural science and technology, or environmental science
- to help prepare students for the FFA Career Development Event (CDE) on Forestry, or for Envirothon

Curriculum Resources

The following Resources (available at learnforests.org) support teaching the curriculum:

- Glossary
- Supplies
- OFRI Publications and Videos
- Student Pages
- Field Investigations
- Oregon Standards Connections
- Oregon Forest Literacy Plan Concepts

About OFRI

The Oregon Forest Resources Institute supports and enhances Oregon's forest products industry by advancing public understanding of forests, forest management and forest products.

ENVIRONMENTAL IMPORTANCE OF OREGON'S FORESTS

1: Forests and Drinking Water

Overview

Students read about the importance of forests for protecting water resources and then conduct an investigation comparing water filtration from different soil materials.

Time Considerations

Preparation: 30-45 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to:

- Develop a hypothesis regarding rates of filtration based on soil type.
- Compare the absorption and runoff of different soil and soil cover conditions.
- Identify ways that forests help protect drinking water.

Standards Connections

Oregon Science Standards

- Science and Engineering Practice – Analyzing and Interpreting Data. Evaluate the impact of new data on a working explanation and/or model of a proposed process or solution.

Oregon Mathematics Standards

- Mathematical Practice – MP.2. Reason abstractly and quantitatively.
- Mathematical Practice – MP.4. Model with mathematics.

Oregon Forest Literacy Plan Concepts

- 1.C.2. Forest ecosystems include processes such as photosynthesis, energy flow and the cycling of nutrients, water, carbon and other matter. Energy and matter are transferred between producers, consumers and decomposers.
- 2.A.1. Forests improve air and water quality, and help stabilize soil.
- 2.B.1. Forests provide multiple economic benefits, including jobs, a source of forest products and business opportunities (e.g., recreation and tourism).

Materials

- *Forest Fact Break: Water* video (1:40 minutes), available at learnforests.org
- *Speakers Bureau Presentation: Oregon's Forests and Water* video (optional), available on the OFRI YouTube channel
- Technology for showing video(s)
- Materials for each soil filtration model, one per group[1] (see Preparation below for details):
    - 2-liter plastic bottle
    - 6-oz can taller than wide
    - Stopwatch (or stopwatch app for smartphone or tablet
    - Clear plastic cups or other containers
- Materials for soil filtration model, per class:
    - A variety of soil materials (for example, fine-grained sand, bark chips, topsoil, clay, mulch, dried leaves, pieces of sod)
    - Graduated cylinders
    - Utility knife
- "Soil Filtration Investigation" student page

Background Information[2]

Clean water is among life's basic necessities. Healthy forest soils provide natural filtration to keep streams clean and water quality high. Most of Oregon's municipal water systems use water that originates in forest watersheds, including those managed for wood production. The quality of this source water is among the best in the nation.

[1] Alternatively, you may use stream tables or runoff models. For larger models, adjust the size of can and water used accordingly.
[2] Source: *Forest Fact Sheet: Do Forests Affect Our Drinking Water?*. Oregon Forest Resources Institute. learnforests.org. Accessed December 2022.

A watershed is an area, usually bounded by mountains and ridges, that collects the rain and snow that falls on it and drains it through a network of streams into a common river or other body of water. All land in Oregon is within one watershed or another.

How do forests keep our water clean? As water reaches healthy forest soils, most is absorbed and, over time, released to nearby streams or groundwater aquifers. In the process, the water is filtered. Most communities in the United States get water from watersheds where mixed land uses, such as agriculture and residential development, may reduce the water's quality.

Key Vocabulary

absorption

runoff

soil filtration

Preparation

- Make copies of the student page.
- Build a soil filtration model for each group of four:
    - Using a utility knife, cut off the side of a 2-liter plastic bottle so that it resembles a canoe.
    - Place the bottle on a book or board, and put blocks or other objects under one end so that the bottom of the bottle is raised a few inches above the open mouth of the bottle. (The bottle should be at a 25- to 40-degree angle with the spout facing downward.) If making more than one model, all models should be at the same angle.
    - Label each group's model with a unique number.
    - Place a collecting cup near the mouth to capture any runoff.
    - Fill the model with materials according to the Procedure below.

Procedure

1. To introduce the lesson, show students the brief video *Forest Fact Break: Water*. For more details, you may also show the 10-minute *Speakers Bureau Presentation: Oregon's Forests and Water* video.
2. Explain to students that to learn more about how forests protect drinking water, they will conduct an investigation of the rate at which water is absorbed into various types of soil, and the amount and quality of water that runs off the soil.

3. Divide the class into groups of four students, giving each a “Soil Filtration Investigation” student page and a model to work with.
4. Groups should fill their model with one or a combination of soil materials. You may either have groups choose their materials or assign them specific materials so that the class has different conditions to compare.
5. Encourage groups to form hypotheses regarding the estimated rate of filtration they would expect for their assigned models.
6. Have groups push the open-ended can about 2 cm into the soil material, and then pour 150 ml of water into the can. If the water leaks around the can’s edges, have students twist it a little further into the material until it stops leaking.
7. Students should record on the student page how long it takes for the water to be absorbed. They should also measure how much water they collect in the downstream container, and indicate the clarity of the runoff water they collect (10=perfectly clear, 0=fully opaque). Have them calculate the percent runoff and percent absorption as indicated on the student page.
8. Have students share their results with other groups and then use all the data to plot, on the student page, time against percent absorption and against water clarity.
9. Discuss the results:
    a. Which model had the highest and which the lowest percent runoff?
    b. Which had the cleanest water?
    c. Which model is most like a forest?
    d. What does this investigation indicate about soils?
    e. Was your hypothesis correct? How might you amend it based on what you observed?

Assessment

Give students the following writing prompt, and use their words to assess their learning: “Describe your result from the soil filtration investigation and what it indicates about soils.”

Extension Idea

Take students on a field trip to a drinking water treatment facility to find out how urban filtration systems are modeled after natural systems.

STUDENT PAGE

LESSON 1

NAME(S): _____

Soil Filtration Investigation

Identify which substrates were used for each model and the amount of water added. Then record the results.

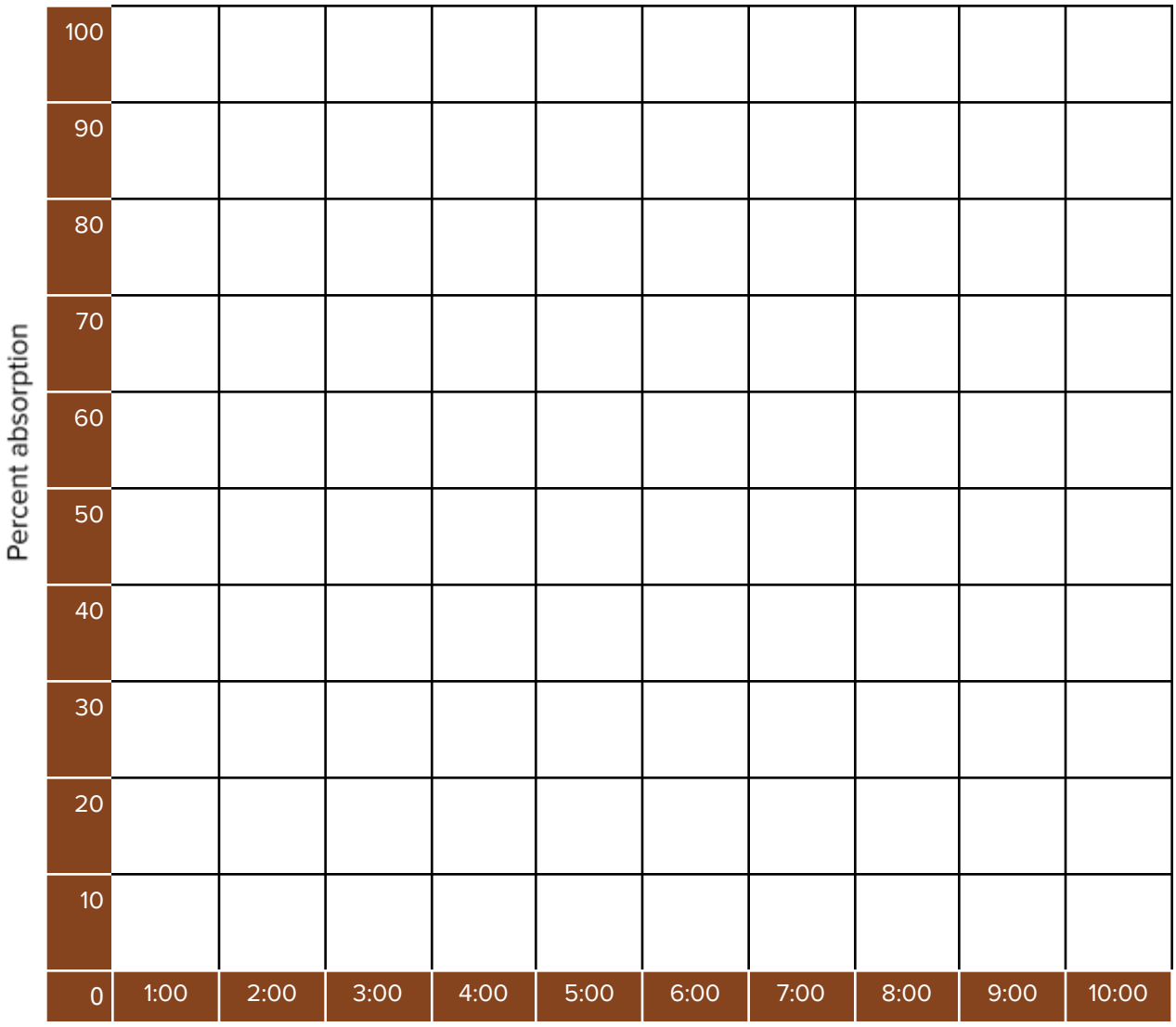
Model #	Soil Material	Water Added (in ml)	Amount of Runoff (in ml)	Percent Runoff	Percent Absorption	Absorption Time	Water Clarity (10=clear, 0=opaque)
Example	*Clay with leaf cover*	*150*	*85*	*57%*	*43%*	*4:25 minutes*	*6*

Percent Runoff = Water Added (in ml) – Amount of Runoff (in ml) x 100%

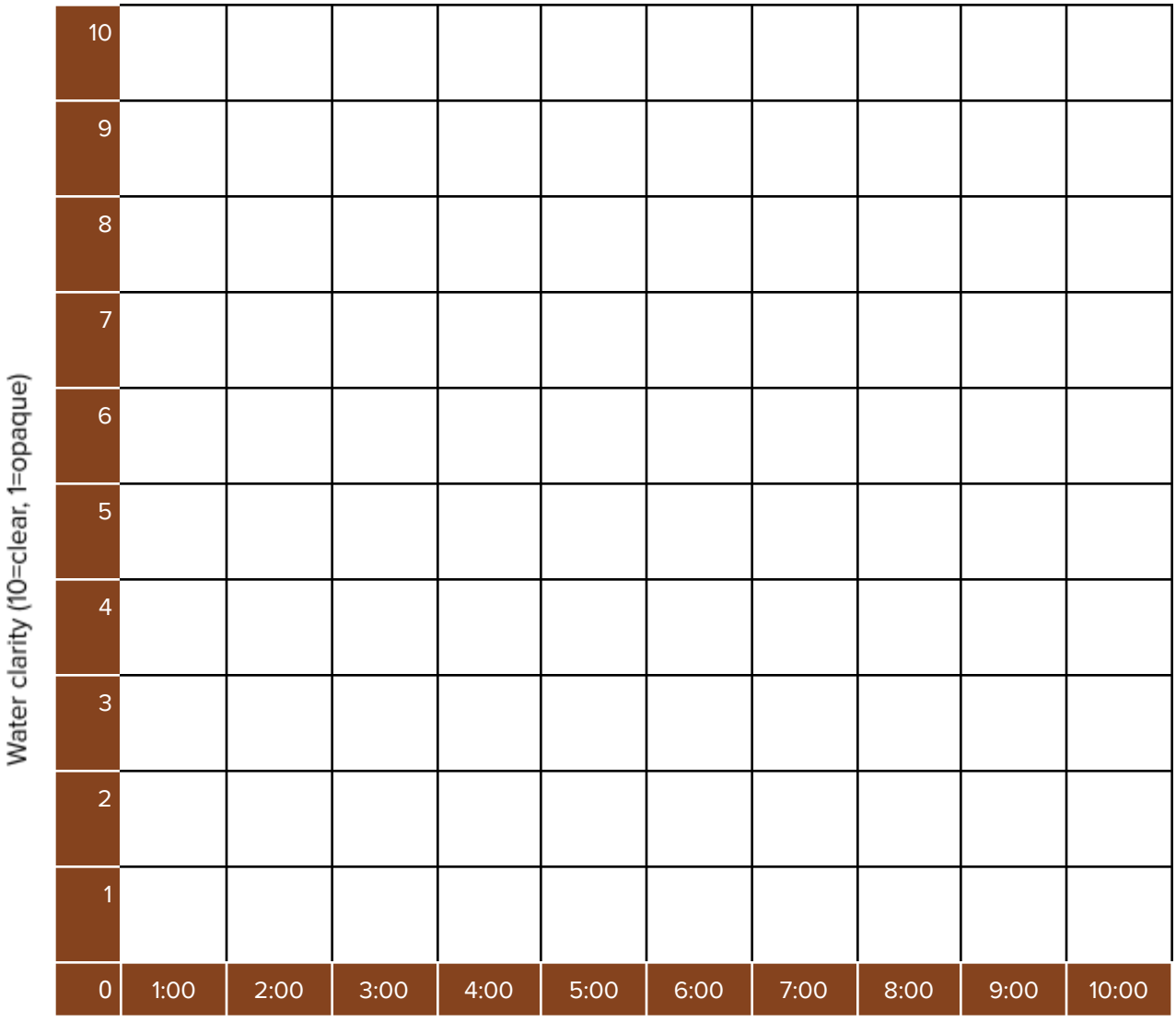
Percent Absorption = 100% – Percent Runoff

Percent Absorption Over Time

Plot the results of the experiment from all the models.



Water Clarity Over Time



What patterns do you notice?

2: Watershed Survey[3]

Overview

Students use mapping imagery to investigate the land use around waterways in their community or a nearby forested area.

Time Considerations

Preparation: One hour or more

Procedure: Two to three 50-minute class periods

Learning Objectives

Students will be able to:

- Use various online sources (including topographic maps and aerial and satellite images) to visualize a watershed.
- Determine land use in a watershed.
- Predict potential impacts of land use on water quality.

Standards Connections

Oregon Science Standards

- Science and Engineering Practice – Analyzing and Interpreting Data. Evaluate the impact of new data on a working explanation and/or model of a proposed process or solution.

Oregon Mathematics Standards

- Mathematical Practice – MP.2. Reason abstractly and quantitatively.
- Mathematical Practice – MP.4. Model with mathematics.

[3] Source: This lesson was adapted from "Impact of Land Use on Water Quality," in *Watershed Evaluation* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources, Chemeketa Community College.

Oregon Forest Literacy Plan Concepts

- 1.C.2. Forest ecosystems include processes such as photosynthesis, energy flow and the cycling of nutrients, water, carbon and other matter. Energy and matter are transferred between producers, consumers and decomposers.
- 2.A.1. Forests improve air and water quality, and help stabilize soil.
- 2.B.1. Forests provide multiple economic benefits, including jobs, a source of forest products and business opportunities (e.g., recreation and tourism).

Materials

- Remote mapping and imaging program (Google Earth or NASA's WorldWind – see Background Information below) [4]
- Internet access
- "Online Watershed Survey" student page
- Blank paper

Background Information[5]

Until recently, the conversion of natural landscapes to human-dominated lands, such as agricultural lands and urban areas, was considered a local phenomenon. It is now clear that land use practices have effects that occur at regional and even global scales, and that these practices have a significant impact on environmental quality. Air and water quality, wildlife habitat and forest health, for example, may all be affected by changes in land use.

In this lesson, students evaluate the potential impacts of land use on the water quality of a local river (or stream). The concept of a river as part of a watershed, and the influences of surrounding lands on waterway characteristics such as temperature, water quality, fish and wildlife, is emphasized as students use remote sensing and online sources to gain an understanding of the watershed under study.

Google Earth is available for free download at earth.google.com. NASA WorldWind is open-source software that can be downloaded for free at worldwind.arc.nasa.gov. Both provide high-resolution aerial and satellite imagery and include layers such as elevation, terrain and other features, but WorldWind requires more programming expertise.

[4] As an alternative, you may choose to use topographic map printouts instead of a mapping program, although those maps will include little information about land use along the river.

[5] Source: Adapted from "Impact of Land Use on Water Quality," in *Watershed Evaluation* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources, Chemeketa Community College.

Key Vocabulary

disturbed

effluent

industrial effluent

sediment

solid waste dumping

stream channelization

volume extraction

watershed*

**included in Glossary*

Preparation

- Choose a river for students to study and identify the coordinates of several specific locations along it.
- Decide which mapping and imaging program to use. Test it out with the "Online Watershed Survey" student page activities.
- Download the program onto student computers.
- Plan to allow time for students to become familiar with the software.

Procedure

1. Introduce the activity by asking students how land uses along a river might affect water quality. List their ideas on the board.
2. Explain that students will be using a mapping and imaging program to survey a local waterway to determine the different land uses along its border. If necessary, give students a brief tutorial on how to use the program and allow time for them to practice using it.
3. Divide the class into pairs or small groups, providing each a copy of the "Online Watershed Survey" student page and the coordinates for or name of the river they'll study. Introduce the various land uses presented on the student page, and discuss with students the potential impacts (and descriptions) of each impact presented in the table.
4. Allow time for pairs or groups to complete their survey.
5. Lead a discussion about students' findings, asking such questions as:
    a. What percentage of each type of land use did you find along the waterway?
    b. To what extent might each of these uses affect water quality? How might they affect the forest ecosystem?

Assessment

To assess their learning, ask students to write a few paragraphs, describing what they found on their watershed survey and predicting the potential impacts on water quality.

Extension Idea

Take a field trip to the specified reach of the river and document actual land uses and direct and indirect impacts. Compare findings to class predictions.

STUDENT PAGE
LESSON 2

NAME(S): _____

Online Watershed Survey[6]

- Using the mapping program, either follow the coordinates provided by your teacher or enter the name of the river you'll be studying.

- To become familiar with the watershed you'll be studying, follow the river from its source to its entry into a major river, bay or the ocean. What types of landscapes do you encounter along the way?

- Use the "rotation" and "tilt" features to get various three-dimensional views of the watershed. Try changing the elevation exaggeration (under "tools" and "options") from the default setting of "1" to "2" or "3". This feature will exaggerate elevation changes and help you visualize the shape of the watershed. Try navigating through the watershed by moving uphill from the river. The watershed boundaries will appear as ridge tops. With careful observation, you should be able to determine the watershed's approximate boundaries.

- Draw the approximate shape of the watershed boundaries on a blank sheet of paper. Include the river in your drawing.

- Look for the following major land uses along the length of the river you're studying:
    - forest (F)
    - agricultural (A)
    - urban (U)
    - residential (R)
    - industrial (I)
    - disturbed (for example, clearcut, mine or new excavation) (D)

- Closely examine the entire course of the river under study, and indicate in your drawing for step 4 which type of land use borders the river where. (You may use the initials F, A, etc. to indicate the various land uses.)

- Estimate the percentage of the river that is bordered by each of the land uses you have identified in step 6. For this activity, consider only lands immediately adjacent to the river.

[6] Source: Adapted from "Impact of Land Use on Water Quality," in *Watershed Evaluation* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources, Chemeketa Community College.

- For each land use, predict the potential impacts on the water quality of the river by entering one of the following values in each cell. See below for a description of the different land uses identified in the table.

0 = no negative impact
1 = minor impact
2 = moderate impact
3 = major impact
X = unable to determine

Potential Impacts of Various Land Uses on Water Quality

	% of River	Heated Effluent	Volume Extraction	Solid Waste Dumping	Industrial Effluent	Increased Temperature	Stream Channelization	Fertilizer or Pesticide Runoff	Livestock Manure Runoff	Sediment Runoff
Forest										
Agricultural										
Urban										
Residential										
Industrial										
Disturbed										

Description of land uses (in table):

- Heated Effluent – waste water released from a pipe or ditch at a higher temperature than ambient water temperature.
- Volume Extraction – removal of water from a river for irrigation, industrial or residential use.
- Solid Waste Dumping – deposits of usually nontoxic materials (such as tires or old appliances).
- Industrial Effluent – discharge from any industrial facility (such as a sewage treatment or chemical plant).
- Increased Temperature – inferred from removal of shading.
- Stream Channelization – straightening of stream by excavation or levees.

- Fertilizer or Pesticide Runoff – observed/inferred runoff from agricultural or residential lands.
- Livestock Manure Runoff – observed/inferred runoff from agricultural lands used for grazing livestock (or livestock access to a river).
- Sediment Runoff – observed/inferred runoff from disturbed lands resulting in decreased clarity.

3: Forests as Habitat

Overview

Students learn how forests provide habitat for animals and investigate a local study site for animal signs.

Time Considerations

Preparation: 45 minutes or more

Procedure: Two to three 50-minute periods, with time between for student research

Learning Objectives

Students will be able to:

- Identify the habitat needs of forest-dwelling wildlife.
- Identify how forest structure affects wildlife presence.
- Conduct research about forest animals in their habitat to learn about their calls, tracks or other signs.
- Inventory a study site for animal signs.

Standards Connections

Oregon Science Standards

- Disciplinary Core Idea – HS.LS2.C. Ecosystem Dynamics, Functioning, and Resilience. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.
- Science and Engineering Practice – Obtaining, Evaluating, and Communicating Information. Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Oregon English Language Arts Standards

- Reading Science and Technical Subjects – 11-12.RST.7. Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

Oregon Forest Literacy Plan Concepts

- 1.B.5. As part of the forest ecosystem, trees have many roles (e.g., supplying oxygen, providing habitat and food, holding soil, moderating temperature, capturing and storing carbon, and cycling water and nutrients). They may have different roles at different life stages.
- 2.A.2. Forests provide habitat for fish and wildlife. Many species depend on forest habitats for their survival.

Materials

- *Forest Fact Break: Wildlife* video (1:31 minutes), available at learnforests.org
- *Forest Fact Sheet: Why Do Forest Animals Live Where They Do?,* available at learnforests.org
- *Find Your Path: Wildlife Biologist* video (optional, 2:29 minutes), available at learnforests.org
- "Wildlife in Oregon Forests" student page (optional)
- "Wildlife in Oregon Forests – Questions" student page
- Technology for showing video(s)
- *A Guide to Priority Plant and Animals Species in Oregon Forests* (for Preparation), available at oregonforests.org
- "Wildlife Signs" student page
- "Wildlife Inventory" student page
- Large master map or sketch of study site (see Preparation below)
- Thermometer
- Measuring tape and/or string
- Markers (such as pencils or wood stakes with ribbon or flagging tape tied to one end, or other marker)
- Graph paper for mapping plot area
- Clipboards

Background Information

See the "Wildlife in Oregon's Forests" student page.

Key Vocabulary

cover

disturbance

free water

habitat structure

metabolic water

scat

snag*

stand*

vertebrate

**included in Glossary*

Preparation

- For Part 1, make copies of the "Wildlife in Oregon's Forests" student page or provide on-screen access to it. Make copies of the "Wildlife in Oregon's Forests – Questions" student page.
- For Part 2, use *A Guide to Priority Plant and Animal Species in Oregon Forests* to create a list of species found in your bioregion that you may use for assigning students to research.
- For Part 3, choose a study site for the inventory. You may use the same site as in Lesson 10: Tree Identification and Survey, or the site may be on the school grounds, in a nearby park or at local forest. Identify the age of the forest to further focus on what wildlife may be found there.
- Create a large master map of the study site by projecting a map or sketch of it onto a big piece of butcher paper.

Procedure

Part 1 - Learning about Oregon Forest Wildlife

1. To introduce the activity, show the brief video *Forest Fact Break: Wildlife* or have students read *Forest Fact Sheet: Why Do Forest Animals Live Where They Do?* to learn about Oregon forests as habitat for wildlife. (You might also show the *Find Your Path: Wildlife*

Biologist video to introduce what forest managers do in the field to enhance wildlife habitat.)

2. Allow time for students to read the "Wildlife in Oregon's Forests" student page.
3. Give students copies of the "Wildlife in Oregon's Forests – Questions" student page, and have them work in pairs or individually to answer the questions. As a class, discuss the answers.

Part 2 - Animal Signs

1. Point out that in order to survive, many wildlife species avoid detection by humans and other animals. That means that people must rely on a variety of signs to determine whether a particular species is present at a site. Ask: What signs might people use to detect the presence of wildlife? (Possibilities include sounds, prints or tracks, feces or scat, chew or claw marks, egg cases, nests or homes, or shed skin or hair.) Explain that students will become experts at some species' signs and use the signs to inventory a local study site.
2. Using the list of animals you created (see Preparation above), assign individuals or pairs an equal number of animals.
3. Provide each student with a copy of the "Wildlife Signs" student page. Allow time for students to research their animal(s) to learn about the various signs for each.
4. Have students share their findings with the class. This may be done orally, or through an online document-sharing application.

Part 3 - Wildlife Inventory of Study Site

1. Show students the master map (see Preparation), and work with them to determine the area or areas of the site they will observe. For a descriptive study or inventory of the study site, students may divide up the entire site, with different teams collecting data in different sections. For a comparative investigation, students may choose two sites and compare them.
2. Depending on the study site and the type of investigation, determine an appropriate plot size. (Square plots are recommended, but they may be 1 meter, 5 meters or another length per side.) Students can measure plots using premeasured string or tape measures, with markers at each of the corners.
3. Provide students with copies of the "Wildlife Inventory" student page, and discuss the protocol for recording observations. Students will carefully observe their plots, marking on their student page any animals or animal sign they observe within the boundaries of the plot. Remind students that if they want to see and hear wildlife, they need to move slowly and work quietly.

4. At the study site, students should create plots as determined in step 2, and then note the temperature and weather conditions. They should carefully observe the plot, recording any animals or signs of animals they observe within the plot.
5. After making their observations, students may share knowledge with their classmates to determine the species involved (where possible) or to identify any patterns in the observations.

Assessment

- Ask students to describe in writing what they learned about forests as a habitat for wildlife.
- Guided writing: Ask students to write a journal entry on the connections between wildlife habitat and travel or resource use in Oregon.

Extension Ideas

- Conduct the same investigation of the study site several times and compare the findings, or use the plot data to design an investigation to answer a question or solve a problem.
- Watch the OPB *Oregon Field Guide* special on wolves titled "Living with America's Most Iconic Predator," (available at watch.opb.org). Conduct a debate on the pros and cons of an increasing wolf population.
- Invite a member of one of Oregon's tribes to talk with your students about tribal traditions related to forests, wildlife and fish.
- Encourage students to find out more about Oregon's wildlife species through the *Wildlife in Managed Forests* series of publications, with individual booklets focusing on the following species. They are available from OFRI's publication library at oregonforests.org/publications.
    - American Beaver
    - Deer and Elk
    - Early Seral-Associated Songbirds
    - Fish Habitat and Passage
    - Fisher and Humboldt Marten
    - Stream-Associated Amphibians

  Students may also check out the *Wildlife in Managed Forests: Species Reference Series* for fact sheets about different forest wildlife species.

Possible Answers to "Wildlife in Oregon's Forests – Questions" Fisher and Humboldt Marten Student Page

1. Food, shelter or cover, water, space.
2. Getting enough food.
3. The quality of food is a challenge, as plants are low in protein and difficult to digest; the food supply also varies through the year.
4. Thermal cover.
5. By burning fat.
6. Carnivores have larger space requirements since they are both larger and limited by the quantity of food available.
7. Snags (used for cover, shelter, feeding areas and places to rear young). Other possible answers: logs, forest density and tree size.
8. Possibilities: deer mouse, striped skunk, common nighthawk, American goldfinch.
9. Marbled murrelet, red tree vole, Oregon slender salamander.

Wildlife in Oregon's Forests[7]

Many species of wildlife depend on Oregon's forests. As in all ecosystems, animals in forest ecosystems have four basic needs:

- food
- shelter or cover
- water
- space

An animal's habitat is a place where the arrangement of food, water, shelter or cover, and space are suitable for the animal's needs.

Food Requirements

The food requirements for different wildlife depend in large part on whether they are plant eaters or meat eaters.

Herbivores are plant eaters. If you think about a forest, plants are everywhere. Given this abundant resource, herbivores are generally not limited by the amount of food available. Rather, herbivores have problems with the quality of food. Plants in general are low in protein and difficult to digest. In general, protein content and digestibility are highest when a plant is actively growing, and lowest during the winter months when the plant is dormant. The availability of plant foods can also change. For example, shrubs can grow out of reach of herbivores or heavy snowfall can cover grasses.

Carnivores are meat eaters. Everything a carnivore eats (other animals) is high in protein and is highly digestible – and so is high in quality. For carnivores, the trick is getting enough food. That means that they are limited by the quantity of food available.

Shelter or Cover

Shelter or cover is a basic habitat requirement that protects animals from excessive heat, cold or predation.

[7] Source: Adapted from *Exploration of Oregon Forests: Module 6 – Woodland Wildlife*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Short Course*.

Biologists often characterize cover according to the way an animal uses it. For example, thermal cover protects animals from energy loss associated with extreme temperatures. Hiding cover shelters an animal from being seen by a predator, while nesting cover refers to vegetation, rocks and so on where an animal (usually a bird) hides its nest.

Most people think of vegetation (including trees) as providing cover for wildlife. However, cover or shelter can also be provided by the topography of the land or by isolation. For example, in hilly terrain, wildlife can seek shelter by dropping down behind a small ridge. For species that are hunted, such as deer or elk, finding a spot that is a long way from a road may provide sufficient isolation to protect them.

Water

All wildlife species need water in one form or another. Wildlife can meet their water needs in three ways:

- Some wildlife, especially those that hibernate, can use metabolic water. When fat is used or metabolized, water is produced as a byproduct. So a hibernating bear can meet its water needs by burning fat.
- Most animals get some water in their diets. Many foods are high in water content, and this preformed water may be all they need. This is fairly common in desert-adapted animals.
- Free water includes all the sources we normally associate with wildlife, from puddles to lakes and rivers.

Space

Space is a basic wildlife need. Each species has minimum space requirements for obtaining food, cover and water, and raising young. Animals living in areas with abundant resources generally require less space than animals living in more inhospitable habitats.

Two additional generalizations can be made about the amount of space a species requires. First, because carnivores are limited by the quantity of food available, they have much larger space requirements than herbivores of the same size. And second, larger animals need more space than smaller animals.

Structural Components of Habitat

Another attribute that forest stands provide for wildlife is habitat structure. For example, logs and snags are structural components that up to one-half of all wildlife species use at some time. A snag is a standing dead tree or part of a dead tree from which at least the smaller branches have

fallen. Snags can be used for cover, shelter, feeding areas, places to rear young and a host of other needs.

Stand density and tree size also influence a forest's suitability as wildlife habitat. Dense stands with smaller trees may provide valuable cover to songbirds and a host of mammals. Open stands with larger trees provide access for birds of prey and other predators, and tend to have significantly more vegetation available for mammals such as deer and elk.

Forest Age and Wildlife Habitat

In Oregon, about 300 species of native vertebrates use some sort of forest cover for breeding, but forest habitat is not uniform. Disturbance over time has produced a mosaic of forest age classes, each with unique habitat features. While some species thrive in the habitat provided by younger stands or clearings, others need features such as snags and logs provided by older forests.

As forests go through natural cycles of growth, death and regeneration, species may inhabit or be absent from a given area partly in response to natural changes in the structure of trees and other plants.

Different forest types attract different species of wildlife based on their specific habitat needs. Following are descriptions of three different-age forests and some of the wildlife associated with them.

Young Open Stands

This condition occurs within a short time (two to 10 years) after a disturbance such as wind, fire or logging has removed most of the larger trees. This stage is characterized by young trees or saplings and a variety of smaller herbs and shrubs. Species that prefer this stand type include the deer mouse, striped skunk, common nighthawk and American goldfinch.

Middle-Age Stands

This forest structure occurs after young stands have grown trees to a point where natural crowding has eliminated smaller and weaker trees and the forest has opened up enough to allow ground vegetation. Many species use this type of structure, though none exclusively. Some of the animals that gravitate to this type of habitat include the marten, black-tailed deer, common garter snake and Pacific tree frog.

Older Forest Stands

This structure is distinguished by larger trees, trees of mixed ages, and more logs and snags. Species that prefer this habitat include the marbled murrelet, red tree vole and Oregon slender salamander.

Summary

Wildlife animals are very dependent on forests for food, shelter, water and space. These are the four basic needs all animals have regardless of their habitat. There are different nutritional demands for each species, season, sex or age class. Carnivores need to find enough food, while herbivores need to find quality food.

Animals use cover in extreme temperatures to hide and for nesting. From a wildlife management standpoint, vegetation is the cover attribute we typically manipulate. However, there are many other attributes of the landscape that wildlife use for cover. Water is also an important aspect. Wildlife can meet their needs for water in several different ways: metabolic, preformed and free water.

Forest wildlife species also need appropriate amounts and arrangements of space. Larger animals and carnivores need more space than smaller animals and herbivores.

Another obvious attribute that forest stands provide for wildlife is habitat structure. Forest age also influences habitat and the species that live there. The diversity of animal species in an area depends on the existence of different habitats in the system.

STUDENT PAGE NAME: _____

LESSON 3

Wildlife in Oregon's Forests – Questions[8]

1. What are the four basic needs of wildlife?

2. What is the main issue for a carnivore related to its food supply?

3. Explain the challenges of an herbivore's diet.

4. A snowshoe hare is hiding due to a winter storm. What type of cover does it use?

5. How do bears meet their need for water when they hibernate?

6. Do carnivores or herbivores typically have larger space requirements? Why?

7. Describe an example of habitat structure that affects wildlife.

8. Name three species of animals associated with young, open stands.

9. Give three examples of the type of animal species older forests attract.

[8] Source: *Exploration of Oregon Forests: Module 6 – Woodland Wildlife*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Short Course*.

STUDENT PAGE
LESSON 3

NAME: _____

Wildlife Signs

Animal Species:

Describe this species' preferred forest habitat.

Describe the following possible signs that might indicate this species' presence in a habitat. Include illustrations where appropriate.

Sounds
(song, call, screech, chirp or other sound)

Track or print

Scat (feces)

Eggs or egg cases

Gnaw or claw marks

Other signs:

STUDENT PAGE
LESSON 3

NAME: _____

Wildlife Inventory[9]

Inventory beginning time _____ a.m./p.m. Ending time _____ a.m./p.m.

Current temperature_____

Current weather (check all that apply):

- ☐ clear
- ☐ scattered clouds
- ☐ complete cloud cover
- ☐ rain

Wind:

- ☐ calm
- ☐ breezy
- ☐ gusty
- ☐ windy

[9] Source: Data sheet adapted from "Schoolyard Biodiversity Wildlife Survey," *Schoolyard Biodiversity Investigation Education Guide*, Association of Fish & Wildlife Agencies, 2011.

Wildlife Seen or Heard

Type	Species (if known)	Description of Animal's Activity (passing through, eating, hanging out, etc.)	Number Observed
Birds			
Mammals			
Reptiles or amphibians			
Invertebrates (insects, spiders, etc.)			
Other			

Signs of Wildlife

Sign	Species (if known)	Description (What does it look like? Where was it found? Other observations?)	Number Observed
Scat			
Tracks			
Feathers			
Fur			
Nests			
Chewed leaves, branches, etc.			
Other			

4: Habitat Edges[10]

Overview

In this field activity, students evaluate the edge effect between two different ecosystems or habitats, asking and investigating questions about such variables as air and soil temperature, relative humidity and wind velocity to compare the two. After designing the specifics of their investigation, students will establish a transect line that runs perpendicular to the edge and will measure physical variables along the transect.

Time Considerations

Preparation: 45 minutes or more

Procedure: Three 50-minute class periods, including the field investigation

Learning Objectives

Students will be able to:

- Identify microclimate differences between two habitats and the edge that separates them.
- Develop a testable question and conduct an investigation to answer it.
- Use scientific instruments to measure such factors as air and soil temperature, relative humidity and wind velocity.
- Analyze the impacts of the edge on the two habitats.

Standards Connections

Oregon Science Standards

- HS.LS2.2. Ecosystems: Interactions, Energy, and Dynamics. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- Disciplinary Core Idea – HS.LS2.C. Ecosystem Dynamics, Functioning, and Resilience. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.
- Science and Engineering Practice – Planning and Carrying Out Investigations. Plan and conduct an investigation individually and collaboratively to produce data to serve as the

[10] This lesson is adapted from the "Edge Effect" sections in *Environmental Science I* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources, Chemeketa Community College.

basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Oregon Forest Literacy Plan Concepts

- 1.C.6. Forests are interconnected with other terrestrial ecosystems (e.g., grasslands, meadows and agricultural lands) and aquatic ecosystems (e.g., estuaries, riparian areas and wetlands).
- 2.A.2. Forests provide habitat for fish and wildlife. Many species depend on forest habitats for their survival.

Materials

- A study site (see Preparation below)
- Optional: photos or map of the study site (optional)
- "Edge Effect – Designing Your Investigation" student page
- "Edge Effect – Data Analysis" student page
- Measuring equipment, such as
    - Thermometers – to measure air temperature
    - Armored field thermometers – to measure soil temperature
    - Thermohygrometers – to measure relative humidity and air temperature
    - Light meters, or a light meter app for smartphones or tablets – to measure solar radiation
    - Digital anemometer, or a wind meter device and app for smartphones or tablets – to measure wind velocity
    - Compasses, or an app for smartphones or tablets – to measure wind direction
    - Measuring tape – to measure distances
- Data sheets (designed by students in Part 1)
- Measuring tape
- Flagging
- Optional: transect lines (ropes marked at one meter, five meters or another distance along their length
- Graph paper (or access to a spreadsheet program for tables and graphs)

Background Information[11]

The "edge effect" refers to those physical and biological changes that occur along the transition between two different ecosystems or habitats. The forest border adjacent to a clearcut, for example, represents a boundary between two very different environments that differ in minimum and maximum temperature, relative humidity, soil moisture, amount of solar radiation that reaches the surface, wind velocity, and plant and animal species, among others.

Along edges, there may be profound influences of one habitat upon the other in rather complex ways. Temperatures, for example, might be expected to be higher in forested areas that are along an edge as compared with interior forested areas that are not adjacent to such an edge. Living organisms such as plants and animals may in turn be affected by temperature and other differences.

Many wildlife species, known as "edge species," actually prefer habitat edges, where their different needs can be met side-by-side. For example, the sunny, open area of a meadow may provide food, while the forested area next to it may provide cover from predators. Deer, quail and rabbits are examples of edge species. For species like these, the absence of a satisfactory edge can, in fact, make an area unsuitable for them.

Ecological research conducted in the 1980s examined forest patterns at the landscape level in forests in the Pacific Northwest and tropical rainforests. Concern was raised at this time that the pattern of the forested landscape was not adequately protecting the biodiversity of these forests. Research has suggested that biodiversity loss is not simply a matter of decreased acreage (and habitat loss), but also the pattern of habitat loss, including fragmentation (the break-up of large forested stands resulting in the isolation of small parcels of interior forest) and the formation of extensive edges in areas where none existed previously.

One way to determine the effect of an edge on the two habitats is to sample microclimate data along a transect line perpendicular to the edge. Students can make a transect line using rope marked and numbered at regular intervals all along its length, laying it across the study area.

[11] Source: Adapted from "Edge Effect One," in *Environmental Science I* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources, Chemeketa Community College.

Key Vocabulary

dependent variable

edge effect

edge species

independent variable

transect

Preparation

Choose a study site that illustrates a distinct ecological edge between habitats and has sufficient area to accommodate the class. Possibilities include a woodlot or grove on campus, a city or county park, nearby natural area, public or private timberland, or other natural resource area. Take pictures, if possible, to share with the class in advance of going there.

Procedure

Part 1 – Planning the Investigation

1. Using the Background Information, introduce the idea of habitat edges.
2. Describe or show pictures of the study site. Explain that students will be conducting their own investigations to determine the impact of the edge on each of the habitats. The basic question they will be addressing is, To what extent does the edge impact the physical characteristics of the two habitats? They will be measuring how air temperature, soil temperature, relative humidity, wind velocity, solar radiation and plant diversity change as one proceeds from the edge to interior habitats.
3. Ask students what differences they think they might observe between the two habitats, and why. How far into each habitat from the edge do they think those differences might extend?
4. Show students the measuring equipment that will be available for the investigation, and demonstrate how to use and set up a transect line.
5. Review the concept of independent variables and dependent variables. An independent variable is the variable that is changed in a scientific experiment or investigation, while a dependent variable is one that is being tested as the independent variable changes. Remind students that in order to determine the relationship between the distance from the edge and the physical characteristics, their investigation should have just one independent variable: the distance along the transect line. All other conditions should be the same.

6. Divide the class into pairs or small groups, providing each with an “Edge Effect – Designing Your Investigation” student page.
7. Depending on your class and objectives, assign each group one or more of the measurements on which to focus their investigation (air temperature, soil temperature, relative humidity, wind velocity, solar radiation or biodiversity), or have them choose.
8. Direct each group to work through the student page to plan their group’s investigation.
9. Have students either present their investigation plan to the class or submit it to you for review and approval.

Part 2 – At the Study Site

1. Bring along materials and equipment needed for students’ investigations. Students should have their data sheets available for recording their data.
2. Allow time for students to conduct their investigations. Circulate among groups, as necessary, to resolve any issues.

Part 3 – Analyzing the Results

1. Direct groups to summarize their data in tables or graphs, using pencil and graph paper or a spreadsheet program. They should calculate the mean (average) for the parameters they study, and plot these means against distance along the transect. Encourage groups to share information with other groups as appropriate.
2. After students have graphed or tabulated their results, invite them to discuss within their group any trends they see in the data. Provide copies of the “Edge Effect – Data Analysis” student page, and have each group answer the questions presented.

Assessment

Use students' responses on the “Edge Effect – Designing Your Investigation” student page to assess their ability to plan a scientific study, and their responses on the “Edge Effect – Data Analysis” student page to assess their learning.

STUDENT PAGE
LESSON 4

NAME: _____

Edge Effect – Designing Your Investigation

In this activity, you will design and carry out an investigation to learn more about the effect of edges on forest habitats. Meet with your group to identify the following.

I. Investigation Question

Your investigation will help determine the extent to which an ecological edge impacts the physical characteristics of two habitats. A testable question guides an investigation. State the specific question you will investigate.

Investigation question:

II. Hypothesis and Rationale

Hypotheses are "educated guesses" based on prior knowledge that provide a possible answer to a question. Clearly state your hypothesis and describe the rationale you've used to make this prediction.

Hypothesis:

Rationale:

III. Experimental Design

A. Independent and Dependent Variables

An independent variable is the variable that is changed in a scientific investigation. In the case of a transect line, it is the distance along the line.

A dependent variable is the variable being tested in a scientific investigation. The dependent variable is "dependent" on the independent variable: As the investigator changes the independent variable, the change in the dependent variable is observed and recorded.

Independent variable(s):

Dependent variable(s):

B. Equipment Needed

List all equipment you'll need to carry out the procedure you outline below.

1.

2.

3.

4.

5.

6.

7.

8.

C. Procedure

Briefly describe or diagram what your investigation procedure will look like at the study site. Include such information as length of transect line, number of sampling stations, distance between stations and so on. Also describe exactly how you'll measure each variable in the field. All measurements should be in metric units.

D. Data Sheet Design

You've decided what information your group will collect and how you'll measure it. Now design a data sheet that will easily accommodate this information.

NAME: _____

Edge Effect – Data Analysis

1. What conclusions can you draw from the information you've collected? (Extract as much information from your graphs and tables as possible.)

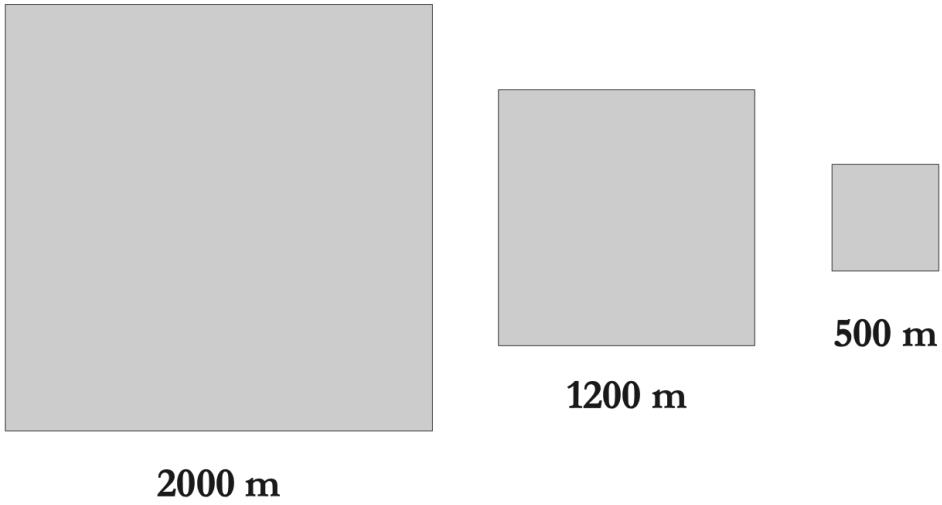
2. Is your hypothesis supported by the data?

3. If you were to repeat this study, what changes would you make?

4. Based on your measurements, does it appear that the transect line was long enough to reach the true "interior habitat" of either of the habitats? What evidence supports your answer?

5. Assuming that you did sample true "interior habitat," what is the approximate width of the edge in the habitats sampled? How did you arrive at this number?

6. For the forested stands below, assume that each is surrounded by clearcuts, and the "edge effect" penetrates 200 meters into the interior forest. For each stand, calculate the total area of edge habitat and the percent of total area in edge.



7. What conclusions can you draw?

8. Overall, does the edge effect have a positive or negative influence on ecosystem health and stability? Explain.

5: Forests and Carbon

Overview

Students explore the process of photosynthesis, estimate and calculate the amount of carbon in a given tree, and then make a model showing how carbon is sequestered in trees. (Note: Students will further explore the topic of climate change in Lesson 5: Climate Change and Oregon's Forests in the "Forest Management Issues" module.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to:

- Describe the process of photosynthesis, whereby green plants use sunlight to make food energy.
- Calculate the amount of carbon stored in a tree.
- Make a model showing how carbon is sequestered in trees.
- Explain the connections between forests and climate change.

Standards Connections

Oregon Science Standards

- HS.LS2.5. Ecosystems: Interactions, Energy, and Dynamics. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- Disciplinary Core Idea – HS.LS2.B. Growth and Development of Organisms. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
- Science and Engineering Practice – Developing and Using Models. Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Oregon Forest Literacy Plan Concepts

- 1.A.1. A forest is an ecosystem dominated by trees, and includes a variety of other organisms. The trees in a forest may differ in species, age and size.
- 2.A.3. Forests sequester carbon from the atmosphere and are an essential component of the global carbon cycle.
- 2.B.1. Forests provide multiple economic benefits, including jobs, a source of forest products and business opportunities (e.g., recreation and tourism).

Materials

- *Forest Fact Break: Photosynthesis* video (1:20 minutes), available at learnforests.org
- *Forest Fact Sheet: How Does Photosynthesis Work?*, available at learnforests.org
- *Forest Fact Break: Carbon Capture* video (2:10 minutes), available at learnforests.org
- *Forest Fact Sheet: Are Forests, Carbon and Climate Change Related?*, available at learnforests.org
- Technology for showing videos
- Copies of the Tree Carbon Tape (printed at actual size on 8½" x 11" paper), available at learnforests.org
- Scissors
- Glue, stapler or tape
- "Plant Food" student page
- "How Much Carbon?" student page
- "The Carbon Cycle Poster" student page (or print copies of *Where's All the Carbon?* posters from learnforests.org)

Background Information[12]

The carbon cycle is the series of processes by which carbon atoms are circulated in the biosphere. In this cycle, carbon dioxide from the atmosphere is converted by plants into complex organic compounds, which are consumed by other organisms; the carbon returns to the atmosphere in the form of carbon dioxide through respiration, the decay of dead material and the combustion of wood and fossil fuels.

[12] Sources: "Forests, Carbon and Climate Change." Oregon Forest Resources Institute, oregonforests.org.

"Forest Fact Sheet: How Are Forests, Carbon and Climate Change Related?" Oregon Forest Resources Institute, learnforests.org.

Trees are an important part of the carbon cycle. Through photosynthesis, they absorb carbon dioxide, transform it into carbohydrates (sugars), release oxygen into the atmosphere and store the carbon in their woody structures as cellulose. While the chemical composition of wood varies from species to species and even from one part of a tree to another, wood is generally made up of approximately 50 percent carbon, 44 percent oxygen and 6 percent hydrogen, with trace amounts of metal ions.

How are forests, carbon and climate change related? Increased amounts of carbon dioxide in the atmosphere result in warmer temperatures. Carbon dioxide, a greenhouse gas, is released through natural events such as volcanic eruptions and forest fires, as well as through human activities such as burning fossil fuels. Scientists generally agree that human contributions to global climate change are increasing, and they are concerned about the future.

Forests store or sequester significant amounts of carbon, reducing the presence of carbon dioxide in the atmosphere. The U.S. Forest Service estimates that U.S. forests sequester a net of approximately 250 million tons of carbon each year, offsetting 10 to 20 percent of the country's carbon emissions from burning fossil fuels each year.

Most of the carbon sequestered in a tree stays out of the atmosphere, even after the tree is harvested and the wood is used to build something. About half the dry weight of wood is carbon, which remains stored in wood products used to construct houses, apartments and office buildings, and helps offset carbon emissions that are contributing to climate change

To compare the amount of sequestered carbon to carbon from emissions, scientists use a term called carbon dioxide equivalent, or CO_2e. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 that would have the equivalent global warming impact.

Key Vocabulary

carbohydrate

carbon cycle*

carbon sequestration*

global climate change*

photosynthesis*

**included in Glossary*

Preparation

- Make copies of student pages and the Tree Carbon Tape. (Instead of copying "The Carbon Cycle Poster" student page, you may choose to provide on-screen access to it. You may also order print copies of *Where's All the Carbon?* posters from learnforests.org.)
- Find an outdoor area that has several trees for students to measure.

Procedure

Part 1 – Photosynthesis

1. To get students thinking about photosynthesis, have them work in pairs or small groups to consider what trees use as food, answering the questions on the "Plant Food" student page. (Note that while this may seem like a simple exercise, it helps uncover students' thinking and understanding about photosynthesis. You may find that even though they may be able to describe photosynthesis, many high school students still hold incorrect notions about it.[13])
2. As a refresher on photosynthesis, show the 90-second *Forest Fact Break: Photosynthesis* video, or have students read *Forest Fact Sheet: How Does Photosynthesis Work?* If students need a further refresher, you might have them simulate the equation for photosynthesis (as below), with different students standing in for the various atoms.

   Equation for photosynthesis:

   $$6CO_2 + 6H_2O \xrightarrow{\text{Sunlight energy}} C_6H_{12}O_6 + 6O_2$$

   Where: CO_2 = carbon dioxide, H_2O = water, $C_6H_{12}O_6$ = glucose (sugar) and O_2 = oxygen

Part 2 – Carbon and Trees

1. Ask students what they think wood is made of. Using the information from the Background Information section, explain that as trees grow, they absorb carbon dioxide, which becomes stored or sequestered in the tree's tissue in the form of cellulose and hemicelluloses, which are carbohydrates. Point out that while the chemical composition of

[13] The exercise is adapted from Keeley, Page, et al. "Is It Food for Plants?" from *Uncovering Students' Ideas in Science*, Volume 2. National Science Teachers Association, 2007.

wood varies from species to species, it is approximately 50 percent carbon, 44 percent oxygen, and 6 percent hydrogen.

2. Show the two-minute video, *Forest Fact Break: Carbon Capture*, or have students read the *Forest Fact Sheet: Are Forests, Carbon and Climate Change Related?* Discuss the connection between forests, carbon and climate change.
3. Give each group of students a copy of the Tree Carbon Tape. Direct them to cut out all 12 sections of the tape and then glue, staple or tape the sections together as indicated on the student page. The finished tape should be 72 inches long.
4. Take students to an outdoor area that has several trees. Invite students to use the Tree Carbon Tape to measure the circumference of five different trees, and to estimate the pounds of carbon dioxide equivalents (CO_2e) stored in them. Have them record their findings on the "How Much Carbon?" student page.
5. Discuss questions such as: What role does photosynthesis play in capturing carbon from the atmosphere? How does the size of a tree affect the amount of carbon it stores? What happens to a tree's carbon if the tree is cut down?
6. Give students copies of "The Carbon Cycle Poster" student page. Point out how the outside arrows depict the carbon cycle – with carbon being incorporated into living tissue by photosynthesis and then returning to the atmosphere through respiration, the decay of dead organisms or the burning of fossil fuels. Point out the three main processes – carbon absorption, carbon storage and carbon release – that are described at the bottom of the student page.
7. Have students work in pairs to identify the points in the cycle where carbon is absorbed, where it is stored and where it is released.
8. Challenge students to create a model – a poster, flow chart, graphic organizer or other visual representation – depicting how carbon ends up either in a tree or in a wood product. The model should include how carbon is absorbed and stored and how it can be released.

Assessment

Use student-created models from the lesson to assess their understanding of the carbon cycle.

Extension Ideas

- Explore other benefits of individual trees using the tool *MyTree*, available for free at mytree.itreetools.org. Students will need to enter details about the tree's location, species, trunk size (either diameter or circumference at chest height), proximity to a building and sun exposure. The tool will estimate the carbon sequestered, rainfall

intercepted, runoff avoided, air pollution removed and energy avoided from the tree. See i-Tree at itreetools.org for more information about this and other tree benefits tools.

- Research the concept of carbon credits. What are they? How do they work? How might their use impact forests? How might timber harvesting affect carbon credits?

Possible Answers to "Plant Food" Student Page

1. Answers may vary, but food is any substance that supplies the energy an organism needs to live and grow. Both plants and animals require food to survive. Plants are able to make their food using energy from sunlight to transform carbon dioxide and water into carbohydrates. Animals must get food by eating plants or other animals.
2. Trees use sugar (such as glucose) as food. While fertilizer, soil and minerals may provide important nutrients, they do not provide energy, which is the necessary requirement for something to be considered food in a biological sense. Sugar is the only item in the list that is considered food for a plant.

NAME: _____

Plant Food[14]

1. All living things need food to survive. How would you define food? How is it the same for plants as it is for animals? How is it different?

2. Which of the following do trees use as food?

- ☐ Sunlight
- ☐ Sugar
- ☐ Carbon dioxide
- ☐ Fertilizer
- ☐ Soil
- ☐ Water
- ☐ Chlorophyll
- ☐ Minerals

Explain your thinking.

[14] Source: Adapted from Keeley, Page, et al. "Is It Food for Plants?" from *Uncovering Students Ideas in Science*, Volume 2. National Science Teachers Association, 2007.

STUDENT PAGE

LESSON 5

NAME: _____

How Much Carbon?

1. Identify five trees to measure using the Tree Carbon Tape.
2. Determine the circumference of each tree: Hold the tape at chest height (about 4.5 feet, or 1.4 meters) from the ground and wrap it once around the tree trunk. Find the measurement to the nearest 3 inches, and record the result below.
3. Use the tape to find the approximate carbon dioxide equivalent (CO_2e) contained in each tree. Record below.
4. Use the tape to find the approximate number of miles in a car that would emit the same amount of carbon as there is stored in the tree. In growing to that size, the tree can "offset" the emissions from driving that number of miles.

Tree location	Circumference at chest height (in inches)	Approximate carbon dioxide equivalent of tree (pounds CO_2e)	Approximate car miles offset by tree

The Carbon Cycle Poster