

INSIDE OREGON'S FORESTS

A high school forestry curriculum



Oregon Forest
Resources Institute

Inside Oregon's Forests

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Oregon Forest Resources Institute

Acknowledgments

This high school course curriculum guide is the result of the vision and support of many different educators and resource specialists, whose commitment to education about Oregon forests profoundly impacts students and communities throughout Oregon.

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About the Oregon Forest Resources Institute

The Oregon Forest Resources Institute is a state agency whose mission is to advance public understanding of how forest stewardship meets the social, environmental and economic needs of both present and future generations. OFRI works closely with the scientific, academic and educational communities at Oregon State University, the Oregon Department of Forestry and other agencies to ensure its K-12 resources are accurate and objective.

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Introduction

Years from now, as historians record the history of the Pacific Northwest, how will they treat us? Will they say we did all we could to live in harmony with the natural environment? That we lived in such a way to provide for our own needs without jeopardizing future generations' ability to provide for their needs? We hope historians treat us favorably, but hope itself will not make it so. As citizens of an abundantly forested state, Oregonians have a special responsibility to be forest literate and to act in ways that protect forest resources. And as a forest resources institute charged with advancing public understanding of forests, forest management and forest products, we have a special responsibility to help teachers do the best they can to pass on forest literacy to their students. For this reason we created *Inside Oregon's Forests*. If we all do our part in the present, there's a good chance we will have done right by the future.

- *Paul Barnum, Executive Director, Oregon Forest Resources Institute*

Why a High School Curriculum on Oregon Forestry?

All life, including our own, depends on forests. Forests help filter fresh water, supply oxygen, provide habitat for diverse animal and plant species and store atmospheric carbon. In Oregon, nearly 50 percent of our state's 61 million acres is forestland. Our forests supply renewable resources for lumber, paper and heating, along with jobs that support families and communities.

Because we depend so profoundly on our forests, being knowledgeable about them is crucial for all Oregonians. We need to understand not only how they work, but also how we are connected to them ecologically, economically and socially.

To play an active role in ensuring the long-term sustainability of Oregon forests, high school students need a deep understanding of both their dependence and effect on forests. Whether they later choose to enter Oregon's forestry sector or not, students need the knowledge and skills to make thoughtful decisions that affect our forest.

Curriculum Goals and Objectives

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

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

How to Use the Curriculum

This guide outlines a high school curriculum focusing on Oregon forests and forestry. It provides a comprehensive set of lesson plans, resources and tools designed to help students gain a deep understanding of this topic. With both classroom and field activities, it enables students not only to learn about the field of forestry in Oregon, but to practice it as well.

This course curriculum is designed to be flexible. Though it is structured as a 12-week course, teachers may select lessons from each section to fit the needs of their educational program, as each lesson can either stand alone or build on prior lessons. The curriculum may be used

- As the basis for a 12-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.

For each lesson, links to relevant resources are embedded in the lesson itself.

Curriculum Overview

This curriculum is divided into seven sections, each focusing on a different topic related to Oregon's forests. It is roughly organized around the topics and concepts presented in the *Oregon Forest Literacy Program*, a forest education conceptual framework developed by the Oregon Forest Resources Institute and a diverse statewide stakeholder group. To help in

planning and articulation with other programs, each of the lessons in this curriculum contains related *Oregon Forest Literacy Program* concepts. At the back of the curriculum, there is also a cross-reference table showing the concepts included in the lessons.

Section 1: Oregon's Forest Heritage

In this section, students are introduced to Oregon forests, learn about our rich forest resource and examine some changes over time in our state's forestland. Students also investigate current forest ownership in Oregon, as well as the challenges and varieties of issues facing forest landowners.

Section 2: Forest Basics

The lessons in this section provide students with an overview of both tree biology and the forest types in Oregon, and give students practice in identifying and measuring trees.

Section 3: Environmental Importance of Oregon's Forests

In this section, students explore the environmental importance of forests: how they protect our water resources, provide plant and animal habitat, and store carbon.

Section 4: Economic Importance of Oregon's Forests

In this section, students examine the Oregon's forest economy, including the products, energy and jobs that come from forests.

Section 5: Forest Management

In this section, students learn about the concept of forest management and practice forest management skills such as surveying a forest tract, analyzing forest soil, calculating forest density, planning for harvest and reforestation and developing a management plan.

Section 6: Forest Health and Forest Management Issues

In this section, students explore the impacts of fire, forest pests and climate change on Oregon forests, evaluate articles on a forest-related topic, and conduct an opinion survey on forest management issues.

Section 7: Our Responsibility to Oregon's Forests

In this section, students learn about certification systems as one means to achieve forest sustainability and plan and carry out a service-learning project related to Oregon forests.

Suggested Time Frame

This curriculum is designed as an approximately 12-week course, with the following suggested time frame.

Weeks 1-2:	Section 1. Oregon's Forest Heritage
Week 3:	Section 2. Forest Basics
Weeks 4-5:	Section 3. Environmental Importance of Oregon's Forests
Week 6:	Section 4. Economic Importance of Oregon's Forests
Weeks 7-9:	Section 5. Forest Management
Weeks 10-11:	Section 6. Forest Health and Forest Management Issues
Week 12:	Section 7. Our Responsibility to Oregon's Forests

We expect that you will put your own spin on the material as needed for your specific courses and students – emphasizing and going more in-depth in some parts and de-emphasizing others. Thus, you may find that the materials require more or less than 12 weeks for your particular situation.

In addition, we have included Time Considerations for each lesson, which are meant as a rough guide to the preparation and instruction time needed for the lesson. Individual teachers and classes will use the lessons differently, and may require more or less instruction on a given topic, so your timing needs may be different.

Standards Connections

Each lesson in the curriculum lists the most relevant connections to Next Generation Science Standards, Common Core State Standards– English/Language Arts, and Common Core State Standards–Mathematics. Please note that for any given lesson, we have listed only standards that relate directly to the main lesson (not extensions) and that are a clear focus of the lesson. In addition to listing between one and five of the most relevant standard connections within the lesson, we have provided a cross-reference table at the back of the curriculum.

Please feel free to revise or extend activities to enhance connections to any particular standard you choose.

Field Investigations

While most of the lessons can be conducted in the classroom or on the school grounds, the following require a visit to a forest or other field location. If necessary, you may want to combine some or several of them into one field trip.

- 13. Forests as Habitat
- 14. Habitat Edges
- 21. Surveying a Forest Tract
- 24. Forest Thinning
- 27. Silviculture Tour

Resources

Forest Education Opportunities

The following programs and materials are included in *Oregon Forest Resources Institute's K-12 Forest Education Opportunities* guide. Check the Oregon Forest Resources Institute K-12 website, LearnForests.org, for updates.

Statewide Programs

Oregon Natural Resources Education Program

Contact: Susan Sahnaw – 541-737-3005
LeeAnn Mikkelsen – 541-737-9121
onrep@oregonstate.edu
<http://onrep.forestry.oregonstate.edu>

Program: Educator workshops

Grade Level: K-12 educators (courses also offered through university and college pre-service programs)

Available: Year-round

Cost: Most workshops are free

Materials: Curricula materials and resources provided at no cost

Other: Substitute reimbursement available

The Oregon Natural Resources Education Program at Oregon State University exposes educators to Oregon's forests, wildlife and water through professional development workshops. The award-winning international environmental education curriculum Project Learning Tree and Project WILD help teachers engage students in learning by providing thought-provoking, field-tested classroom activities that develop critical-thinking skills.

4-H International Summer Camps

Contact: Mario Magaña Álvarez – 541-737-0925
mario.magana@oregonstate.edu
<http://extension.oregonstate.edu/4h-outreach/summer-camp>

Program: Residential summer camps

Grade Level: 3-12

Available: Summer

Cost: Call or check the website for information

4-H International Summer Camps expose youth to different environments and new

information; provide opportunities for students to learn about postsecondary education, financial aid and scholarships; enable youth to develop leadership skills and explore careers related to natural resources, engineering, health professions, new technologies, law, music, culture and art; and engage them in fun and challenging educational activities. The program also allows youth to interact with role-model university students and professionals.

North American Envirothon

Contact: Julie Woodward – 503-807-1614

woodward@ofri.org

<http://oregonenvirothon.org>

Programs: One-day science competition, field trips, teacher workshops

Grade Level: High school

Available: Year-round (competition in May)

Cost: Free

Teams of five students participate in this hands-on environmental problem-solving competition. Teams complete training and testing in five categories – aquatic ecology, forest ecology, wildlife ecology, soils and land use – and one current environmental issue. Winning teams may advance to the National Envirothon event and compete for recognition, scholarships and prizes. Professional development for instructors, student field trips, training session and study equipment are available to prepare teams for competition.

Regional Field Programs

Forests Today & Forever – Lane and Linn Counties

Contact: Beth Krisko – 541-767-9078

coordinator@foreststodayandforever.org

<http://foreststodayandforever.org>

Programs: Tours, field activities

Grade Level: 4-12

Available: Year-round by appointment

Cost: Free

Forests Today & Forever brings students to working tree farms to educate them about forest stewardship and management strategies. Its cornerstone program, Forest Field Days, for grades 6-8, is a cross-curricular package designed to stimulate critical thinking and creative problem-solving through role-playing. Students make observations about wildlife, soils, and water and learn about the forest as an important resource for timber and recreation. Students use their field observations and experiences to cooperatively develop

their own forest management plans. Programs for other grades are designed based on teachers' classroom learning objectives, and can include tours, field studies and service-learning opportunities.

Hopkins Demonstration Forest – Oregon City

Contact: Peter Matzka – 503-884-6202

forestengineer@live.com

<http://demonstrationforest.org>

Programs: Ecological field studies, tours, service-learning; other experiences customized by arrangement

Grade Level: 1-12

Available: Year-round by appointment

Cost: Donations appreciated

In this 140-acre “family forest” dedicated to education, demonstration and research, students examine how forests grow and change under different management strategies. Ongoing demonstrations include wildlife habitat enhancements, selective harvesting, intensive plantation forestry, riparian management and tree-growth research projects. Schools are invited for tours, field studies, service-learning and other experiences customized to their interests and curricular needs.

Klamath Outdoor Science School – Klamath, Jackson, Josephine and Curry Counties

Contact: Bill Hunt – 541-850-8218

billhuntkoss@gmail.com or kossreservations@gmail.com

<http://klamathoutdoorschool.org>

Programs: Residential and day camps, in-class presentations, field trips, service-learning

Grade Level: K-12; primarily 4 and 8

Available: January to mid-November

Cost: Call for rates and scholarship availability

Klamath Outdoor Science School provides youth with a unique experience in a natural setting that inspires learning through exploration and instills an appreciation for the resources of the Upper Klamath Basin. KOSS is a nonprofit organization located about 45 miles north of Klamath Falls in the Sun Pass State Forest, which is managed by the Oregon Department of Forestry. While at KOSS, students learn forest science and an appreciation for a forest that is well-managed for multiple uses. Curriculum can be provided to educators before and after their stay at KOSS to further enhance learning.

Mount Pisgah Arboretum – Eugene

Contact: Jenny Laxton – Office: 541-747-1504
education@mountpisgaharboretum.org
<http://mountpisgaharboretum.org>

Programs: Field trips, self-guided tours

Grade Level: K-5, all levels for self-guided tours

Available: Spring and fall

Cost: \$3.25 per student (teachers and chaperones free)

Mount Pisgah Arboretum is a 209-acre site located along the Coast Fork of the Willamette River, within the Howard Buford Recreation Area, seven miles from downtown Eugene. The arboretum highlights the native ecosystems of the southern Willamette Valley. Seven miles of groomed trails meander through mixed forest, oak savanna, meadow and riparian areas. Students learn about tree identification, forest ecology, wildlife habitats and other seasonal topics. All programs address the state science standards for elementary grades. Check the website for more information or call to schedule a tour.

Rediscovery Forest Education Program – Silverton

Contact: Julie Woodward – 503-807-1614
woodward@ofri.org
<http://LearnForests.org>

Programs: Field trips, educator workshops, service-learning, special events

Grade Level: K-12

Available: Year-round

Cost: Free

The Rediscovery Forest, a collaboration between The Oregon Garden and OFRI, is a dynamic demonstration forest located in the park-like environment of The Oregon Garden. This 15-acre educational forest helps students discover why Oregon's working forests are essential to sustaining our quality of life. Students participate in programs focused on forest ecology, forest management, wildlife habitat, science inquiry, tree identification, STEM, sustainability and much more. Visit the OFRI website for information on a variety of interactive, grade-appropriate, science-based programs and to register. Registration is available only online. OFRI also offers several educational events and educator workshops at the Rediscovery Forest throughout the year.

ROCK-ED Outdoor Education Center – Douglas County

Contact: Dan Meyer – 541-496-3484
dan.h.meyer@state.or.us
Rock Creek Hatchery, Glide, OR
<http://jimurf-rocked.org>

Program: Field trips, self-guided tours
Grade level: K-12
Available: Year-round
Cost: Free

ROCK-ED Outdoor Education Center is a new natural resources education facility located 22 miles east of Roseburg at the Oregon Department of Fish and Wildlife's Rock Creek Hatchery. Constructed as a cooperative nonprofit project through the Joe Merchep Umpqua River Foundation, the 1,300-square-foot, one-room schoolhouse features a large classroom, a display area, a 200-gallon fish tank and a covered deck overlooking a pond. There is also an outside gathering place with a soon-to-be-built gazebo and interpretive signs. A half-mile trail starts at hatchery rearing ponds and takes visitors into forest and along nearby Rock Creek. Reservations for use of the classroom and arrangements for tours should be made in advance. The hatchery facility, gathering place and trail are open to the public from 7:30 a.m. to dusk every day. Check the website or call the hatchery for more information.

Science in the Forest® – Oregon City, Sisters

Contact: Dale Waddell – 503-730-5999
sierra@ccgmail.net
<http://beoutside.org>

Programs: Two-day field experience, classroom sessions, service-learning
Grade Level: 6-12
Available: Year-round
Cost: Free

Science in the Forest is a comprehensive science inquiry education project offered by WolfTree, a nonprofit corporation with a mission to serve people and their communities through innovative science education, community-based restoration and applied research. The program enlivens science curricula with cutting-edge classroom and field-based activities that examine forest science and management. It encourages students to be actively engaged in the scientific method and to use their creative and critical thinking skills. It also cultivates their interest in technology, engineering and math by demonstrating how these disciplines apply to the management of natural resources. The program uses numerous outdoor classrooms in northwest and central Oregon.

Starker Forests – Corvallis

Contact: Dick Powell – 541-929-2477
dick@starkerforests.com
<http://starkerforests.com>

Program: Field trips

Grade Level: K-12

Available: Year-round

Cost: Free by appointment

A family-owned business, Starker Forests, Inc. started in 1936 with purchases of abandoned farmland and cut-over and second-growth forests. Today it is a thriving working forest. The company encourages forestry education and offers curricula for use in the classroom. The Starker Forestry Trail is available for half-day and all-day field trips; a forester leads school groups on these trail tours. The Starker family encourages recreational use of their lands and offers tours by appointment. The trail is open all year for self-guided tours. A brochure with directions to the trail is available at the Starker office and describes stops along the trail. A CD with lessons and resources, including PowerPoint presentations related to program objectives, is available on request.

Tillamook Forest Center – Tillamook County

Contact: Oregon Department of Forestry
Register online or call 503-815-6800
tfcinfo@odf.state.or.us
<http://tillamookforestcenter.org>

Programs: Field trips, school-to-work programs, educator workshops, self-guided trips, service-learning, scouting programs for boys and girls

Grade Level: K-12

Available: March-November

Cost: Free

The Tillamook Forest Center, located in the heart of the Tillamook State Forest on Highway 6 about one hour west of Portland, offers educational and interpretive programs, hands-on exhibits and field-trip opportunities. It's fun, fully accessible and free. Programs examine the natural and cultural history as well as the stewardship of the Tillamook State Forest. All programs include pre- and post-activity suggestions and are correlated to state education requirements. The center is open March through November. Please check the website for hours and days of operation.

Tryon Creek State Park – Portland

Contact: Linda Koser – 503-636-4398

linda@tryonfriends.org

<http://tryonfriends.org>

Programs: Field trips, traveling programs, educator workshops

Grade Level: K-12

Available: Year-round

Cost: Variable, from \$6/student for half-day field trips to \$10/student for full-day field trips; \$95/class for traveling programs

The Friends of Tryon Creek State Park offer educational opportunities at Tryon Creek State Natural Area, an urban forest in southwest Portland. A variety of educational programs investigating different elements of forest ecology are available. The Friends offer morning-only and full-day field trips as well as professional development opportunities for teachers. They also bring traveling programs to metro-area schools. Field trips consist of indoor hands-on lessons and longer trail-based hikes in the forest. Traveling programs use interactive activities to explore forest ecology topics in the classroom. Participants must preregister for both field trips and traveling programs. Professional development opportunities provide significant time outdoors and are aligned with the Next Generation Science Standards as well as the Oregon Environmental Literacy Plan.

World Forestry Center – Portland, Wilsonville, Silverton

Contact: Rob Pierce – 503-488-2118

rpierce@worldforestry.org

<http://worldforestry.org>

Programs: Field trips, special tours, guided programs, educator workshops, service-learning

Grade Level: Pre-K-12

Available: Year-round

Cost: Check website for current rates, group discounts, special events

The World Forestry Center offers both indoor and outdoor educational experiences for groups of all sizes and ages, including an interactive museum and two tree farm sites.

Discovery Museum – Portland

Contact: Make reservations online or call 503-488-2147

The Discovery Museum is located in Washington Park, across from the Oregon Zoo. Two floors of highly interactive, hands-on exhibits focus on the ecological,

social and economic benefits of sustainable forestry in the Pacific Northwest and around the world. Students can crawl through a nurse log, be a forest scientist or a smoke jumper, take a whitewater rafting trip, drive a giant harvest machine and enjoy an amazing tour of the world's diverse forests by railcar, riverboat, safari jeep and canopy crane. Allow two hours. A lunchroom is available for groups. A program guide is available on the website. Registration is available only online.

Magness Memorial Tree Farm – Wilsonville

Contact: Make reservations online or call 503-488-2147

This beautiful 80-acre Pacific Northwest demonstration forest and outdoor education site features 2.5 miles of trails, a meadow, a stream, a picnic shelter, interpretive signs, an education center with restrooms and kitchen, and rustic log bunkhouses for overnights. Guided tours and classes are available. Check the program guide on the website for more information. Groups of 10 or more must register in advance.

Johnson-Swanson Memorial Tree Farm – Silverton

Contact: Bill Wood – 503-625-7471

This 80-acre historic farm features old-growth trees and new forest plantations and is an excellent site for service-learning projects. Reservations required.

Other Resources

The following resources may also be used to enhance the curriculum:

- Partnership for Forestry Education: <http://knowyourforest.org>.

The Partnership for Forestry Education is a collaboration of state, federal and private organizations providing educational resources to Oregon's forest landowners, managers and operators.

- The Learning Library: <http://knowyourforest.org/learning-library>.

The learning Library is an extensive library of resources from the Partnership for Forestry Education containing publications, guides, videos, presentations and practical information for managing forestlands.

- 4-H Forestry Invitational: <http://4hforestryinvitational.org/training>.

This website, designed to help teams prepare for this national championship of 4-H forestry, has some great resources, ID cards for diseases and insects, and lesson plans.

- L. DeVere Burton. *Introduction to Forestry Science*, 3rd Edition. Delmar Cengage Learning. 2013.
and
Renne Peugh and L. DeVere Burton. *Lab Manual to Accompany Introduction to Forestry Science*, 3rd Edition. Delmar Cengage Learning.

This textbook and accompanying lab manual – suitable for many high school students – teach the principles of science and the forest management practices that contribute to healthy forests.

- 1: Introduction to Oregon's Forests
- 2: Changes in Oregon's Forestland
- 3: Oregon's Forest Resource
- 4: Who Owns Oregon's Forests?
- 5: Oregon's Federal Forestland
- 6: Interview a Forest Landowner

OREGON'S FOREST HERITAGE

A photograph of a dense, moss-covered forest. The trees are heavily laden with green moss, and the ground is covered in a thick layer of green ferns and other forest floor vegetation. The lighting is soft and dappled, creating a serene and ancient atmosphere.

Section 1: Oregon's Forest Heritage

1: Introduction to Oregon's Forests

Overview

Students consider the truth of different statements about Oregon forests and then use a booklet called *Oregon Forest Facts & Figures* to validate or refute each statement. They then identify ways that Oregon's history has been shaped by forests and vice versa.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Use resources to validate or refute statements about Oregon's forests.
- Identify ways that Oregon's history has been shaped by forests.

Standards Connections

Next Generation Science Standards

- Performance Expectation – HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Disciplinary Core Idea – HS-ESS3.A: Resource availability has guided the development of human society.
- Science and Engineering Practice – 4. Analyzing and Interpreting Data: Evaluate the impact of new data on a working explanation and/or model of a proposed process or solution.

Common Core State Standards – English Language Arts

- RST.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions..

Oregon Forest Literacy Program Concepts

- Theme 2, A.1. In Oregon’s development toward becoming a state, forests provided basic resources for Native Americans and settlers, jobs for a growing workforce, resources for building the nation and dollars for a new state economy.
- Theme 2, C.3. Forests influence the economic, social and cultural composition of both urban and rural communities.

Materials

For Part 1

- [*Oregon Forest Facts & Figures 2015-16*](#) (either one copy for each pair, or on-screen access)
- “Oregon Forests – True or False” student page

For Part 2

- [*Oregon Forest History Timeline*](#)
- Equipment for sharing the *Oregon Forest History Timeline* with class
- *Hats Off to the Beaver* (in [Forest Literacy Readings Grades 9-12](#))
- *How Oregon’s State Tree Got Its Name* (in [Forest Literacy Readings Grades 9-12](#))
- *1920s Logger Becomes Leader in Sustainable Forestry* (in [Forest Literacy Readings Grade 8](#))
- *Planting a Tree Could Change Your Life* (in [Forest Literacy Readings Grade 7](#))

Background Information¹

A key influence in creating first the Oregon Territory and then the state of Oregon was the area’s abundant natural resources – in particular, its forests. Before settlement, native peoples appreciated the forests for their material and aesthetic qualities. They used wood to make implements for daily living, and many built their homes from wood. They gathered berries and other food in the forest’s edges and clearings. In some places they used fire, one of their most effective land management tools, to clear patches of ground for better hunting and gathering.

As European-American traders and settlers moved into the Pacific Northwest, the rich Douglas-fir timber on the west side of the Cascade Range attracted early lumbering entrepreneurs. The logging of these forests and the manufacture and trade of wood products spurred economic development of Oregon. Largely because of timber, Oregon grew from a string of frontier settlements to a vibrant economic community.

¹ Source: *What Do Western Oregon’s Forests Look Like After a Century of Management?* Oregon Forest Resources Institute, 2009.

http://oregonforests.org/sites/default/files/publications/pdf/What_do_western.pdf

An early Oregon saying, “Timber is King,” acknowledged timber’s critical role as an economic engine that helped build cities, railroads, highways, ships and ports. Wealth derived from timber made possible civic and cultural institutions such as schools, libraries and symphony halls.

Unquestionably, all this economic development had environmental consequences, in Oregon and across America. In the course of building a modern society, forests were cut down, prairies were plowed under, rivers were dammed and wetlands were drained – all in the name of “progress.”

There is a popular perception that the rich forests existing before European-American settlement have been lost or irretrievably damaged. However, the evidence shows that perception to be inaccurate. Today’s forests are of different ages and sizes than they were 100 years ago, but the area covered by forest has increased considerably, largely because of the growth of forests and the development of modern fire suppression.

Key Vocabulary

clearcutting

fire suppression*

forest sector

reforestation*

sustainable forest management*

timber harvest*

*included in Glossary

Preparation

Makes copies of the student page. Make copies of the Forest Literacy Readings or provide on-screen access to them.

Procedure

Part 1

1. Introduce the curriculum and the lesson by pointing out that throughout its history, forests have been a crucial component of Oregon’s environment and economy.
2. Give each pair of students a student page and allow them a few minutes to read the different statements and decide which they think are true and which are false.
3. Provide copies of *Oregon Forest Facts & Figures* or direct students to the booklet online. Direct pairs to use the data provided in the booklet to either validate or refute each statement, citing the evidence they find.

4. As a whole class, discuss the students' findings:
 - Which statements did you find to be true? Which were not true?
 - Did any of your findings surprise you?
 - What did you learn about Oregon's forests from this exercise?

Part 2

1. Lead a brief discussion to ascertain students' current understanding of Oregon's historical connection to forests, asking questions such as
 - How have forests shaped Oregon's history?
 - How has Oregon's history shaped forests?
 - In what ways do you think Oregon's forests have changed over time?
2. Share the *Oregon Forest History Timeline*.
3. Randomly assign each student one of the Forest Literacy Readings. Allow time for students to read their passage and to answer the questions at the end of it.
4. Have students form groups of four, with each student in a group focusing on a different reading.
5. Direct students to share the main points of their reading with their other group members. As a group, have them create a T-chart like the one below, adding information from the readings, from the timeline, from *Oregon Forest Facts & Figures* or from other sources.

How have forests shaped Oregon's history?	How has Oregon's history shaped forests?

Assessment

Ask students to use their T-chart from the activity to write a brief essay describing how Oregon and its forests are interrelated.

Extension Idea

Show a video about the formation of the US Forest Service: *The Greatest Good* video. (Available at <http://forestryvideos.net/videos/greatestgood/>)

Possible Answers to “Oregon Forests – True or False?” Student Page²

(Page numbers refer to Oregon Facts & Figures, 2015-16.)

1. True. Page 1 – 29.9 million acres – about 47% – of Oregon’s total acreage is forestland.
2. True. Page 30 – table indicates about 59,000 jobs in Oregon’s forest sector. (This statistic is also stated on page 18.)
3. False. Page 3 – the amount of forestland acreage and the volume of wood growing in Oregon have remained about the same since the 1950s.
4. True. Page 16 – graph shows 36% managed for wood production, 33% for multi-resource, and 31% for reserve.
5. False. Page 1 – table shows federal and state governments own 19.2 million acres of forestland in Oregon, while the total owned by private landowners is 10.3 million acres.
6. False. Page 3 – graph shows that 66% of timber comes from large private landowners.
7. True. Page 4 – graph shows that falloff in home construction from the recession in 2007-2009 was echoed in a reduction of Oregon timber harvest.
8. True. Pages 21 and 22 – show Oregon as top softwood lumber-producing state and top plywood-producing state in the nation.
9. False. Pages 20 and 23 – Oregon forests provide a wide range of products, including lumber, plywood, engineered wood products, paper and paper products, reconstituted wood products, posts, poles and timbers, etc.
10. False. Page 8 – Oregon Forest Practices Act places limits on clearcuts.
11. True. Page 7 – under Oregon Forest Practices Act, forest landowners must replant within two years after harvest.
12. True. Page 36 – fire suppression has led to drier eastern and interior southwest Oregon forests growing very dense, and these forests are at risk for larger and hotter fires.
13. True. Pages 18 and 19 – under Oregon Forest Practices Act, timber harvesting, road building and chemical use are restricted near waterways to protect fish habitat and water quality.
14. True. Page 17 – chart shows 4.2 million acres certified by three major systems.

² Source: *Oregon Forest Facts & Figures, 2015-16*, Oregon Forest Resources Institute

Oregon Forests – True or False?

First, for each statement, underline whether you think it is true or false. Then, look for evidence in *Oregon Forest Facts & Figures* to verify or refute each statement. Circle the correct answer based on your findings.

True or False?	Statement	Supporting Evidence (and Page Number)
T F	1. About half of Oregon's land area is forested.	
T F	2. The forest industry accounts for tens of thousands of jobs in Oregon.	
T F	3. The amount of forestland in Oregon has shrunk dramatically since 1950.	
T F	4. About one-third of Oregon's forestland is managed for wood production and about one-third is conserved for parks, wilderness areas or other reserves.	
T F	5. Private property owners control most of the forestland in Oregon.	
T F	6. Three-fourths of the timber harvested in Oregon comes from federal land.	
T F	7. When the U.S. economy slows, fewer new homes are built, which affects wood products sales in Oregon.	
T F	8. Oregon is one of the top lumber-producing states in the U.S.	
T F	9. Wood from Oregon forests is used only for making paper and lumber.	
T F	10. Forest owners in Oregon may clearcut (log all or most of the trees) on their own land without any restrictions.	
T F	11. Oregon landowners must replant forest trees after harvesting them.	
T F	12. Fire suppression (putting out wildland fires) has resulted in a greater fire risk for much of Oregon's forests.	
T F	13. In Oregon, logging is restricted near waterways to protect fish and water quality.	
T F	14. Over 4 million acres of Oregon forest are certified by a sustainable forest certification system.	

2: Changes in Oregon's Forestland³

Overview

Students analyze land use changes in the Willamette Valley (or other area of the state), describing changes over time in ecosystem elements such as riparian vegetation and forest type, as well as changes in Oregon's timber volume over time.

Time Considerations

Preparation: 15 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Evaluate maps of the same location at different time periods and analyze differences in land and ecosystem elements.
- Articulate several key findings from their map analysis.

Standards Connections

Next Generation Science Standards

- Performance Expectation – HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Disciplinary Core Idea – HS-LS2.C: Anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
- Disciplinary Core Idea – HS-ESS3.A: Resource availability has guided the development of human society.

³ This lesson was adapted from “Willamette Valley Land Use” by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/WillametteValleyLandUseChange.pdf>.

- Science and Engineering Practice 4 – Analyzing and Interpreting Data: Analyze data using tools, technologies and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.

Oregon Forest Literacy Program Concepts

- Theme 2, A.1. In Oregon’s development toward becoming a state, forests provided basic resources for Native Americans and settlers, jobs for a growing workforce, resources for building the nation and dollars for a new state economy.
- Theme 2, A.2. Historical perspectives, which may include aesthetic, cultural, spiritual, economic and educational factors, aid our current understanding of Oregon forests and inform future generations about their use.
- Theme 2, B.3. Forests provide the opportunity to study ecosystems, conservation and natural resource management.

Materials

- “A View Across the Willamette Valley” teacher page
- “The Willamette Valley” student page
- “Willamette Valley Land Use Changes” student page
- “Western Oregon Timber Volume” teacher page
- Equipment for showing teacher pages

Key Vocabulary

board measure
 development*
 riparian*
 timber volume
 vegetation
 urbanization
 wetland*

*included in Glossary

Preparation

Make copies of the student pages. Set up equipment for showing teacher pages.

Background Information⁴

More than a century of mapping, managing and measuring has yielded quite a bit of information about Oregon's forests. Early maps provide a good general idea of what forests looked like around the end of the 19th century. From them, we know generally where logging, wildfire and other disturbances have occurred during the past 100 years, and we know much about patterns of regrowth in forest ecosystems. And with modern tools such as satellites, other remote imaging techniques and records from extensive on-the-ground mapping, we can gain an accurate and precise picture of what western Oregon forests look like today.

In 1900 the USGS published a map of Oregon that showed forested areas, classifying them according to the volume of timber per acre in board measure. In the mid-1990s, the Oregon Forest Industries Council (OFIC), a trade association representing more than 50 Oregon forest landowners and forest products manufacturing-related firms, set out to create a similar map of the western part of the state, utilizing information gathered at thousands of sampling plots on private and public lands combined with Landsat satellite data.

Comparing these two maps yields an interesting picture of how forests in western Oregon have changed during the past century from both human and natural influences. The two maps are snapshots in time of ever-changing forest conditions. The historic map does not represent a timeless or static state – it was drawn at a particular moment in a dynamic history. In the same way, the modern map captures conditions at the end of a century in which human influences have been significant across the whole landscape. One of those influences has been ongoing, conscious management of forests by public and private owners. The forests today do not look the same as the forests of 50 years ago, and 50 years hence they will look different still.

In other words, a forested landscape is something of a moving target. Comparing these two snapshots and analyzing the influences – human and natural – that shaped and continue to shape Oregon's forests reveals a lot about the variability and resilience of forests in the Northwest.

It should be noted that past land managers made decisions based on the best information available to them, and in a cultural context that is different from today's. Since we have the benefit of hindsight when looking at the consequences of those decisions, it is tempting to be

⁴ Source: *What Do Western Oregon's Forests Look Like After a Century of Management?* Oregon Forest Resources Institute, 2009.

http://oregonforests.org/sites/default/files/publications/pdf/What_do_western.pdf.

judgmental of them. It is also tempting to embrace a nostalgic view of historic ecosystems as being inherently “good.” Past management practices left a footprint that is not necessarily “bad,” but is certainly different than it would have been had the ecosystems been left untended.

Procedure

1. Introduce the activity by showing students the images of the same view across the Willamette Valley in western Oregon at two different times: 1851 (top) and 1990 (bottom). Point out that the images show an area just north of present-day Eugene.
2. Ask students to identify differences and similarities between the two images (for example, the shape and path of the river, the presence or absence of plants (riparian vegetation) around the river) and the presence or absence of agriculture or other development.
3. Project the two maps from “The Willamette Valley” student page, as well as the legend, or provide student access to the maps and legend online.
4. Direct students to work in small groups to complete the “Willamette Valley Land Use Changes” student page by looking at the two maps and describing, first, changes they observe (or infer) between the images, and then any impacts they would predict from the images.
5. Have groups share some of their findings. See answers on page 27 for some of the possibilities.
6. Show students the two maps on the “Western Oregon Timber Volume” teacher page. Explain that BM (board measure) indicates the amount of timber present in an area of forestland.⁵ Discuss the differences between the two maps, and ask students how they might explain the changes they see.

Assessment

Use student responses to the “Willamette Land Use Changes” student page to assess their understanding of the lesson concepts.

Extension Idea

- Explore the three possible future scenarios for the Willamette Valley described in “Willamette Valley Land Use” by Dr. Wynn Cudmore (on pages 15-16, and depicted in

⁵ You may want to point out that foresters today express timber volume in board feet rather than board measure. Both a board foot and a board measure are the dimensions of a piece of lumber one inch thick, 12 inches wide, and 12 inches long, or its equivalent. However, the two are calculated using different formulas.

the maps on pages 31-34). Available at

<http://learnforests.org/sites/default/files/WillametteValleyLandUseChange.pdf>.

- Using Google Earth or other aerial imagery, look for land use changes in your local area.

Possible Responses to the “Willamette Valley Land Use Changes” Student Page⁶

Willamette River

- From: Braided, highly complex river system with oxbows, back channels, sloughs, etc.; highly interactive with its floodplain
- To: Channelized river lacking above complexity
- Impacts: Some river habitats eliminated for aquatic species (e.g., salmon spawning and rearing habitat). Changes in flow patterns and proneness to flooding. Greater potential for impacts on human structures.

Wetlands

- From: Extensive wetlands of many types associated with Willamette River
- To: Most wetlands replaced with agricultural or urban lands
- Impacts: Loss of water-quality improvement function of wetlands (e.g., filtration, absorption). Loss of wetland habitat. Increased proneness to flooding due to decreased water retention. More land made available for agriculture and urban use.

Riparian Vegetation

- From: Extensive riparian vegetation along river
- To: Only a narrow band of vegetation remains; conifers mostly removed
- Impacts: Loss of habitat for riparian species. Increased water temperature with impacts on aquatic species. Impaired water quality due to loss of filtering function of riparian vegetation.

Urbanization

- From: None – some Native American settlements
- To: Cities, towns and rural residential development now occupies significant percentage of the landscape

⁶ Source: “Willamette Valley Land Use” by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/WillametteValleyLandUseChange.pdf>.

Impacts: Loss of natural habitats (riparian, wetland, prairie, savanna). Urban pollutants (air, water, soil). Human population increases energy consumption and CO₂ production. Greater potential for flooding on human structures.

Agriculture

From: None

To: Major land use for this area – grass seed, nursery stock, pasture, orchards

Impacts: Habitat loss/edge creation. Runoff of agrochemicals affecting water quality. Air pollution. Fossil fuel consumption. Agricultural commodity production.

Native Prairie/Savanna

From: Major habitat represented

To: Minimal habitat remaining

Impacts: Habitat loss resulting in decline of native prairie/savanna species

Water Quality

From: High quality (inferred)

To: Poor quality

Impacts: Decline of susceptible aquatic species. Increasingly difficult and expensive to produce clean water for human uses.

Forests

From: Upland – savanna-like forests with oaks scattered among grasslands due to natural and human-set fires. Riparian (by the river) – extensive cottonwood/maple forests along the river.

To: Upland – dense forests, with Douglas-firs overtaking oaks, due to fire suppression. Riparian – large areas replaced with other land uses.

Impacts: Loss of prairie/savanna habitats

Fish and Wildlife Habitat

From: Extensive availability of a wide range of fish and wildlife habitats

To: Decreased availability of natural habitats

Impacts: Loss of natural biodiversity at genetic, species and ecosystem levels. Extinction of some endemic species. Increase in number of threatened and endangered species.

Teacher Page

Lesson 2

A View Across the Willamette Valley⁷



Just north of present-day Eugene, 1851



View from the same location, 1990

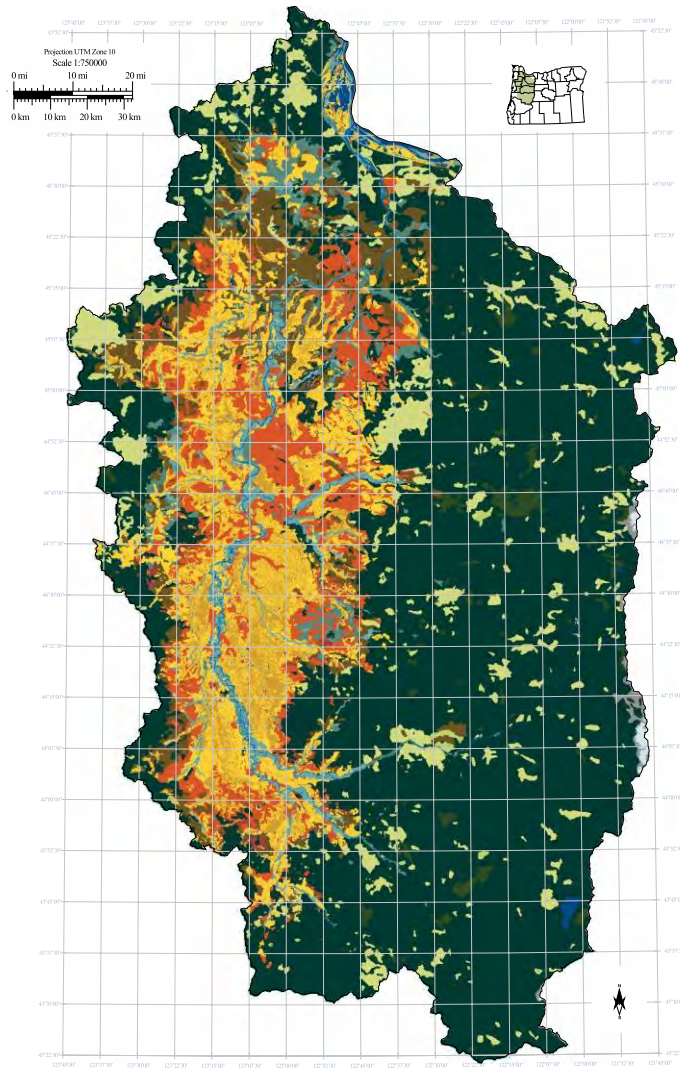
⁷ Source: "Willamette Valley Land Use" by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/WillametteValleyLandUseChange.pdf>.

Note: Original source as cited by Cudmore: D. Hulse, S. Gregory and J. Baker (eds.). 2002. *Willamette River Basin Atlas: Trajectories of Environmental and Ecological Change*. Oregon State University Press, Corvallis, OR. 178 pp. http://fsl.orst.edu/pnwer/wrb/Atlas_web_compressed/PDFtoc.html.

Student Page

Lesson 2

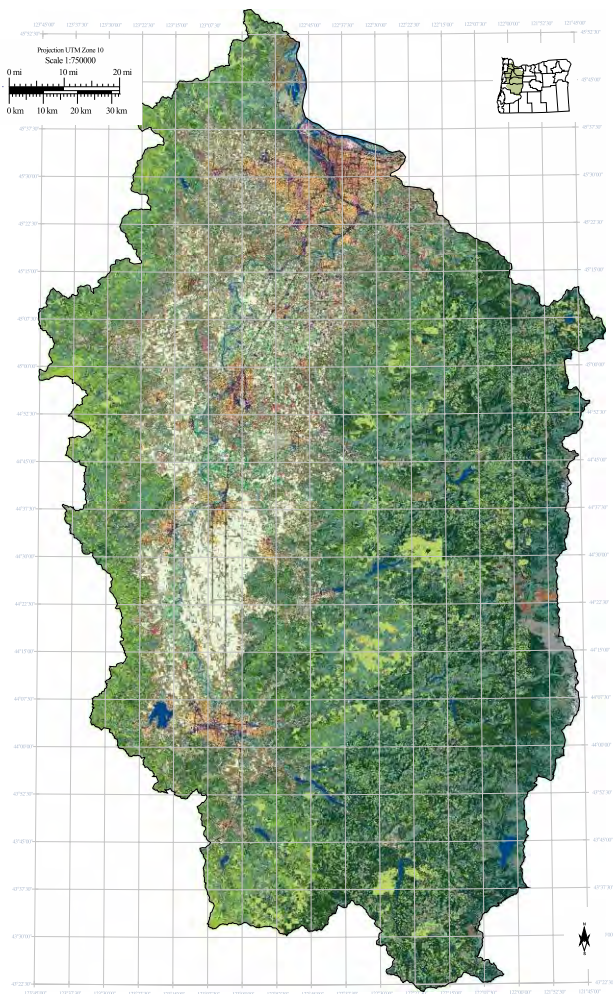
The Willamette Valley⁸



Land use: Pre-EuroAmerican Settlement

⁸ Source: “Willamette Valley Land Use” by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/WillametteValleyLandUseChange.pdf>.

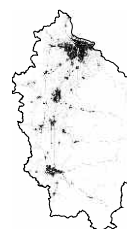
Note: Original source as cited by Cudmore: D. Hulse, S. Gregory and J. Baker (eds.). 2002. *Willamette River Basin Atlas: Trajectories of Environmental and Ecological Change*. Oregon State University Press, Corvallis, OR. 178 pp. http://fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/PDFtoc.html.



Land use: 1990

Built features

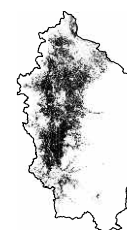
Residential 0 - 4 DU/ac	
Residential 4 - 9 DU/ac	
Residential 9 - 16 DU/ac	
Residential > 16 DU/ac	
Commercial	
Commercial/Industrial	
Industrial	
Residential & commercial	
Rural structures	
Railroad	
Primary roads	
Secondary roads	
Light duty roads	



Built (black)

Agriculture

Hybrid poplar	
Grass seed rotation	
Irrigated annual rotation	
Grains	
Nursery	
Berries & vineyards	
Double cropping	
Hops	
Mint	
Radish seed	
Sugar beet seed	
Row crop	
Grass	
Burned grass	
Field crop	
Hayfield	
Late field crops	
Pasture	
Bare/fallow	
Irrigated perennial	
Turfgrass	
Urban tree overstory	
Orchard	
Christmas trees	
Conifer Woodlot	



Agriculture (black)

Natural & native vegetation

Upland Forest open	
Upland Forest semi-closed mixed	
Forest closed hardwood	
Forest closed mixed	
Upland Forest semi-closed conifer	
Conifers 0 - 20 yrs.	
Forest closed conifer 21 - 40 yrs.	
Forest closed conifer 41 - 60 yrs.	
Forest closed conifer 61 - 80 yrs.	
Forest closed conifer 81 - 200 yrs.	
Forest closed conifer older than 200 yrs.	
Upland Forest semi-closed hardwood	
Natural grassland	
Natural shrub	
Flooded/marsh	
Oak Savanna	
Wet shrub	
Wet prairie	



Natural and native vegetation (black)

Water & physiographic features

Main channel non-vegetated	
Stream orders 5 - 7	
Permanent lentic water	
Topographic shadow	
Snow	
Barren	



Unknown

Urban non-vegetated unknown	
Rural non-vegetated unknown	
Unknown	

Water (blue) and Unknown (black)

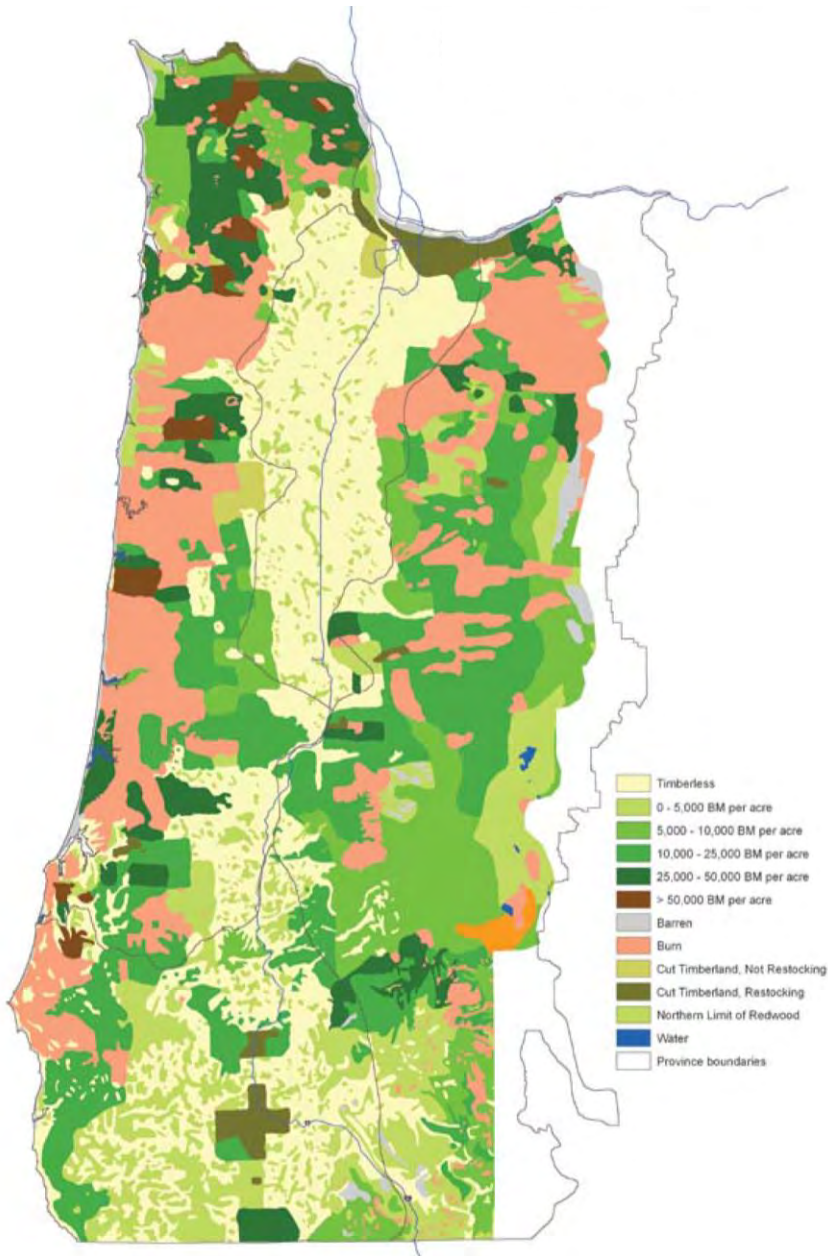
Willamette Valley Land Use Changes

Feature	Changes	Impacts
Willamette River	From: To:	
Wetlands	From: To:	
Riparian Vegetation	From: To:	
Urbanization	From: To:	
Agriculture	From: To:	
Native Prairie/Savanna	From: To:	
Water Quality	From: To:	
Forests	From: To:	
Fish and Wildlife Habitat	From: To:	

Teacher Page

Lesson 2

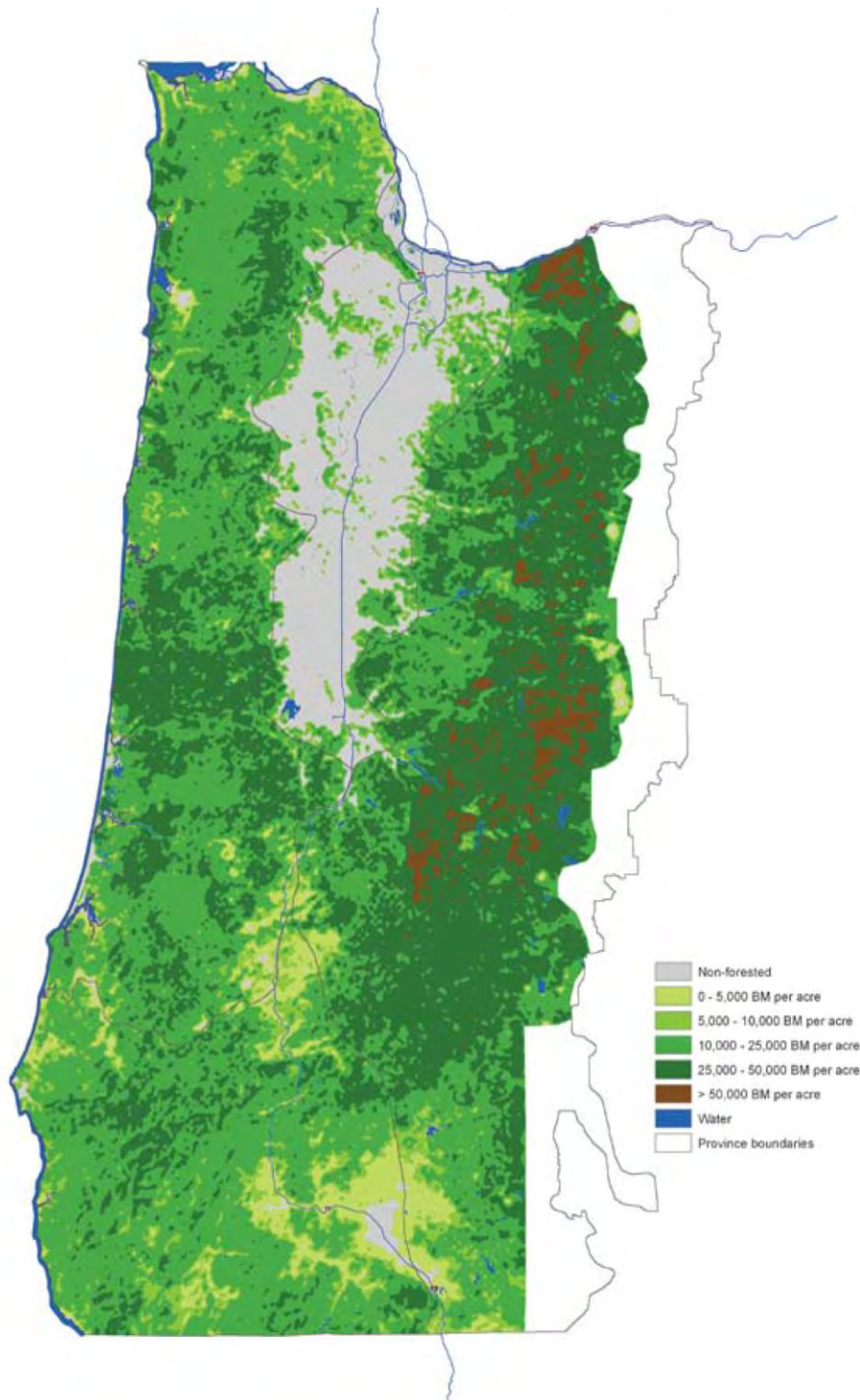
Western Oregon Timber Volume⁹



Historic timber volume

⁹ Source: *What Do Western Oregon's Forests Look Like After a Century of Management?* Oregon Forest Resources Institute, 2009.

http://oregonforests.org/sites/default/files/publications/pdf/What_do_western.pdf.



1990s Timber Volume

3: Oregon's Forest Resource

Overview

Students read (or listen to a brief teacher-prepared lecture) about Oregon's forest heritage and then answer questions based on the information.

Time Considerations

Preparation: 15 minutes (more, if preparing lecture)

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Identify whether Oregon is losing forestland to other uses.
- Describe the Oregon Forest Practices Act.
- Explain how ecological, social and economic benefits of forests contribute to sustainability.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.A: Resource availability has guided the development of human society.
- Science and Engineering Practice – 8. 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 Forest Literacy Program Concepts

- Theme 1, C.3. Humans depend on and influence forest ecosystems and are themselves influenced by forest ecosystems.

Materials

- "Oregon's Forest Heritage" student page
- "Oregon's Forest Heritage – Questions" student page

Background Information

See [“Oregon’s Forest Heritage”](#) student page.

Key Vocabulary

canopy^{*}

conifer^{*}

ecology^{*}

economic value^{*}

forest^{*}

sustainability

photosynthesis^{*}

^{*}included in Glossary

Preparation

Make copies of student pages or provide on-screen access to them. (As an alternative to students reading the “Oregon’s Forest Heritage” student page, you may choose to prepare a brief lecture based on the material.)

Procedure

1. Have students read the “Oregon’s Forest Heritage” student reading, or present a brief lecture based on the material.
2. Give students copies of the “Oregon’s Forest Heritage – Questions” student page, and allow time for them to answer the questions in pairs or groups.

Assessment

Use student responses to “Oregon’s Forest Heritage – Questions” student page to assess their learning.

Possible Answers to “Oregon’s Forest Heritage – Questions” Student Page

1. They help cool and regulate the earth’s climate by removing carbon dioxide from the atmosphere.
2. The amount of forestland in Oregon has remained fairly constant, with about 8 percent loss due to human development.
3. Ecological value: They provide food, shelter and habitat for wildlife; stabilize soil and prevent erosion; regulate temperature and moisture; capture carbon dioxide to produce oxygen; and filter water. Social value: They provide places for people to relax, rejuvenate, find food and have fun, as well as raw materials for wood products. Economic value: They provide softwood lumber and tens of thousands of jobs.
4. Ecological, social and economic benefits are all considered when we talk about forest sustainability.
5. A set of laws and rules governing harvest practices and forest management operations in Oregon.
6. Lumber, door and window frames, fencing material, plywood, newsprint, printer and photocopy paper, egg cartons, food containers, glues, packing material, furniture, toys, playground equipment, pencil stock, cabinets, cosmetics, and more.
7. Individual consumer choices affect the demand for forest products – and, in turn, ecosystems and human communities – in Oregon and around the world.
8. Individual responses will vary.

Student Page

Lesson 3

Oregon's Forest Heritage¹⁰

Introduction

A **forest** is a living, complexly interrelated community of trees and associated plants and animals. Forests help provide the earth with oxygen necessary for life. Green plants take in energy from the sun and use that energy in their cells to transform water and carbon dioxide into oxygen and glucose, a carbon-based molecule. This process is called photosynthesis. High levels of carbon dioxide and other gases in the atmosphere contribute to global warming. Forests help cool and regulate the earth's climate by removing carbon dioxide from the atmosphere. The carbon-based molecules that result from photosynthesis are stored in trees' trunks, stems and leaves.

From the soil, trees take moisture and nutrients, and with the aid of sunlight, they grow wood and other natural products used by humans. Oregon's forests are very diverse, ranging from mixed-species, old-growth trees in roadless wilderness areas to single-species, intensively managed industrial forests. To better understand forestry in Oregon, it is important to understand some of the basic facts that shape Oregon's forests.

Oregon's Forest Heritage

Of the 62 million acres of land in Oregon, some 28 million acres, or 45 percent, are classified as forestland. Over the past four centuries, the amount of forestland in the state has remained fairly constant, with about 8 percent having been lost to human development (agriculture, urban growth, highways, electric transmission lines and other infrastructure) since Europeans first visited the Northwest. While the amount of forestland has not changed considerably, its composition has changed, as much of the state's virgin forests were harvested for timber during the 19th and 20th centuries.

Forest Sustainability

The ecological, social and economic benefits of forests are all important to Oregon's citizens. Using our forests sustainably, so they continue to provide these important benefits far into the

¹⁰ Source: *Exploration of Oregon Forests: Module 1 – Oregon's Forest Heritage*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Shortcourse*.

future, requires us to recognize the interdependent relationships among these various uses and to acknowledge the need for balance among them.

- **Ecological Value:** The forest floor provides food, shelter and habitat for animals, from the simplest worm to the biggest bear. Tree roots help stabilize the soil and prevent erosion. The top portion of the forest, called the “canopy,” helps regulate forest temperature and moisture. Forests also capture carbon dioxide (a greenhouse gas), produce oxygen and filter water to keep it clean. These are all important ecological functions, also known as ecosystem services, of forests.
- **Social Value:** Forests provide places for people to relax, rejuvenate, seek food and have fun. Each year, thousands of Oregonians visit our forests to go hiking, biking, camping, hunting, fishing, foraging, off-roading and wildlife watching. Another reason forests are important to society is that they provide the raw materials for all the wood products that we use on a daily basis, such as housing, furniture, newspaper, books and cardboard.
- **Economic Value:** Oregon harvests more conifers (cone-bearing evergreens) than any other state and is the leading producer of softwood lumber in the nation. Tens of thousands of people in Oregon earn a living by working directly with the state’s forest sector. Forestry is especially important to rural economies, with most forestry-related jobs located in communities outside the Portland metropolitan area.

Oregon Forest Practices Act

All private and state forestland is protected under the rules of the Oregon Forest Practices Act (OFPA), the nation’s oldest and one of the most comprehensive sets of laws and rules governing harvest practices and other forest management operations. Although US Forest Service and Bureau of Land Management (BLM) lands are not regulated by the OFPA, these federal agencies have agreed to meet or exceed many of its requirements. Oregon’s landmark land use laws offer further protection by tightly restricting the conversion of forests to other uses, attempting to ensure that future generations will have ample forest resources.

OFPA includes laws that

- ***Require Prompt Reforestation.*** On average, more than 40 million new trees are planted each year in Oregon’s forests. Reforestation is required any time forest density drops below established standards following harvest.

- **Require Written Plans.** The Oregon Department of Forestry must be notified of all harvesting operations and be provided site maps for review. In addition, some planned actions require that the landowner or timber operator submit a written plan that documents how the operation will meet the Oregon Forest Practices Act. In general, harvesting, road construction or other operations conducted near streams or wetlands require a written plan.¹¹
- **Protect Water Resources.** To protect water resources in forests, particularly where fish and domestic water supplies are involved, harvest operations are restricted within a certain distance from the banks of streams and water bodies.
- **Protect Wildlife Habitat.** Landowners must be responsive to the nesting and feeding needs of a wide variety of forest wildlife. For example, they must ensure that snags (standing, dead trees), fallen logs or standing green trees are present to provide nesting sites and other habitat for many birds, mammals and other animals.
- **Limit Clearcuts.** Clearcutting is when most or all of the trees in an area are cut down. OFPA limits the size and location of clearcuts.
- **Regulate Road Construction and Maintenance.** Strict regulations govern the location, construction, maintenance and repair of roads on both state and private forestland. Roads must avoid marshes, meadows, drainage channels, riparian areas and, when possible, steep terrain.

Oregon's Wood Products

Different types of trees lend themselves to different kinds of wood products. “Hardwood” broadleaf trees such as oak, cherry and walnut provide dense, durable wood – the kind commonly used to make flooring and furniture. “Softwood” cone- and needle-bearing trees such as pine, fir, spruce and cedar produce lumber that is less dense and lighter in weight. It is often used in construction and papermaking.

Beyond the “hardwood” and “softwood” distinction, the different characteristics of dozens of tree species, such as flexibility, straightness and tightness of grain, make for a wide range of applications.

Wood is a component in 5,000 different products, many of them not as easily recognizable as a baseball bat or table. While some products are made directly from hardwood or softwood lumber, many engineered wood products are made of combinations of sawdust, shavings and other waste materials. A wide range of products comes from wood pulp and plant chemicals extracted from wood pulp.

¹¹ Source: “Forest Management Planning.” Oregon State University.
<http://outreach.oregonstate.edu/programs/forestry/node/306>.

Oregon's wood and paper products are sold in all 50 states and some 40 foreign countries. They include lumber, door and window frames, fencing material, plywood, newsprint, printer and photocopy paper, egg cartons, food containers, glues, packing material, furniture, toys, playground equipment, pencil stock, cabinets, cosmetics, and more.

Wood Use in a Global Context

U.S. wood consumption per person has increased 40 percent since 1960. Much of this demand has been met by imports from around the world. Across the globe, about 50 percent of all forests have been converted to other land uses (compared with 33 percent in the U.S. and 8 percent in Oregon). Timber harvests in countries without strong forest practice laws often destroy critical habitat, such as tropical rainforests, and affect endangered species. Individual consumer choices help shape forests, ecosystems and communities, not only in Oregon, but across the United States and around the globe.

A Career in Forestry

A career in forestry or wood products offers an exciting chance to benefit people, the environment and the economy of Oregon. Forestry professionals are engaged in the practice of creating, managing, using and conserving forests and wood products in a sustainable manner to meet the needs, goals and values of forestland owners. They care for trees and other forest resources including soils, water and wildlife and make innovative products. Some people are drawn to forestry because they want to work in the outdoors. Many forest sector careers involve working in the forest, but there are other forest-related jobs that might surprise you: writing policy papers, managing timber investments, using satellite mapping technology, managing product quality and educating the public are just a few examples.

Types of job responsibilities among Oregon's forest sector professionals include

- Growing trees for wood products
- Managing water quality
- Protecting endangered wildlife
- Ensuring healthy forests
- Planning recreational uses
- Researching tree genetics
- Planning and supervising timber harvests
- Developing mill technologies
- Creating new wood products
- Researching global markets
- Producing renewable biomass energy

Oregon's Forest Heritage – Questions¹²

1. How do forests help combat global climate change?
2. Over the last four centuries, what percentage of forestland has Oregon lost?
3. How do Oregon's forests contribute to the ecological, social and economic well-being of Oregon and beyond?
4. What factors are included when we talk about the sustainability of Oregon forests?
5. Describe the Oregon Forest Practices Act (OFPA).
6. What everyday products are made of wood or wood byproducts from Oregon trees?
7. How do consumer choices affect Oregon's forests?
8. Which forest-related job responsibility sounds the most interesting to you?

¹² Source: *Exploration of Oregon Forests: Module 1 – Oregon's Forest Heritage*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Shortcourse*.

4: Who Owns Oregon's Forests?

Overview

Students examine a map showing forest ownership in Oregon by ecoregion and identify differences in ownership and forest management challenges.

Time Considerations

Preparation: 15 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Compare the different ecoregions of Oregon in terms of patterns in forestland ownership.
- Identify challenges faced by forest owners in Oregon's different ecoregions.
- Recognize the forest management objectives for different types of forest landowners.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS4.D. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- Science and Engineering Practice – 5. Using Mathematics and Computational Thinking: Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Common Core State Standards – Mathematics

- Mathematical Practice – MP.2. Reason abstractly and quantitatively.

Oregon Forest Literacy Program Concepts

- Theme 3, A.3. Oregon forests are managed under private (e.g., industrial, family and tribal) and public (e.g., city, county, state and national) ownership. Each type of ownership may have different objectives for how to manage forests.
- Theme 3, A.4. Many forest landscapes are made up of a mix of ownerships, a variety of management objectives and a blend of forest ecosystems.

Materials

- [*Forest Fact Sheet: Who Owns Oregon's Forests?*](#) (optional)
- "Oregon's Forest Landowners" student page
- *Oregon Forestland Ownership* map (from http://oregon.gov/odf/resource_planning/forestatlas/forestland_ownership.jpg on other source)
- [*Forests of Oregon*](#) posters
- "Oregon Ecoregion Conservation Strategy" overviews (available from Oregon Department of Fish and Wildlife, <http://dfw.state.or.us/conservationstrategy/contents.asp - eco>)
- Internet access (optional)
- Tracing graph paper

Background Information¹³

Oregon contains more than 30 million acres of forestland and nearly half the state is forested. All that forestland is divided between tens of thousands of different landowners: federal, state and local governments, small businesses, large corporations, tribes, families and individuals.

By far the biggest single forest landowner is the federal government, which owns 60 percent of Oregon's forestland. Most of the federal forestland is managed by two agencies: the US Forest Service and the Bureau of Land Management.

Different landowners have different priorities when it comes to managing their forestland. Some grow timber to be harvested for wood products. Others focus on wildlife habitat. And many try to balance a mix of environmental and economic values.

¹³ Sources: *Who Owns Oregon's Forests?* fact sheet. Oregon Forest Resources Institute. http://oregonforests.org/sites/default/files/publications/pdf/FactSheet14_Ownership.pdf.

"Ecoregions." Oregon Department of Fish and Wildlife. http://dfw.state.or.us/conservationstrategy/docs/document_pdf/b-eco_1.pdf.

In this lesson, students examine forestland ownership through the lens of Oregon’s ecoregions – portions of the state with similar climate and vegetation. Oregon’s diverse landscapes range from lush rainforests to deserts, contributing to diverse ecosystems that differ from one area to another. These differences, as well as the local history of human use, influence issues facing landowners. They also affect the way landowners perceive, value and manage their natural resources.

Key Vocabulary

ecoregion
federal government
private ownership*
state government
tribal government

*included in Glossary

Preparation

Make copies of the student pages and of the “Oregon Ecoregion Conservation Strategy” overviews.

Procedure

1. Introduce the lesson by asking students who they think owns most of the forestland in Oregon: Is it owned by federal, state, or local governments; by tribal governments; by private companies; or by families or individuals? (They may remember, from Lesson 1, that approximately 60 percent of Oregon’s forestland is owned by the federal government.) You may want to show them the Forest Fact Sheet: Who Owns Oregon’s Forests? as a basis of the discussion. What impact might the ownership of a particular tract of forestland have on how that land is managed or used?
2. Display the *Oregon Forestland Ownership* map, and ask students whether they notice any patterns. Point out that the location of forests – and forest ownership patterns – vary in different areas (ecoregions) of the state.
3. Explain that students will be looking at different ecoregions of Oregon to learn more about patterns of forestland ownership in the various regions, as well as the particular challenges owners may face. Divide the class into eight groups, assigning each group one of the following ecoregions:

- Blue Mountains
- Coast Range

- Columbia Plateau
 - East Cascades
 - Klamath Mountains
 - Northern Basin and Range
 - West Cascades
 - Willamette Valley
4. Give students copies of the “Oregon’s Forest Landowners” student page and the *Oregon Forestland Ownership* map. In addition, give them copies of (or online access to), the *Forests of Oregon* poster and the “Oregon Ecoregion Conservation Strategy” overview for their assigned ecoregion.
 5. Allow time for groups to answer the questions on the student page using the other materials as resources. Provide sheets of tracing graph paper, and suggest that students may use them to help estimate area on the map.
 6. After groups have answered the questions on the student page, ask them to present their findings to the class. Discuss the differences and similarities among the various ecoregions. For example:
 - Which ecoregion has the highest percentage of federally owned forestlands?
 - Where are privately owned forests – forests owned by industrial companies or by families and individuals – more prevalent?
 - What similar challenges do forest landowners face across the state? What are regional differences?

Assessment

Use the student responses on the student page to assess their understanding and learning.

Extension Idea

- Compare and contrast ecoregions in the United State. Download a map of ecoregions (such as from the U.S. Environmental Protection Agency’s “Ecoregions of North America” web page, http://epa.gov/wed/pages/ecoregions/na_eco.htm). Have students research differences in the ecoregions and discuss why the differences are present. Create a visual key to compare their findings.

Oregon's Forest Landowners

Ecoregion researched: _____

1. Using the map on your ecoregion's overview, draw the boundaries of your ecoregion on the *Oregon Forestland Ownership* map.
2. Looking at the *Oregon Forestland Ownership* map, what patterns of forest ownership do you notice in this ecoregion?
3. Estimate the percentage of forestland owned by each of the following in this ecoregion. In addition to your answer, explain the method you used to estimate it.
 - a. The federal government (including Bureau of Land Management, National Park, and National Forest lands)
 - b. Private industrial companies
 - c. Families and individuals
 - d. Tribal governments
 - e. Oregon state government
4. Using the *Forests of Oregon* poster, identify which forest types are most prevalent in this ecoregion. Why do you think these types are most prevalent here?
5. Using your ecoregion's overview or other sources, identify possible challenges forest owners in this ecoregion face.

5: Oregon's Federal Forestland

Overview

Students examine a report on federal forestland in Oregon and draw conclusions about the issues facing a large portion of Oregon forests.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Summarize the content of a special report on the history, policies and issues shaping Oregon's federally owned forest lands.
- Draw conclusions about Oregon's federal forestlands.
- Make recommendations for resolving issues involving federal forestlands.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS4.D. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- Science and Engineering Practice – 8. Obtaining, Evaluating, and Communicating Information: Evaluate the validity and reliability of, and/or synthesize multiple claims, methods and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Common Core State Standards – English Language Arts

- Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

Oregon Forest Literacy Program Concepts

- Theme 3, A.3. Oregon forests are managed under private (e.g., industrial, family and tribal) and public (e.g., city, county, state and national) ownership. Each type of ownership may have different objectives for how to manage forests.
- Theme 3, A.4. Many forest landscapes are made up of a mix of ownerships, a variety of management objectives and a blend of forest ecosystems.

Materials

- [Federal Forestland in Oregon: Coming to Terms with Active Forest Management of Federal Forestland](#)
- Highlighters (optional)

Background Information¹⁴

The US Forest Service was established in 1905 by President Teddy Roosevelt, who set aside initial forest reserves of 60 million acres. By the time he left office in 1909, Roosevelt had designated 230 million acres of public lands and waters for conservation purposes, including national forests, parks, monuments and wildlife refuges.

In Oregon, the federal government manages more than 18 million acres (an area nearly equal to the entire state of South Carolina). Of that amount, 8.7 million acres are considered “reserved,” meaning they are managed primarily for non-economic values such as mature habitat and aesthetics. The other 9.6 million acres of federal forestland are classified as unreserved or multi-resource. For decades, these forests produced nearly 5 billion board feet of lumber each year. Since 1989, timber harvest on federal land has declined by 90 percent due to a shift in management emphasis and environmental litigation. Lack of management of these forests has produced some undesired consequences and remains a major issue.

¹⁴ Source: “Federal Forestland.” <http://oregonforests.org/content/public-forests>.

Nearly 40 percent of federal forestland in Oregon is now classified at high-risk of uncharacteristically intense fire due to dense, unnaturally overcrowded and dying trees. This is especially true of federal forests east of the Cascades.

Collaborative efforts involving federal and state agencies, the forest sector, the conservation community and private forest landowners are resulting in innovative forest management solutions that are helping to restore the health of our federal forestland.

Key Vocabulary

conservation^{*}

ecosystem service^{*}

federalism

overstocked

restoration

^{*}included in Glossary

Preparation

- Make copies of the *Federal Forestland in Oregon* report, or provide students on-screen access.
- Look at the *Federal Forestland in Oregon* report and decide how you will divide it up among student groups. Depending on your class, you may have groups examine larger sections, such as “The Roots of Federal Forestland” on page 3, or smaller subheads such as “The Cost of Federal Forest Policy” on page 4. Be sure to include the graphs, tables and figures in the assignments.

Procedure

1. Introduce the lesson by asking students, based on the prior lesson, what issues they think may face our state’s federally owned forests.
2. Explain that the class will study a report on the status of Oregon’s federal forestlands. They will be responsible for reading a portion of the report and very briefly summarizing it for the class.
3. Hand out copies of the report *Federal Forestland in Oregon* or provide access to it on tablets or computers.
4. Divide the class into pairs and assign each a section of the report to read and summarize. Be sure to include the graphs, tables and figures in the assignments.
5. Encourage students to use a highlighter (either real or virtual) to mark the two or three key points of their assigned reading. They may also write in the margins or use virtual sticky

notes to help them summarize their passage. Each pair must be able to report about their passage in two or three sentences.

6. After they have had time to prepare, step chronologically through the sections of the report with pairs sharing their summaries.
7. Assign a student to take notes and create a one-page summary of all the report sections in real time.
8. Lead a discussion about the report and its findings, asking such questions as
 - What are the key points of the report as a whole?
 - What conclusions can you draw from the report?
 - What further information would you want to have?
 - What recommendations for our state's federally owned forests might you make based on the report?

Assessment

Based on the information gathered from the report, have students write a letter to their congress member, newspaper editor or other influential person with their recommendation for managing Oregon's federally owned forests. They should include data or evidence to back their recommendations.

Extension Ideas

- Research the differences among the various agencies charged with managing Oregon's federally owned forests: the US Forest Service, Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service. What is each agency's mandate? How do their mandates differ? How are Wilderness Areas different from National Parks or National Forests? How do the different mandates determine how each forest is managed?
- Find out what proposed actions are currently being considered on federal lands in Oregon (by searching, for example, "draft environmental impact statement Oregon"). Get copies of the draft environmental impact statement describing the positive and negative effects of the proposal. Encourage students to research the issues involved and to submit a public comment.

6: Interview a Forest Landowner

Overview

Students interview forest landowners to learn about the choices individual owners make in managing their forests, as well as changes and challenges they face.

This lesson was adapted from “Who Owns America’s Forests?” *Exploring Environmental Issues: Focus on Forests, Secondary Environmental Education Module*. Project Learning Tree.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Conduct an interview to explore choices, changes and challenges facing forest landowners.
- Make inferences about private forestland ownership in Oregon.
- Understand different objectives of forest landowners.

Standards Connections

New Generation Science Standards

- Disciplinary Core Idea – HS-LS4.D. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Common Core State Standards – English Language Arts

- Speaking and Listening – SL.11-12.1.C: Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of

positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

Oregon Forest Literacy Program Concepts

- Theme 3, A.3. Oregon forests are managed under private (e.g., industrial, family and tribal) and public (e.g., city, county, state and national) ownership. Each type of ownership may have different objectives for how to manage forests.

Materials

- “Forest Landowner Interview” student page (optional, see Procedure)

Background Information¹⁵

In Oregon, 65,000 individuals own between 10 and 5,000 acres of forestland. Classified as “family forestlands,” these acres have often been handed down through generations.

Most of these landowners are not professional foresters; they are doctors, teachers, accountants and clergymen. They’re also quite possibly your neighbors. That’s because a lot of family forestland is located close to residential areas in the foothills just outside Oregon’s primary metropolitan areas.

The amount of timber coming from family forestlands varies greatly depending on demand in the market. Family forestlands accounted for about 11 percent of Oregon’s annual timber harvest in 2007, but only about 3 percent in 2009. Yet not all family forestlands are managed for timber production. Family forest landowners also manage forests for recreational use, fish and wildlife habitat or just pure aesthetics.

A recent survey of family forest landowners indicated that they, like most Oregonians, desire to keep their property as forestland. But caring for the forest costs money. In many cases, family forest landowners use their land to earn a living. If the cost of regulation and management gets too expensive, they will turn to alternatives and, unfortunately, consider selling off the family forest for subdivisions, strip malls, vineyards or other development.

Key Vocabulary

regulation

resource

¹⁵ Source: “Family Forestlands.” Oregon Forest Resources Institute.

<http://oregonforests.org/content/family-forestlands>

Preparation

- Decide whether students will conduct interviews individually in the community or as a group in class with a panel of landowners you invite. To find possible forest landowners in your area to interview, contact your local chapter of the Oregon Small Woodlands Association (<http://oswa.org>) or your local OSU Extension Forester (<http://extensionweb.forestry.oregonstate.edu/directory>) and ask for a Master Woodland Manager.
- You may choose to have students use the questions provided on the student page or develop their own. If they will be developing their own questions, allow extra time for them to do so.

Procedure

1. Introduce the lesson by asking students what they think they could learn from local forest landowners about what it is like to own forestland.
2. Explain that students will interview forest landowners to find out about the choices, changes, and challenges landowners face. Depending on what you have decided, these may be individual interviews students conduct in the community, or a group interview in class with a panel of landowners.
3. You may have students use the sample interview questions on the “Forest Landowner Interview” student page or have them develop a different set of questions based on their interests or on local issues. If developing questions, have each student prepare one to three possibilities and as a class choose the best ones.
4. Provide copies of the final interview questions to use in conducting the interviews and for taking notes.
5. After the interviews, lead a class discussion about the findings:
 - What did students learn from the interviews about either individual owners or the choices and challenges they face?
 - What confirmed students’ prior understanding about forestland ownership? What was a surprise to them?
 - From the interviews, what can students infer about private forestland ownership in this ecoregion? In the state?

Assessment

- Students write a response to one of the following prompts:
 - Based on what you learned from the interviews, what is the biggest challenge private forest landowners in our area face? Use specific examples from the interview to support your view.

- Based on what you learned from the interviews, what were the goals/objectives of the landowner? Use specific examples from the interview to support your view.

Extension Idea

- Compare Oregon forest landowners with those across the United States by looking at data from the National Woodland Owner Survey, which is conducted periodically by the US Forest Service. See “National Woodland Owner Survey” <http://fia.fs.fed.us/nwos/results/> or “Family Forest Owners of the United States, 2006” http://nrs.fs.fed.us/pubs/gtr/gtr_nrs27.pdf for more information.

Forest Landowner Interview¹⁶

Forest Landowner's Name:

1. Describe the forestland you own: Where is it located? What types of trees, water, resources and built structures does it have? What is the surrounding area like?
2. How long have you owned this land? How did you acquire it?
3. Why do you own this forestland? What do you value most about it?
4. How do you use this land?
5. How do you make decisions about managing this forestland?
6. What are the biggest challenges you face in managing this forestland?
7. How has this forestland changed over the past 10, 20 or 50 years? In what ways has it stayed the same?

¹⁶ Source: Adapted from "Who Owns America's Forests?" *Exploring Environmental Issues: Focus on Forests, Secondary Environmental Education Module*. Project Learning Tree.

8. What do you see happening to this land in the next 10, 20 or 50 years?
9. What are your hopes and dreams for this forestland?
10. What are your biggest concerns about the future of this land?



- 7: Tree Biology
- 8: Forest Types in Oregon
- 9: Tree Identification and Survey
- 10: Measuring Trees

Section 2

FOREST BASICS



Section 2 – Forest Basics

7: Tree Biology

Overview

Through a brief video and a reading (or lecture), students review the basics of tree biology.

Time Considerations

Preparation: 15 minutes (more, if preparing lecture)

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Identify characteristics commonly used to define a tree.
- Describe the basic biological functions of a tree, including how it supports itself, produces food, transports food and water, and reproduces.
- Describe basic differences and similarities between conifers and broadleaf trees.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS1.A: Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
- Science and Engineering Practice – 8. 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 Forest Literacy Program Concepts

Theme 1, B.1. A tree is a woody perennial plant usually 12 feet tall or higher (4 meters or more), with a single main stem and a more or less distinct crown of leaves.

Theme 1, B.3. Trees have life stages that include germination, growth, maturity, reproduction, decline and death.

Theme 1, B.4. As part of the forest ecosystem, trees have various roles (e.g., providing habitat, holding soil, moderating temperature, and cycling water and resources).

Materials

- [Forest Fact Break: Tree Biology](#) video (2:15 minutes)
- Equipment for sharing video
- “Basic Tree Biology” student page
- “Tree Biology – Questions” student page

Background Information

See the [“Basic Tree Biology”](#) student page

Key Vocabulary

bark	phloem	sprouting
branch	photosynthesis*	stem
broadleaf*	pith	stomata
cambium	primary growth	suckering
conifer*	sapwood	summerwood
dendrochronology	secondary growth	tree*
heartwood	seed reproduction	vegetative reproduction
layering	shrub	xylem
leaf	springwood	

*included in Glossary

Preparation

Make copies of student pages or provide on-screen access to them. (As an alternative to students reading the “Basic Tree Biology” student page, you may choose to prepare a brief lecture based on the material.)

Procedure

1. Introduce the topic by asking students how trees get the things they need to survive: food, water and air. Show the *Forest Fact Break: Tree Biology* video as a review of basic tree biology.
2. Have students read the “Basic Tree Biology” student page, or present a brief lecture on the material.
3. Give students copies of the “Tree Biology – Questions” student page, and allow time for them to answer the questions in pairs or groups.

Assessment

Provide students with a list of vocabulary words from the reading and have them either define each word or use all of them in a short essay or paragraph.

Possible Answers to “Tree Biology – Questions” Student Page

1. Tree – usually has a single stem or trunk and is tallest organism in an ecosystem. Shrub – usually has multiple stems and is shorter.
2. Leaves – produce food from sunlight. Branches – support leaves to get most sunlight, transport water and nutrients. Stems – support branches above competing vegetation, transport water and nutrients. Woody roots – secure tree to soil and transport water and nutrients. Fine roots – take up water and nutrients.
3. Bark – protection. Phloem – transporting food within tree. Cambium – diameter growth of tree. Sapwood (xylem) – water and nutrient transport from roots to leaves. Heartwood (xylem) supports tree. Pith – stores nutrients.
4. Stomata – water and air.
5. A process by which green plants use the sun’s energy to transform water, carbon dioxide and minerals into carbohydrates used for growth.
6. Primary growth – starts at the tree’s top and results in more leaf area, height and access to sunlight. Secondary growth – increases diameter of stem, branches and roots to provide greater support.
7. Root – May-June and November. Shoot – July-August.
8. It grows as cambium divides and a ring of xylem cells is laid down.
9. Broadleaf trees – have wide flat leaves; bear seeds inside fruits, nuts, flowers; are usually deciduous, so don’t photosynthesize in winter months. Coniferous trees – have needle or scalelike leaves; bear seeds inside woody cones; are usually evergreen.
10. Broadleaf – hardwood. Coniferous – softwood.
11. Seed reproduction and vegetative reproduction (sprouting, suckering or layering).

Student Page

Lesson 7

Basic Tree Biology¹⁷

Introduction

Plants are complex organisms that differ greatly in structure. While studying plants, you may discover trees, shrubs, flowering herbs, mosses, lichens and ferns, all of which share some common characteristics.

A **tree** is usually the tallest organism in the ecosystem (usually greater than 20 feet at maturity) and usually has a single stem, which is also known as the trunk. **Shrubs**, on the other hand, generally have multiple stems and relatively short statures.

A tree is a long-lived species. Some species live 1,000 years or more, so they must be able to meet the most severe conditions for long periods of time, including cold and hot temperatures, high winds, drought, rain and fire.

Trees cannot move to a new location if they do not like where they are located, so they must be well adapted to their site in order to thrive. A variety of factors including climate, geology and topography (the shape of the land) determine the tree species found in an ecosystem.

Trees serve many useful purposes to humans such as providing food, shelter, clothing, fuel, clean air, clean water, shade and medicine. Trees also provide food and shelter for many other living organisms such as squirrels, woodpeckers, insects, fungi, lichens and other plants.

Fun Facts

- Oregon's most common tree is the Douglas-fir, which is also the state tree. West of the Cascades, if you guessed that any evergreen tree you see is Douglas-fir, you would be right eight out of 10 times.
- The largest tree in Oregon is a 329-foot-tall Douglas-fir located in Coos County's Brummet Creek. It is taller than a 28-story building!
- The oldest tree in Oregon may be a limber pine on Cusick Mountain in Wallowa County, estimated to be between 1,600 and 2,000 years old.

¹⁷ Source: *Exploration of Oregon Forests: Module 2 – Tree Biology*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Shortcourse*.

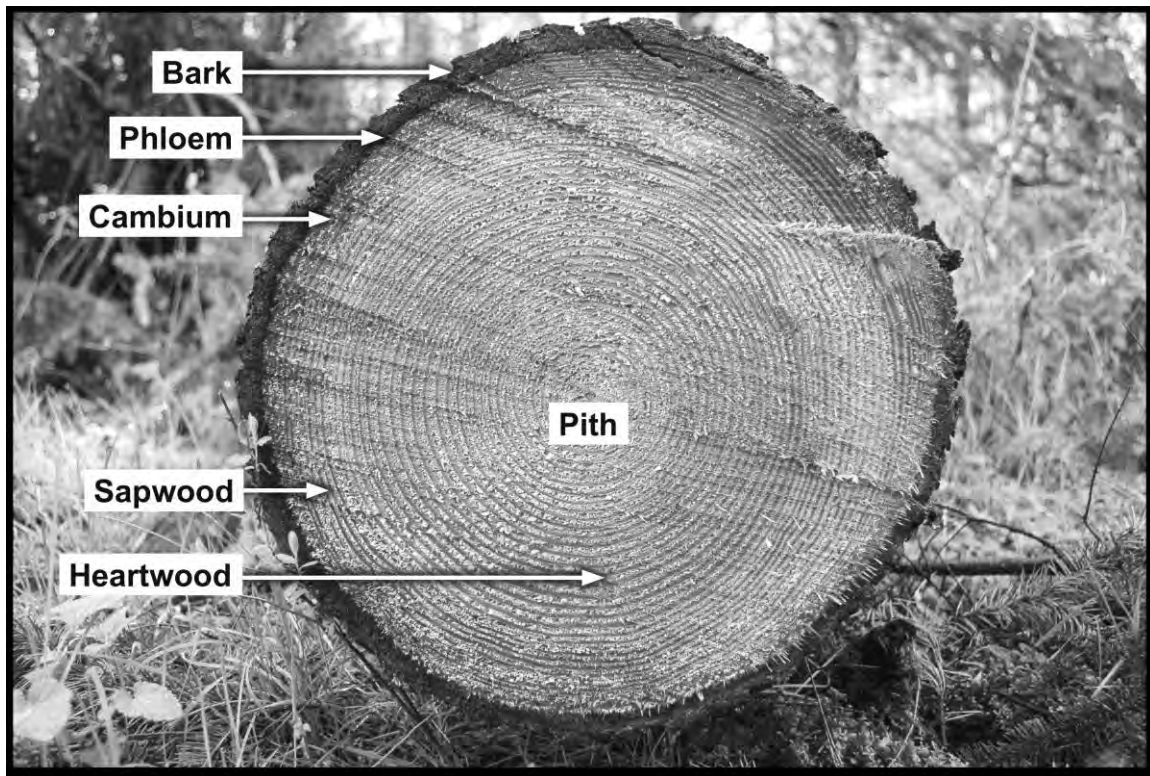
Tree Structures and Their Functions

Trees have specialized parts that enable them to meet their basic needs. The following are a few of these parts:

- **Leaves.** Leaves capture sunlight and produce food in a process called photosynthesis. They are an important component of the tree's transport system, releasing water to the air and drawing in carbon dioxide.
- **Branches.** Branches support the leaves and extend them into sunlit areas. They transport water and nutrients to leaves, and nutrients from leaves to the rest of the tree.
- **Stem.** The stem, or trunk, holds the tree's branches high above competing vegetation and transports food and water.
- **Woody roots.** Woody roots secure the tree to the soil and transport water and nutrients.
- **Fine roots.** Fine roots are responsible for much of the tree's uptake of water and nutrients.

A tree's stem, or trunk, also contains several layers, each of which serves different functions. Moving from the outside of the trunk toward the inside, you will find these layers:

- **Bark.** Bark provides the outer covering of a tree, which can be very thick (Douglas-fir) or thin (western hemlock). Bark protects against fire, disease, extreme temperatures and mechanical damage.
- **Phloem.** Phloem is a layer of living tissue just inside the protective outer bark. Phloem serves as the primary mechanism by which food is transported within the tree, and it is a favorite treat for bears in the spring.
- **Cambium.** Cambium is composed of living cells that actively divide and result in diameter growth. Cells on the outside of the cambium become phloem, while those on the inside become xylem.
- **Sapwood (xylem).** Sapwood, or xylem, is recently formed cells capable of water transport. They serve as the primary mechanism by which water and nutrients are moved from the roots to the leaves.
- **Heartwood (xylem).** Heartwood, also a form of xylem, is the nonfunctioning wood cells that used to be sapwood. They no longer transport water but still provide support. They may have a distinctive color and enhanced decay resistance depending on species and age. The heartwood is the part that shows annual rings. These are produced when the sapwood cells grow rapidly in the spring and are followed by the slower-growing, denser cells of summerwood. The main function of heartwood is to support the tree.
- **Pith.** Pith is found in the center core of the tree trunk and is made of air-filled cells with a distinctive dark color. The pith is a remnant of the first year's growth in the tree, and its main function is to store nutrients.



Cross section of a tree's trunk.

Leaf Functions

Leaves release oxygen into the atmosphere through small holes called **stomata**, which are usually located on the underside of the leaf. They can open and close to control movement of water and air. When they are open, water vapor escapes and carbon dioxide (CO₂) can enter the leaf. If there is a drought or high summer temperatures, the tree may close its stomata to conserve water. A lack of carbon in the leaf then limits photosynthesis. Drought-adapted species have found ways to keep stomata open even when water in the soil is limited.

Photosynthesis

Photosynthesis is a natural process by which green trees and plants use energy from the sun to transform water, carbon dioxide and minerals into organic compounds for their growth. Photosynthesis begins when green plants absorb water through roots and carry it to needles or leaves. At the same time, needles and leaves absorb carbon dioxide from the air. The carbon dioxide then flows to plant cells called chloroplasts, which contain chlorophyll. Chlorophyll uses sunlight as energy to transform carbon dioxide and water into oxygen and carbon-based compounds such as glucose (sugar). These carbon-based compounds provide energy as well as the building blocks for growth and tissue repair. As the plant grows, it releases oxygen into the atmosphere.

The elements needed for photosynthesis to take place:

- sunlight
- carbon dioxide (CO₂)
- nutrient-rich water from the soil

Photosynthesis produces sugars, which are needed for many things. Since it can only produce a limited amount of food, a tree must budget the sugars created through photosynthesis to satisfy the following priorities:

- Root growth
- Reproduction (flowers, cones, etc.)
- Growth so the tree can compete with other vegetation for light and maintain strength
- Food storage to help with spring growth and maintain the tree when photosynthesis is not possible
- Defensive compounds, which protect the tree against insects, rot and disease. If a tree is weak and not producing enough sugars, then it is more likely to be a target for disease-causing germs, or pathogens.

If sunlight, CO₂, water or nutrients are limited, then photosynthesis is reduced and not as much food is produced.

Tree Growth

Trees grow both in height and diameter. We call this primary growth and secondary growth, respectively. Primary growth starts at the top, or tip, of the tree and branches. Primary growth results in more leaf area, height and increased access to sunlight. Secondary growth increases the diameter of the stem or trunk, branches and roots. Secondary growth provides support to increase the numbers of leaves or needles.

Root growth and shoot growth occur at different times of the year. In the winter in the Pacific Northwest, we plant trees because this is when they are most fully dormant and least likely to become stressed by transplanting.

Trees respond directly to light, water, nutrients, humidity, temperature and other physical factors in the ecosystem. When these conditions are sufficient for a particular species, tree height and diameter may significantly increase with age. Drought, severe heat, early frost and other physical stresses, as well as interactions with other organisms, can slow tree growth. Each year, a tree increases in diameter as the cambium divides and a ring of xylem cells is laid down.

Close examination of a tree's cross section reveals that each ring is made of two bands. The first band is a lighter-colored area of large, thin-walled cells (springwood). The second band is a darker-colored area of small, dense, heavy-walled cells (summerwood). By counting these rings outward from the center, it is possible to determine the age of a tree. In the tropical regions of the world, there is not a definite growing season. Therefore, determining the age of a tropical tree is more difficult.

Annual rings result from defined seasons of growth and dormancy. Most trees in North America have annual rings. Annual rings vary in width, and the width of tree rings tells the story of the growth conditions of a tree. Wider rings usually indicate a fast growth rate. If a tree is stressed by less-than-optimal conditions in its environment, tree rings are often narrow.

Fun Fact

Dendrochronology is the study of growth rings. Using dendrochronology, a scientist can estimate climate variation and other past events through the comparison of successive annual growth rings. Tree ring analysis provides insights into a variety of abiotic and biotic factors such as climate, disease, disturbance, management activity, competition and forest productivity. Using this information in conjunction with observations from the rest of the ecosystem, researchers can hypothesize about the causes of changes in tree growth.

Broadleaf vs. Conifer

Trees are generally classified as either broadleaf (or deciduous) trees or conifers.

Broadleaf trees usually have wide, flat leaves and bear seeds inside fruits, nuts or flowers. Most broadleaf trees are deciduous – that is, they drop their leaves in winter – but a few are evergreen. All broadleaf trees are referred to as hardwoods because their wood generally is harder than that of conifers. That's because, unlike conifers, they don't photosynthesize in the winter months. A few, however, such as cottonwoods and balsa, have very soft wood.

Conifers have needlelike or scalelike leaves and usually bear seeds inside woody cones. Conifers are often called evergreens because most hold their leaves all year long. There are, however, some deciduous conifers, such as the larch, that drop their leaves in winter. All conifers are also called softwoods because their wood is relatively soft when compared with that of broadleaf (hardwood) trees.

Tree Reproduction

There are two processes by which trees reproduce: seed reproduction and vegetative reproduction (sprouting, suckering and layering). Broadleaf trees usually sprout profusely from cut stems, or by sending up shoots from underground roots (suckering), or when lower branches of a tree touch the ground and the branch tips become covered and eventually a new tree grows from the branch tips (layering).

Conifer trees typically reproduce by seed production. For example, pine seeds are produced on the scales of the carpellate (female), cones. In the spring, the pine produces clusters of staminate pollen-bearing cones, or strobili. Upon ripening, they disperse their pollen and fall to the ground. Female cones are produced on the tree at about the same time and are usually greater in number and located on the outside of the crown. Once the female cones have been pollinated, they grow rapidly with developing seeds. Most pines require two years for the seeds to mature. At that time, the cone dries out, the scales open up, and the winged seeds are dispersed (usually by wind). In general, about 85 percent of the seeds fall within 125 feet of the parent tree.

Summary

A tree is the tallest organism in the ecosystem and usually has a single stem, which is also known as the trunk. Shrubs, on the other hand, generally have multiple stems and are relatively short. A tree is a long-lived species that must be well adapted to its site in order to prosper. Trees serve many useful purposes such as providing food, shelter, clothing, fuel and medicine.

Through the use of specialized parts, a tree provides itself with its basic biological requirements. The following are a few of these parts: leaves, branches, the stem, woody roots and fine roots. A tree cross section highlights additional specialized parts of a tree: bark, cambium, phloem, xylem and heartwood.

Trees can actually clean water by absorbing contaminated water through their roots and releasing clean water through their leaves. In addition, leaves release oxygen into the atmosphere through small vapor holes called stomata, which are located on the undersides of leaves. They open and close to control movement of water and air. Chlorophyll in leaves

converts sunlight to energy that plants use to produce food. This process is known as photosynthesis.

Trees grow both in height (primary growth) and diameter (secondary growth). Root and shoot growth occurs at different times of the year. Trees respond directly to light, water, nutrients, humidity, temperature and other physical factors in the ecosystem. Annual rings are created by defined seasons of growth and dormancy. Most trees in North America have annual rings. Tropical trees generally do not have annual rings, because there is no dormant season.

Trees can be divided into two main categories: broadleaf and conifer. Broadleaf trees are often referred to as hardwoods, because their wood is generally harder than conifers (softwoods). Broadleaf trees reproduce by seeds inside fruits, nuts, or flowers and typically drop their leaves in winter. Conifers reproduce with seeds in woody cones and hold their needles all year long.

8: Forest Types in Oregon

Overview

Students examine different forest types found in Oregon, identifying and comparing the characteristics of the bioregions in which forests grow.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Explain how characteristics such as soil, elevation, temperature and precipitation determine what types of forest will grow where.
- Identify the factors that characterize at least two different forest types in Oregon.

Standards Connections

Next Generation Science Standards

- Performance Expectation – HS-LS2-2: 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: 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.

Common Core State Standards – English Language Arts

- WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
- WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate: synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Common Core State Standards – Mathematics

- MP.2: Reason abstractly and quantitatively.
- MP.4: Model with mathematics.
- HSN-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Oregon Forest Literacy Program Concepts

Theme 1, C.8. Oregon’s regions vary in soil types, elevation, temperature, wind and rainfall patterns. These variations create the different forest types and residents (plants and animals) that, together with disturbance histories, contribute to that region’s biodiversity.

Materials

- [Forest Fact Break: Forest Types](#) video (2:09 minutes)
- Equipment for showing video
- [Forests of Oregon](#) posters (one for each pair or small group, or on-screen access)
- “Oregon Forests Compared” student page
- Internet access (optional)

Background Information¹⁹

Oregon’s forests are among the most diverse, productive and magnificent in the entire world. They range from the dry, scenic juniper and pine forests east of the Cascades to the wet, majestic old-growth Douglas-fir forests west of the Cascades; they blanket most of western Oregon and all the mountains of central and eastern Oregon. Although most of our forests are dominated by needle-leaved conifers, many species of hardwoods play important ecological roles. Many of the tree species that grow in our forests have their largest and oldest members here.

Although the percentage of Oregon occupied by forests hasn’t changed much in the past 200 years, the structure, composition and distribution of our forests have changed dramatically. Most forests of the early 1800s have been removed by fire, logging and other disturbances—replaced by native trees but in different mixes than were present originally. Some old-growth forests remain, mostly in remote parts of public lands. Many valley forests have been lost to

¹⁹ Source: “Oregon Forests.” *Forest Learn* website. College of Forestry. Oregon State University. http://cof.orst.edu/cof/newfmc/product_examples/forestlearn/watershed/forest_types/index.htm.

agricultural and urban development, although many communities now try to preserve remaining stands. Fire suppression that has accompanied settlement has also created many changes, described in the various sections on the back of the *Forests of Oregon* poster.

Given such change over time, much of modern forestry is directed at maintaining the health, diversity and productivity of Oregon's forest while producing the wood, water, wildlife and recreation that society demands.

Key Vocabulary

bioregion

climate

ecology*

forest management*

forest type*

*included in Glossary

Preparation

Make copies of the student page.

Procedure

1. Show *Forest Fact Break: Forest Types*. This 2-minute video introduces the idea that different types of forests grow in different bioregions of Oregon.
2. Divide the class into pairs or small groups, giving each a *Forests of Oregon* poster (or provide on-screen access to the poster). Direct each group to use the poster to discuss and answer the questions on the "Oregon Forests Compared" student page.
3. Assign or have groups choose two different forest types from the map to explore the question, What causes different forests to thrive in different regions of Oregon? Using the information on the back of the poster, have students compare and contrast the two forests in terms of their ecology, climate and management. In addition, have them do a quick Internet search on their two forest types to determine the typical soil and the average or mean elevation, temperature and precipitation in each.
4. Instruct groups to create graphs or other visuals comparing their two forests.
5. Ask groups to share their results with the class.

Assessment

Have students use their results as the basis for writing a paragraph that explains what causes different forests to thrive in different regions of Oregon.

Extension Idea

Conduct the activity “Mapping the World’s Forests” from Project Learning Tree’s *Global Connections: Forests of the World* secondary module. In this activity, students examine a system for classifying the world’s forests that uses climate characteristics and vegetation types.

Oregon Forests Compared

Use the *Forests of Oregon* poster to answer the following questions:

1. Which forest type do you live in (or which is closest to your community)?
2. What patterns do you notice about the forest types in Oregon? Identify at least seven different patterns.
3. How does each of these patterns relate to what you understand about Oregon's geography?
4. What might cause these patterns?

Choose two different forest types shown on the *Forests of Oregon* map. Using the information on the back of the poster and additional research, compare and contrast the two forest types.

	Forest Type 1: _____	Forest Type 2: _____
Ecology		
Climate		
Management		
Typical Soil		
Average Elevation		
Average Temperature		
Average Precipitation		

9: Tree Identification and Survey

Overview

Students identify the genus of trees around their school, recording both variety and abundance of the trees they find. Note: This lesson should be conducted when deciduous trees have their leaves.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Use a dichotomous key to identify different tree genera.
- Conduct a tree survey of their school grounds (or other location) and identify the genus of each tree.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS1.A: Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
- Science and Engineering Practice – 4. Analyzing and Interpreting Data: Analyze data using tools, technologies and/or models in order to make valid and reliable claims or determine an optimal design solution.

Oregon Forest Literacy Program Concepts

Theme 1, B.2: Forests comprise trees that differ in species, age and size and are affected by biotic factors (e.g., plants, animals and humans) and abiotic factors (e.g., soils, nutrients, moisture, sunlight and climate).

Materials

- Access to [Common Trees of the Pacific Northwest](#) on the Oregon State University College of Forestry website (or hard copies of *Trees to Know in Oregon* by Edward C. Jensen)
- [“Trees of Oregon’s Forests”](#) tree guide on the Oregon Forest Resources Institute website
- Sample tree branchlet for demonstrating dichotomous key
- Map or aerial photograph of your school grounds or other survey location (from Google Earth or other source)
- “Tree Survey” student page
- Journals or electronic tablets
- Internet access
- Labels for tagging trees, optional

Background Information²⁰

Oregon is home to a wide range of trees, including 30 native coniferous species and 37 native species of broadleaf trees. Oregon varies greatly in terms of elevation, temperature, wind, rainfall and soil composition. Combinations of all these factors help determine the dominant tree species of an area.

Using a dichotomous key that centers on leaf shape and form, students can find out the genus or species of the trees they see around them. A dichotomous key is a tool that allows the user to determine the identity of items in the natural world, such as trees, wildflowers, mammals, reptiles, rocks and fish. The key consists of a series of choices that lead the user to the correct name of a given item. “Dichotomous” means “divided into two parts.” Therefore, dichotomous keys always give two choices in each step.

A genus is a group of organisms, in this case, trees, that are closely related and share similar characteristics. For example, all trees in the pine genus (*Pinus*) have long, narrow needles bound in bundles and hard, woody cones with thick, tough scales. “Genera” is the plural term for more than one genus.

All plants have two types of names: a common name and a scientific name. Common names are written in English (or in German if you’re in Germany, or in French if you’re in France), but

²⁰ Sources: “Trees of Oregon’s Forests.” Oregon Forest Resources Institute.

<http://oregonforests.org/content/tree-variety>.

“Common Trees of the Pacific Northwest – Dichotomous Key.” Oregon State University.

http://oregonstate.edu/trees/dichotomous_key.html.

scientific names are always written in Latin, so they can be used anywhere in the world.
Scientific names are always italicized or underlined.

Example:

Common name = sugar pine

Scientific name = *Pinus lambertiana*

The genus name refers to the general type of tree (e.g. “pine” or *Pinus*), while the species name refers to the specific type of pine (e.g. “sugar” or *lambertiana*). An organism’s scientific name includes the genus followed by the particular species name.

Key Vocabulary

common name

dichotomous key

genus

scientific name

Preparation

- Gather a sample branchlet from a tree on your school campus.
- Make copies of the student page.

Procedure

1. Introduce the lesson by asking students how they might go about determining what trees are present on the school grounds or other study site.
2. Using a sample branchlet from one of the trees, demonstrate using the [Common Trees of the Pacific Northwest](#) dichotomous key to determine the tree genus (and, possibly, species)
3. Show students the map or photograph of the study site. On the map, number each tree pictured.
4. At the study site, have students find each tree shown on the map and, if you choose, tag it with a number that corresponds to the map. (Draw on the map any newly planted trees and cross out any trees that have been removed.)
5. As a class, decide how to divide up the area to be surveyed.
6. Give each pair or small group a “Tree Survey” student page and assign them an area to survey. They should identify each tree in that area and write a brief description of it. If you have electronic tablets, students may use the dichotomous key to identify the trees on-site. Otherwise, have them draw pictures of the trees and close-up illustrations or rubbings of

the leaves and bark to identify the trees later. In addition to the [Common Trees of the Pacific Northwest](#), they may use the “Trees of Oregon’s Forests” [tree guide](#) for information about the tree.

7. Upon completing the tree survey, have students present their most important findings and add their tree identification to the map key.

Assessment

Have students use the dichotomous key to identify two or more “mystery trees” included on the [Common Trees of the Pacific Northwest](#) site.

Extension Ideas

- Create a spreadsheet or other database for all the trees in the study area, with the genus and species as well as students’ descriptions of each tree. Students may also measure and include the DBH, height, basal area, and board feet of each tree.
- Learn to identify the forest plant species listed for the FFA Forestry Career Development Event (CDE).
- Look for patterns in tree size by measuring and graphing the height and diameter of trees in the study site by species.

Student Page

Lesson 9

Name(s): _____

Tree Survey

Tree Number	Tree Identification	Tree Characteristics

10: Measuring Trees

Overview

Students practice measuring tree diameter at breast height (DBH) and tree height.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Articulate why measuring trees is important to forest managers.
- Determine the diameter of a tree using one or more methods.
- Estimate the height of a tree.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS1.A: Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
- Science and Engineering Practice – 3.Planning and Carrying Out Investigations: Select appropriate tools to collect, record, analyze, and evaluate data.

Common Core State Standards: Mathematics

- Numbers and Quantity, HSN-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Oregon Forest Literacy Program Concepts

- Theme 1, A.2: Forests comprise trees that differ in species, age and size and are affected by biotic factors (e.g., plants, animals and humans) and abiotic factors (e.g., soils, nutrients, moisture, sunlight and climate).

- Theme 1, B.1: A tree is a woody perennial plant usually 12 feet or more (4 meters or more) tall, with a single main stem and a more or less distinct crown of leaves.

Materials

- Woodland stick (available from Oregon State University Extension Service)
- String
- Measuring tape or ruler
- “Measuring Trees” student page
- Lab notebooks (optional)

Background Information

See the “Measuring Trees” student page for information about measuring trees. Depending on the materials you have available for measuring, decide which methods your students will use to measure tree diameter and height.

Key Vocabulary

Biltmore stick (or woodland stick)

calipers

clinometer

diameter at breast height (DBH)*

diameter tape

*included in Glossary

Preparation

Make copies of the student page or provide on-screen access to it.

Procedure

1. Ask students, “If you were a forester, what are some things you might like to know before making decisions about the trees?”
2. Using information from the student page, explain why tree diameter and tree height are important measurements. Demonstrate how to use the woodland stick (or other tools available) to take these measurements.
3. Divide the class into pairs or small groups and give each a copy of the student page or provide on-screen access to it.

4. Direct students to practice measuring the diameter and height of trees on your school grounds or other site. If you do not have suitable trees to measure, students may practice with utility poles or field lights. They may record their measurements in their lab notebooks.

Assessment

Ask students to write (in their own words) a set of pointers for measuring tree height and diameter.

Extension Ideas

- Have students calculate tree volumes from tree height and diameter. See the Oregon State University Extension Service's bulletin *Measuring Your Trees* (available at <http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/38324/em9058.pdf>) for details. If possible, consider inviting a forester to explain how and why forest landowners calculate tree volume.
- Use the FFA Forestry CDE "Bd Feet Volume Estimation Worksheet" and "Doyle Log Rule" sheets (on pages 19 and 20 of *National FFA Forestry Career Development Event 2012-2016*, available at https://ffa.org/documents/cde_forestry_2012.pdf) to determine board foot volume.
- Calculate the value of the trees measured in the lesson using the website <http://treebenefits.com>.
- Use a relascope to measure tree height, tree diameter and basal area. A relascope is a multi-use instrument for [inventorying](#) trees. Basal area is the area of a cross section of a tree trunk at its base. Foresters use basal area to describe the area of land occupied by tree trunks, and it is generally expressed as square feet per acre (or square meters per hectare).
- Use a clinometer to measure tree height as described in the following box. Basically, by measuring the angle between you and the tree's top, a clinometer lets you estimate the tree's height. The bigger the angle is, the taller the tree.

Measuring Tree Height with a Clinometer

1. You must first know the horizontal distance from the tree to where you are standing. It doesn't matter what this distance is, as long as you know it.
2. Looking at the top of the tree with one eye and through the clinometer with the other eye, line up the marker in the clinometer with the top of the tree. Read the value on the percent scale.
3. Repeat step 2 for the bottom of the tree.
4. Subtract your top measurement from your bottom measurement. If the bottom is a negative, then add the two numbers.
5. Convert the percent to a decimal number and multiply by the horizontal distance between you and the tree. You now have the tree's height.

Formula

Tree height = (top of tree reading – bottom of tree reading) x distance from tree in feet

Example

Distance from tree = 100 feet

Top of tree reading = +90%

Bottom of tree reading = -5%

Combined reading = 90% + 5% = 95%

Tree height = 0.95 x 100 feet = 95 feet

Student Page

Lesson 10

Measuring Trees²¹

One of the most important things foresters need to know about trees is their size. Knowing trees' diameter and height enables foresters to monitor tree growth, to calculate tree volume in a given forest area, and to make informed management decisions. Foresters often use tree measurements to estimate the amount of marketable timber that could be harvested from a forest stand – a process that is called timber cruising.

The diameter is the distance from one side of a circle, passing through the center, to the other side. A tree's diameter is basically the width of its trunk. A tree's height is how tall it is from the ground to its very top.

Determining Tree Diameter

Because tree trunks can be wider or narrower at the base, foresters measure tree diameter at a standard height above ground level. Known as "diameter at breast height," or DBH, this measurement is taken at a height of four and a half feet above ground level. If the tree is on a slope, it is measured on the uphill side of the tree.

When foresters need an accurate DBH measurement, they may use calipers or a special diameter tape that, when placed around the tree, shows the conversion of tree circumference to diameter. Following are two different methods you can use to measure diameter.

Woodland Stick Method

A convenient way to measure the diameter is with a special stick, called a woodland stick or Biltmore stick, which contains built-in formulas for measuring diameter. While not the most accurate method, it does provide a good, quick estimate.

1. To use the woodland stick, hold it against the tree 4.5 feet above the ground. Stand so that your eye is 25 inches from the stick.
2. Without moving your head, line up the zero end of the stick with one edge of the tree, then read the tree's diameter at the other edge of the tree using the scale printed on the stick.

²¹ Source: Information was adapted from "Forest Measurements: Tools of the Trade." *Rediscovery Forest Field Notes, Secondary*. Oregon Forest Resources Institute.]

String Method

Another way to measure the diameter involves string and a tape measure or ruler. For this method, you first find the tree's circumference (the distance around the trunk).

1. Take the string and wrap it around the tree at 4.5 feet above the ground, making sure that the string stays level all the way around the tree.
2. Hold or mark the place where the string matches up with the end of the string, then use a tape measure or ruler to determine the inches of circumference.
3. Divide this number by 3.14 (or π) to find the tree's diameter.

(Note: You may also measure the circumference directly using a tape measure. A diameter tape or d-tape measures circumference and reads it out as diameter.)

Determining Tree Height

It's surprisingly difficult to accurately measure the height of a tree, particularly when it is on a slope or surrounded by other trees or objects. The most accurate way involves climbing to the top of the tree and dropping a measuring tape to the ground. This method is used primarily by professional tree researchers or arborists, especially to measure the height of record-breaking trees. (Safety Note: This method should be used only by experienced professionals with the relevant training and equipment. Do not attempt this method yourself!)

Professionals may also use laser rangefinders and other digital equipment to estimate tree height. A couple of lower-tech options involve a woodland stick or a simple pencil.

Woodland Stick Method

The woodland stick or Biltmore stick contains lines and formulas for helping you determine tree height.

1. Using a woodland stick, position yourself 100 feet from the tree with your eye approximately level with the bottom of the tree.
2. Hold the stick 25 inches from your eye and align the bottom of the stick with the bottom of the tree.
3. Without moving the stick or your head, read the measurement that lines up with the top of the tree.

Pencil Method

An easy way to estimate tree height uses a pencil and a measuring tape.

1. Working with a partner, take a pencil and stand away from the tree.
2. Outstretch your arm and hold the pencil so that you can line it up with the trunk of the tree.
3. Close one eye and move the pencil until one end looks even with the top of the tree.
4. Place your thumb on the pencil where it matches the base of the tree.
5. Turn the pencil by 90 degrees, keeping your thumb in place.
6. Direct your partner to mark the place on the ground where it looks like the end of the pencil lies.
7. Use a measuring tape to measure the distance from that point to the tree. This is the approximate height of the tree.



- 11: Forests and Drinking Water
- 12: Watershed Survey
- 13: Forests as Habitat
- 14: Habitat Edges
- 15: Forests and Carbon

Section
3

A photograph of a stream flowing through a forest. The water is dark and rippling, reflecting light. The banks are covered with moss, ferns, and fallen logs. The background shows a dense forest of tall trees.

ENVIRONMENTAL IMPORTANCE OF OREGON'S FORESTS

Section 3 – Environmental Importance of Oregon’s Forests

11: 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

Next Generation Science Standards

- Science and Engineering Practice – 4. Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.

Common Core State Standards – Mathematics

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

Oregon Forest Literacy Program Concepts

- Theme 1, C.4. Forest ecosystems include processes such as photosynthesis, energy flow and the cycling of nutrients, water, carbon and other matter.
- Theme 2, B.1. Forests affect air, water and soil quality.

- Theme 2, B.2. Forests provide multiple economic benefits, including jobs and commodities such as forest products, renewable energy and minerals, financial returns to owners and investors, and ecosystem service benefits such as climate change mitigation, clean water, recreation and tourism.

Materials

- [*Forest Fact Break: Water*](#) video (1:40 minutes)
- [*Speakers Bureau Presentation: Oregon's Forests and Water*](#) video (optional)
- Equipment for showing video(s)
- Soil filtration model, one per group of four students (see Preparation for materials needed) – each labeled with a unique number²²
- A variety of soil materials, such as
 - fine-grained sand
 - bark chips
 - topsoil
 - clay
 - mulch
 - dried leaves
 - pieces of sod
- Graduated cylinders
- 6-oz cans that are taller than wide (such as tomato paste cans), with both ends removed
- Stopwatches (or stopwatch app for smartphone or tablet)
- Clear plastic cups or other containers for catching runoff
- “Soil Filtration Investigation” student page

Background Information²³

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.

²² Alternatively, you may use stream tables or runoff models. For larger models, adjust the size of can and water used accordingly.

²³ Source: *How Do Forests Affect Our Drinking Water?* fact sheet. Oregon Forest Resources Institute.

http://oregonforests.org/sites/default/files/publications/pdf/FactSheet14_Drinking_water.pdf.

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.
 - Place a collecting cup near the mouth to capture any runoff.
 - Fill the model with materials according to the Procedure.

Procedure

1. To introduce the lesson, show students the 100-second 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=perfectly 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:
 - Which model had the highest and which the lowest percent runoff?
 - Which had the cleanest water?
 - Which model is most like a forest?
 - What does this investigation indicate about soils?
 - 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

Name(s): _____

Lesson 11

Soil Filtration Investigation

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

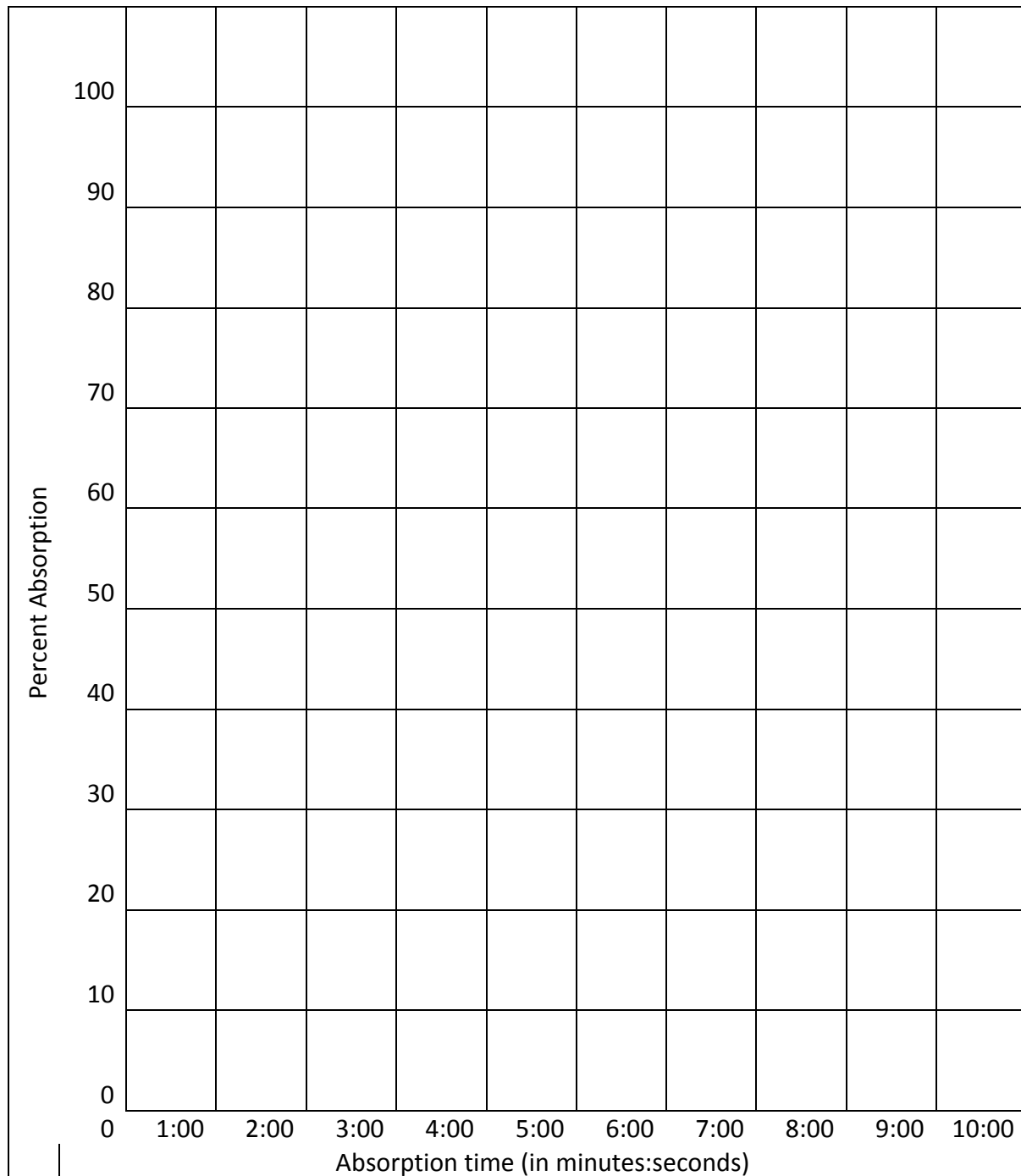
Model #	Soil Material	Water Added (in ml)	Amount of Runoff (in ml)	Percent Runoff	Percent Absorption	Absorption Time	Water Clarity (10=clear, 0=opaque)
<i>Example</i>	<i>Clay with leaf cover</i>	<i>150</i>	<i>85</i>	<i>56%</i>	<i>44%</i>	<i>4:25 minutes</i>	<i>6</i>

Percent runoff = $\frac{\text{collected water (in ml)}}{150 \text{ ml}} \times 100\%$

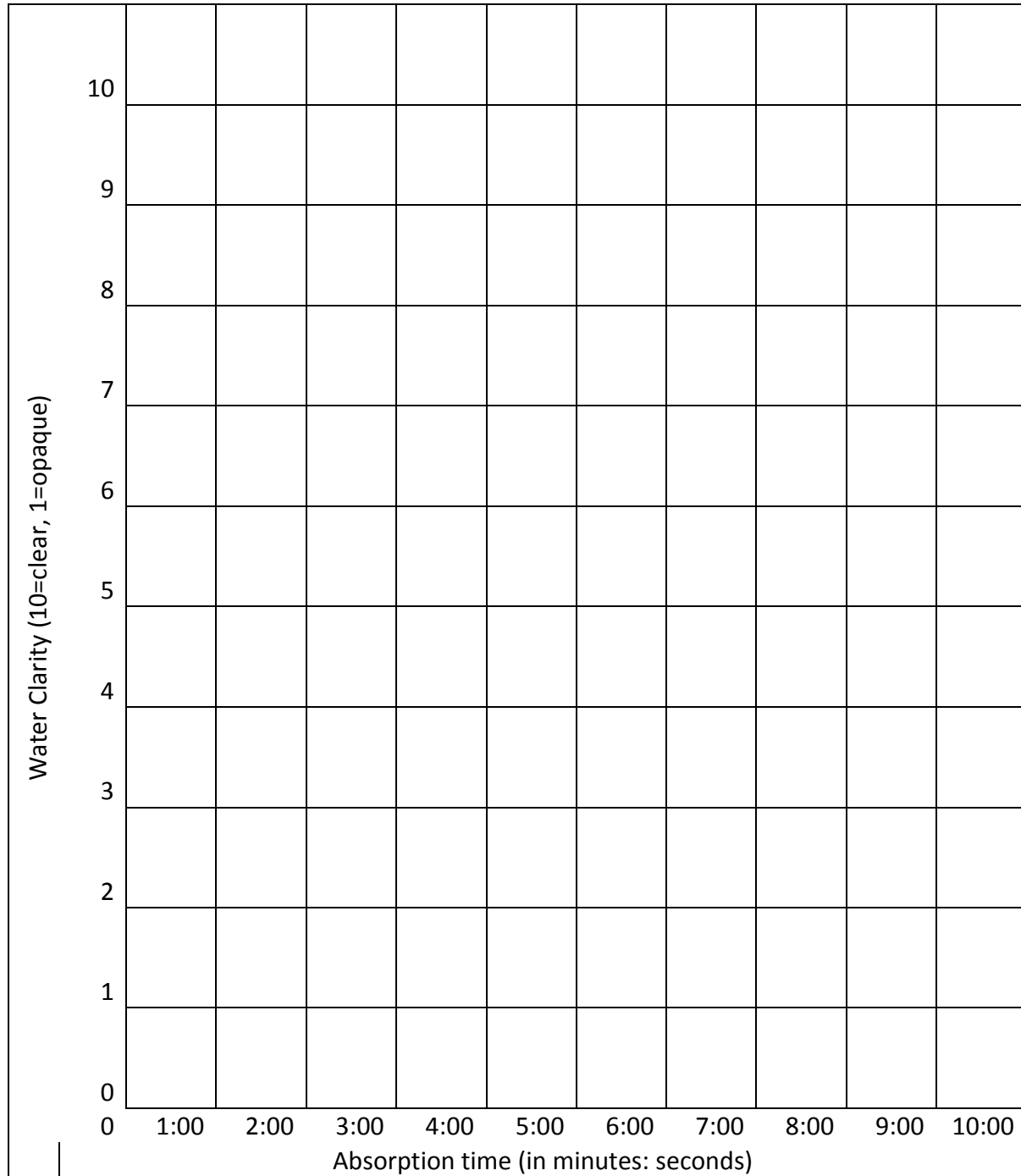
Percent absorption = 100% – percent runoff

Plot the results of the experiment from all the models.

Percent Absorption Over Time



Water Clarity Over Time



What patterns do you notice?

12: Watershed Survey²⁴

Overview

Students use mapping imagery to investigate the land use around waterways in their community or in 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

New Generation Science Standards

- Science and Engineering Practice – 4. Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.

Common Core State Standards – Mathematics

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

Oregon Forest Literacy Program Concepts

²⁴ 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. Available at <http://learnforests.org/sites/default/files/ImpactofLandUseonWaterQuality.pdf>.

- Theme 1, C.4. Forest ecosystems include processes such as photosynthesis, energy flow and the cycling of nutrients, water, carbon and other matter.
- Theme 2, B.1. Forests affect air, water and soil quality.
- Theme 2, B.2. Forests provide multiple economic benefits, including jobs and commodities such as forest products, renewable energy and minerals, financial returns to owners and investors, and ecosystem service benefits such as climate change mitigation, clean water, recreation and tourism.

Materials

- Remote mapping and imaging program ([Google Earth](#) or NASA's [NASA'S World Wind](#) – see Background Information)²⁵
- Internet access
- “Online Watershed Survey” student page
- Blank paper

Background Information²⁶

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 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.

²⁵ 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.

²⁶ 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. Pages 7-11. Available at <http://learnforests.org/sites/default/files/ImpactofLandUseonWaterQuality.pdf>.

Google Earth is available for free download at <https://earth.google.com>. World Wind is open source software that can be downloaded for free at <http://goworldwind.org/>. Both provide high resolution aerial and satellite imagery and include layers such as elevation, terrain, and other features, but World Wind requires more programming expertise.

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 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 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
 - What percentage of each land use did you find along the waterway?
 - 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 river and document actual land uses and direct and indirect impacts. Compare findings to class predictions.

Online Watershed Survey²⁷

1. Using the mapping program, either follow the coordinates provided by your teacher or enter the name of the river you'll be studying.
2. 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?
3. 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.
4. Draw the approximate shape of the watershed boundaries on a blank sheet of paper. Include the river in your drawing.
5. Look for the following major land uses along the length of the river you are studying:
 - forest (F)
 - agricultural (A)
 - urban (U)
 - residential (R)
 - industrial (I)
 - disturbed (for example, clearcut, mine or new excavation) (D)
6. 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.)
7. 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.
8. For each land use, predict the potential impacts on the water quality of the river, completing the following table.

²⁷ Source: Adapted from "Impact of Land Use on Water Quality" by Dr. Wynn Cudmore.

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										

Enter one of the following values into each cell in the table:

0=no negative impact

3=major impact

1=minor impact

X=unable to determine

2=moderate impact

Descriptions:

Heated Effluent – waste water released from a pipe or ditch at a higher temperature than ambient water temperature.

Volume Extraction – removal of water from 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 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 river).

Sediment Runoff – observed/inferred runoff from disturbed lands resulting in decreased clarity.

13: 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 sign.
- Inventory a study site for animal signs.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS2.C. 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 – 8. 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.

Common Core State Standards – English Language Arts

Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.7:
Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Oregon Forest Literacy Program Concepts

- Theme 1, B.4. As part of the forest ecosystem, trees have various roles (e.g., providing habitat, holding soil, moderating temperature, and cycling water and nutrients).
- Theme 2, B.2. Forests provide habitat for fish and wildlife.

Materials

- [*Forest Fact Break: Wildlife video*](#) (1:31 minute)
- *Forest Fact Sheet: [*Why Do Forest Animals Live Where They Do?*](#)*
- [*Find Your Path: Wildlife Biologist video*](#) (optional, 2:29 minutes)
- “Wildlife in Oregon Forests” student page (optional)
- “Wildlife in Oregon Forests – Questions” student page
- [*Speakers Bureau Presentation: Wildlife in Managed Forests*](#) video (optional)
- Equipment for showing video(s)
- [*A Guide to Priority Plant and Animal Species in Oregon Forests*](#) (for Preparation)
- “Wildlife Signs” student page
- “Wildlife Inventory” student page
- Large master map or sketch of study site (see Preparation)
- Thermometer
- Measuring tape and/or string
- Markers (such as pencils or wood stakes with ribbon or flagging tape tied to one end, or other maker)
- 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

Key Vocabulary (continued)

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. Alternatively, plan to show the *Speakers Bureau Presentation: Wildlife in Managed Forests* video. Make copies of the “Wildlife in Oregon’s Forests – Questions” student page.
- For Part 2, use the Ecoregion Index on pages 6-23 of *A Guide to Priority Plant and Animal Species in Oregon Forests* to create a list of species found in your bioregion to assign students to research.
- For Part 3, choose a study site for the inventory. You may use the same site as in Lesson 9: Tree Identification and Survey, or the site may be on the school grounds, in a nearby park or at local forest. Identify what age forest you are in 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 or to watch the *Speakers Bureau Presentation: Wildlife in Managed Forests* video.
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 in the Preparation, 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 other 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 develop a research study using the steps of the scientific method.
- Watch the OPB *Oregon Field Guide* special titled “Living with Wolves” (<http://opb.org/television/programs/ofg/segment/living-with-wolves-an-oregon-field-guide-special/>). Conduct a debate on the pros and cons of an increasing wolf population.
- Invite a member of one of Oregon’s Native American tribes to talk with your students about tribal traditions related to forests, wildlife and fish.

Possible Answers to “Wildlife in Oregon’s Forests – Questions” 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.

Student Page

Lesson 13

Wildlife in Oregon's Forests²⁸

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.

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

²⁸ 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 Shortcourse*.

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-aged forests and some of the wildlife associated with them.

Young Open Stands

This condition occurs within a short time (2 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 deer mouse, striped skunk, common nighthawk and the American goldfinch.

Middle-Aged 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 the 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 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.

Wildlife in Oregon's Forests – Questions²⁹

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 with 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.

²⁹ Source: *Exploration of Oregon Forests: Module 6 – Woodland Wildlife*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Shortcourse*.

Student Page

Lesson 13

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 13

Name: _____

Wildlife Inventory

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

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			

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

14: Habitat Edges³⁰

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 among 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

Next Generation Science Standards

- Performance Expectation – HS-LS2-2: 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: 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.

³⁰ 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. Available at http://learnforests.org/sites/default/files/EnvironmentalScienceI_0.pdf.

- Science and Engineering Practice – 3. Planning and Carrying Out Investigations: Plan an investigation or test a design individually and collaboratively to produce data to serve as the 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 Program Concepts

- Theme 1, C.7. Forests are interconnected with other terrestrial (e.g., rangeland) and aquatic (e.g., estuary) ecosystems.
- Theme 2, B.2. Forests provide habitat for fish and wildlife.

Materials

- A study site (see Preparation)
- 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 light meter app for smart phones or tablets – to measure solar radiation
 - Digital anemometer, or wind meter device and app for smart phones or tablets – to measure wind velocity
 - Compasses, or app for smart phones or tablets – to measure wind direction
 - Measuring tape – to measure distances
- Data sheets (designed by students in Part 1)
- Measuring tape
- Flagging
- Transect lines (ropes marked at one meter, five meters, or other distance along their length), optional
- Graph paper (or access to spreadsheet program for tables and graphs)

Background Information³¹

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.

Key Vocabulary

dependent variable

edge effect

³¹ Source: Adapted from “Edge Effect One,” in *Environmental Science I* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at http://learnforests.org/sites/default/files/EnvironmentalScienceI_0.pdf.

Key Vocabulary (continued)

edge species

independent variable

transect

Preparation

Choose a study site that illustrates a distinct ecological edge between habitats and that 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 timber land, 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.

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 have 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 will need to carry out the procedure you outline below.

- | | |
|----|----|
| 1. | 5. |
| 2. | 6. |
| 3. | 7. |
| 4. | 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 measure each variable in the field. All measurements should be in metric units.

D. Data Sheet Design

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

Edge Effect – Data Analysis

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

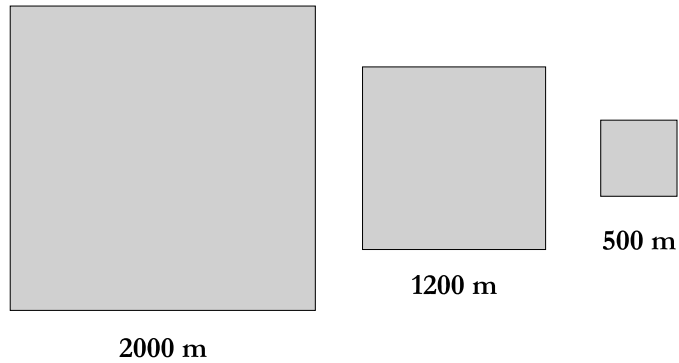
2. Is your hypothesis supported by the data?

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



What conclusions can you draw?

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

15: 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 33: The Effects of Climate Change on Oregon Forests.)

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

Next Generation Science Standards

- Performance Expectation – HS-LS2-5: 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 – LS2.B: 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 – 2. 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 Program Concepts

- Theme 1, A.2. Forests comprise trees that differ in species, age and size and are affected by biotic factors (e.g., plants, animals and humans) and abiotic factors (e.g., soils, nutrients, moisture, sunlight and climate).
- Theme 2, B.4. Forests sequester carbon from the atmosphere.
- Theme 2, D.2. Forests provide multiple economic benefits, including jobs and commodities such as forest products, renewable energy and minerals, financial returns to owners and investors, and ecosystem service benefits such as climate change mitigation, clean water, recreation and tourism.

Materials

- *Forest Fact Break: [Photosynthesis](#)* video (1:20 minutes)
- *Forest Fact Sheet: [How Does Photosynthesis Work?](#)*
- *Forest Fact Break: [Carbon Capture](#)* video (2:10 minutes)
- *Forest Fact Sheet: [Are Forests, Carbon and Climate Change Related?](#)*
- Equipment for showing videos
- *Carbon Tree Calculator*, available at <http://fs.usda.gov/ccrc/tools/cufr-tree-carbon-calculator-ctcc>
- Tree measurements from Lesson 10: Measuring Trees (or materials for measuring tree diameter as described in that lesson)
- Internet access
- “Plant Food” student page
- “How Much Carbon Is Sequestered?” student page
- “The Carbon Cycle Poster” student page

Background Information³²

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.

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.

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 US Forest Service estimates that U.S. forests sequestered a net of approximately 309 million tons of carbon each year between 1952 and 1992, which offset approximately 25 percent of our country's human-produced carbon emissions during that time period.

When a tree is harvested and made into a house, cabinetry or furniture, the wood continues to store the carbon that the tree had sequestered. So the carbon continues to be kept from the atmosphere. In contrast, the manufacture of steel, concrete and plastic requires the use of much more fossil fuel.

The chemical composition of wood varies from species to species and even from one part of a tree to another. But generally, wood is made up of approximately 50 percent carbon, 44

³² Sources: "The Great Carbon Storers." Oregon Forest Resources Institute.

<http://oregonforests.org/content/carbon-sequestration>.

"How Are Forests, Carbon and Climate Change Related?" Oregon Forest Resources Institute.

http://oregonforests.org/sites/default/files/publications/pdf/FactSheet14_Carbon.pdf.

Peterson, Roger C. "The Chemical Composition of Wood."

<http://fpl.fs.fed.us/documnts/pdf1984/pette84a.pdf>.

percent oxygen, and 6 percent hydrogen, with trace amounts of metal ions. Aside from water, wood has three main components: 41-43 percent cellulose, a carbohydrate derived from glucose; 20-30 percent hemicelluloses, carbohydrates made from glucose and other sugars; and 23-27 percent lignin, a complex polymer that makes the cell walls rigid.

Key Vocabulary

carbohydrate

carbon cycle*

carbon sequestration*

global climate change*

photosynthesis*

*included in Glossary

Preparation

- Make copies of student pages. (Instead of copying “The Carbon Cycle Poster” student page, you may choose to provide on-screen access to it.)
- Test out the *Carbon Tree Calculator*: <http://fs.usda.gov/ccrc/tools/cufr-tree-carbon-calculator-ctcc> (As a simpler alternative, you might use the National Tree Benefits Calculator, available at <http://treebenefits.com/calculator/> which estimates the quantity of carbon dioxide sequestered in a year.)

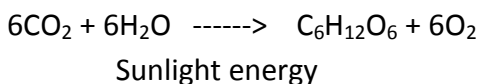
Procedure

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.³³)
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.

³³ 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.

Equation for photosynthesis:



Where: CO_2 = carbon dioxide, H_2O = water, $\text{C}_6\text{H}_{12}\text{O}_6$ = 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 wood varies from species to species, it is approximately 50 percent carbon, 44 percent oxygen, and 6 percent hydrogen.
2. Show the 2-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. Introduce the *Carbon Tree Calculator*, demonstrating how to use it by inputting a tree's size (DBH) or age, climate zone and species.
4. Give students copies of the "How Much Carbon Is Sequestered?" student page. Using data from Lesson 10: Measuring Trees, direct students to first estimate and then calculate the amount of carbon sequestered in the trees on your school grounds or other study site.
5. 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.
6. 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.
7. 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

- To explore the relationship between forests, climate change and the carbon cycle in more depth, see “Forests and the Carbon Cycle,” a set of high school lessons developed by the California Forest Foundation. Available at <http://calforestfoundation.org/pdf/Forests+and+the+Carbon+Cycle.pdf>.
- 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.

Plant Food³⁴

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

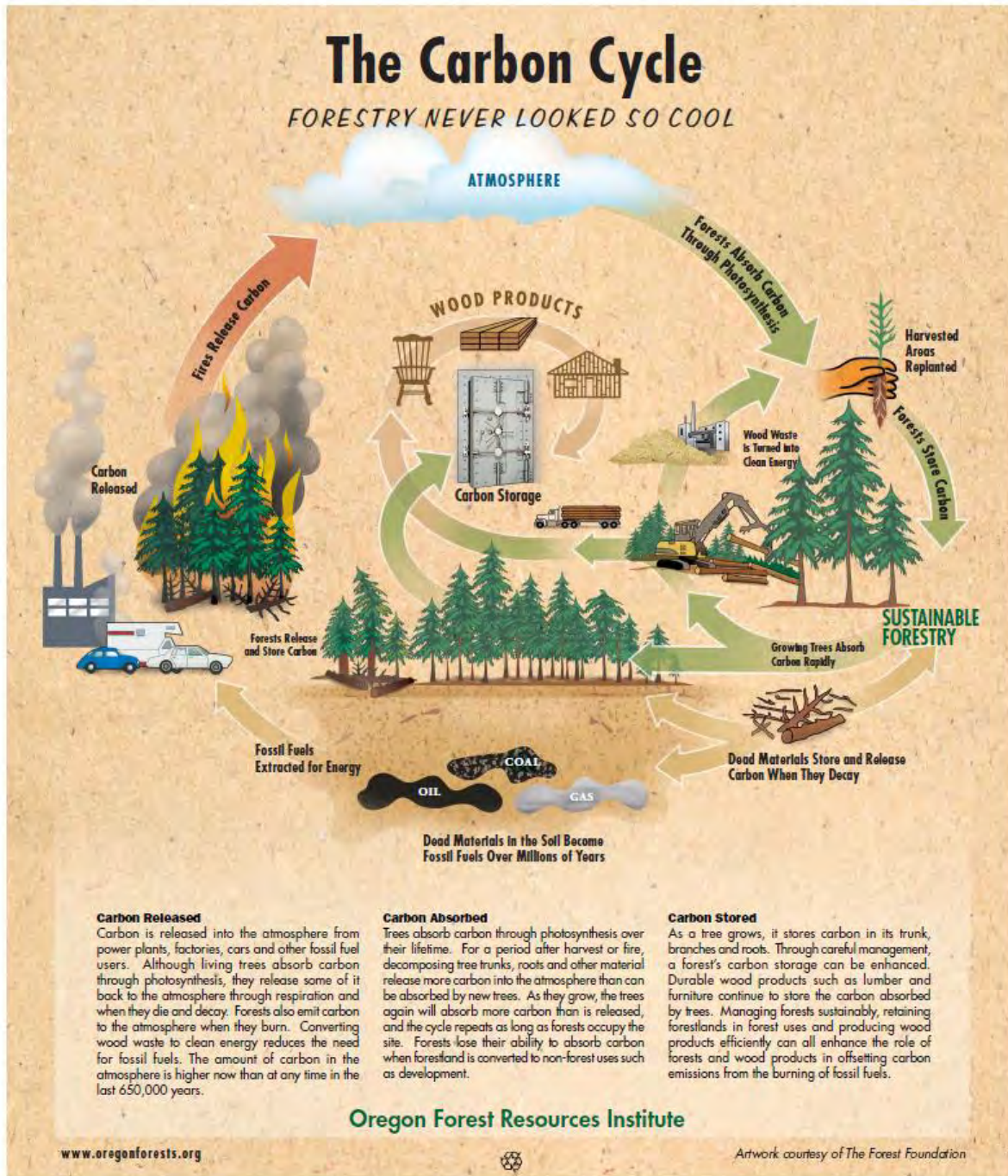
Explain your thinking.

³⁴ 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.

How Much Carbon Is Sequestered?

Tree	Diameter (DBH)	How much carbon would you estimate is stored in the tree?	How much carbon is there (from the carbon calculator)?

The Carbon Cycle Poster





- 16: Oregon's Forest Economy
- 17: Oregon's Wood Products
- 18: Biomass Energy from Oregon's Forests
- 19: Forestry Careers – Find Your Path

Section 4



ECONOMIC IMPORTANCE OF OREGON'S FORESTS

Section 4 – Economic Importance of Oregon’s Forests

16: Oregon’s Forest Economy

Overview

Students read about the economic importance of forests in Oregon and discuss the importance of forests to Oregon’s economy.

Time Considerations

Preparation: 15 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Articulate the benefits of and current challenges to the forest sector within Oregon’s economy.
- Read and interpret graphs related to Oregon’s forest economy.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.A: All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.
- Science and Engineering Practice – 8. 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.

Common Core State Standards – English Language Arts

- Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

Oregon Forest Literacy Program Concepts

- Theme 2, D.2. Forests provide multiple economic benefits, including jobs and commodities such as forest products, renewable energy and minerals, financial returns to owners and investors, and ecosystem service benefits such as climate change mitigation, clean water, recreation and tourism.
- Theme 2, D.3. Forests provide income for local, state, national and international economies. Oregon’s forest sector is one of the state’s largest economic sectors.

Materials

- “The Forest Economy of Oregon” student page

Background Information

See the “The Forest Economy of Oregon” student page for an overview of Oregon’s forest sector. For more details on the economic picture of forests in Oregon, see *The 2012 Forest Report*, which is available for download at <http://theforestreport.org/>.

Key Vocabulary

economic benefit*

*included in Glossary

Preparation

Make copies of the student page or provide on-screen access to it.

Procedure

1. Introduce the activity and the lesson by reviewing the historical and environmental importance of Oregon forests and asking students why Oregon’s forests might be important economically.
2. Provide copies of the “Oregon’s Forest Economy” student page, or make it available online. Allow time for students to read the material.
3. Discuss the reading:

- What economic benefits do Oregon's forests provide?
- Who benefits from Oregon's forests?
- What challenges are facing Oregon's forest sector today?
- What can Oregonians do to get the most economic benefits from our forests?

Assessment

Have students create a T-chart showing the benefits of and current challenges to the forest sector within Oregon's economy. The chart should include specific examples from the video or the reading to support their description.

Extension Idea

- To learn more in-depth about the economic picture of Oregon's forests, invite students to read parts or all of *The 2012 Forest Report*, available at <http://theforestreport.org/>.

Student Page

Lesson 16

The Forest Economy of Oregon³⁵

Oregon's forestlands are some of the most productive in the world. The state's mild climate, deep soils and abundant rainfall make it one of the best places to grow trees. A strong social climate helps support our forestlands as well.

As Oregonians, we enjoy

- Widespread public support for the economic, environmental and social contributions of a stable forest sector.
- Solid educational and research institutions, such as the Oregon State University College of Forestry and the USDA Pacific Northwest Research Station, which keep the sector at the vanguard of best practices.
- Strong forest protection laws under the Oregon Forest Practices Act that ensure landowners employ sound forest management practices.

As a result, by internationally recognized standards of sustainability, Oregon is a world leader in timber production, wood product manufacturing and sustainable forestry.

Jobs and Community

According to 2013 data, forestry products and services employ about 60,000 people in Oregon. These jobs are particularly critical to rural communities where wood product manufacturing can account for more than 50 percent of all manufacturing jobs.

Oregon's forest sector provides

- about 60,000 Oregon jobs
- 5.3 percent of all jobs in Oregon
- An average yearly wage of \$49,000

Growing Oregon's Forests

The total acreage of Oregon's forestland has remained virtually unchanged since 1953. Yet during the same time period, harvesting has produced more than 400 billion board feet of timber. To put that number in perspective, Oregon's forests have provided enough timber to

³⁵ Source: *Oregon Forest Facts & Figures, 2015-16*, Oregon Forest Resources Institute.

frame 25 million homes³⁶ without a reduction in the size and volume of the state's forestland. Now that's what you call sustainability.

Today, 75 percent of Oregon's timber production comes from forestlands owned by companies, families and Native American tribes. As active forest managers, these owners are leaders in sustainable forest management practices. To accelerate growth and improve yield per acre, they optimize methods of reforestation, thinning, and fire and infestation prevention, while protecting natural resources such as water and fish and wildlife habitat.

A Renewable Harvest

Forests remain Oregon's most abundant natural resource and a crucial part of the state's economy. As the country's economy and housing starts have declined, Oregon's annual timber harvest has followed. Harvest levels from combined private and public forests now total about 3 billion board feet per year — which is only about 30 percent of the new growth being added to our forests each year. While harvest on state and private forestland has remained somewhat stable, harvest of federal forestland has declined by 90 percent over the last two decades due to government restrictions.

Oregon leads the nation in

- softwood lumber production
- plywood production
- engineered wood product development

Deck the Halls with Oregon Christmas Trees

In addition to growing timber for wood and paper products, tree farmers from around the state have made Oregon the country's leading producer of Christmas trees. Oregon has nearly 68,000 acres dedicated solely to growing Christmas trees. Each year, Oregon tree farmers harvest 6.5 million Christmas trees — nearly twice as many as any other state — contributing more than \$143 million to Oregon's economy!

Some 92 percent of all Christmas trees are exported out of the region, bringing holiday cheer to markets as far away as China, Japan, Guam and the Philippines.

³⁶ According to <http://idahoforests.org>, framing an average 2,000-square-foot home requires 15,800 board feet.

Tourism: Oregon's Natural Attraction

Oregon attracts tourists from around the world, and many of them come to enjoy the natural beauty of our forests and abundant recreational opportunities in the outdoors. A recent survey by the US Forest Service estimated that more than 11 million recreational tourists visit Oregon's national forests each year, sustaining nearly 15,000 jobs and contributing an estimated \$440 million to the economy.

17: Oregon's Wood Products

Overview

Students watch a brief video on Oregon wood products and read how engineered wood products are helping build a more sustainable future for Oregon and beyond. They then research and report on different products made from Oregon trees.

Time Considerations

Preparation: 30 minutes

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

Learning Objectives

Students will be able to

- Articulate the importance of wood products for Oregon's economy.
- Conduct research on several different products made from Oregon forests.
- Summarize their research.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.A: All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Common Core State Standards – English Language Arts

- Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects – WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects – WHST.9-12.9. Draw evidence from informational texts to support analysis, reflection, and research.

Oregon Forest Literacy Program Concepts

Theme 2, D.1. Forest products come from a renewable resource. Most are reusable and recyclable. They store carbon and require less energy to produce than materials such as concrete and steel.

Theme 2, D.2. Forests provide multiple economic benefits, including jobs and commodities such as forest products, renewable energy and minerals, financial returns to owners and investors, and ecosystem service benefits such as climate change mitigation, clean water, recreation and tourism.

Materials

- An assortment of items made from trees (for example, a piece of paper, a swatch of rayon fabric, a piece of cellophane, a disposable diaper, and a bottle cork)
- *Forest Fact Break: [Wood Products](#)* video (1:31 minutes)
- Equipment for sharing video
- *[Forest Literacy Reading: Engineered Wood for a More Sustainable Future](#)*
- “Wood Products Made from Oregon Trees” student page

Background Information³⁷

Wood products make up 47 percent of all raw materials used in manufacturing in the United States. Nearly 100 percent of a harvested log can be used to make wood and other products we use every day — most of which are completely recyclable.

Products from Oregon’s forests include

- Structural lumber: Dimensional lumber, beams, joists, laminated veneer lumber and engineered structural softwood.
- Millwork: Doors, windows, cabinets, furniture, siding, flooring, moldings and fencing.
- Plywood and paneling: Veneer or other composite panels such as particleboard, hardboard and fiberboard.
- Posts, poles and timbers: Utility poles, fence posts, pilings, treated timbers, cross-arms and railroad ties.

³⁷ Source: “Forest Economy.” Oregon Forest Resources Institute.
<http://oregonforests.org/content/forest-sector-economy>.

- Pulp and paper products: Packaging, printing paper, newsprint, tissue, toweling, absorbents, adhesives, fluff pulp, and cellulose products such as rayon, cellophane, food additives and pharmaceuticals.
- Biomass energy: Many Oregon mills burn wood waste to generate heat and electricity for manufacturing.

Key Vocabulary

biomass energy
dimensional lumber
fiberboard
hardboard
particleboard
reconstituted wood
veneer

Preparation

- Gather an assortment of items made from trees.
- Make copies of the *Forest Literacy Reading* and student page, or provide on-screen access to them.

Procedure

1. Introduce the lesson by showing students the assortment of items you have collected and asking them which are made from trees. After they have had time to consider the items, ask whether they would be surprised to hear that all of them come from trees.
2. Show the 90-second video *Forest Fact Break: Wood Products* and discuss the importance of wood products to Oregon's economy.
3. Provide copies of *Forest Literacy Reading: Engineered Wood for a More Sustainable Future* (Gr. 9-12) or have it available for students to access online. Allow time for students to read the story and answer the questions. Ask students what other wood products might be important in Oregon, and begin a list on the board.
4. Give students copies of the "Wood Products Made from Oregon Trees" student page. Direct students to choose a number of the wood products to research, or you may assign students particular products to explore. (Assign a number of products for each student to research that takes into account your time, learning objectives, and the size of your class.)
5. Allow time for students to conduct quick research on each product, focusing on the questions listed in the Task section of the student page. Students should write a brief report (one to two paragraphs) about each product, describing what they learned.

Assessment

Use students' brief reports to assess what they learned about the wood products and their importance to Oregon's economy.

Extension Idea

- Explore two careers associated with wood products in Oregon. Show the 5-minute *Find Your Path: Mill Operator* and *Find Your Path: Procurement Forester* videos, and have students compare the two careers portrayed.
- Visit a mill.

Student Page

Lesson 17

Wood Products Made from Oregon Trees

- Lumber
 - Dimensional lumber
 - Solid beams
 - Laminated beams
 - Joists
 - Laminated veneer lumber
 - Finger-jointed lumber
- Plywood
- Reconstituted Wood
 - Particleboard
 - Hardboard
 - Fiberboard
 - Heating pellets
- Posts, poles and timbers
 - Utility poles
 - House logs
 - Fence posts
 - Pilings
 - Treated timbers, cross-arms and railroad ties
- Pulp and paper products
 - Packaging
 - Printing paper
 - Newsprint
 - Tissue
- Paper towels
- Absorbents
- Adhesives
- Fluff pulp
- Cellulose products
 - Rayon
 - Cellophane
 - Food additives
 - Pharmaceuticals
 - Biomass energy
- Millwork
- Lumber for products
 - Doors
 - Windows
 - Cabinets
 - Furniture
 - Siding
 - Flooring
 - Moldings
 - Fencing
 - Pallets
 - Lath
 - Pencils
 - Musical instruments
- Cross laminated timber (CLT)

(Source: Oregon Forest Facts & Figures 2013)

Task

As directed by your teacher, select a number of products from the above list. For each product, research and describe the following.

- ☐ Product: _____
- ☐ What is it? How would you define it?
- ☐ What is it used for?
- ☐ How is it made? What raw materials are required to make it?
- ☐ What are the potential environmental, economic and social impacts of this product for Oregon?
- ☐ What sources did you consult?

18: Biomass Energy from Oregon's Forests³⁸

Overview

Students explore renewable energy from forests by generating biomass gas and investigating its potential as a fuel.

Note: For non-lab classes, introduce the topic with the suggested video and then explore further using one or more of the Extension Ideas.

Safety Notes

- The procedures provided in this lesson are intended as suggestions.
- Be sure to follow all lab safety guidelines set out by your school or district.
- Have students wear safety goggles throughout the lab.
- Be mindful of open flames. Use a hood, if possible.

Time Considerations

Preparation: 30 minutes

Procedure: One to two 50-minute class periods, with the lab (steps 3-4) conducted during one period

Learning Objectives

Students will be able to

- Explain the pros and cons of using biomass gasification to produce energy.
- Use proper lab techniques to generate and collect biomass gases.
- Carry out a scientific investigation using the biomass gases.
- Analyze their data and draw conclusions.

³⁸ The lab was adapted from “Investigating and Using Biomass Gases” by Eric Benson and Melissa Highfill. National Renewable Energy Laboratory, U.S. Department of Energy. Available at http://www1.eere.energy.gov/education/pdfs/biomass_investigatinggases.pdf.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.A: All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Oregon Forest Literacy Program Concepts

Theme 2, D.2. Forests provide multiple economic benefits, including jobs and commodities such as forest products, renewable energy and minerals, financial returns to owners and investors, and ecosystem service benefits such as climate change mitigation, clean water, recreation and tourism.

Materials

- [Powered by Oregon](#) video (9:02 minutes)
- “Syngas Lab” student page
- Lab equipment, per group:
 - Safety goggles
 - Lab coats
 - Latex or nitrile gloves
 - Fume hood (if possible)
 - 35-55 mL test tube with matching one-hole rubber stopper
 - Two ring stands with metal test tube clamp and clamp for Erlenmeyer flask
 - Three pieces stainless steel or glass tubing, each approximately 5 cm long
 - 250 mL Erlenmeyer flask with matching two-hole stopper
 - Three pieces rubber or Tygon tubing, two approximately 60 cm long and one just shorter than the Erlenmeyer flask
 - Bunsen burner and lighter
 - Sink with faucet connection for tubing
 - Wood pellets (enough to fill test tube approximately 3/4 full)
 - Regular-sized marshmallow (not mini-sized)
 - Skewer for roasting marshmallow
 - One large sealable bag for test tube disposal
- Lab equipment, per class
 - One pair leather gloves

- Acetone (optional, for cleanup)
- Additional marshmallows

Background Information³⁹

If we imagine a way to power Oregon that is less dependent on fossil fuels, that is built instead on renewable and homegrown sources of energy, then woody fuel should be a significant part of the picture. Using local fuel creates jobs and keeps money at home.

In Oregon, we produce millions of tons of wood byproducts every year, from logging slash to sawdust to small trees from US Forest Service thinning projects. All of it contains stored solar energy – in total, enough to power hundreds of thousands of homes, businesses and public buildings.

Woody biomass includes branches, tree tops and other slash left over from logging, as well as bark, sawdust, chips and other residuals from sawmills. It is currently used to heat schools and hospitals and to generate electricity. Entrepreneurs, scientists and advocates are also working to develop fuel to power cars, trucks and airplanes, as well as other practical uses for what we used to call a “waste product.”

Combustion of biomass has been an energy source since humans (or pre-humans) first discovered fire. Biomass fires are, of course, still used for heating and cooking around the world. Modern wood-burning technology extracts more energy from a pound of wood than ever before, and does so with negligible emissions. In addition to wood, people use corn stover (dried leaves and stalks of maize plants), other crop wastes, manure, and other once-living materials for fuel.

In this lab, students will synthesize and use syngas, a gaseous fuel made from biomass. If the biomass is heated at high temperatures, gasification occurs, producing syngas. The main components of syngas are hydrogen, methane, carbon monoxide and carbon dioxide. It can be burned directly to power a turbine and generate electricity.

³⁹ Sources: *Powered by Oregon: Woody Biomass Offers Potential for Heat, Electricity and Fuel*. Oregon Forest Resources Institute.

http://oregonforests.org/sites/default/files/publications/pdf/OFRI_woody-biomass-report_WEBsinglepgs.pdf.

“Investigating and Using Biomass Gases” by Eric Benson and Melissa Highfill. National Renewable Energy Laboratory, U.S. Department of Energy.

http://www1.eere.energy.gov/education/pdfs/biomass_investigatinggases.pdf.

For more information, see the publication, [Powered by Oregon: Woody Biomass Offers Potential for Heat, Electricity and Fuel](http://oregonforests.org/sites/default/files/publications/pdf/OFRI_woody-biomass-report_WEBsinglepgs.pdf). Oregon Forest Resources Institute. Available at http://oregonforests.org/sites/default/files/publications/pdf/OFRI_woody-biomass-report_WEBsinglepgs.pdf.

Key Vocabulary

biomass energy
gasification
syngas
woody biomass

Preparation

- Before the lab, push two of the pieces of 5-cm long tubing into the two holes of the Erlenmeyer flask stopper, and one into the hole of the test tube stopper.
- Make copies of the student page.

Procedure

1. Introduce the lesson by asking students what they think biomass is. What are common forms of biomass? How is it used as energy?
2. Show the 9-minute film *Powered by Oregon* and discuss the benefits of woody biomass as a source of fuel. Point out that researchers are working to develop wood-based liquid fuel and other forms of energy from wood.
3. Divide the class into lab groups to create a biomass gas called syngas. Give each group a copy of the “Syngas Lab” student page. Note that although the gases produced are trapped in the flask, it is advisable to conduct the lab in a fume hood, if possible.
4. As lab groups complete step 10 of the lab procedure, disconnect each groups’ test tube tubing from their Erlenmeyer flasks and – using leather gloves – move the hot tubing out of the way.
5. After students have completed the lab, discuss the results:
 - What did you observe during the lab?
 - What do you think the gas you synthesized is made of? (Explain that the gas is a mixture of methane, hydrogen, carbon monoxide and carbon dioxide. The methane, carbon dioxide and hydrogen are the components of the gas that actually burn.)
 - What was the purpose of roasting the marshmallow?
 - How might this experiment compare with actual gasification? (This experiment is at a much lower temperature than commercial gasification and produces more pyrolysis oils than gas.)

- What might be the environmental and economic impacts of biomass gasification or other forms of woody biomass fuels for Oregon – both positive and negative?
6. Lab cleanup: Once the test tubes are cool to the touch (this may be after the class period is over), remove them from the clamps and place the tubes and their contents in the sealable bags. Seal the bags – as the tubes will be very stinky – and dispose in the trash. Wash the dirty tubing and flask in hot soapy water to remove any oils. If oils remain, rinse with acetone.

Assessment

Have students write a short essay summarizing what they learned from the lab. The essay should include relevant terminology, a summary of gas collection procedures and the implications of large-scale gasification as a source of renewable energy.

Extension Ideas

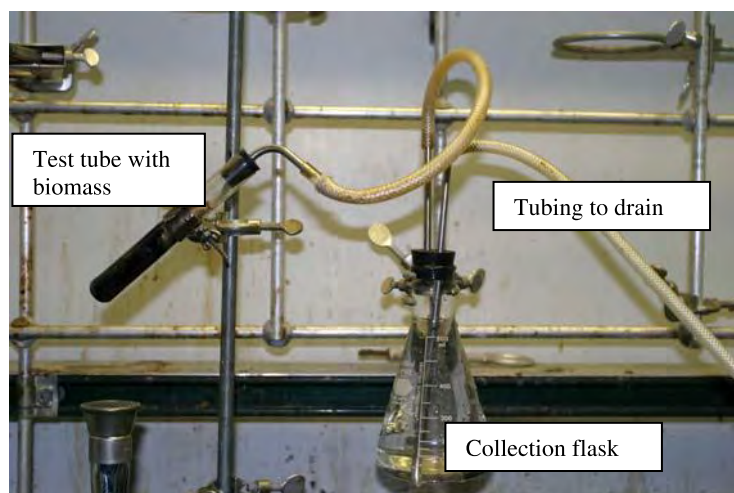
- Using the same procedure as described in the lab, students compare different biomass materials to determine which is the best energy source. Sources of biomass could include wood pellets or splints, dried grass, nut shells, manure, and corn stover (leaves and stalks of maize plants). Students could set their own parameters for what the “best” means, but one possibility is the volume of gas produced by one gram of material.
- Have students calculate their average home energy use over four months and compare it to biomass energy. Electricity usage is stated in terms of kilowatts (KW), while gas usage is in therms (one therm = 100,000 British Thermal Units, or BTUs).⁴⁰ In general, one kilogram of dry wood or other biomass can produce about one kilowatt (KW) of electricity, and one liter of syngas contains 13.4 BTUs of energy. How much wood and syngas would students’ households need to meet their current energy usage?
- Investigate the possibility of using biomass fuels for your school. See “Biomass Boiler to Heat Oregon School” at <http://energy.gov/articles/biomass-boiler-heat-oregon-school> to learn about one school’s project.
- Visit a biomass energy plant, or research bio-energy or co-energy plants in Oregon.

⁴⁰ One BTU is the amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit.

Syngas Lab⁴¹**Procedure**

1. Fill test tube 3/4 full with wood pellets.
2. Clamp the test tube to the ring stand using the metal clamp. Adjust the height of the tube relative to the Bunsen burner. The bottom of the test tube should be at least 3 centimeters above where the flame will be.
3. Insert the one-hole stopper with tubing into the test tube.
4. Attach the rubber tubing to one of the tubes in the two-hole stopper. The rubber tubing should come from the bottom of the stopper.
5. Fill the Erlenmeyer flask full of water and insert the two-hole stopper with the tubing going into the water. The tube should almost touch the bottom of the flask.
6. Connect the test tube and the Erlenmeyer flask with the piece of rubber tubing from step three.
7. Connect the last piece of rubber tubing to the top of the two-hole stopper and place the other end into the sink. Check the figure to ensure your setup is correct.
8. Light the Bunsen burner and begin heating the test tube. Make sure the flame is at least 3 centimeters away from the test tube so the tube does not melt.
9. Record observations while the tube is being heated.
10. After a few minutes gas will be evolved and will begin to displace the water in the Erlenmeyer flask. Continue heating until all of the water has been displaced.
11. At this point have your teacher disconnect the hot test tube tubing from the Erlenmeyer flask and move the hot test tube out of the way.
12. Connect the drain tubing to the faucet.
13. Slowly turn on the water and light the gas flowing from the end of the glass tubing. Adjust water flow rate to maintain a constant flame.
14. Roast a marshmallow on the flame (but don't eat it, as it may have a little tar on it). Record your observations below. At the completion of the lab, you may have a fresh marshmallow to eat.

⁴¹ Source: "Investigating and Using Biomass Gases" by Eric Benson and Melissa Highfill. National Renewable Energy Laboratory, U.S. Department of Energy.
http://www1.eere.energy.gov/education/pdfs/biomass_investigatinggases.pdf.



Equipment setup for syngas lab.

Observations

Lab Step	Time	Observations
Heating test tube		
Turning on water		
Lighting gas		
Roasting marshmallow		

19: Forestry Careers: Find Your Path

Students learn about different forest sector careers in Oregon, articulate which careers appeal to them, and identify what education, skills, experience and personal qualities it takes to succeed in a particular career.

Learning Objectives

Students will be able to

- Explain that Oregon's forest sector is an important source of jobs in the state.
- Identify what it takes to succeed in different forest sector careers.
- Articulate which forest sector careers appeal to them and why.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.A: All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Common Core State Standards – English Language Arts

- Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects – WHST.9-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Oregon Forest Literacy Program Concepts

- Theme 2, D.2. Forests provide multiple economic benefits, including jobs and commodities such as forest products, renewable energy and minerals, financial returns to owners and investors, and ecosystem service benefits such as climate change mitigation, clean water, recreation and tourism.
- Theme 4, A.7. Forest research and management involves professionals and skilled workers with background and experience in many fields, including forestry, biology, fish and wildlife management, soil and water conservation, land management, political science, engineering, sociology, geography, information technology, environmental education, chemistry, natural resource law, economics, finance and communications.

Materials

- [*Find Your Path*](#) booklet
- [*Find Your Path*](#) videos
- Equipment for sharing videos
- “What Does It Take?” student page

Background Information⁴²

Oregon’s forest sector – the part of Oregon’s economy derived from forests – represented about 60,000 jobs for our state in 2013. This sector encompasses the management of forests, the harvest of trees, and their conversion into consumer and construction products, such as lumber, plywood, poles, paper and energy. It also includes careers in forestry, science and engineering, trucking and equipment, manufacturing, energy, recreation, government, and forest support.

Find Your Path is a booklet produced by OFRI that explores a variety of careers in the forestry sector. It includes profiles of 19 different Oregonians working in the following forest-related careers:

⁴² Source of information in first paragraph: *Oregon Forest Facts & Figures, 2015-16*. Oregon Forest Resources Institute.

- Field Forester
- Forest Manager
- Wildlife Biologist
- Forest Engineer
- Natural Resource Ecologist
- Recreation Unit Manager
- Road and Right-of-Way Specialist
- Research Economist
- Logging Crew
- Harvester Processor Operator
- Log Truck Driver
- Field Technician / Service Mechanic
- Wildland Firefighter/Base Manager
- Nursery Manager
- Mill Operator
- Shipping and Sales Coordinator
- Vice President of Manufacturing
- Millwright
- Vice President of Timberlands

In addition to the booklet, OFRI has also created a series of short *Find Your Path* videos, each highlighting a particular forest career from the voice and perspective of a real person in that career. Currently, the videos profile a Field Forester, Wildlife Biologist, Forest Engineer, Logging Crew, Mill Operator, Procurement Forester, Recreation Forester, Hydrologist, Wildland Firefighter, Electrician, and Nursery Manager.

Preparation

Make copies of the student page.

Procedure

1. Show one or more of the *Find Your Path* videos to begin a discussion about Oregon forest sector careers. Ask students to describe the education, skills, experience and personal attributes necessary to be successful in each career. Discuss: What does or doesn't appeal to you about that career? What might be challenging about that career?
2. Give students copies of the *Find Your Path* booklet (or online access to it), and a copy of the "What Does It Take?" student page.
3. Direct students to choose three (or more) careers in the booklet to examine in-depth. For each career, they should describe the job involved, as well as the education, skills, experience and personal attributes that someone would need to be successful in that career. They should also write a brief paragraph about whether or not that particular job appeals to them, and why.

Assessment

Use students' responses to the "What Does It Take?" student page to assess their learning.

Extension Ideas

- Students conduct research on a different forest-related career to find out what education, experience, skills and personal qualities are required (see Careers in Forestry and Natural Resources at <http://forestrycareers.org> for a list of possibilities). Then, they create an online poster or other visual to share what they learned.
- Create a “dichotomous key” to forest sector careers that can help others determine which might be best suited to them. The key would be a series of paired questions or attributes to which users respond. It might include such attributes as indoor versus outdoor, high school education versus college education, urban setting versus rural setting and so on, to organize the career options.
- Invite someone from the forest sector to come in and talk to students about a range of careers.
- Share the *Find Your Path* video of the [Recreation Forest Manager](#) and explore recreation careers related to forests, including opportunities, safety, regulations and OHV (off highway vehicle) use.
- Have students explore their interests and skills related to future careers using various assessment tools available on the Oregon Career Information System website, <https://oregoncis.uoregon.edu>.

What Does It Take?

For each forest sector related career, identify what education, skills, experience and personal qualities are required. Then, write a paragraph telling whether that career appeals to you and why (or why not).

Job Title:

Job Description:

Education:

Skills:

Experience:

Personal Qualities:

Does this career appeal to you? Explain why or why not.

Job Title:

Job Description:

Education:

Skills:

Experience:

Personal Qualities:

Does this career appeal to you? Explain why or why not.

Job Title:

Job Description:

Education:

Skills:

Experience:

Personal Qualities:

Does this career appeal to you? Explain why or why not.



FOREST MANAGEMENT

20: What Is Forest Management?

21: Surveying a Forest Tract

22: Analyzing Forest Soil

23: Forest Density Lab

24: Forest Thinning

25: Harvesting

26: Reforestation

27: Silviculture Tour

28: Developing a Forest
Management Plan

Section
5



Section 5 – Forest Management

20: What Is Forest Management?

Overview

Students watch a brief video exploring the concept of forest management and then consider what forest management might mean for particular management goals.

Time Considerations

Preparation: 15 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Develop a working definition of the concept of forest management.
- Identify activities that may be involved in forest management.
- Compare different forest management strategies for a forest depending on management goals.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Common Core State Standards – English Language Arts

- Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

Oregon Forest Literacy Program Concepts

- Theme 3, B.1. Forest management embodies the use of natural processes as well as purposeful management activities to achieve desired forest outcomes, including

reducing the impacts of destructive disturbances such as unwanted wildfire, insect and disease epidemics, storm damage or vandalism.

- Theme 3, B.2. Forest management ranges from active management to passive management, using silvicultural techniques (e.g., planting, thinning and harvesting) to grow, conserve or alter forests.

Materials

- [Forest Fact Break: Forest Management](#) video (1:53 minutes)
- “Managing Forests for Specific Goals” student page

Background Information⁴³

How do you ensure that a forest is sustainable for the long run? Forest management is the practice of giving forestlands the proper care so that they remain healthy and vigorous and so that they provide the products and amenities the landowner wants.

Many people believe that the best way to protect a forest is to leave it alone. But generations of forest management and harvesting experience show that most forests do better with some form of management to ensure their health and sustainability.

This does not mean that all forests are managed the same way. Oregon’s forests generally fall into one of three management classifications:

- Reserve – managed primarily for environmental attributes, such as old-growth habitat
- Multi-resource – managed for multiple uses including recreation, water, wildlife habitat and some timber production
- Wood production – managed primarily for timber production, while protecting water quality and habitat

Forest management helps balance a forest’s environmental, social and economic values, providing the wood products and recreational access that society desires. It involves planning how to address the well-being of wildlife, the quality of watersheds, the health of the trees and plants, and the reduction of fires, insect infestations and diseases. It may include planting, thinning, prescribed burning, harvest and replanting.

⁴³ Source: Adapted from “Active Management.” Oregon Forest Resources Institute.
<http://oregonforests.org/content/active-management>.

This lesson introduces the concept of forest management as students consider what it might involve for a particular forest. In the next eight lessons, students will examine in depth specific management skills and strategies.

Key Vocabulary

carbon sequestration*

forest management*

forest reserves

management strategies

recreation

sustainability

timber production

watershed protection

*included in Glossary

Procedure

1. Ask students what they think of when they hear the term “forest management.” Have students call out words or phrases, and write them on the board.
2. Show the brief video *Forest Fact Break: Forest Management* and discuss with students how the video’s description of forest management compared with their ideas.
3. Point out that the management of a specific forest depends on the amenities and products that the landowner wants (or that society expects) the forest to provide. Ask students what some of the goals people might have for forests are and create a list of the goals on the board. (Possibilities include timber production, watershed protection, wildlife habitat, recreation, forest reserves and sequestering carbon.) Discuss the value of each goal.
4. Ask students for their ideas of management activities that landowners might undertake to meet their goals and create a separate list of these on the board. (Possibilities may include planting, thinning, prescribed burning, harvest and replanting, among many others.)
5. Divide the class into small groups and give each group one of the goals on the list from step 3. Their job will be to identify how they might manage a 100-acre forest based on their goal.
6. Give each group a copy of the student page and allow time for them to work through the questions.
7. Have groups share their main management strategies based on their goal. As a class, compare and contrast the management strategies presented. Discuss:

- What activities does forest management include?
- In what ways do forest management strategies differ depending on the management goal?
- Is there management activity or outcome that all forest management goals share?
- Are there any scenarios for which the best forest management strategy is to do nothing?
- How is forest management similar to or different from farm management?
- In what ways does forest management ensure the sustainability of forests?

Assessment

Ask students to write two paragraphs defining forest management and how it might differ for different goals.

Extension Idea

Explore how forest management might change over time with changes in laws or values or with environmental changes.

Lesson 20

Imagine that your group owns and manages 100 acres of forest that consists primarily of same-aged conifer trees.

- Section 5 – Forest Management – Page 159

21: Surveying a Forest Tract⁴⁴

Overview

Students learn some skills that forest managers use to survey forestland: pacing to measure horizontal distance, using compasses to find direction, map reading, and creating a map of a forest stand (or other site).

Time Considerations

Preparation: 30 minutes

Procedure: Two to four 50-minute class periods

Learning Objectives

Students will be able to

- Identify ways that pacing, using compasses, and mapping are useful in survival and forest management.
- Determine their average pace and measure distances between two points using pacing.
- Accurately use a compass to determine direction.
- Combine compass and pacing skills to follow an “orienteering” course.
- Identify common symbols on a topographic map.
- Use pacing and compass skills to create a simple forest map.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 5. Using Mathematics and Computational Thinking: Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

⁴⁴ This lesson was adapted from *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

Common Core State Standards – Mathematics

- High School: Number and Quantity – HSN-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Oregon Forest Literacy Program Concepts

- Theme 3, A.3. Oregon forests are managed under private (e.g., industrial, family and tribal) and public (e.g., city, county, state and national) ownership. Each type of ownership may have different objectives for how to manage forests.

Materials

- “Pacing” student page
- 100-foot measuring tape
- Stakes, flags or other markers for course
- Orienteering compasses, one per pair of students
- “Compass and Pacing Instruction Cards” teacher page, copied and cut apart (two cards per student pair)
- Topographic maps of a nearby forest, available for free download from U.S. Geological Survey, <http://store.usgs.gov> (either printed, or accessible on-screen as PDFs)
- Graph paper (or gridded lab notebook)

Background Information

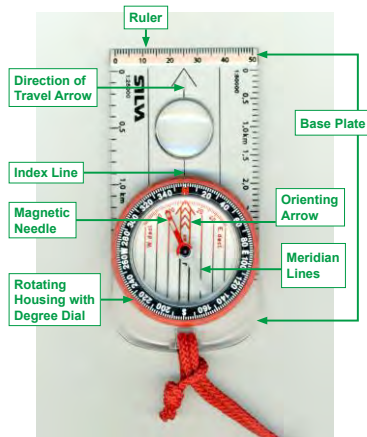
Pacing is a useful technique for measuring distance in the field, as it requires no equipment. In Ancient Rome, one pace was measured as two natural steps, from the heel of one foot striking the ground to the heel of that same foot striking the ground. Today, while many people measure one-step paces (from the heel of one foot to the heel of the other), foresters and ecologists generally use two-step paces.

The average length of a pace will vary between people and will also vary across different types of terrain. Most people have a one-step pace of about 30 inches and a two-step pace of about 60 inches.

The map symbols introduced in Part 3 of the lesson are those required for the FFA Forestry Career Development Event’s map reading. More symbols may be found in the USGS publication *Topographic Map Symbols*, available at <http://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf>.

Using a Compass to Follow a Bearing

1. Turn the dial on your compass until the degree you want matches up with the index line.
2. Hold the compass flat in your hand so the direction-of-travel arrow points directly away from you.



3. Turn your entire body until the north (red) end of the needle rests squarely in the orienting arrow.
4. You are now facing your bearing. Step forward in that direction to follow that bearing.

Key Vocabulary

bearing*
compass
contour*
pacing*
topographic map*

*included in Glossary

Preparation

- For Part 1 of the lesson, you will need to set up four different courses. Two of the courses should be 300 feet long, or a similar same-size length – one on an uneven or irregular surface (such as a field) and one on a smooth surface (such as pavement or sidewalk). In addition, measure and set up two “mystery” courses of different lengths (A and B) for students to measure using pacing.

- For Part 2 of the lesson, you will need to set up a compass course that consists of 20 markers placed five feet apart in a straight line running from magnetic west to magnetic east. Number the most westerly marker “1” and consecutively number the markers moving east until all 20 markers are numbered.
- Copy student page. Copy onto card stock and cut apart “Compass and Pacing Instruction Cards” teacher page.
- For Part 4 of the lesson, identify a suitable forest stand or other site near your school for students to map.

Procedure

Part 1 – Pacing

1. Ask students how measuring distances, using a compass, and mapping might be useful for survival and for forest management.
2. Explain that students will be learning some skills that forest managers may use to survey their forestland. First, they will learn a technique for measuring horizontal distances called pacing. With this technique, individuals use their own natural pace to estimate distances.
3. Show them the two 300-foot courses, and direct them to pace the two courses – two times per course – to compute their pace length. Give them copies of the “Pacing” student page to record their results.
4. Challenge students to use their pace length to estimate the length of the two “mystery” courses, recording their estimates on the student page.
5. Discuss student findings. First, get a show of hands to find out their estimates for the two mystery courses. Then, share the actual distances with them. How close were their estimates? What factors might affect the accuracy of this method? (Examples include ground cover, weather, footwear, ground surface and time of day.) In what situations might this method be useful for forest landowners?

Part 2 – Using a Compass

1. Show students how to use a compass to follow a bearing (see “Using a Compass to Follow a Bearing” in the Background Information). Give them practice following various degree bearings such as 225 degrees, 120 degrees, due north, due east, and so on.
2. Show students the course you have set up (see Preparation). Explain that each pair of students will get one of the “Compass and Pacing Instruction Cards” that has a starting point marker number and directions to follow.
3. Pairs should start at the marker number indicated on their card and follow the steps described. All routes lead back to a marker number on the starting line. After they’ve followed the instructions, students should note the number of the nearest marker.

4. When students have completed the instructions on one card, give them a different instruction card to follow.

“Compass and Pacing Instruction Cards” Answer Key

Starting Point	Destination Point
1	7
2	19
3	2
4	8
5	16
6	8
7	8
8	9
9	15
10	19

Part 3 – Reading Forest Maps

1. Divide the students into pairs, and give each a copy of the topographic map (or access to viewing on-screen).
2. Introduce or review some or all of the map symbols identified on the “Topo Map Symbols” student page.
3. Challenge students to find as many of the symbols as possible on their maps, marking them with sticky notes or highlighter (either real or virtual).

Part 4 – Creating a Forest Map

1. Take students to a forest stand or other site on or near your school (see Preparation). As a class, identify the boundaries of a rectangular study area at the site and, using a steel measuring tape, measure the length and width of the area.
2. Direct students to make a rough scale drawing of the perimeter on graph paper or in their lab notebooks, using as much of the space available as possible.
3. Have students work in pairs and, using hand compasses and their pace, measure and draw in the important features encountered at the study site, such as paths, ridges, valleys, vegetation boundaries, and so on. Students should sketch these features and include data on pacing and compass direction.

4. Back in the classroom, allow students time to create scale maps of the area, using the information they recorded in the field and some of the map symbols they explored in Part 3.

Assessment

Use students' forest maps as an assessment of their surveying skills. Based on your particular situation, develop a rubric for assessing the maps with criteria such as number and quality of important features, accuracy of location, number of map symbols, and so on. You may also want to create a map transparency of the study site to use in assessing student maps.

Extension Ideas

- The FFA Forestry Career Development Event requires participants to determine the degree reading between each set of stakes. Practice determining compass bearings as follows.
 - Face the stake or other object.
 - Hold the compass flat in your hand with the direction-of-travel arrow pointing out toward stake. Do not hold the compass near metal belt buckles.
 - Turn the dial until the north (red) end of the needle rests squarely in the orienting arrow.
 - Read the number at the index line. That number is the bearing for your stake.
- Practice reading the information available on maps of forested areas. For online interactive GIS maps of Oregon, see Oregon Department of Forestry's Locate OR application, available at http://oregon.gov/odf/pages/gis/gis_home.aspx.
- Work in small groups to design geocaching trails to share with another group.

Pacing⁴⁵

Pacing is a useful skill for measuring forest stands or other distances in the field. It involves using your natural walking pace to estimate a distance. For this exercise, count two steps as one pace: that is, from the heel of one foot striking the ground to the heel of that same foot striking the ground again.

1. To determine your pace, walk a measured course, counting the number of paces you take. Then, divide the length of the course by that number. For accuracy in the field, find your average pace on both smooth and uneven surfaces.

Smooth Surface**Trial 1:**

Course Length: _____

Number of paces in course: _____

Pace Length = Course Length ÷ number of paces: _____

Trial 2:

Course Length: _____

Number of paces in course: _____

Pace Length = Course Length ÷ number of paces: _____

Uneven Surface**Trial 3:**

Course Length: _____

Number of paces in course: _____

Pace Length = Course Length ÷ number of paces: _____

Trial 4:

Course Length: _____

Number of paces in course: _____

⁴⁵ Source: Adapted from *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.

<http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

Pace Length = Course Length \div number of paces: _____

Average Pace Length = (Trial 1 Pace Length + Trial 2 Pace Length + Trial 3 Pace Length + Trial 4 Pace Length) \div 4 = _____

2. Use your average pace length to measure unknown distances.

Mystery Course A

Number of paces in course: _____

Course Length = Average Pace Length x number of paces in course = _____

Mystery Course B

Number of paces in course: _____

Course Length = Average Pace Length x number of paces in course = _____

Teacher Page

Lesson 21

Compass and Pacing Instruction Cards⁴⁶

(Copy and cut cards apart)

Starting Point: 1 Go 36 degrees for 122 feet Then 149 degrees for 58 feet Then 235 degrees for 86 feet Destination number: _____	Starting Point: 6 Go 03 degrees for 100 feet Then 132 degrees for 74 feet Then 225 degrees for 69 feet Destination number: _____
Starting Point: 2 Go 17 degrees for 104 feet Then 150 degrees for 52 feet Then 142 degrees for 64 feet Destination number: _____	Starting Point: 7 Go 34 degrees for 119 feet Then 186 degrees for 50 feet Then 228 degrees for 74 feet Destination number: _____
Starting Point: 3 Go 38 degrees for 125 feet Then 237 degrees for 90 feet Then 186 degrees for 50 feet Destination number: _____	Starting Point: 8 Go 346 degrees for 102 feet Then 129 degrees for 78 feet Then 211 degrees for 58 feet Destination number: _____
Starting Point: 4 Go 36 degrees for 122 feet Then 174 degrees for 50 feet Then 228 degrees for 74 feet Destination number: _____	Starting Point: 9 Go 346 degrees for 102 feet Then 129 degrees for 78 feet Then 186 degrees for 50 feet Destination number: _____
Starting Point: 5 Go 22 degrees for 107 feet Then 158 degrees for 54 feet Then 186 degrees for 50 feet Destination number: _____	Starting Point: 10 Go 343 degrees for 104 feet Then 141 degrees for 64 feet Then 145 degrees for 61 feet Destination number: _____

⁴⁶ Source: *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.

<http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

Student Page

Lesson 21

Topographic Map Symbols⁴⁷

Map symbols are an important part of map reading. They can depict many various features such as roads, boundaries, buildings, landmarks, places of interest, water supplies, mines, and so on. Following is a list of some common symbols used in topographic maps.

Building	
Cemetery	
Quarry or open pit mine	
Gravel, sand, clay, or borrow pit	
School; house of worship	
Perennial stream	
Perennial river	
Intermittent stream	
Perennial lake/pond	
Spring or seep	
Highway or road bridge; drawbridge	

ROADS AND RELATED FEATURES

Please note: Roads on Provisional-edition maps are not classified as primary, secondary, or light duty. These roads are all classified as improved roads and are symbolized the same as light duty roads.

Primary highway	
Secondary highway	
Light duty road	
Light duty road, paved*	
Light duty road, gravel*	
Light duty road, dirt*	
Light duty road, unspecified*	
Unimproved road	
Unimproved road*	
Trail	
Power transmission line; pole; tower	
Standard gauge railroad, single track	
Standard gauge railroad, multiple track	

CONTOURS

Topographic

Index	
Approximate or indefinite	
Intermediate	
Approximate or indefinite	

⁴⁷ Source: Adapted from "Forestry CDE Workshop, 2009."
http://pte.idaho.gov/pdf/AG/Forestry_CDE_Workshop.pdf.

22: Analyzing Forest Soil⁴⁸

Overview

Students participate in a lab comparing soils from two or more different sites, looking at organic composition, pH, macronutrients, soil texture and the presence of soil invertebrates, to learn more about this important element in forest management.

Safety Notes

- Be sure to follow all lab safety guidelines set out by your school or district.
- Have students wear safety goggles throughout the lab.
- Be mindful of open flames for the organic component procedure.
- Be aware of the possibility of chemical contact with skin while using the soil test kit.
- Follow the test kit guidelines for disposing of spent chemicals.
- Be sure that students follow rules for the safe and ethical treatment of living things.

Time Considerations

Preparation: 30-60 minutes (with time enough in advance to dry soil samples)

Procedure: One to three 50-minute class periods

Learning Objectives

Students will be able to

- Describe some chemical and physical components of soil (organic composition, pH, soil macronutrients, and texture).
- Use a dichotomous key to identify soil invertebrates.
- Compare two or more different soil samples.
- Explain the importance of soils in forest management based on evidence from their investigation.

⁴⁸ Source: This lesson was adapted from “Soils: Physical and Biological Analysis,” in *Environmental Science II* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.

<http://learnforests.org/sites/default/files/EnvironmentalScienceII.pdf>.

Standards Connections

Next Generation Science Standards

- Performance Expectation – HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- Performance Expectation – HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Science and Engineering Practice – 5. Using Mathematics and Computational Thinking: Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Common Core State Standards – Mathematics

- Mathematical Practice – MP.2. Reason abstractly and quantitatively.

Common Core State Standards – English Language Arts

- Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects – WHST.9-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Oregon Forest Literacy Program Concepts

- Theme 1, C.8. Oregon’s regions vary in soil types, elevation, temperature, wind and rainfall patterns. These variations create the different forest types and residents (plants and animals) that, together with disturbance histories, contribute to that region’s biodiversity.
- Theme 4, A.7. Forest research and management involves professionals and skilled workers with background and experience in many fields, including forestry, biology, fish and wildlife management, soil and water conservation, land management, political science, engineering, sociology, geography, information technology, environmental education, chemistry, natural resource law, economics, finance and communications.

Materials

For the class:

- 12” soil core samples from two or more sites, dried (see Preparation)

- Leaf litter samples from the same sites (see Preparation)
- One-gallon sealable bags and garbage bags (for soil and leaf litter samples)
- Large aluminum trays (for litter samples)
- Asbestos gloves
- Tongs (for lifting crucibles)
- Digital balance

For each lab group:

- Safety goggles
- Porcelain crucible with cover (for heating core samples)
- Needle probe (for stirring core sample)
- Bunsen burner
- Ring stand and clamp (for crucibles)
- Matches
- Asbestos pads
- Soil test kit (for testing pH, nitrogen, phosphorous, and potassium levels)
- Screw cap vial (for soil invertebrates)
- Tweezers or forceps (for soil invertebrates)
- “Soil Lab Procedures” student page
- “Soil Lab Data Sheet” student page
- “Key to Soil and Leaf Litter Invertebrates” student page

Background Information

Soils are complex systems of organic and inorganic components. Soil composition greatly influences plant and animal communities, as well as the potential human uses for a given site. Land management decisions are fundamentally tied to soil types – whether it is forestry, agriculture, building/construction or other land use. In this lesson, students examine various physical and biological characteristics of soil. For more details, see the soil lab student pages.

Key Vocabulary

clay
 invertebrate*
 leaf litter*
 loam
 macronutrient*
 nutrient*

Key Vocabulary (continued)

organic*

soil*

soil pH*

*included in Glossary

Preparation

- Choose two or more sites that are likely to have different soil types for collecting soil samples – either on your school grounds or from nearby locales. Possible sites might include a grassy area, a treed area, a timber production tree farm, a wildlife refuge slough area, a pastureland, or a forest with 50- to 70-year or older trees. Wherever you collect the samples, be sure you have permission from the landowner or manager to do so.
- At each site, collect a 12-inch core sample placed in a one-gallon sealable bag, as well as the litter layer from a 1-m² area, placed in large plastic bags. Dry the core samples in aluminum pans in a drying oven at 55 C° for 4 days.
- Set up soil analysis kits and other equipment for each group on lab benches. Make copies of the student pages.

Procedure

1. Discuss: What is soil? Why is it important? What might forest managers want to know about the soil in the forests they manage?
2. Divide the class into pairs or small groups. Give them copies of the “Soil Lab Procedures” student page, and explain the various tests students will conduct.
3. Give each group a soil sample and matching leaf litter to analyze. Have them use the equipment provided to follow the lab procedures, recording their results on the “Soil Lab Data Sheet” student page. They will also need a copy of the “Key to Soil and Leaf Litter Invertebrates” to identify the organisms they find.
4. Lead a class discussion about students’ findings:
 - What differences did the groups find between the sites’ soil organic content, pH, macronutrient levels, soil texture, and soil invertebrates? What might these differences say about each of the sites?
 - Given the findings for a particular site, would this site be suitable for the commercial production of trees? What might be major forest management concerns for this site?
 - Which sites might be suitable for recreational activities? What soil characteristics may limit the type of recreation that occurs at each site?

Assessment

Give students the following writing prompt: Assume that your sample was taken from a 100-acre plot of land that you have just inherited. Prepare a one- to two-page narrative that describes what you have learned about this land and, taking into account the characteristics of the soil, describe what you might do with this land. Include the evidence that supports your choices.

Extension Ideas

- Construct food webs representing the energy flow in the soil samples.
- Find out more about your area's soil by checking out Natural Resources Conservation Service's Web Soil Survey website at <http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>, which includes a soil survey for every county in the United States with soil descriptions and characteristics, aerial photographs and other soil resources.
- Compare soils in Oregon with other regions of the world.

Soil Lab Procedures⁴⁹

Safety Note: Wear goggles during this lab and follow any other safety instructions provided by your teacher.

Organic Content

Organic material increases the water-holding ability and aeration of soil. As decaying plants decompose, they add important nutrients and influence the soil's pH. Thus, the amount of organic material in soil is an important consideration.

Organic matter burns at high temperature and decomposes to CO₂ and H₂O. In general, the inorganic components of the soil do not decompose at high temperatures. Therefore the loss in weight of a soil sample after burning can be used to estimate organic content.

Procedure

1. Weigh a glazed porcelain crucible (without the cover) to the nearest 0.01 gram:
_____.
2. Fill the crucible approximately two-thirds full with an oven-dried sample of soil.
3. Reweigh the sample plus the crucible to the nearest 0.01 gram: _____.
4. Subtract the weight of the crucible. This is the "dry sample weight": _____.
5. Place the uncovered crucible over a flame (Bunsen burner) and cook for 15 minutes. While cooking, stir with a probe, but be careful not to remove any soil in the process.
6. Ask the teacher to use tongs and asbestos gloves to remove the crucible from the flame. Cover and allow to cool on a heat-proof pad.
7. After about 5 minutes, when cool enough to weigh, remove the cover and reweigh the sample to the nearest 0.01 gram. This is the "cooked sample weight": _____.
8. Calculate the percent (%) organic matter in the soil sample using the formula:
$$\text{Percent Organic Matter} = \frac{(\text{dry sample weight} - \text{cooked sample weight}) \times 100}{\text{dry sample weight}}$$
9. Record the percent organic matter for your sample on the data sheet.

⁴⁹ Source: Adapted from "Soils: Physical and Biological Analysis," in *Environmental Science II* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. <http://learnforests.org/sites/default/files/EnvironmentalScienceII.pdf>.

pH

A soil's pH is a measure of its acidity. The pH scale runs from 0-14, with 7 being neutral. Values below 7 are progressively more and more acidic, while values above 7 are progressively more and more alkaline or basic.

Plants often have specific soil pH requirements. Crops such as blueberries and strawberries, for example, prefer more acidic soils, while most vegetable crops require somewhat more alkaline soils. Soils closely associated with Douglas-fir and other cone-bearing trees are often acidic. That is because tannic acid accumulates as a result of decomposition of conifer needles and branches.

Interpretation of Soil pH Levels

pH 4.0 – strongly acidic

pH 5.0 – moderate to strong acidity

pH 6.0 – slight to moderate acidity

pH 7.0 – neutral (neither acidic nor alkaline)

pH 8.0 – slight to moderate alkalinity

pH 9.0 – moderate to strong alkalinity

Procedure

1. Use soil from your soil core sample.
2. Follow the instructions that come with the soil test kit to determine the soil's pH.
3. Record your measurements on the data sheet.
4. Clean and dry soil kit components and pack neatly back in the case.

Macronutrients

Macronutrients are chemical elements that plants need for growth and development. Three primary macronutrients in soil that plants use are nitrogen (N), phosphorus (P), and potassium (K). A measure of these three components provides a good picture of soil fertility. Most commercial fertilizers contain varying amounts of these three macronutrients, which are often shown on fertilizer labels. A label of "15-30-10," for example indicates 15 percent by weight for N, 30 percent for P, and 10 percent for K.

Procedure

1. Use soil from your soil core sample.
2. Follow the instructions that come with the soil test kit to determine the soil's nitrate-nitrogen level.
3. Follow the instructions to determine the phosphorus level.
4. Follow the instructions to determine the potassium level.
5. Record all the values for soil macronutrients on the data sheet.
6. Clean and dry soil kit components and pack neatly back in the case.

Soil Texture

Soil texture is a physical property determined by the size of mineral particles in the soil. Soils are generally made up of larger fragments of sand or gravel embedded in microscopic silt or clay particles. Soil texture is very important because it affects a plant's ability to get nutrients, water, and air at the root level.

Mineral Particles in Soil

Gravels – 2.0 mm in diameter or greater

Sands – 0.02 mm – 2.0 mm in diameter

Silts – 0.002 mm – 0.02 mm in diameter

Clays – less than 0.002 mm in diameter

Most soils contain a mixture of sand, silt and clay. Soils that are predominantly sand have few nutrients, don't hold water, and are prone to drought. Soils that are predominantly clay contain nutrients and hold water well, but do not allow movement of air or water, and don't drain well. The best soils for most plants contain a relatively even mixture of sand, silt and clay – called loam.

Procedure

Conduct a simple field test using the sense of touch to approximate soil texture:

1. Place a small handful of dry soil (about the size of a marble) on the palm of your hand.
2. Add a few drops of water to moisten it to the point that it can be worked with the fingers.

3. Knead the soil between thumb and fingers, breaking up clumps. Remove any sticks, gravel, or pebbles.
4. Squeeze the soil between your thumb and fingers. Use the following chart to determine the approximate soil type.
5. Record your findings on the data sheet.

Soil Type	Characteristics of Squeezed Moist Soil ⁵⁰
Sand	Feels gritty and does not hold ball shape.
Sandy Loam	Can be molded into a ball, but ball breaks up easily.
Silt	Has silkiness like flour (not gritty; can be molded into a ball, but is easily deformed).
Loam	Can be molded into a ball that can be handled without breaking or deforming.
Clay Loam	Can be formed into a long thin “ribbon” that easily breaks.
Clay	Feels sticky, and can easily be formed into a long thin “ribbon.”

Soil Invertebrates

Soil invertebrates play critical roles in the long-term stability and fertility of soils. Their activities aerate the soil, speed up decomposition of organic materials and distribute important nutrients.

Procedure

1. With your leaf litter in a large tray, use tweezers to collect any invertebrates you see, placing them in a vial.
2. Use the “Key to Soil and Leaf Invertebrates” to identify the organisms you found.
3. Record your findings on the data sheet.

⁵⁰ Adapted from “Monitoring Forest Health,” *Project Learning Tree Exploring Environmental Issues: Focus on Forests*, page 44.

Student Page

Lesson 22

Name(s): _____

Soil Lab Data Sheet**Soil Characteristics**

	Site #1	Site #2	Site #3	Site #4
% Organic Matter				
pH				
Nitrate N (lbs/acre)				
Phosphorus P (lbs/acre)				
Potassium K(lbs/acre)				
Soil Texture				

Soil Invertebrates

	Site #1	Site #2	Site #3	Site #4
Springtails				
Earthworms				
Roundworms				
Beetles				
Beetle larvae				
Slugs				
Snails				
Flies				
Fly larvae				
Millipedes				
Proturans				
Pseudoscorpions				
Spiders				
Sowbugs				
Mites				
Ants				
Caterpillars				
True Bugs				
Harvestmen				
Other: _____				
Other: _____				
Miscellaneous				
Total # Individuals				
Total # Species				

Student Page

Lesson 22

Key to Soil and Leaf Litter Invertebrates⁵¹

For each organism you find, start with #1 and, depending on whether legs are present or not, go to the question number indicated. Continue until you determine the type of organism.

Please note that some immature insects such as fly larvae, beetle larvae, and moth larvae may not be accurately identified with this key.

1. Legs present 4
Legs absent 2
2. Body spindle-shaped, smooth, unsegmented, slender, usually light-colored, minute (approx. 0.5-1.5 mm long)
..... **Phylum Nematoda** (roundworms)
Body not spindle-shaped, or if spindle-shaped, animal is segmented, usually darker in color and 1.5 mm long 3
3. Body distinctly segmented and worm-like, shell absent
..... **Phylum Annelida** (earthworms)
Body not segmented, soft and smooth, with or without shell
..... **Phylum Mollusca** (snails and slugs)
4. Three pairs of legs present 5
More than three pairs of legs present 14
5. With functional wings 6
Without functional wings 10
6. With only one pair of wings; second pair of wings replaced by a pair of short, pin-like structures (halteres) **Order Diptera** (flies)
With two pairs of wings 7
7. Front and hind wings similar in texture and thickness 8
Front and hind wings unlike in texture; front wings may be horny or leathery 9

⁵¹ Source: "Soils: Physical and Biological Analysis" in *Environmental Science II* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/EnvironmentalScienceII.pdf>.

8. Wings usually covered with scales; sucking mouthparts **Order Lepidoptera** (moths and butterflies)
 Wings transparent; chewing or sucking mouthparts **Order Hymenoptera** (wasps)
9. Front wings horny or leathery and usually meeting in a straight line down the back, forming a veinless sheath over the abdomen; hind wings folded under front wings when not in use; chewing mouthparts **Order Coleoptera** (beetles)
 Front wings thickened and leathery at base and membranous at tip; mouthparts, a piercing-sucking beak arising from the anterior portion of the head **Order Hemiptera** (true bugs)
10. Abdomen terminating in two or three tail-like appendages (cerci); long antennae, chewing mouthparts **Order Thysanura** (silverfish)
 No cerci at end of abdomen or, if cerci-like appendages are present, they are pointed in an anterior direction (i.e., the springs of springtails) 11
11. Narrow-waisted; chewing mouthparts **Order Hymenoptera** (ants)
 Not narrow-waisted 12
12. Ant-like, but broad-waisted and usually light-colored **Order Isoptera** (termites)
 Not ant-like 13
13. Small, delicate insects with long, usually double, appendages on underside of abdomen; chewing mouthparts (very common in litter samples!) **Class Collembola** (springtails)

 Small, soft-bodied, plump insects with two short tubes at end of abdomen; piercing mouthparts in a beak that arises from back of head **Order Homoptera** (aphids)
14. Four pairs of walking legs present; head and thorax fused to form cephalothorax (**Class Arachnida**) 15
 More than four pairs of walking legs present 18
15. First pair of appendages (pedipalps) with large pincer-like claws; abdomen distinctly segmented; generally less than 10 mm long **Order Pseudoscorpionida** (pseudoscorpions)

First pair of appendages not usually highly modified; abdomen not distinctly segmented; length variable	16
16. Minute, total length less than 2 mm; body generally oval or shield-like	
..... Order Acari (mites)	
Larger, total length greater than 2 mm; body shape variable.....	17
17. Cephalothorax distinct from abdomen; leg length less than 3x body length	
..... Order Araneae (spiders)	
Cephalothorax not distinct from abdomen; leg length greater than 3x body length	
..... Order Opiliones (harvestmen, daddy-long-legs)	
18. Two pairs of appendages per abdominal segment	Class Diplopoda (millipedes)
One pair of appendages per abdominal segment	19
19. Thorax composed of eight overlapping segments, abdomen composed of six segments; seven pairs of legs plus one pair of maxillipeds (anterior)	Order Isopoda (sowbugs)
Thorax and abdomen variable; more than seven pairs of legs	20
20. Antennae with three distinct prongs, nine pairs of legs.....	Class Pauropoda
Antennae not as above, more than nine pairs of legs.....	21
21. Minute, total length less than 10 mm, 10 to 12 pairs of legs, poison claws absent on first trunk segment.....	Class Symphyla
Larger, total length generally more than 10 mm, generally more than 12 pairs of legs, poison claws present on first trunk segment	Class Chilopoda (centipedes)

23: Forest Density Lab⁵²

Overview

Students use Lego® bricks to model forest density and to “build” forest stands with optimal spacing.

Time Considerations

Preparation: 30 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Define forest stand density.
- Model different forest stands to compare their density and spacing.
- Determine the optimal spacing and size class distribution for a particular stand.

Standards Connections

Next Generation Science Standards

- Performance Expectation – HS-LS2-2. 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. 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 – 2. 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.
- Science and Engineering Practice – 4. Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.

⁵² Source: Adapted from “Lego® Forest Density Lab” in *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

Oregon Forest Literacy Program Concepts

- Theme 3, B.1. Forest management embodies the use of natural processes as well as purposeful management activities to achieve desired forest outcomes, including reducing the impacts of destructive disturbances such as unwanted wildfire, insect and disease epidemics, storm damage or vandalism.
- Theme 3, B.2. Forest management ranges from active management to passive management, using silvicultural techniques (e.g., planting, thinning and harvesting) to grow, conserve or alter forests.

Materials

- 16x16-stud Lego® baseplates, one per individual or pair
- Assortment of different-sized Lego® bricks: 1-stud⁵³, 2-stud, 4-stud, 6-stud, and 8-stud ones (if possible, it is helpful if the bricks of one size are the same color, and the different sizes are different colors)
- “Forest Stand Density” student page
- Camera (optional)

Background Information⁵⁴

Stand density is an important concept in forest management. It is a measure of how many trees are growing per unit area. The density of a stand of trees affects a number of factors: tree size (and therefore tree value), tree and stand growth, branch and crown size, wood quality (such as presence of knots), and certain attributes of wildlife habitat. Land managers can directly influence stand development by manipulating stand density.

Forest managers use a variety of measures such as trees per acre (TPA), basal area per acre (BA/A), Reineke’s Stand Density Index (SDI), volume (board feet) and Relative Density (RD) to determine density. In this lesson, students calculate the trees per acre and use Stand Density Index and Relative Density to observe the spacing of trees within stands.

⁵³ The “studs” are the extensions on the bricks and the platform that enable them to hold together. The number of studs denotes brick size.

⁵⁴ Source: “Lego® Forest Density Lab” in *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.
<http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

A stand's SDI is equal to the number of trees averaging 10 inches in diameter (DBH) present in the stand. A site's maximum SDI is both site- and species-specific and describes the maximum number of 10-inch-diameter (DBH) trees that the stand could support before natural thinning would occur. RD is calculated by dividing the measured SDI by the maximum SDI. Thus,

$$RD = \text{Measured SDI} \div \text{Maximum SDI}$$

Each species has a different maximum Stand Density Index as well as optimal Relative Densities. Decades of research and empirical data have yielded some general rules for tree vigor and growth rates of coastal Douglas-fir in the Pacific Northwest. The following tree-growth zones have been established for Douglas-fir.

Note that the Coast Range is very productive, so Douglas-fir's maximum SDI is higher than it may be in other areas. In the Willamette Valley, for instance, the maximum SDI will vary between 510 and 550, depending on site quality. Also, remember that each species has a different maximum SDI value.

Table: Growth Zones for Coastal Douglas-Fir⁵⁵

Zone	Description	SDI (per acre)	RD
Maximum Density Zone	The biological maximum of 10-inch-diameter trees that could possibly grow in an acre in this area.	600	1.0 (100%)
Mortality Zone	Some trees will begin to die due to tree-to-tree competition.	330-600	.55-1.0
Healthy Zone	Trees are vigorously growing, optimally using site resources.	210-330 ⁵⁶	.35-.55
Diversity Zone	This density allows for differentiation of crown positions in the canopy.	120-240 ⁵⁷	.20-.40

⁵⁵ Source: "Using Lego® Blocks to Demonstrate Concepts of SDI and Relative Density" by Monica Spicker. Spokane Community College.
<http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/7996/Using%20Legos2.pdf?sequence=1>

⁵⁶ This is the well-accepted thinning zone; allowing the stand to grow to 330 SDI and then thinning back to 210 SDI optimizes site resource utilization without allowing competition-induced mortality.

⁵⁷ Thinning back to these levels of SDI should promote growth of understory vegetation or regenerated trees.

In this lesson, each 2-stud Lego® brick represents a 10-inch-diameter (DBH) Douglas-fir tree growing in Oregon's Coast Range. The 2-stud brick has an SDI of 1, a 1-stud brick represents 0.5 SDI, a 4-stud brick presents 2 SDI, and so on. A Lego® baseplate of 16x16 studs has a total SDI of 128, and represents 1/4-acre of forestland. The following table shows the brick sizes, their comparable tree size and SDI, as well as the number of bricks that would be needed for even SDI distribution among the five sizes at various relative densities.

Table: Number of bricks needed for even SDI distribution at different Relative Densities (RD) for a 16x16 baseplate

Brick Size	Comparable Tree Size (DBH)	Stand Density Index (SDI)	Relative Density (RD)		
			RD = 0.15	RD = 0.35	RD = 0.55
1-stud	6.5 inches	0.5	8	18	28
2-stud	10.0 inches	1	4	9	14
4-stud	15.4 inches	2	2	4	7
6-stud	19.9 inches	3	1	3	5
8-stud	23.8 inches	4	1	2	4

Key Vocabulary

basal area
diameter at breast height (DBH)*
Relative Density (RD)
stand density
Stand Density Index (SDI)*
tree size class
trees per acre (TPA)

*included in Glossary

Preparation

Gather the materials. Make copies of the student page.

Procedure

1. Ask students what the consequences might be of forest trees growing very close together or very far apart?

2. Point out that forest density is an important measure of a forest's health. Using information from the Background Information, introduce the concepts of trees per acre (TPA), Stand Density Index (SDI) and Relative Density (RD).
3. Give each individual or pair a 16x16 stud Lego® baseplate, an assortment of different-sized Lego® bricks and a copy of the "Determining Stand Density" student page. Direct them to follow the directions on the student page to build three different forest stands with different characteristics. You also may have students take pictures of each of their stands to compare later.
4. When students have completed the lab, lead a class discussion about what they learned, asking such question as
 - What distribution of tree sizes enabled you to best achieve the optimal density?
 - How did your mixed-age stand model compare with your optimal stand density model?
 - What does your modeling tell you about stand densities in a real forest?

Assessment

- Have students write a paragraph describing what they observed in the modeling exercise and what they learned from it.

Extension Idea

- Use the data from the activity to determine Basal Area (BA) for each of the stands. Basal Area describes the average amount of an area (usually an acre) occupied by tree stems. It is defined as the total cross-sectional area of all stems in a stand measured at breast height, and expressed as per unit of land area (typically square feet per acre). For this exercise, students calculate the area of each class of trees at breast height and then add together all the areas of all the trees, multiplying by four to express square feet per acre.

Determining Stand Density

Use Lego® bricks to model a forest stand, with each brick size representing a different size Douglas-fir tree and the 16x16-stud baseplate representing a quarter acre.

Stand 1: Place “trees” on the 16x16 baseplate in any array you choose. Then, determine the Trees per Acre (TPA), Stand Density Index (SDI) and the Relative Density (RD) for your stand, using the table below.

Brick Size	Comparable Tree Size (DBH)	Stand Density Index (SDI) per Tree	Number of Trees in Size Class (N)	SDI for Size Class (SDI x N)
1-stud	6.5 in	0.5	i)	a)
2-stud	10.0 in	1	ii)	b)
4-stud	15.4 in	2	iii)	c)
6-stud	19.9 in	3	iv)	d)
8-stud	23.8 in	4	v)	e)
TPA (sum of i-v above) x 4:				
Stand SDI (sum of a-e above):				f)
Stand SDI per Acre (f x 4):				g)
Relative Density (RD) = Stand SDI per Acre ÷ Maximum Stand SDI (g ÷ 512)				h)

Stand 2: Place trees on the 16x16 baseplate to build a forest stand with a Stand SDI of 240 per acre, the optimal density for Douglas-fir trees growing in the Coast Range. Be careful not to crowd trees (crowding is when one brick touches another brick at more than one stud).

Brick Size	Comparable Tree Size (DBH)	Stand Density Index (SDI) per Tree	Number of Trees in Size Class (N)	SDI for Size Class (SDI x N)
1-stud	6.5 in	0.5	i)	a)
2-stud	10.0 in	1	ii)	b)
4-stud	15.4 in	2	iii)	c)
6-stud	19.9 in	3	iv)	d)
8-stud	23.8 in	4	v)	e)
TPA (sum of i-v above) x 4:				
Stand SDI (sum of a-e above):				f)
Stand SDI per Acre (f x 4):				g)
Relative Density (RD) = Stand SDI per Acre ÷ Maximum Stand SDI (g ÷ 512)				h)

Stand 3: Create a mixed-aged stand with a Relative Density of .35 per acre by choosing three or more different tree sizes and placing enough of each in the stand so that the total SDIs for each size class are about the same. Be careful not to crowd trees.

Brick Size	Comparable Tree Size (DBH)	Stand Density Index (SDI) per Tree	Number of Trees in Size Class (N)	SDI for Size Class (SDI x N)
1-stud	6.5 in	0.5	i)	a)
2-stud	10.0 in	1	ii)	b)
4-stud	15.4 in	2	iii)	c)
6-stud	19.9 in	3	iv)	d)
8-stud	23.8 in	4	v)	e)
TPA (sum of i-v above) x 4:				
Stand SDI (sum of a-e above):				f)
Stand SDI per Acre (f x 4):				g)
Relative Density (RD) = Stand SDI per Acre ÷ Maximum Stand SDI (g ÷ 512)				h)

24: Forest Thinning⁵⁸

Overview

In this field investigation, students determine the trees per acre of a forest plot and then make recommendations for thinning it to a given density, including which trees they would remove.

Time Considerations

Preparation: 30 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Determine the trees per acre of a given forest plot.
- Calculate the number of trees that should be removed to reach a given optimum density.
- Recommend which trees to remove based on their location, size, live crown ratio, health and form.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 6: Constructing Explanations and Designing Solutions: Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

⁵⁸ Source: Lesson was adapted from *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.

<http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

Common Core State Standards – Mathematics

- Mathematical Practice – MP.2. Reason abstractly and quantitatively.
- High School: Number and Quantity – HSN-Q.A.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Oregon Forest Literacy Program Concepts

- Theme 3, B.2. Forest management ranges from active management to passive management, using silvicultural techniques (e.g., planting, thinning and harvesting) to grow, conserve or alter forests.
- Theme 3, B.3. Management and natural processes can lead to changes in tree-species composition, size and age as well as forest health and resilience.

Materials

- Flagging tape
- Stakes
- “Forest Thinning Tally Sheet” student page
- Measuring tapes
- Calculators (optional)

Background Information⁵⁹

The most common tool used in silviculture is thinning, which means removing some trees so that the remaining trees have more light and other resources to grow. All plants have a predetermined size-density relationship, meaning that at a given density (trees per acre) individual plants can only grow to a certain size. To get larger, they need more space.

This relationship has been well researched by foresters, so they know the optimal spacing for tree growth. Managing tree growth with thinning requires staying above a minimum spacing and far enough above the optimal spacing to allow for growth until the next thinning.

⁵⁹ Source (first three paragraphs of information): “Tending Your Trees,” in *Establishing and Managing Forest Trees in Western Oregon*. Oregon Forest Resources Institute.

A general rule for Douglas-fir, for example, says that minimum adequate spacing can be estimated by the number of inches of diameter measured at breast height (DBH, 4.5 feet above ground on uphill side of tree). Using this method, a 12-inch-diameter tree would need a minimum of 12 feet to the nearest 12-inch-diameter tree, while a 20-inch tree would need 20 feet. If you were thinning a forest, you would want to provide for future growth, so Douglas-fir forests are commonly thinned to spacings of diameter plus 4 or 5 feet. The chart below indicates the optimal spacing of various Oregon forest tree species.

Optimal spacing for various tree species			
Species	Optimal spacing (in feet) at		
	6" diameter	10" diameter	16" diameter
Douglas-fir	8	12	17
Western hemlock	6	10	14
Western redcedar	7	11	16
Grand fir	8	12	18

In deciding which trees to remove in thinning, foresters will take into account the health of the individual trees, including whether they are alive, show any deformities (such as the top missing), or have signs of poor health (such as fungus or evidence of insect damage).

Another factor they may consider is a tree's "live crown ratio." This is the percentage that the crown represents of the total tree height. Determining live crown ratio involves measuring or estimating the vertical distance from the top of the tree to the lowest live branch and dividing that measurement by the total height of the tree. For Pacific Northwest conifers, a live crown ratio of 30 percent or more is considered healthy. Trees with less than 30 percent may be good candidates for thinning.

Key Vocabulary

live crown ratio^{*}
 plot density
 target density
 thinning

^{*}included in Glossary

Preparation

- Identify a suitable forest study area. It should include space for 0.05-acre (1/20 of an acre) circle plots for each student group. At 0.05 acres, each circle plot will have a radius of 26.3 feet.

- You may mark the circle plots in advance, with a stake at the center and stakes or flags around the perimeter, or have students do that as part of the lab.

Procedure

1. Ask students what happens if the trees in a forest stand grow too close together?
Discuss the importance of thinning as a way to maximize tree growth.
2. Give students the following scenario: You are in charge of managing a 4-acre forest plot for maximum wood production. Foresters have determined that the optimal stand density for this forest is 200 trees per acre (for west-side forests) or 100 trees per acre (for eastside forests). Your job will be to determine how many trees you would need to reduce, and which specific trees you would cut or thin, to reach the target.
3. Point out that each team will look at a 0.05-acre sample plot within the stand – a circle plot, with a radius of 26.3 feet – and mark the trees they would thin with flagging tape. Ask students what characteristics they might consider to determine which trees to thin?”
4. Hand out copies of the student page. Explain live crown ratio and answer any other questions about the task.
5. Take students to the study area, and divide them up into lab groups of two to four students. If you haven’t already marked the plots, have groups measure and mark their 0.05-acre plots.
6. Direct groups to count the number of trees in their plot, calculate the trees per acre (as shown on the student page), determine how many trees they would need to thin to reach the target density, and identify (on the student page and with flagging tape) which trees they would recommend removing. Point out that every tree larger than 2" DBH should be identified and recorded on their student pages.
7. When groups finish up their task, have them share with another group their findings and which trees they recommend thinning.

Assessment

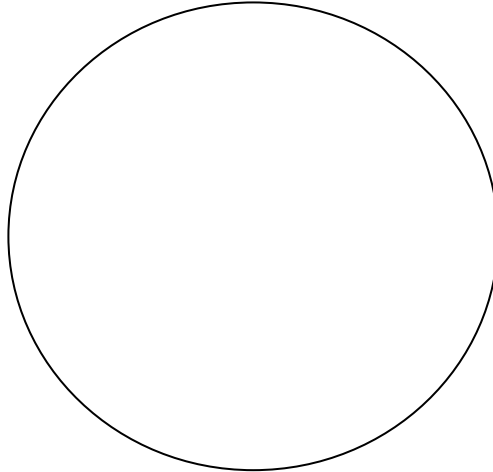
Ask students to write a few paragraphs describing their lab experience, including their method and reasoning for determining how many and which trees to thin.

Extension Ideas

- Enter the data collected into a modeling program to estimate tree growth and to visualize other forest process. *Landscape Management System* at <http://landscapemanagementsystem.org> offers free software developed by University of Washington, College of Forest Resources, Silviculture Laboratory; Yale University School of Forestry and Environmental Studies; The Cradle of Forestry in America; and the US Forest Service.
- Watch an OPB Oregon Field Guide episode on forest thinning <http://opb.org/television/programs/ofg/episodes/2105/>.
- Explore forest thinning with OSU Forestry and Natural Resources Extension <http://knowyourforest.org/learning-library/thinning-my-forest>.

Forest Thinning Tally Sheet⁶⁰

1. Mark in the circle below the locations of each of the trees in the circle plot. Give each tree a number.



2. For each tree in your circle plot, determine the following.

Tree Number	Species	DBH	Height	Live Crown Ratio	Health	Thin?

⁶⁰ Source: Adapted from *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. Available at <http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

3. Calculate the Plot Density (in trees per acre) using the following formula.

Plot Size: 0.05 acres (1/20 of an acre)

Number of Trees (larger than 2" diameter at breast height) in Plot: _____

Plot Density = Number of Trees in Plot x 20 = _____ trees per acre

4. Determine the thinning requirement for the plot by finding the difference between the Plot Density and the Target Density.

Target Density (trees per acre): _____

Plot Density (trees per acre): _____

Difference between Target Density and Plot Density: _____

Number of trees to thin = Difference in Density x Plot Size = _____ trees

25: Harvesting

Overview

Students learn about the Oregon Forest Practices Act and its general requirements for harvesting and reforestation. They then compare six different timber forest harvest systems and choose the most appropriate system for a specific scenario.

Time Considerations

Preparation: 15 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Describe the key features of the Oregon Forest Practices Act.
- Compare different timber harvest systems.
- Given a real-life scenario, choose the best harvest system or systems for it.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Oregon Forest Literacy Program Concepts

- Theme 3, B.2. Forest management ranges from active management to passive management, using silvicultural techniques (e.g., planting, thinning and harvesting) to grow, conserve or alter forests.
- Theme 3, B.4. Forests can be managed for a variety of ecological (e.g., water resources and wildlife), economic (e.g., forest products and recreation) and social (e.g., aesthetic appreciation, recreation and wilderness) outcomes. Many of these outcomes are interrelated, and some can be managed for simultaneously.

Materials

- “Timber Harvest Systems” student pages
- “Timber Harvest Systems Compared” student page

Background Information⁶¹

In forest management, trees are harvested for a variety of reasons. They may be harvested to improve the health of the forest; to control the types of trees that grow on the site; to attract certain wildlife species; to provide a source of income for the landowner; to produce paper, lumber and numerous other forest products; or to improve access to the area for hikers, hunters and other recreational users.

Oregon has strict laws for protecting forests, some of which have been in place since 1941. Oregonians recognize that assuring the abundance of our forest resources helps everyone, and that keeping them economically viable prevents their conversion into non-forest use. These laws have been developed and updated as an ongoing collaboration between scientists, landowners, elected officials and the general public. They help ensure that all Oregon forests operate under a unified set of guidelines and practices to help assure that we sustain our forestlands for generations to come. Forest laws provide protection for soil, air, water, fish, wildlife and forest resources.

In 1941, Oregon adopted the Oregon Forest Conservation Act to address reforestation and fire protection. In 1971, Oregon became the first state to implement a comprehensive set of laws governing forest practices with the Oregon Forest Practices Act (OFPA). Leaders from the forest sector helped develop these laws to guide pre-operation planning, education for operators and cooperative efforts among landowners and government.

Some of the requirements in the Oregon Forest Practices Act include

⁶¹ Sources: Information about Oregon Forest Practices Act: “Planning and Protecting for the Future.” Oregon Forest Resources Institute. <http://oregonforests.org/content/laws-planning>.

“Oregon’s Forest Protection Laws.” Oregon Forest Resources Institute. <http://oregonforests.org/content/forest-laws>.

Information about timber harvest systems: “Common Types of Timber Harvest Systems.” *Oregon Forest Protection Laws: An Illustrated Manual*, page 144.

- Reforestation: Landowners must complete replanting within two years after harvest. Within six years, the harvest area must be a healthy stand of trees that can outgrow competing grass and brush.
- Protection of water sources: Timber harvesting, road building and chemical use are restricted close to streams to protect fish and drinking water.
- Protection of wildlife habitat: Live trees, snags and fallen logs must be left after harvest to provide structure for wildlife habitat.
- Limits on clearcuts: A clearcut cannot be more than 120 acres. Clearcuts within 300 feet of each other cannot total more than 120 acres on the same ownership.

Since 1971, Oregon has adopted additional rules that help protect forests, water quality and wildlife habitat. The OFPA is periodically updated to reflect new scientific data, new operating technology and new forestry practices to ensure our forest resources are properly protected.

Common Types of Timber Harvest Systems

Cutting trees, moving logs to a landing, and loading logs for transport to a mill all are part of a timber harvest system. There are different timber harvest systems. Each one has advantages, which are described on the student pages. Modifications can make them even more versatile. The systems include: conventional chainsaw and tractor skidder harvest, cable logging, shovel logging, cut-to-length harvesting, whole-tree harvesting, and helicopter harvesting.

The terrain of the forest area will influence the choice of logging system. On gentle terrain, tree processors and forwarders, excavators, tractors, and skidders (explained in the student pages) and even horses can be logical choices. On steep terrain, the choice shifts to cable or helicopter systems.

Key Vocabulary

cable logging

cut-to-length harvesting

helicopter harvesting

shovel logging

timber harvest*

timber harvest system

tractor/skidder harvest

whole-tree harvesting

*included in Glossary

Preparation

Make copies of the student pages, or provide on-screen access to them.

Procedure

1. Remind students of the many different products that come from Oregon forests. Ask them what might happen if forest owners were able to harvest trees on their land whenever and however they wanted.
2. If students are not aware of it, provide a brief overview of the Oregon Forest Practices Act, using ideas from the Background Information. Point out that this law is designed to protect Oregon's forests.
3. Discuss how harvesting timber might compare to harvesting agricultural crops such as lettuce or pears. (For example, lettuce or pears could be harvested by hand in the field, but since trees are so massive, harvesting requires large equipment to cut, move and load the logs. In both types of harvest, care must be taken not to compact the soil or disturb the landscape.)
4. Give students copies of the "Timber Harvest System" student pages. Direct them to read about each system and, using the "Timber Harvest Systems Compared" student page, make notes about which system is best for which situation.
5. Ask students to work in pairs or groups and write a scenario to describe a particular forestland area. They should include in their description its size, how sloped or flat it is, how large or dense, and the forest landowner's goal for harvesting it.
6. Invite students to swap scenarios with another pair or group to determine the best harvesting method for the scenario they are given. Pairs or groups should be able to give their reasoning to defend their choice.

Assessment

- Have students use presentation software (such as PowerPoint or Prezi) to describe the Forest Practices Act and its requirements for timber harvest.

Extension Ideas

- Show students the video [*Inquiry at Hinkle Creek: Doing Science in Our Forests*](#) (16:59 minutes, available from Oregon Forest Resources Institute), and discuss what the investigation revealed about management methods in the two watersheds.
- Share with students the [*Find Your Path: Logging Crew*](#) video (2:20 minutes), and arrange for students to visit an active logging site in your area.

Student Page

Lesson 25

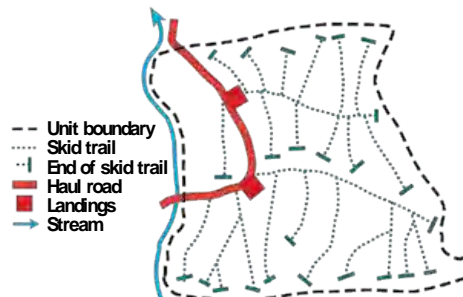
Timber Harvest System: Conventional Chainsaw and Tractor/Skidder Harvest

Hand-operated chainsaws are used to cut, delimb and buck trees into logs at the stumps. Skidders or crawler tractors (dozers) drag the logs to landings, where they are loaded onto trucks.



Tree felling, limbing and bucking are done with chainsaws.

Typical harvest layout. Skid trails should be planned and marked in advance. They often follow parallel branching patterns as shown (see Page 60). By winching logs across greater distances, skid trails can be located farther apart, reducing the area of skid trails and soil impacts from vehicle traffic.



Advantages

- adaptable to smaller harvest locations
- generally less costly equipment

Equipment used

- chainsaw
- log skidder or crawler tractor (dozer)
- log loader or self-loading log truck

Topography considerations

- normally restricted to slopes less than 35 percent
- haul roads usually located at the bottom of the logging unit

Soil considerations

- use of designated skid trails keeps machines on planned routes to help reduce soil disturbance
- on weaker soils, heavy traffic may result in trail ruts that require more water bars after logging
- soil disturbance can be reduced with widely spaced trails and pulling a winch line farther to logs – synthetic lines and other equipment features can make this task easier
- tractors and skidders should lift the front end of logs to reduce soil gouging

Forest stand considerations

- provides much flexibility with a variety of stand management goals

Slash disposal considerations

- lop and scatter possible with light accumulations of slash
- pile and burn is an option but requires additional steps and costs
- chipping and biomass energy utilization may be possible

Reforestation considerations

- yarding traffic or post-logging treatment can scarify ground and create areas for natural regeneration or hand-planting
- some advance regeneration may be lost or damaged by vehicle traffic

Economic considerations

- often more labor intensive
- generally, more roads are necessary
- least expensive method if road construction is not needed or is budgeted separately

Left: Skidders or dozers drag logs from the forest to the log landing. To reduce soil disturbance, rubber-tired skidders or crawler tractors are kept on skid trails. Winch line and chokers pull logs to the machine. Right: At the landing, a log loader moves logs onto trucks for delivery to the mill.



Student Page

Lesson 25

Timber Harvest System: Cable Logging

On steep terrain, this system uses a steel cable to carry either whole trees or logs to a landing after trees are felled with chainsaws.

Advantages

- allows for harvesting on steep ground and other sensitive terrain
- eliminates the need for skid trails
- can reduce construction and less favorable locations of roads

Equipment used

- chainsaw
- cable yarder
- delimer and log loader

Topography considerations

- well-suited for slopes of 35 percent and greater
- concave slopes allow more cable deflection and greater system efficiency
- intermediate supports allow for log lift in uneven terrain
- haul roads usually located at the top of the logging unit

Soil considerations

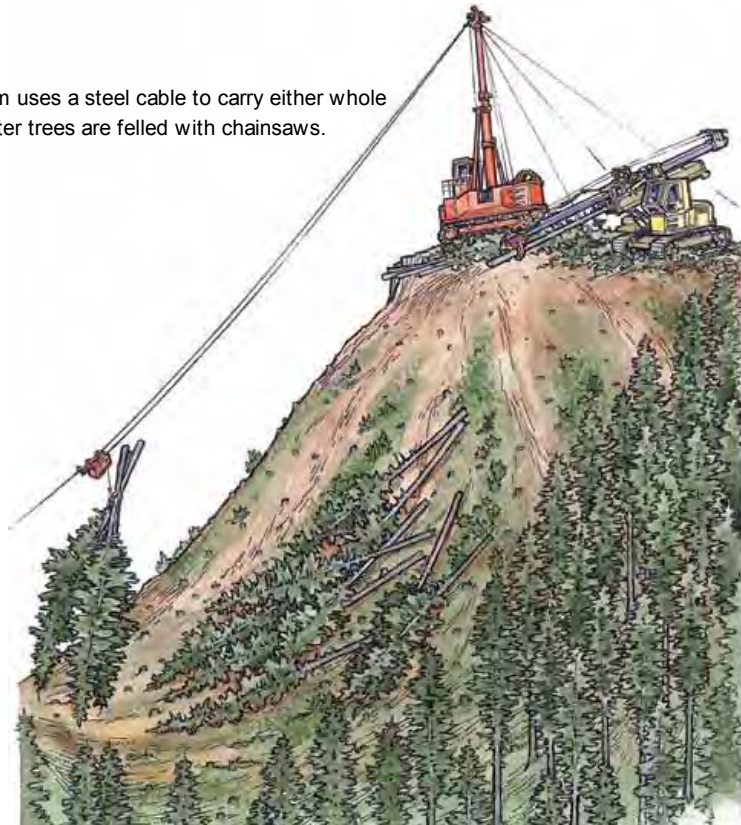
- can significantly reduce soil compaction and disturbance if logs are properly lifted
- heavy equipment is confined to roads and landings

Forest stand considerations

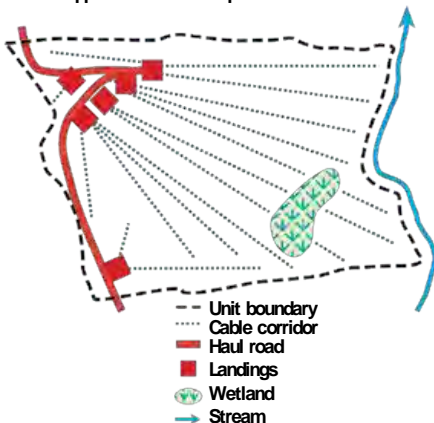
- primarily used with clearcuts and some partial cuts
- a more difficult method for thinning, with potential damage to residual stems

Slash disposal considerations

- if whole trees are brought to the landing, in-unit slash is minimized



Cable yarding systems can reach out 2,500 feet or more, especially with intermediate cable supports. This can help limit road construction needs.



Typical cable harvest layout. Generally logs are pulled uphill, but can also be moved downhill. With a strategic layout, logs can be lifted over streams, wetlands and canyons (see page 63).

- heavy slash piles at the landing must be treated or utilized
- if whole tree yarding is not used, prescribed burning of slash may be needed (see pages 69-72)

Reforestation considerations

- may expose fewer spots for easier planting or natural seeding
- brush control needs also may be greater when scarification is reduced

Economic considerations

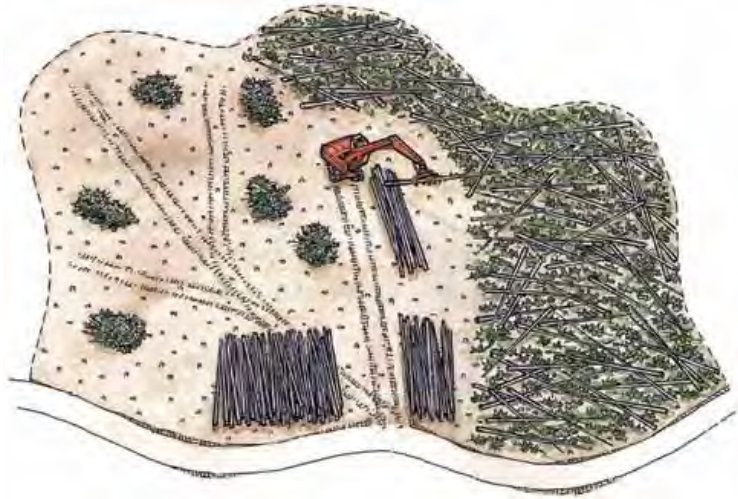
- can be more costly and specialized than ground-based systems
- small-scale systems can be competitive in some situations

Student Page

Lesson 25

Timber Harvest System: Shovel Logging

This ground-based harvest system uses a log loader (also called a shovel) to move logs rather than a skidder, tractor or forwarder. The shovel moves logs across the unit to locations near the road where they can be loaded onto log trucks. Logs are often picked up and moved ("swung") several times before reaching the road.



The shovel starts at the nearest access point and moves logs until they are within reach of the road. From there they can be loaded on trucks.

Below: Excavators equipped with grapples are common choices for handling logs and doing other useful tasks.



Advantages

- requires few people and machines
- few or no skid trails needed; existing roads may be adequate
- brush can be piled during harvest operations.

Equipment used

- chainsaw
- tracked excavator equipped with a grapple to grip and move logs

Topography considerations

- limited by slope due to machine instability on steep side hills
- may allow for harvest of some sensitive areas, with less disturbance than other systems

Soil considerations

- less compaction and disturbance if machine passes are limited

Forest stand considerations

- used primarily in clearcuts or partial cuts
- requires clearing of roadsides for log decks

Slash disposal considerations

- while moving logs, the excavator can pile heavy concentrations of slash for burning, chipping or other utilization

Reforestation considerations

- while or after moving logs or slash, the excavator can prepare the site for planting or seeding

Economic considerations

- small crew size
- one machine for multiple tasks can reduce costs
- efficiency improves with shorter yarding distances

Student Page

Lesson 25

Timber Harvest System: Cut-to-Length Harvesting

This ground-based system uses a mechanized harvester (tree processor) and a forwarder. The harvester severs, de-limbs and cuts each tree into logs and stacks them in the forest. The forwarder follows, picking up the logs and carrying loads to log trucks. It is also called a harvester-forwarder system.



A single grip processor can reach out 30 feet, cut a tree, strip the limbs, cut the stem into pre-programmed lengths and lay the logs on the ground, all in less than a minute. Ideally, they travel over the tree tops and limbs they leave.



A forwarder follows the harvester, picking up logs and delivering them to log trucks. They can travel long distances, reducing the need for log truck roads.



Logs are offloaded from the forwarder directly to log trucks.

Advantages

- leaves slash (tree branches and tops) in the forest
- reduces the need for log landings and access roads

Equipment used

- harvester/processor (tracked or wheeled)
- forwarder (often wheeled)

Topography considerations

- normally limited to slopes less than 35 percent

Soil considerations

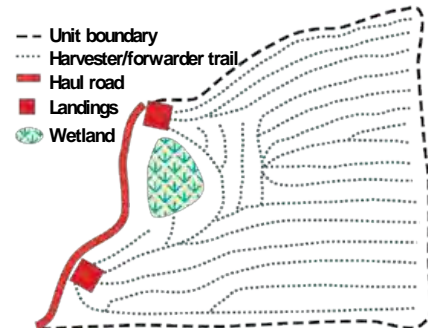
- can reduce compaction and disturbance, especially if the processor moves over duff and slash and if forwarders stay on slash-covered, designated skid trails
- slash left in the harvest unit will recycle nutrients and organic matter

Forest stand considerations

- an efficient method for commercial thinning
- typically used to move short logs out of the forest rather than long logs
- processor efficiency in dense stands is useful for forest health and fuels treatments

Slash disposal considerations

- by traveling over and compacting the slash, the system can reduce wildfire hazards and may meet slash hazard control requirements with no further treatment
- equipment can be used for slash piling for burning, chipping or other utilization



Typical harvest layout. Designated harvester/forwarder trails are about 60 feet apart and often follow parallel patterns across the harvest units.

Reforestation considerations

- common for thinnings where residual stocking does not trigger reforestation requirements
- if used for heavier cuts and slash loads, extra steps could create spots for planting or seeding

Economic considerations

- may not require new or improved roads
- relatively expensive and specialized machinery and operators
- may require larger volumes or higher quality timber for efficient use

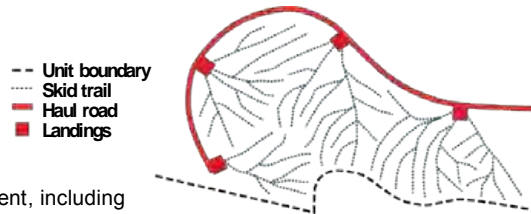
APPENDIX

Student Page

Lesson 25

Timber Harvest System: Whole-Tree Harvesting

This harvest system brings the entire tree, limbs and tops attached, to the landing or roadside. It can be used for both ground-based and cable applications. When used in ground applications, a feller-buncher often is used to cut and pile bundles of trees in the forest. Then a tractor or skidder drags the tree bundles to the landing or roadside. Finally, a delimber converts the trees to logs.



Advantages

- can be relatively efficient, including use of smaller material
- slash is brought to the landing or roadside where it can be burned, chipped or otherwise utilized

Equipment used

- feller-buncher
- crawler tractor or skidder with grapple
- stroke-boom delimer
- log loader

Topography considerations

- normally limited to slopes less than 35 percent
- with ground-based harvest, haul roads are usually at the bottom of the logging area

Soil considerations

- vehicles travel over a larger portion of the area as they cut, stack, gather and drag whole trees
- potential for more soil disturbance and compaction than other ground-based systems
- removal of tops and limbs does not recycle nutrients and organic matter near its source

Forest stand considerations

- efficient harvest and stand conversion when using a clearcut,
- can be used when thinning, but damage to remaining trees can be a problem.



A feller-buncher severs trees and lays them in bunches with limbs and tops attached. Bunches are oriented with tree trunks facing downhill.

Slash disposal considerations

- slash can be piled and later burned, chipped or otherwise utilized
- slash returned to the harvest area can recycle nutrients and organic matter (see pages 67-69)

Reforestation considerations

- widespread traffic and large tree bundles may damage advance regeneration
- dragging tree bundles can expose areas for planting or seeding

Economic considerations

- costs can increase on steeper ground or with longer skid distances
- bunching trees can help reduce the cost of handling small diameter trees.

Typical harvest layout. The feller-buncher and grapple skidder travel over most of the unit. Confining multiple trips to primary skid trails can reduce soil disturbance.



A crawler tractor or skidder with a grapple picks up bunched trees and drags them to a landing or roadside. Some grapples can swing 180 degrees, making it easier to operate in tight spaces.



The stroke-boom delimer operates at the landing or roadside, removing tree limbs and top, cutting the stem into logs and stacking them.



The loader serves two needs: loading trucks and piling tops, branches and log chunks for later burning, chipping or other utilization.

Student Page

Lesson 25

Timber Harvest System: Helicopter Harvesting

This harvest system was once used exclusively for large, high-value timber. Helicopter harvest remains a higher-cost alternative, but it can be used for smaller logs when timber volumes and quality are adequate.

Advantages

- can harvest visually sensitive, inaccessible or other areas where other systems are unsuitable
- useful option for locations with high recreational use, special wildlife habitat, riparian/wetlands or geologic hazards
- may reduce or avoid new road construction, including hazardous/sensitive locations

Equipment used

- chainsaw
- logging helicopter
- helicopter maintenance and fueling equipment
- log loader

Topography considerations

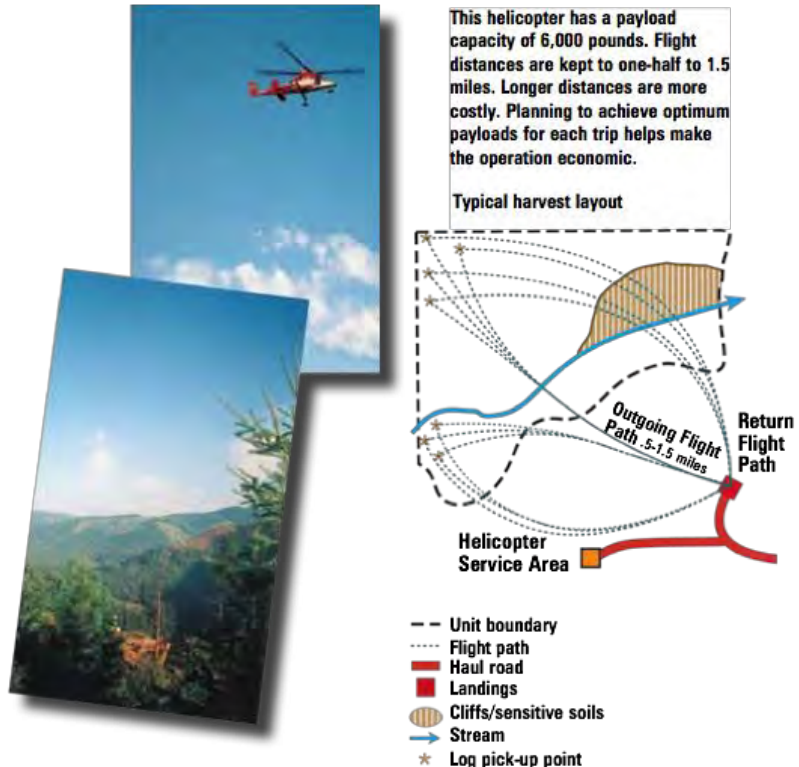
- can be used on any type of terrain with suitable landing and helicopter service area locations (i.e., adequate size, safety and efficiency)

Soil considerations

- minimizes in-unit soil disturbance and compaction because logs are fully suspended
- large landings and service areas may require extra drainage or other treatment

Forest stand considerations

- offers efficient, but costly method for commercial thinning
- large landings and service areas can locally impact forest stands.



Slash disposal considerations

- lop-and-scatter methods typically are used to reduce fire hazards
- if further treatment is needed, it can be costly where road access is limited

Reforestation considerations

- slash left on-site and limited yarding disturbance result in fewer exposed spots for easy planting or natural seeding

Economic considerations

- typically the most expensive logging system
- equipment and crew needs can result in costs three to four times those of ground-based systems
- reduced road construction needs may help offset high costs
- without adequate volume of higher value logs, harvest costs may exceed timber revenues

Timber Harvest Systems Compared

Good for...	Conventional Chainsaw and Tractor/Skidder Harvest	Cable Logging	Shovel Logging	Cut-to-Length Harvesting	Whole-Tree Harvesting	Helicopter Harvesting
Smaller harvest or thinning?						
Clearcuts or partial cuts?						
Level land (less than 35% slope)?						
Sloped land (35% slope or greater)?						
Minimizing the number of skid trails needed?						
Areas with special wildlife habitat?						
Minimizing soil disturbance?						
Minimizing Cost?						

26: Reforestation

Overview

Students read about and answer questions on techniques for successful reforestation and then calculate the number of seedlings that would be required to reforest a given area.

Time Considerations

Preparation: 15 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Describe the key features of the Oregon Forest Practices Act.
- Explain the steps involved in successful reforestation.
- Calculate the number of seedlings that would be required to reforest a given tract of land.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 5. Using Mathematics and Computational Thinking: Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Common Core State Standards – Mathematics

- Mathematical Practice – MP.4. Model with mathematics.

Oregon Forest Literacy Program Concepts

- Theme 3, B.2. Forest management ranges from active management to passive management, using silvicultural techniques (e.g., planting, thinning and harvesting) to grow, conserve or alter forests.

- Theme 3, B.3. Management and natural processes can lead to changes in tree-species composition, size and age as well as forest health and resilience.

Materials

- [Forest Fact Break: Reforestation](#) video (1:22 minutes)
- Equipment to share video
- “Reforestation in Oregon” student page
- “Reforestation in Oregon – Questions” student page

Background Information⁶²

Reforestation is Oregon law. But even before these laws were in place, forest landowners – much like farmers – replanted after every harvest. Because of landowners, Oregon is a national reforestation leader, planting about 40 million new seedlings each year, according to the Oregon Department of Forestry.

Reforestation is an essential part of active forest management. Before harvest, foresters determine the best plan of action to ensure the regrowth of a healthy forest. Sometimes this means immediate replanting, while other times it means leaving trees as seed sources. When appropriate, seedlings of several different tree species are planted to maintain diversity in a working forest.

The land needs to be prepared to improve the growth and health of young trees. This requires clearing away post-harvest debris through a few different methods:

- Controlled and contained burning
- Using herbicides within the rules and regulations of the Environmental Protection Agency and Oregon Department of Forestry to control weeds and other vegetation that compete with young trees
- Using machines to clear excess logging debris to allow planting of seedlings

Seedlings are planted while they are dormant so they can take advantage of cool, wet weather conditions that promote good root development. This means seedlings are typically planted from winter into early spring. In Oregon, seedling survival typically surpasses 95 percent.

Through consistent and responsible reforestation, Oregon can keep its forests healthy and sustainable.

⁶² Source: “Replanting Keeps Oregon Green.” Oregon Forest Resources Institute.
<http://oregonforests.org/content/reforestation>.

Key Vocabulary

artificial regeneration

bare root stock

container stock

free to grow*

reforestation*

regeneration*

*included in Glossary

Preparation

Copy the student pages or provide on-screen access to them.

Procedure

1. Ask students to jot down what they think reforestation means. What might be the purpose of reforestation?
2. Show students the 90-second video *Forest Fact Break: Reforestation*. Discuss: How did the information in the video compare to what students wrote down?
3. Give students copies of the “Reforestation in Oregon” student page.
4. After allowing time for students to read, give them copies of the “Reforestation in Oregon – Questions” student page and have them discuss the questions in pairs or small groups.
5. Have students work in pairs to solve the following problem:

You are the manager of 8 acres of forestland that have just been completely cleared and need to be reforested. After talking with foresters in your area, you have decided to plant Douglas-fir seedlings spaced 12 feet apart, as this would be the optimal spacing for your site. Your task now is to determine how many Douglas-fir seedlings you would need to reforest the entire area, with the seedlings spaced 12 feet apart.

You may choose to have students look up the area of an acre as part of their problem-solving, or tell them that an acre is equivalent to 4,840 square yards or 43,560 square feet.
6. Have students share their responses, explaining how they got their answer. (The correct answer is in the following box.) Discuss how the number would change if the trees were planted 6x6 feet or 10x10 feet apart, and why someone might choose to plant the seedlings closer or farther apart.

Spacing and Number of Trees per Acre – Answer

To determine the number of trees needed to plant 1 acre, you must divide 43,560 square feet (the area of an acre) by the number of square feet each tree needs. For 12x12 spacing, 43,560 square feet per acre \div 144 square feet per tree = 302 trees per acre. For 8 acres, multiply the trees per acre times 8 (302 trees per acre \times 8 acres = 2,516 trees).

Spacing (feet)	Square feet per tree	Trees per acre	Trees for 8 acres
12x12	144	302	2,416
10x10	100	436	3,488
6x6	36	1,210	9,680

Assessment

To assess student understanding, direct them to write a report describing their reforestation plan for the forestland described in the activity – including why they are reforesting the land and how they determined the number of trees required.

Extension Ideas

- Have student participate in a tree planting or reforestation effort. For information on how to plant trees, see *Establishing and Managing Forest Trees in Western Oregon*, page 188, available at <http://oregonforests.org/content/ofri-resources>. See Lesson 36: Forest Service-Learning Project for ideas for developing this as a service-learning activity.
- Visit a forest seedling nursery to learn firsthand how seedlings are grown. See “Sources of Native Forest Nursery Seedlings,” at <http://oregon.gov/odf/privateforests/pages/seedlings.aspx> for a possible nursery in your area.

Possible Answers to “Reforestation in Oregon – Questions” Student Page

1. Besides being the law in Oregon, reforestation provides multiple benefits, including wood products, watershed protection, fish and wildlife habitat, and recreational opportunities, as well as providing shade and absorbing greenhouse gases.
2. Planning and evaluating the site; preparing the site; selecting proper species and stock-type; planting at the optimal time for the location; maintaining the seedlings until they are “free to grow.”
3. Bare root seedlings – packaged in bags, with roots exposed. Container seedlings – come in a container, often made of Styrofoam.
4. Ponderosa pine.
5. Possible answers: western hemlock, western red cedar.
6. Planted in rich planting soil; at the proper depth; with no air pockets; with roots directed down into the soil with space between them; and with the main stem upright.

Reforestation in Oregon⁶³

Replanting a forest after it has been harvested, known as reforestation, is important. For one thing, it's the law in Oregon. Beyond the law, however, reforesting makes good sense for the environment and for the economy. Since nearly half of the state's land area grows trees, forests can provide multiple benefits, including wood products, watershed protection, fish and wildlife habitat and recreational opportunities. Our forests can even make an impact beyond our borders, since trees provide cool shade and absorb greenhouse gases that contribute to climate change.

Oregon was the first state in the nation to pass laws to ensure continuous harvest of timber on private lands while safeguarding soil, air, fish and wildlife resources. In 1971, Oregon enacted the Oregon Forest Practices Act, which regulates many activities conducted on forestland, including reforestation. Oregon law requires reforestation when timber harvesting reduces the number of trees below specific stocking levels. Landowners must complete reforestation within 24 months after harvesting. Depending on site productivity, at least 100 to 200 seedlings per acre must be established. However, most landowners plant 300 to 400 trees per acre.

Today, about 40 million trees are planted every winter and spring in Oregon. These tree seedlings are carefully planted on public, industrial and family forestlands. It takes good planning and follow-through to assure success in this labor-intensive and expensive work.

Planting is the most common way to ensure a fully stocked young forest. This is known as artificial regeneration and is often used in heavily managed stands. Advantages to artificial reforestation include quick, uniform regeneration, less susceptibility to environmental factors (e.g., natural seed dispersal, poor seed years, etc.), a head start over brush, and selection of seedlings from superior genetic stock. Natural regeneration, by comparison, may take longer and result in spotty regeneration.

⁶³ Source: *Exploration of Oregon Forests: Module 4 – Forest Management 1– Cycles and Reforestation*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Shortcourse*.

The Five Steps to Reforestation:

STEP 1:

Carefully plan, evaluate and prepare the site. Consider the condition of the planting site: vegetation present, soil type, aspect (direction the slope faces), wildlife and pests. Site characteristics affect critical site resources necessary for seedling survival and growth, including water, sunlight, temperature and nutrients.

STEP 2:

Choose an appropriate site preparation method or combination of methods. Several methods are available to prepare sites for planting. These methods include mechanical, manual and chemical. Costs depend on site conditions, methods used, existing vegetation and amount of logging debris or slash.

STEP 3:

Select the proper species and seedling stock-type for the site. Different tree species are adapted to different site conditions. Choose seedlings specifically for the seed zone and elevation. Obtain tree seedlings by encouraging natural seeding, by transplanting seedlings growing in the wild, or by purchasing nursery-grown seedlings.

STEP 4:

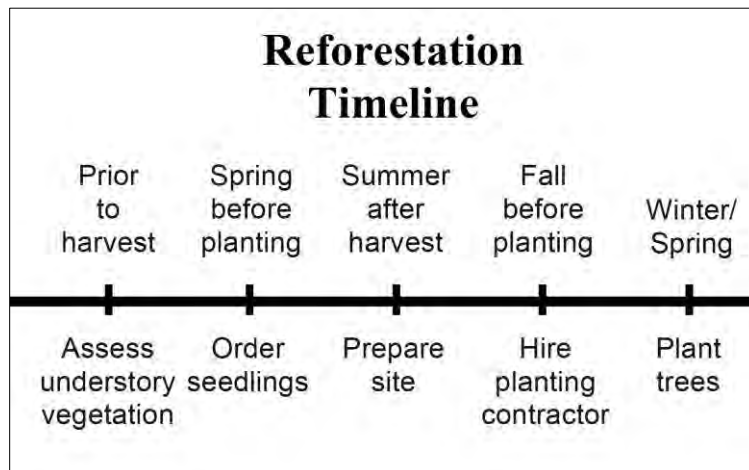
Plant conifer seedlings in western Oregon from January through March. In higher elevations or in eastern Oregon, plant as soon as possible after snow melts and the ground thaws, generally late March through April. Keep seedlings cool (34 to 40 degrees F) and moist, and handle them gently at all times. Site conditions dictate the spacing and density of trees. In western Oregon, typical spacing is 10' x 10'. In central Oregon, trees are generally spaced at 12' x 12'. Select good planting spots such as areas of exposed mineral soil that are free of weeds.

STEP 5:

Once seedlings are planted, additional maintenance often is needed to ensure their continued survival and growth. The first two years following planting are critical for survival. New seedlings may require protection from animals, weeds or drought. According to Oregon laws, by the sixth year, the new stand must be "free to grow" (able to out-compete surrounding grasses and brush).

Timing

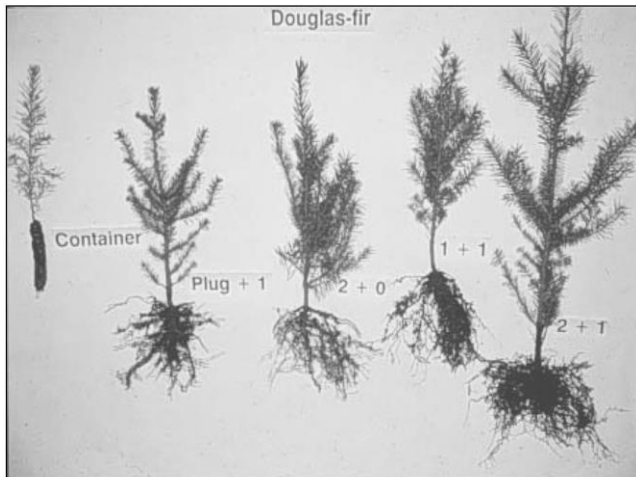
Although planting is only done in winter and early spring, reforestation is an effort that takes place year-round for most landowners. The figure below outlines a typical reforestation timeline.



Nursery Stock

Nursery stock used for planting includes bare root and container stock. Bare root is just as it sounds: the trees are packaged, usually in bags, but their roots are exposed. Bare root seedlings are usually less expensive than container stock. Container stock comes in a container, usually made of Styrofoam. Although it is usually more expensive, this method avoids the damage associated with uprooting the trees before transport, as the seedlings are planted along with the soil from the container.

The following figure illustrates examples of seedling stock types. The names can be a bit confusing, but the numbers are associated with how many years the tree spent in a container and in the ground as a bare root. For example, Plug + 1, means that the tree spent one year in a container, or "plug," and one year in the ground as a bare root.



Examples of seedling stock types.

Planting Seedlings

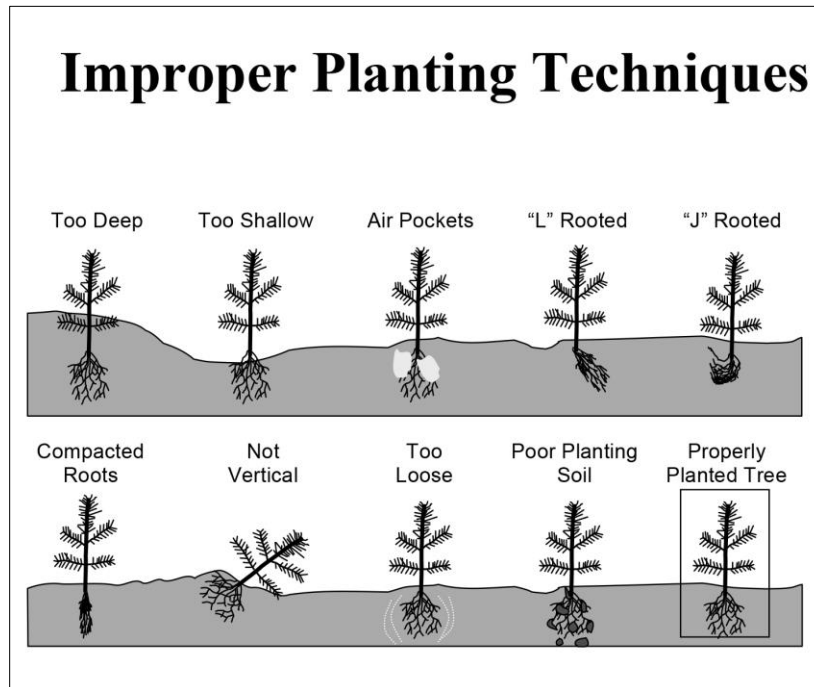
Planting should occur when the seedlings are dormant and the soil is moist and subsequent rains will water the plants. This generally means mid-December to mid-March. Species of seedlings to plant should be determined by soil type, native species and existing vegetation, and seeds must be from the correct seed zone.

When planting seedlings, it is also important to ensure trees have enough space to grow and meet the landowner's long-term objectives. Another important component is properly matching tree species with site conditions. The following figure briefly summarizes common Oregon tree species and their tolerance to specific site conditions.

Matching Species to Site					
Species	Shade	Wet Soil	Drought	Frost	Browse
Alder	1	4	1	2	2
P. Pine	1	4	5	5	4
Douglas-fir	2	2	2-3	4	2
Grand Fir	4	3	2	3	4
W. Hemlock	5	3	1	1	4
W. Redcedar	5	4	1	2	1

(1=not tolerant, 5=tolerant)

Tree planting requires time and practice. Proper tree planting techniques are important to successful reforestation and long-term tree survival. Below are diagrams of poor planting techniques that often lead to seedlings dying.



Summary

Replanting trees after harvest, or reforestation, is required by the Oregon Forest Practices Act. Beyond the letter of the law, replanting also makes environmental and economic sense. But this labor-intensive and expensive work requires good planning and follow-through, including the choice of timing, nursery stock, tree species and planting technique. Today, about 40 million trees are planted every winter and spring in Oregon on public, industrial and family forestlands.

Reforestation in Oregon – Questions⁶⁴

1. Why is reforestation important?
2. What steps are involved in reforesting an area?
3. Explain the differences between bare root and container seedlings.
4. Name an Oregon tree species that tolerates drought conditions well.
5. Name an Oregon tree species that tolerates shade well.
6. Describe a properly planted seedling.

⁶⁴ Source: *Exploration of Oregon Forests: Module 4 – Forest Management 1– Cycles and Reforestation*. Developed by Julie Woodward based on the Oregon State University Forestry Extension's *Basic Forestry Shortcourse*.

27: Silviculture Tour⁶⁵

Overview

Students visit a forest site to learn about management techniques and strategies and then create a written report or other documentation of the visit. (As an alternative to a field trip, a forest management representative may be invited to class for a presentation there.)

Time Considerations

Preparation: 30-60 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Describe the management objectives of a particular forest site or forest owner.
- Explain the silvicultural techniques used to manage the forest to meet the objectives.
- Write a detailed report describing what they learned.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 8. Obtaining, Evaluating, and Communicating Information: Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or process of development and the design and performance of a proposed process or system) in multiple formats (i.e. orally, graphically, textually, mathematically).

⁶⁵ This lesson was adapted from “Silviculture Tour” in *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College. <http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

Common Core State Standards – English Language Arts

- Writing – WHST.9-10.4, WHST.11-12.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Oregon Forest Literacy Program Concepts

- Theme 3, B.1. Forest management embodies the use of natural processes as well as purposeful management activities to achieve desired forest outcomes, including reducing the impacts of destructive disturbances such as unwanted wildfire, insect and disease epidemics, storm damage or vandalism.
- Theme 3, B.2. Forest management ranges from active management to passive management, using silvicultural techniques (e.g., planting, thinning and harvesting) to grow, conserve or alter forests.

Materials

- [*K-12 Forest Education Opportunities: A Guide to Forestry Education Programs and Materials Available to You and Your Students*](#)
- “Silviculture in Practice” student page

Background Information⁶⁶

Silviculture is the practice of growing and managing forests and forest stands to increase their productivity. The name comes from the Latin “silvi-” (forest) + “culture” (as in growing).

Silviculture attempts to create and maintain the composition and structure of a forest that will best meet the objectives of the landowner. These objectives vary greatly among owners, but may include

- Controlling stand structure – A stand’s shape or structure may be modified for aesthetic reasons, to facilitate treatments and harvest, to control animal pests or improve wildlife habitat. Its structure may be modified to select for certain age classes, arrangements of canopy levels/layers of vegetation or distribution of diameter classes.
- Controlling composition – The types and quality of various species in the forest define the forest composition. Composition is controlled to limit undesirable species or poorly

⁶⁶ Adapted from “Silviculture Tour” in *Forest Surveying and Silviculture* by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.
<http://learnforests.org/sites/default/files/SpecialTopics1.pdf>.

formed trees and is achieved by site preparation, cutting, poisoning, burning, planting and introduction of new species.

- Restocking unproductive areas – Areas capable of growing trees but not fully stocked because of fire, logging, disease or animal damage may be restocked by planting seeds or seedlings.
- Protecting and reducing losses – Forest losses from fire, diseases, insects, wind, or competition may be reduced by applying silvicultural methods such as thinning and salvage logging.
- Controlling rotation length – The number of years required to grow a stand to a specified condition of economic maturity (i.e., rotation length) may be modified to achieve different goals. Douglas-fir, for example, is commonly grown on a 40 to 60 year rotation to produce sawtimber in western Oregon, but landowners may carry it longer for improving wildlife habitat and having larger trees to market.
- Facilitating harvesting – Planning operations may include management activities that make harvesting efficient, economical, and predictable.
- Conserving site quality – Silviculturists, like farmers, must conserve resources (particularly soils) on a site to preserve future productivity. Silvicultural practices also have a great deal of influence on site microclimate. If site quality is conserved, renewable resources such as trees can replace themselves. Soil erosion is considered the least reparable of disturbances. Nutrients and applied chemicals can be lost through surface runoff and leaching.

Note that forests are managed for different purposes and may serve very different societal needs. Research in social science and economics – as well as in the natural sciences – may be used to inform forest management decisions.

Field trips to actual silvicultural operations are valuable for seeing how things are done in the “real world.” This lesson provides an opportunity for students to ask questions of the forest manager and to gain insight into the day-to-day challenges and issues facing this type of operation.

Key Vocabulary

converting species
cost/benefit analysis
density diagram
silviculture*

*included in Glossary

Preparation

- Arrange a visit to a forest site where silviculture is being practiced. For possible field-trip locations and activity ideas, see the *K-12 Forest Education Opportunities* guide, which lists many of the diverse forestry education programs offered throughout Oregon. If a field trip is not possible, seek out and invite a forest manager to visit your class. In either case, students may use the student page to record their findings and form the basis of their reports.
- When arranging the field trip or class visit with the forest manager, share the student page questions so that he or she can plan a presentation that is as relevant as possible to the lesson's learning objectives.

Procedure

1. Discuss the meaning of the term "silviculture." Talk about some of the forestland objectives that may be met through silviculture techniques. (See the Background Information for possibilities.)
2. Explain that students will have a chance to learn more about silviculture from someone in the field.
3. Either on the field trip or in the classroom with a forest manager, encourage students to use the "Silviculture in Practice" student page to ask questions and record their answers.
4. After the field trip or presentation, direct students to use their notes to develop a report of on their findings. Establish criteria for the report, such as
 - Write a two- to four-page report (double spaced, 12-point font) describing the field-trip site (or class visitor).
 - Include a title with the name and location of the silvicultural operation and the date it was visited.
 - Use the headings topics from the "Silviculture in Practice" student page as a template for the body of the report, using the pertinent sections.
 - Describe concisely, yet thoroughly, the processes involved in the organization's silvicultural process.
 - Write the report in coherent paragraphs, not just bullet points.

Assessment

Use students' reports to assess both what they learned about silviculture practices and their ability to communicate scientific information.

Silviculture in Practice

While on the field trip, find out as many of the following items as you can:

Ownership and personnel

- ☐ Who is the landowner?
- ☐ Who decides what management activities will be done?
- ☐ Who actually implements the activities done to this forest?

Management objectives

- ☐ What are the main management objectives for this forest?
- ☐ What “rules of thumb” are used to determine management strategies?
- ☐ What other planning tools are used (such as density diagrams, cost/benefit analysis, or other)?

Information about the forest

- ☐ What pressures or impacts does this forest face?
- ☐ What wildlife habitat does it support?
- ☐ What opportunities does this forest offer for the future?

Management Activities

- ☐ What methods are used for
 - Thinning?
 - Pruning?
 - Planting?
 - Fertilizing?
 - Converting species?
- ☐ What challenges do these activities present?

28: Developing a Forest Management Plan

Overview

Students use an Oregon forest management plan template to describe a tract of forestland and to consider different ecological, economic and social outcomes for it.

Time Considerations

Preparation: 30 minutes

Procedure: One 50-minute class period up to several weeks, depending on how involved students become in the plan development

Learning Objectives

Students will be able to

- Explain the purposes of a forest management plan.
- Use a forest management plan template to describe and plan for a specific forestland.

Standards Connections

Next Generation Science Standards

- Performance Expectation—HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 6. Constructing Explanations and Designing Solutions: Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Common Core State Standards – English Language Arts

- WHST.9-10.2, WHST.11-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Core State Standards – Mathematics

- Math Practice – MP.2: Reason abstractly and quantitatively.

Oregon Forest Literacy Program Concepts

- Theme 3, C.4. Oregon foresters and forest managers prepare forest management plans based on landowner goals and objectives, capabilities of the forest site, laws and available tools (e.g., planting, harvesting and using prescribed fire).
- Theme 3, C.7. Management decisions attempt to integrate the social, economic and ecological dimensions of sustainability.
- Theme 3, C.8. Sustainable management of forests includes maintaining forest health, productivity and diversity, and conserving a forested land base for the needs of present and future generations.

Materials

- Fillable PDF of “The Oregon Woodland Discovery Tool” (from http://outreach.oregonstate.edu/programs/forestry/sites/default/files/oregon_woodland_discovery_template_reader_enabled_070313.pdf)
- Internet access
- [*Establishing and Managing Forest Trees in Western Oregon*](#) (optional), available from Oregon Forest Resources Institute
- [*Understanding Eastside Forests*](#) (optional), available from Oregon Forest Resources Institute
- Additional materials and information needed to complete the management plan (optional, see Preparation)

Background Information⁶⁷

Forest management plans are overarching, long-range plans that guide the annual management of forestlands. Federal, state and private forest managers develop plans to meet regulations and to guide on-the-ground operations.

⁶⁷ Source: Adapted from “About Management Planning,” *Oregon Forest Management Planning*. Oregon State University. <http://outreach.oregonstate.edu/programs/forestry/oregon-forest-management-planning/about-management-planning>.

Even individual forest landowners should have a written forest management plan for an increasing number of reasons, including tax and business needs, land use actions and forest certification. But perhaps the most important reason to develop a management plan is so that the landowners can learn about their forest, describe how it looks today and how they want it to look in the future, and develop or refine a course of action. A plan is also a good way to let heirs and others know the landowners' vision for the future of the forest and the steps they have taken to achieve that vision.

A management plan helps ensure that the forest will be managed so that its many resources are available for generations to come. It may incorporate social, economic and environmental considerations. Plans typically include

- Property information, including the location, size, ownership, history and other details
- Goals and objectives
- Maps and photos
- Property resource information, with details about the wood, water, wildlife and other resources on the site
- Recommendations for future action
- Business and operations information, such as tax, management and liability matters

For this lesson, students will be using a forest management template designed specifically for individual forest landowners in Oregon.⁶⁸ It includes sections on the history and description of the property, landowner goals, planned actions for improving the property and where to get help. In addition to the fillable form, the template includes suggestions for completing it, starting on page 15 of "The Oregon Woodland Discovery Tool."

Key Vocabulary

forest management plan

Preparation

- Decide what forest area students will use as the basis for their management plan. For example, they may develop a plan for a forest they have studied in the other lessons, or they may create a draft plan for a particular forest landowner in your community.

⁶⁸ The Woodland Discovery Template was developed by the American Forest Foundation in collaboration with Oregon State University Forestry and Natural Resources Extension, Oregon Tree Farm System, Oregon Forest Resources Institute and the Oregon Department of Forestry, with funding provided by the Oregon Forest Resources Institute and the Oregon Department of Forestry.

- Depending on your time and student interest, determine how in-depth you want students to go in their management planning. For a brief introduction to forest management plans, groups might simply fill out as much as possible in the template from what they know. For a more thorough study or as a culminating activity, groups might develop full-blown plans by interviewing the landowners for details about the land's history and their vision for its future, researching maps and images, surveying and inventorying the forestland and determining recommended actions.

Procedure

1. Ask students what they think the value of having a forest management plan might be. What might a plan include?
2. Explain that students will gain experience developing a management plan for the selected forest area.
3. Introduce students to the "The Oregon Woodland Discovery Tool," pointing out the different sections and discussing which ones students will be responsible for completing. Point out the directions and explanations for each section starting on page 15 of the PDF.
4. Ask students what goals they would see for this forestland and what actions would support those goals. Encourage them to consider environmental, economic and social aspects.
5. Direct students to work in pairs or small groups to fill in the details of their management plans. You might have on hand forest management resources for them to draw on, such as *Establishing and Managing Forest Trees in Western Oregon* or *Understanding Eastside Forests*.

Assessment

Ask students to present their plans to the class, pointing out their key features and recommendations.

Extension Idea

Invite a forestland manager to your class to share features of their management plan.



FOREST HEALTH AND FOREST MANAGEMENT ISSUES

- 29: Fire in Oregon's Forests
- 30: Assessing Wildfire Safety
- 31: Evaluating Articles on Forest Issues
- 32: Forest Pests
- 33: The Effects of Climate Change on Oregon's Forests
- 34: Community Views on Forest Management Issues



Section 6 – Forest Health and Forest Management Issues

29: Fire in Oregon’s Forests

Overview

Students compare the forests of eastern and western Oregon in terms of historical fire behavior, current fire risks and approaches to fire management.

Time Considerations

Preparation: 30 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Explain why fires behave differently today than they did historically.
- Compare eastern and western Oregon forests in terms of fire behavior and fire risk.
- Identify solutions for making eastern and western Oregon forests more fire-resilient.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Oregon Forest Literacy Program Concepts

- Theme 3, C.3. The type and intensity of forest management are dependent on the purposes for which the forest is managed, as well as the forest type, ownership, size and location.
- Theme 3, C.8. Sustainable management of forests includes maintaining forest health, productivity and diversity, and conserving a forested land base for the needs of present and future generations.
- Theme 3, D.2. Forest management can be controversial because of safety issues, aesthetic impact, differences between past and current practices, and insufficient communication with those affected.

- Theme 3, D.3. Issues that can arise from forest management decisions include: the effects of timber harvest; impacts on water quality, air quality and carbon sequestration; wilderness designation; recreational uses; erosion; salvage; livestock grazing; harvest methods; forest roads; forest taxation; and many others.

Materials

- [*State of Fire*](#) 12-minute video
- Equipment for showing video
- [*Forest Fact Sheet: Why Are Some Forest Fires More Intense?*](#)
- [*Speakers Bureau Presentation: Fire in Oregon's Forests*](#) video
- [*State of Fire*](#) report
- "Fire: Comparing Oregon Forests" student page

Background Information⁶⁹

Fire is a natural part of forest ecosystems in Oregon. Historically, fires in the dry pine and mixed-conifer forests of eastern and southwestern Oregon occurred every five to 40 years. Fires in the wetter, Douglas-fir and western hemlock forests of western Oregon burned every 100 to 450 years. As humans have actively fought fire over the past century, the "housekeeping" that fire provides hasn't happened at these natural intervals. With no matching level of fuel removal, many of these forests have become unnaturally dense, particularly in Oregon's dryer forests.

Although fire can provide benefits, wildfire or a fire out of control causes significant damage to forest values of timber, watersheds, wildlife habitat and homes. Treatments that can reduce fire severity and promote fire-resiliency – particularly in Oregon's dryer forests – include

- Thinning. Thinning subordinate trees mimics natural stand mortality by removing trees that would naturally die from competition or from natural surface fires, leaving the more dominant trees and eliminating "fuel ladders." The remaining dominant and codominant trees are more fire-resistant because their bark is thicker and their crowns are much higher.
- Pruning. Pruning is the removal of tree limbs to improve wood quality, aesthetics and fire resistance. Pruning improves fire resistance by raising the tree canopy so fire will be

⁶⁹ Source: Adapted from "Why Are Some Forest Fires More Intense?" Oregon Forest Resources Institute. http://oregonforests.org/sites/default/files/publications/pdf/FactSheet14_Fire.pdf

less likely to climb into the crowns. The branches need to be removed from the site, burned or chipped.

- **Mowing.** Mowing is one tool used in central Oregon to remove flammable shrubs such as bitterbrush, which contains volatile oils that can produce flames 15 feet or higher. Mowing reduces the surface fuel and often is used adjacent to developments where prescribed burning might be risky and produce unwelcome smoke.
- **Prescribed Fire.** Prescribed fire is the purposeful and controlled application of fire to rid the understory of fuels. Prescribed fire also helps control insects and disease, improves the quality of grass for animals, prepares a seedbed for regeneration, removes undesirable older shrubs, improves access, and allows more nutrients, water and space for remaining trees. Sometimes, a naturally occurring fire, such as one started by lightning, can be managed to achieve the goals of a prescribed burn.

Fire Basics⁷⁰

Wildfires are ignited by either lightning or humans. Human activities that can cause wildfires include debris burning, campfires, equipment fires, smoking and arson.

To sustain a fire, three elements are needed: heat or an ignition source, oxygen and fuel. Together, these elements are known as the “fire triangle.” Take one of these things away, and the fire will go out or won’t start. For example, constructing a fire line down to the mineral soil removes fuel from the forest floor.

Fires differ in terms of how fast they spread, how high their flames are, and how hot they burn (their intensity). Once a fire ignites in forestland or rangeland, the manner in which a fire reacts to local conditions is known as its behavior. The “fire behavior triangle” includes three elements: the amount and arrangement of fuel, the topography, and the weather conditions. A change in any one factor during the fire alters its behavior and type (whether it’s a ground, surface or crown fire).

There is not much people can do about weather and topography. The one element in both of these triangles that we can do something about is fuel. Fuels include grass, shrubs, litter and slash. By reducing the amount of fuel and changing its arrangement, we can influence a fire’s behavior.

⁷⁰ Source: Adapted Source: Adapted from *Chapter 9: Fire in the Forest* online course draft, which was adapted for high school students by Rod Bardell from the Oregon State University Forestry Extension’s *Basic Forestry Shortcourse*.

Key Vocabulary

fire intensity

fire suppression*

fire triangle

fuel

ignition

prescribed fire*

*included in Glossary

Preparation

- Plan whether you will use the video, the fact sheet or both to introduce the topic of fire. (Alternatively, you may use the [Speakers Bureau Presentation: Fire in Oregon's Forests](#) video.)
- Plan how students will access the [State of Fire](#) report.
- Make copies of the student page.

Procedure

1. Explain to students that over the next few lessons, they will be exploring some of the challenges and issues that face Oregon's forest managers. Ask them what they think some of those might be.
2. If they don't mention it, point out that fire is one of the topics they will explore. With a show of hands, ask students whether they think forest fires are good for forests, bad for forests or neither good nor bad for forests. Have a few students explain their thinking.
3. Using information from the Background Information, introduce or review the fire triangle (the three elements needed for a fire to ignite or burn), as well as the fire behavior triangle (the three factors that influence the fire's rate of spread and intensity).
4. Ask students how fire might be different in western Oregon than in eastern and southwestern Oregon.
5. Show the *State of Fire* video or have students read the *State of Fire* report, using the "Fire: Comparing Oregon Forests" student page to take notes on the differences among western, eastern, and southwestern Oregon forest fires. (Note that the film mostly discusses western and eastern Oregon forests, while the report differentiates among all three.)
6. Lead a discussion about students' findings:
 - What role has fire played in Oregon's landscape, both historically and recently?
 - In what ways have people's views of wildfire changed over time?

- What differences between eastern and western Oregon forests influence our approach to wildfires in these regions?

Assessment

Ask students to use the information from the student page to write a paragraph describing one or more fire-related issues in Oregon.

Extension Ideas

- Practice properly and safely using hand tools to construct a fuel break or trail in the field. Discuss with students the importance of gas-powered equipment operating with a spark arrester and off-road vehicles having proper exhaust systems to minimize fire hazard. Keep Oregon Green has fire prevention tips and videos.
<http://keeporegongreen.org/preventionvideos.html>.
- Do a classroom demonstration with “forests” made out of matchsticks to show how slope (or density) affects the behavior of fire. See “A Matchstick Forest” in the Bureau of Land Management’s *Exploring Wildland Fire Educator Guide* for a sample procedure.
http://blm.gov/pgdata/etc/medialib/blm/wo/Communications_Directorate.Par.69102.File.dat/Fire_ed_guide.pdf.

Fire: Comparing Oregon Forests

Describe the differences related to fire among Oregon's broad forest types.

	Western Oregon	Eastern Oregon	Southwestern Oregon
Climate			
Forest Type			
Land Ownership			
Historical Fire Frequency			
Historical Fire Intensity			
Recent Fire History			
Management Solutions			

30: Assessing Wildfire Safety

Overview

Students do a wildfire safety assessment of their home or school and make recommendations for increasing wildfire safety.

Time Considerations

Preparation: 30 minutes

Procedure: Two 50-minute class periods, with time between to conduct the assessment

Learning Objectives

Students will be able to

- Define the term “wildland urban interface.”
- Identify strategies for reducing the risk of damage to their homes and communities from wildfire.
- Conduct a wildfire safety assessment at their home or school, or in their community, and make recommendations for increasing wildfire safety.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 8. Obtaining, Evaluating, and Communicating Information. Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (e.g. orally, graphically, textually, and mathematically).

Oregon Forest Literacy Program Concepts

- Theme 3, C. 7. Management decisions attempt to integrate the social, economic, and ecological dimensions of sustainability.

Materials

- “Oregon Wildland Urban Interface, 1990” teacher page
- “Oregon Wildland Urban Interface, 2010” teacher page
- Equipment for sharing teacher pages
- “Wildfire Safety Checklist” student page

Background Information⁷¹

In Oregon, more and more people are living in what is known as the wildland urban interface — or WUI — where homes and other structures are built in or near woodlands or forests. While residents in these areas enjoy the beauty of the environment, they also face the very real danger of wildfire.

The WUI is composed of both intermix and interface communities. Intermix communities are places where housing and wildlands intermingle. In intermix, wildland vegetation is continuous and more than 50 percent vegetation. Interface communities are next to or very near wildlands. These areas are defined as having less than 50 percent vegetation, but being within 1.5 miles of a large area with more than 75 percent vegetation.

For those fortunate enough to live nestled in or near forests, planning and preparation can help safeguard their homes and communities against catastrophic wildfire damage. This includes

- Clearing a 30-foot perimeter of defensible space around the home
- Removing dead material
- Pruning branches in the adjacent forest to remove fuel ladders
- Creating fire-resistant landscapes with plants such as Oregon grape, holly and Pacific rhododendron

Working together, residents can make their own properties – and their neighborhoods – much safer from wildfire. In addition, land use planning helps strike a balance between growth and conserving Oregon forestlands for both humans and wildlife.

Note on maps: The 2010 map was produced using different land cover data sets than the 1990 map, and should only be compared on a very general basis.

⁷¹ Source: Adapted from “Where Urban and Wildlife Habitat Intersect.” Oregon Forest Resources Institute. <http://oregonforests.org/content/wildlifeurban-interface>. Maps and information about maps from “The Wildland Urban Interface.” Silvius Lab. University of Wisconsin. http://silvis.forest.wisc.edu/maps/wui_main.

Key Vocabulary

defensible space

flammable

non-flammable

wildland urban interface (WUI)*

*included in Glossary

Preparation

Make copies of the student page and set up equipment for sharing teacher pages.

Procedure

1. Ask students whether they have heard the term “wildland urban interface.” Ask them what they think it means. What issues might it raise for forests and for humans?
2. If students don’t mention it, point out that one issue with the wildland urban interface is an increased vulnerability to wildfire.
3. Show students the two maps of Oregon’s wildland urban interface and have them compare and contrast the maps. What Oregon communities are most at risk for wildfire? What is the wildfire risk of our community?
4. Have students conduct an assessment of their school, home or community using the “Wildfire Safety Checklist” student page.
5. Invite students to share what they learned. Which items on the checklist have been addressed? What could students do to encourage parents or community members to tackle items that haven’t been addressed?

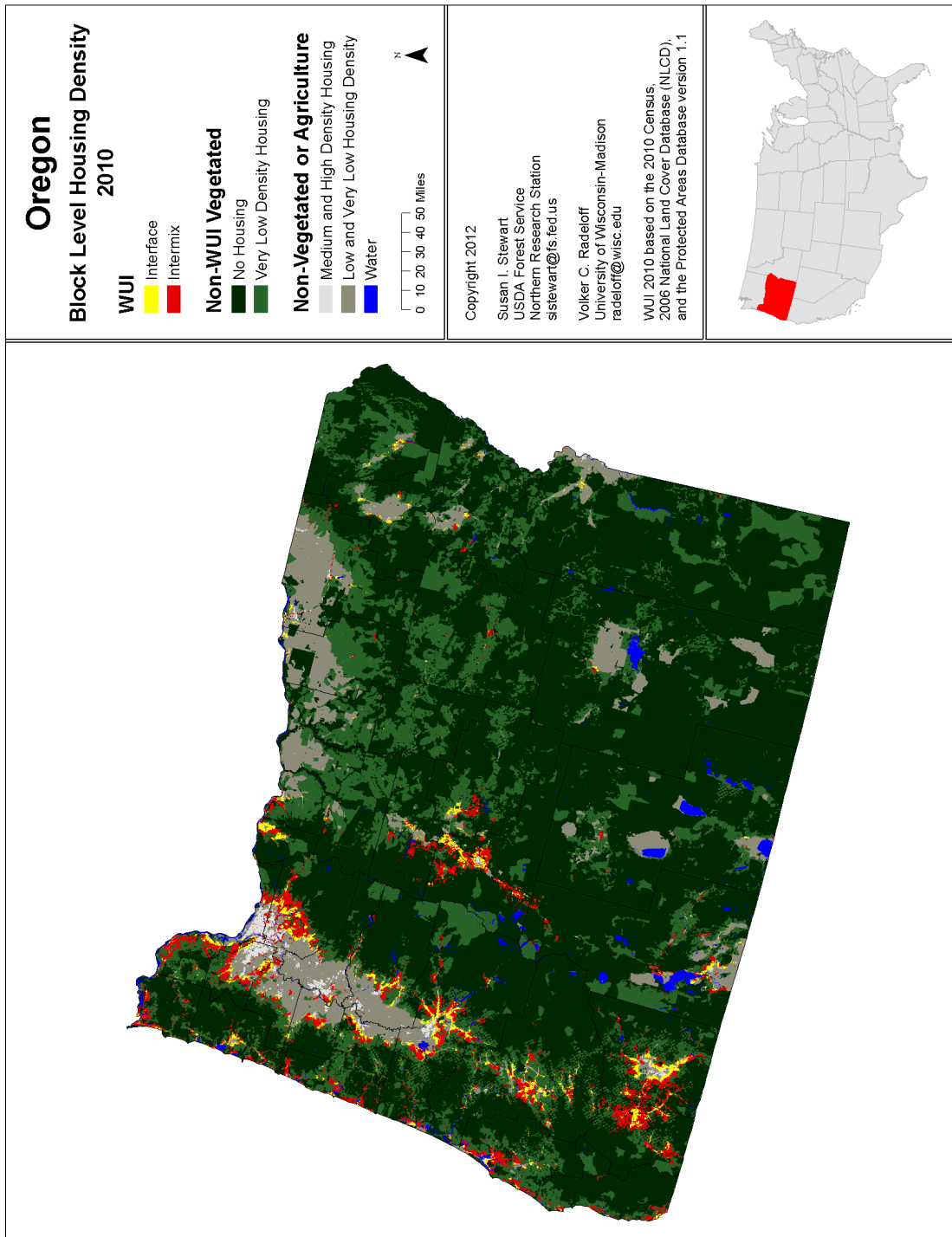
Assessment

Have students develop a recommendation plan for addressing one or more of the items on the checklist that still need attention.

Extension Ideas

- Find out whether your community has a wildfire protection plan. (See <http://oregon.gov/odf/pages/fire/fireplans.aspx> - [Community Wildfire Protection Plans in Oregon](#) for links to some plans.) If so, evaluate whether it is sufficient. If not, talk to community leaders about developing one.
- Challenge students to design a home or community that would exemplify living safely and responsibly in the wildland urban interface. Have them present their designs to the class. (From “The Nature of Fire,” Project Learning Tree’s *Exploring Environmental Issues: Focus on Forests* secondary environmental education module.)

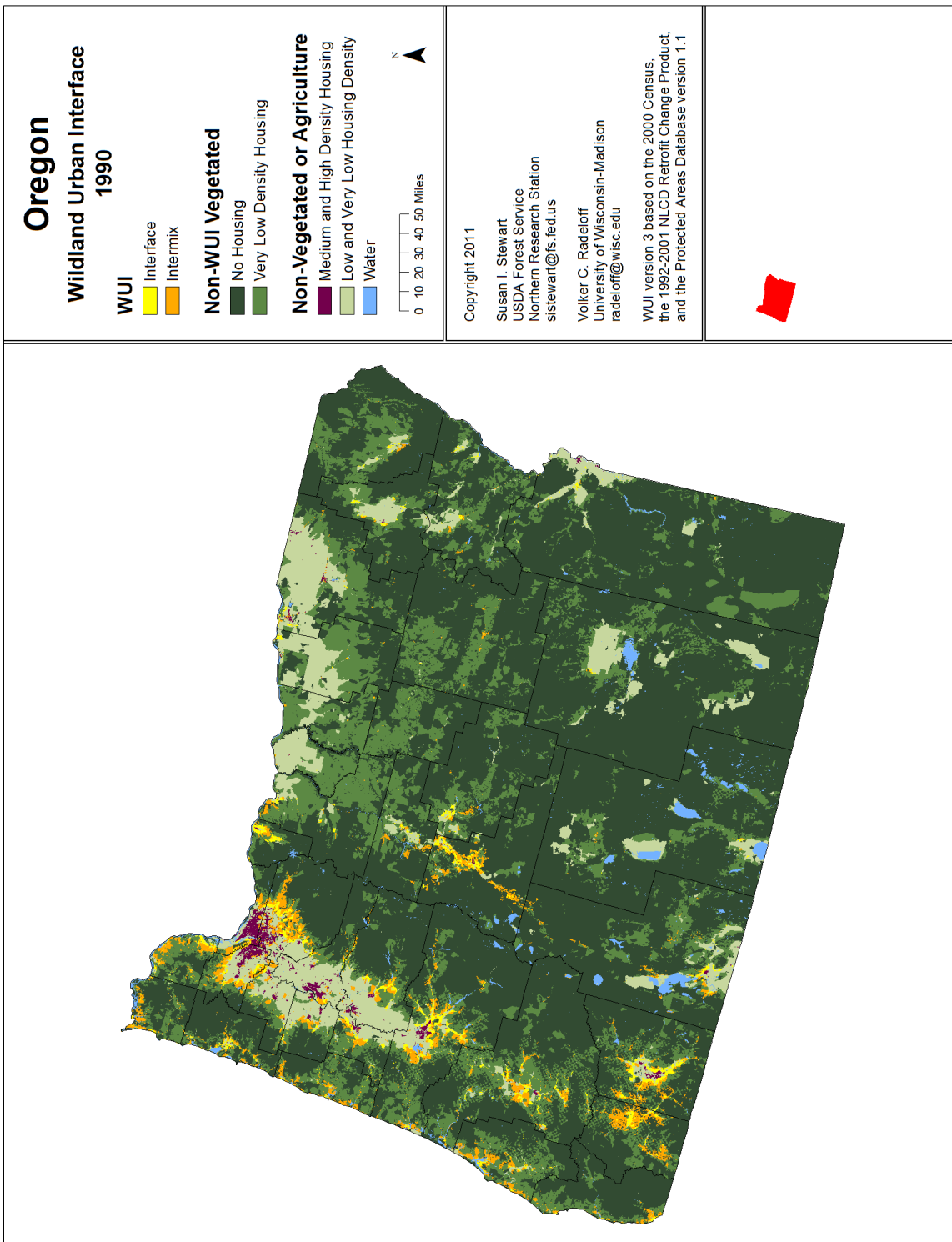
Oregon Wildland Urban Interface, 2010



Source of map: "The Wildland Urban Interface." SILVIS Lab (Spatial Analysis for Conservation and Sustainability). University of Wisconsin, Madison.

http://silvis.forest.wisc.edu/maps/wui_main.

Oregon Wildland Urban Interface, 1990



Source of map: "The Wildland Urban Interface." SILVIS Lab (Spatial Analysis for Conservation and Sustainability). University of Wisconsin, Madison.

http://silvis.forest.wisc.edu/maps/wui_main.

Wildfire Safety Checklist⁷²

Wildfires are part of the Oregon landscape and may even help maintain healthy forest ecosystems. There are many things you can do to make sure your property is more likely to survive a wildfire. Assess your home or school now and throughout the year to keep it wildfire safe.

Around the Building

- ☐ Remove all flammable materials (firewood stacks, propane tanks, dry vegetation, or construction materials) within 30 feet of any structure, including garages or sheds.
- ☐ Place any firewood stacks and propane tanks uphill of structures.
- ☐ Clear any flammable vegetation at least 10 feet away from woodpiles or tanks.
- ☐ If there is a deck, clear the space underneath of all vegetation.
- ☐ For a deck or mobile home, provide a skirting or wire mesh all around to keep flammable materials from accumulating underneath.

The Roof

- ☐ Keep roof and gutters free of all dead leaves and needles.
- ☐ Remove any dead branches overhanging the roof or within 10 feet of the chimney.
- ☐ Place a non-flammable screen with 1/4-inch or smaller mesh on the chimney and stovepipe outlets.
- ☐ Check to make sure there are no loose or missing roof tiles.
- ☐ Cover any exterior attic and under-eave vents with metal mesh to prevent ember entry.

Vegetation and Landscaping

- ☐ Prune trees so that the lowest branches are 10 feet from the ground.
- ☐ Keep the lawn watered and maintained (or, if brown, cut it close to the ground).
- ☐ Wherever possible, use fire-resistant plants in the landscaping.

Emergency Access and Preparedness

- ☐ Identify at least two exit routes from the neighborhood.
- ☐ Make sure that the property address is easily visible from the road.
- ☐ Make sure all road signs are clearly visible.
- ☐ Discuss and develop an escape plan with family members.
- ☐ Have a fire extinguisher, a ladder, and tools such as rakes, shovels and axes available.

⁷² Sources: Adapted from “Precautions for Defensible Space Around Your Home,” Keep Oregon Green, <http://keeporegongreen.org/Additionalprecautionsfordefensiblespace.html>. And from “Firewise Tips Checklist for Homeowners,” *Firewise*. http://firewise.org/~media/Firewise/Files/Pdfs/Toolkit/FW_TK_Tips.pdf.

31: Evaluating Articles on Forest Issues⁷³

Overview

Students select an article from print or online sources related to Oregon forests and analyze it using a series of questions such as “What claims does the article make?” and “What is the source of the evidence?”

Time Considerations

Preparation: 30 minutes or more, depending on whether teacher or students are locating articles

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Critically evaluate an article on a forest-related topic or issue.
- Recognize some common types of bias in an article.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.A: All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.
- Science and Engineering Practice – 8. Obtaining, Evaluating, and Communicating Information: Evaluate the validity and reliability of, and/or synthesize, multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

⁷³ This lesson was adapted from “Media Coverage,” by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.
http://learnforests.org/sites/default/files/EvaluationofMediaCoverageofanEnvironmentalIssue_0.pdf.

Common Core State Standards – English Language Arts

- Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Oregon Forest Literacy Program Concepts

- Theme 3, D.1. Forest-related issues can be affected by politics, science, emotion, economics, values and perception.
- Theme 3, D.2. Forest management can be controversial because of safety issues, aesthetic impact, differences between past and current practices, and insufficient communication with those affected.

Materials

- “Analyzing the Reporting of a Forest Topic” student page
- “Article Analysis” student page
- News stories, articles, or reports on an issue related to Oregon forests (selected by students or by teacher, see Preparation)

Background Information⁷⁴

With the boon of the “Information Age,” we now have access to a tremendous number of stories and reports on environmental issues. These accounts appear in both print and online sources. However, reports are frequently sensationalized or exaggerated, and there is often reason to suspect bias. Students must learn to critically evaluate these reports to fully understand the issues. This activity is designed to help student practice evaluating claims related to forestry issues.

⁷⁴ Source: “Media Coverage” by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.

http://learnforests.org/sites/default/files/EvaluationofMediaCoverageofanEnvironmentalIssue_0.pdf.

Key Vocabulary

anecdote

bias

evidence

peer-reviewed

popular media

Preparation

- Decide whether students will find their own articles to analyze or whether you will provide them. (See the box below for ideas.) If you will be selecting them, choose articles that vary in terms of their sources and perspectives. If you want students to find their own articles, look for possible general sources on the chosen topic, such as organizations, government agencies and journals to which you can direct students. Also decide any selection criteria you want students to follow, such as a minimum acceptable length and acceptable sources.

Sample Articles from *The New York Times*

Dan Glickman and Harris Sherman. "Paying for the Forest Fire Next Time." *The New York Times*. June 17, 2014. <http://nytimes.com/2014/06/18/opinion/paying-for-the-forest-fire-next-time.html>.

Kirk Johnson. "Town That Thrived on Logging Is Looking for a Second Growth." *The New York Times*. November 15, 2014. http://nytimes.com/2014/11/16/us/town-that-thrived-on-logging-is-looking-for-a-second-growth.html?_r=0.

Gayathri Vaidyanathan. "Deadly Fungus Gains Foothold in Warmer Northwest." *The New York Times*. July 28, 2010. <http://nytimes.com/gwire/2010/07/28/28greenwire-deadly-fungus-gains-foothold-in-warmer-northwes-2313.html>.

Deborah Weisberg. "The Chain Saw Circle: Women of the Woodlands." *The New York Times*. July 10, 2012. <http://green.blogs.nytimes.com/2012/07/10/the-chain-saw-circle-women-of-the-woodlands/>.

- Make copies of the "Analyzing the Reporting of a Forest Topic" student page, or provide on-screen access to it. Alternatively, you might prepare a brief lecture to present to students.

Procedure

1. Select a current issue related to Oregon forests for students to explore. Topics that are contentious, well-publicized, and for which there is scientific uncertainty or different viewpoints would work well for this activity. Examples include the impacts of global climate change and how to address them, who should be responsible for managing wildland fires and how they should be managed, or economic pressures on the forest sector workforce.
2. Give students copies of the “Analyzing the Reporting of a Forest Topic” student page to read or present a brief lecture on the key points of the reading.
3. Explain that students will be using this information to analyze an article related to Oregon’s forests. Provide copies of the “Article Analysis” student page and one or more articles to analyze. If students will be finding their own articles, direct them to possible sources and explain any selection criteria you want them to follow.
4. Allow students time to evaluate their article by responding to the questions on the “Article Analysis” student page.
5. Have students meet in groups of three or four to discuss their evaluations.

Assessment

Use student responses to the “Article Analysis” student page to assess their analyzing skill. Have them submit both the completed student page and a copy of the article they analyzed. Acceptable responses will depend on the article.

Extension Idea

Write articles or letters to the editor on a local forest-related issue.

Student Page

Lesson 31

Analyzing the Reporting of a Forest Topic⁷⁵

Articles, reports and stories on forest topics can come from a variety of sources with a range of viewpoints. To understand a particular topic, it is important to know the source of the information, as well as to analyze how it is presented. The following questions will help you evaluate the credibility of a particular report.

Consider the source. Where was the article published?

Try to get as close to the original source of information as possible. Although environmental information reaches the general public through many pathways, a common sequence looks like this:

- A scientific study appears in a peer-reviewed science journal (e.g., *Journal of Forestry*, *Science*, *Nature*). This information is usually reliable but often inaccessible to the general reader because of the technical style of the writing.
- A summary of the scientific study (or studies) is prepared by a science writer and appears in a journal designed for a more general readership (e.g., *Science News*, *Discover*, *Environment*, and *Scientific American*). This information is usually reliable but less detailed and is usually more accessible to the average reader.
- Accounts of scientific findings are written by journalists for newspapers or popular magazine articles (such as *The New York Times*, *Newsweek*, or *Time*). The authors may or may not have any particular expertise on the topic, and may place their own interpretation on the findings. Also, limited space often means that the findings must be shortened and perhaps oversimplified. As a result, reliability may be somewhat diminished.
- Newspaper or magazine accounts of scientific findings may be used as a source for a radio talk show broadcast, Internet site, or another written article. For all the reasons indicated above, reliability may be further compromised.
- Selected information from any of the above is used to produce an article that supports a particular agenda or viewpoint. Only information that supports that view is reported,

⁷⁵ Source: "Media Coverage" by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.

http://learnforests.org/sites/default/files/EvaluationofMediaCoverageofanEnvironmentallsue_0.pdf.

and conflicting information is omitted or discredited. This report may take the form of an editorial, promotional brochure or a tabloid article.

Note that the reliability of information fades as one gets further and further from the original source.

Journalists in the popular media (unlike scientists) are trained to present both sides of a contentious issue. The viewpoints of individuals or groups that represent these sides are generally described in an effort to present a “fair and balanced” account. This may be done even when the preponderance of scientific evidence supports one viewpoint over another. However, viewpoints rather than evidence are emphasized, and the uninformed reader may be left with the understanding that there is a legitimate debate when, in fact, none exists. This “false dichotomy” is frequently seen in reports on environmental issues, so be aware of it, especially when you consult resources in the popular media.

The Internet as a Source of Information

Most traditional sources of information such as books or journal articles have to run through some filters before publication, but this may not be the case for what we encounter online. Reliable sources are frequently intermingled with less reliable sources, and it is important to be able to tell the difference.

Although there is no foolproof method to assure the best information online, here are some suggestions:

- Domain names (the suffix of the URL) give some indication of the source of information and the motive for posting the information. Educational (.edu) and governmental (.gov) sites, for example, generally provide more reliable information than commercial (.com) sites, which may have a motivation other than providing useful information. Web sites sponsored by organizations (.org) are a mixed bag. Many are excellent sources of unbiased information, while others clearly have an “agenda.”
- To be sure that you are not getting outdated information, examine the “last updated or modified” note at the bottom of the first page.
- The appearance of poor grammar, misspellings and other errors should be seen as an indication of lack of editorial control. Thus, any sites that exhibit these characteristics should be looked upon with suspicion.

What type of information was used to prepare the report? What is credible “evidence”?

Expect the report to be prepared using complete information. If only selected information that supports a particular point of view is presented, the claims should be looked upon with suspicion. Also, be aware of the way the information is presented.

A common strategy is to present data by reporting only the extremes. Phrases such as “as many as” or “as few as” should serve as red flags, indicating that the author is reporting extreme values to make a point. A more credible report would report numbers as a mean, with some indication of variation around that mean (i.e., range, standard deviation or confidence interval).

Different types of evidence carry with them different levels of credibility. Consider the following hierarchy, ranked in increasing order of credibility:

- opinion
- single anecdote
- collection of anecdotes
- single scientific study
- group of independent studies

Beware of anecdotal information. Single accounts of isolated incidents are inherently unreliable. Many people rely solely on anecdotal information to formulate opinions. For example, the summer of 2001 was dubbed by the media as the “Summer of the Shark,” as several high-profile attacks occurred along the East Coast. The public interpreted these accounts as an unusually high rate of attacks when, in reality, those who keep shark-attack statistics confirmed that it was a rather average year.

A peer-reviewed (or “refereed”) article is one that has been scrutinized by experts in the field prior to publication. As a result, such articles carry more weight than one that has not been peer-reviewed. However, not all scientific studies carry the same degree of reliability. For example, the results from a “preliminary observational study” may not be as reliable as a “controlled experimental study,” even though both are published in peer-reviewed journals. Reliability is also influenced by factors such as sample size, length of the study and even researcher bias. A claim gains credibility when it is confirmed by several independent studies, particularly when different methods are used by each study.

Do the conclusions or claims follow logically from the evidence, or does the author appear to be “shooting from the hip”?

Expect the connection between “the evidence” and “the conclusions” (or “claims”) to be logical and straightforward. If the connection is convoluted or illogical, less credence should be given to the claims.

What bias or hidden agenda may be at play?

Bias is defined as a mental leaning or inclination, partiality, or prejudice. When we exhibit bias, conclusions are based on preconceived notions rather than on a critical evaluation of the evidence.

Consider the following statement:

Hunting and trapping regulations on cougar and bear should be relaxed because these predators pose a threat to humans and livestock.

Suppose that while deciding whether you agree or disagree with this statement, you consult the following sources:

- Partnership for the Ethical Treatment of Animals (PETA)
- National Rifle Association (NRA)
- U.S. Fish and Wildlife Service (USFWS)

The first two sources clearly would present a biased view of this topic. The first promotes animal rights and supports anti-hunting and anti-trapping legislation. The second promotes the right to bear arms, hunter education and pro-hunting legislation. Although it might be interesting to see how each of these groups approaches the topic, neither should be used as the sole source of information.

The U.S. Fish and Wildlife Service is a federal agency responsible for wildlife management on national wildlife refuges and endangered species management. The agency employs professional wildlife biologists and other scientists who conduct scientific studies of wildlife populations and evaluate the results of studies conducted by others. Although individuals within the agency may exhibit biases, the agency itself (ideally, at least) draws conclusions, establishes policy and takes action based on an objective evaluation of the information at hand. As a result, the agency is a less-biased source of information on this particular topic.

Article Analysis⁷⁶

Choose a current news story, article or report on a topic related to Oregon forests. Analyze the piece using the following questions.

1. Different media carry with them different degrees of credibility. In what type of publication does your report appear?
2. Is the author of the report given? Who is it? Is it an individual or an organization?
3. If an organization has produced the report, what is the mission of the organization? If an individual has produced the report, what credentials or affiliations does he/she have?
4. Does the report attempt to persuade, advocate or inform? Explain.
5. What information was used to prepare the report? Circle those that were used and add others if necessary. Some possibilities include
 - observation of actual occurrences
 - consultation with experts
 - discussion with non-experts
 - reports in scientific journals
 - reports or findings from a particular organization (scientific or other)
 - sources are not stated in article
6. Is this information properly referenced so that you could check it out if you wanted to?

⁷⁶ Source: Adapted from "Media Coverage" by Dr. Wynn Cudmore. Northwest Center for Sustainable Resources. Chemeketa Community College.

http://learnforests.org/sites/default/files/EvaluationofMediaCoverageofanEnvironmentalIssue_0.pdf.

7. What is the date of publication? Is the information in the report (or the report itself) reasonably up to date? The importance of having recent information will vary with the topic under consideration.
8. Claims are positions or conclusions that are stated in the article. They should be supported by some kind of evidence – specific observations or data. What claims are made in your article? What evidence is used to support those claims? List the claims and the specific evidence supporting them in the space below:

Claim	Evidence

9. Do the claims in the report follow logically from the evidence given or are “leaps in logic” required to reach the same conclusions as the authors? Could alternative claims be made from the same evidence?
10. Is there a basis for suspecting bias on the part of the sources, the author of the report or yourself? If so, circle those that you detect from the list of common biases below:
- The author or source has a clear stake in the issue and will benefit in some way from the claims that are being made.
 - Only selected information is being reported. (Are you aware of other information that would refute the claims being made?)
 - You reject the claims of the article because you disagree with them, or you accept them because the claim happens to agree with your opinion.
 - The publication has a well-known or suspected position on the issue.

For each of the biases you have detected, explain where in the article it appears.

11. Does the report appear to be objective, or does there appear to be a particular agenda being promoted? Explain.

12. Is there anything in the article that you consider to be unnecessarily sensationalized to make a point or to stimulate some emotion? Examples may include misleading or exaggerated titles, phrases that are meant to appeal to our emotions or accompanying photographs.

32: Forest Pests

Overview

Students read about the mountain pine beetle and learn how some insects and other pests can damage forests. They research specific pests and quiz each other on methods for controlling these organisms and reducing their damage.

Time Considerations

Preparation: 20 minutes

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

Learning Objectives

Students will be able to

- Identify the major insect types (defoliators, bark beetles, etc.) present in Oregon forests.
- Describe the major diseases that can affect Oregon forests.
- Identify the major mammal species that harm the forest and the characteristics of the damage they cause.
- Explain the various strategies used to control and reduce damage from forest pests.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 6. Constructing Explanations and Designing Solutions: Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Common Core State Standards – English Language Arts

- Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects – WHST.9-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Oregon Forest Literacy Program Concepts

- Theme 3, C.8. Sustainable management of forests includes maintaining forest health, productivity and diversity, and conserving a forested land base for the needs of present and future generations.
- Theme 3, D.3. Issues that can arise from forest management decisions include: the effects of timber harvest; impacts on water quality, air quality and carbon sequestration; wilderness designation; recreational uses; erosion; salvage; livestock grazing; harvest methods; forest roads; forest taxation; and many others.

Materials

- [Forest Literacy Reading](#): *When Beetles Battle Pines, It's a Pitched Pine Beetle Battle*
- “Damaging Forest Pests” student page
- “Pest Report” student page
- Index cards (4x6 or other size)

Background Information

This lesson introduces some of the insects, diseases and other forest pests that can affect forest health. Students should be aware that damage and decay are essential components of healthy forests. Insects that feed on trees become, in turn, food for other animals. And, fungi that rot away trees also replenish the soil with essential nutrients that would otherwise be locked up in the wood. At low levels, insects, diseases and other organisms may even contribute to forest health. When levels are high enough to weaken or kill trees, they diminish forest health.

See the student page “Damaging Forest Pests” for a definition of forest health and basic information about these agents. In the next lesson, students will learn how global climate change affects forest health, including forest susceptibility to insects and disease.

Possible Forest Pests for Student Research

Insects

- Defoliators: western spruce budworm, Douglas-fir tussock moth, pine butterfly, hemlock looper, gypsy moth, tent caterpillar and sawfly
- Bark beetles: Douglas-fir bark beetle, pine engraver beetle and fir engraver beetle
- Sucking insects: aphids and scale insects
- Wood borers: flatheaded borer, roundheaded borer, ambrosia beetle, wood wasp larvae, carpenter ants and termites
- Terminal feeders: Sitka spruce weevil and midges
- Root feeders: white grubs, some weevils, termites and wireworms
- Gall makers: oak wasp gall and Cooley spruce gall adelgid

Diseases

- Biotic diseases: heart rot, white pine blister rust, Swiss needle cast, Dutch elm disease, blue stain, dwarf mistletoe

Mammals

- Deer, elk, bear, rabbit, mice, porcupine, beaver

Key Vocabulary

abiotic^{*}

biotic^{*}

defoliator

disease

forest health^{*}

gall maker

integrated pest management (IPM)

^{*}included in Glossary

Preparation

Make copies of the student pages, or provide on-screen access to them. (Alternatively, for the “Damaging Forest Pests” student page, you may choose to prepare a brief lecture based on the content.)

Procedure

1. Ask students what they think the term “forest health” means and ask them what factors might influence forest health.

2. Give them copies of the *Forest Literacy Reading: When Beetles Battle Pines, It's a Pitched Pine Beetle Battle*. Have them read the passage and then work in groups to answer the questions provided.
3. Discuss what other insects, diseases or pests might impact forest health – both positively and negatively. Have students read the “Damaging Forest Pests” student page, or present the information to them in a brief lecture.
4. Assign each student a forest pest to research (see the list of possibilities in the Background Information section). Using the “Pest Report” student page as a guide, they should find out how the species or disease affects trees and forests, under what conditions it is most damaging and the methods forest managers use to control it. When possible, students should also locate a photo or illustration of the pest and another showing the impact on a tree or forest.
5. Make a class set of Forest Pest Cards by giving each student an index card and having them summarize their findings on one side of the card and place their photos on the other side.
6. Invite students to use the cards to quiz each other on the different pests and best methods of control. They may do this similar to a spelling bee or other game format.

Assessment

Use students’ “Pest Report” responses or their Forest Pest Cards to assess their learning.

Extension Ideas

- Encourage students to make a flyer or poster “advertising” the hazards of one or more of the forest pests explored in the lesson.
- Participate in a project to protect seedlings or school garden plants from deer damage.
- Research diseases commonly found in Oregon forests and their impact on trees.
- Explore the topic of invasive species and how they affect Oregon forests. Conduct research to learn about invasive organisms that threaten our forests. See the Oregon Invasive Species Council website for information and resources.

Student Page

Lesson 32

Damaging Forest Pests⁷⁷

A healthy forest is a balanced system of interacting and interdependent components. Defining forest health is difficult because it means different things to different people. For those who see forests mainly for their economic benefit, a healthy forest is one that produces the most tangible goods. For those who mostly value their environmental benefit, a healthy forest may be one that is high in biodiversity and other measurements.

The Society of American Forests describes forest health as “the perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance.”

In addition to fire, a multitude of insects, diseases and mammals affect trees and forest health. Many are part of a natural forest cycle – and may even be beneficial. In fact, damage and decay are essential components of healthy forests. Insects that feed on trees become, in turn, food for other animals. And fungi that rot away trees also replenish the soil with essential nutrients that would otherwise be locked up in the wood.

At low levels, insects, diseases and other organisms may contribute to forest health. When levels are high enough to weaken or kill trees, they diminish forest health.

Insects

Insects constitute 90 percent of the species found in the animal kingdom. Many insects help forests thrive. For example, they are an important food source for forest birds and other animals, and may also help decompose dead wood and return nutrients to the soil.

But harmful insects, present at too high a level, destroy more timber in the United States than any other factor. Insects cause damage in various ways, depending on the type of insect. In addition to killing trees, insects may also cause limb and leaf dieback and stunt growth.

⁷⁷ Source: Adapted from “Forest Damage” online course draft, which was adapted for high school students by Rod Bardell from the Oregon State University Forestry Extension’s *Basic Forestry Shortcourse*.

Defoliators attack the needles and leaves of trees. Their chewing mouthparts are designed to eat leaves, and they may completely remove all the leaves in a stand. Deciduous trees can usually withstand three consecutive years of attack without serious harm. Evergreen trees will often die after being defoliated just once.

Bark beetles enter trees through the bark and are considered more destructive than defoliators, posing a serious threat to timber trees. Although their life histories vary, most follow a similar pattern. First, a few attacking insects enter a tree. A healthy tree produces resinous pitch to drown and flush out (pitch out) the beetles that attempt to enter. If the tree is stressed or cannot resist the attack, the invading insect sends out a chemical message (pheromone) to attract neighboring bark beetles. Then, thousands of bark beetles attack the tree, creating tunnels, called galleries, which destroy the cambium layer. Female beetles lay eggs in the galleries, and when they hatch, the larvae “mine” their way out, killing the tree from within. Generally, the insects spend the winter in one host tree and start the process over in the spring.

Besides defoliating insects and bark beetles, there are a number of other insects that impact trees and forests in different ways. **Sucking insects** attack both foliage and stems. Their sucking mouthparts pierce tissues and siphon fluid from trees. **Wood borers** use abandoned tunnels and usually damage timber after the tree has been felled but before it has been harvested. **Terminal feeders** usually damage seedlings, which is very serious in nurseries and plantations, while **root feeders** attack young trees. **Gall makers** deposit larvae on a tree limb, causing a tree growth called a gall to form around them that provides protection and food for the growing insects. Galls are usually not harmful to trees.

Controlling Insect Pests

Forest managers can choose among many different methods for controlling insect pests and minimizing their damage. These include silvicultural controls, biological controls, chemical controls and integrated pest management.

Silvicultural controls aim to create unfavorable conditions for potential pests. Knowing the natural history of the invader (such as host species, season of emergence, key predators, tolerance of extreme temperatures) can determine control measures. Forest managers may try

- Selecting the “right tree for the right place.” That means knowing what insects are present and avoiding planting host trees, or planting trees that are resistant to the insects.
- Maintaining tree health by thinning.

- Sanitation cutting to remove damaged or susceptible trees from a stand and to reduce the spread to other trees.
- Creating multiple-aged stands, which are less susceptible to some insect attacks than even-aged stands.

Biological controls work by either introducing known predators or through disturbing growth or reproductive cycles. Fungi, bacteria, viruses, parasites and predators (other insects, small mammals, reptiles, birds, etc.) are all biological control agents. Since exotic species from abroad can become invasive without natural predators in their new “home,” introducing natural predators from their native habitat may be the only way to control the invading insects.

Chemical controls (insecticides) are the most common and most controversial method of controlling insects since they can have unintended consequences on the ecosystem. They are best used as treatment to control epidemic outbreaks.

Integrated pest management (IPM) uses a combination of controls (silvicultural, biological and chemical) to manage outbreaks. This method recognizes that insects are a natural and necessary part of the ecosystem and focuses on keeping populations in check, rather than on complete eradication.

Forest Diseases

Many diseases and disorders can also affect forests in Oregon. Some of these are abiotic diseases, which are caused by physical conditions of the forests, and some are biotic, which are caused by living organisms.

Abiotic diseases are growth problems that come from poor soil, drought, extreme climatic conditions or other environmental stresses. Some of the problems are caused by human activity, including increased urbanization, soil compaction, air and water pollution or incorrect species selection.

Biotic diseases are caused by living organisms, usually from a fungal attack. Most are specific to a certain type of host tree. Examples in Oregon include heart and root rots, white pine blister, Swiss needle cast, wilts and dieback, blights and stains.

Dwarf mistletoe, a relative of the harmless “Christmas” mistletoe, is a very serious pest in Western coniferous forests. It is a parasitic, leafless seed plant whose roots (called sinkers) invade the bark of the host plant and its sapwood, draining the tree of water and nutrients.

Mammals

Deer and elk can seriously hamper reforestation projects by browsing or eating new growth, which damages seedlings and saplings. Deer are the most common browsers in Oregon, eating young shoots and leaves until the tree reaches a height of five feet. They also damage bark when they rub their antlers against the trunk. Elk will sometimes pull recently planted seedlings out of the ground.

Bears expose a tree's cambium layer by tearing or biting at the bark. Trees in younger forest areas (sometimes called second-growth forests) are particularly susceptible because they aren't surrounded by berries and other ground plants associated with older forests.

Other woodland mammals can affect trees and forest health. Rabbits cause damage by eating all the way around (girdling) young tree shoots. Porcupines eat bark, exposing the cambium to insect attack and disease. Beavers cut down trees for food, lodges and dam construction. Squirrels, chipmunk and mice eat the seed crop. Pocket gophers and voles girdle seedlings, hampering replanting efforts.

Domestic mammals, particularly grazing and range animals, cause significant damage to planting sites. Cattle, sheep, goats and other grazers eat young shoots, seedlings, bark and seeds, interfering with regeneration as well as weakening or killing trees. Soil compaction and trampling by horses are also major problems, damaging young root systems and hampering regeneration.

Humans and their various activities can affect forests in many far-reaching ways. Although humans are not usually considered "pests," forest managers must often consider ways to reduce human impact on forest ecosystems. Damaging contact with the forest may include vandalism, drug labs and marijuana plantations, use of ATVs and off-road vehicles, and illegal dumping, as well as the broader effects of roads, homes and other development, air pollution and increased carbon dioxide emissions from the burning of fossil fuels.

Student Page

Lesson 32

Name: _____

Pest Report

Forest Pest:

Pest Species:

How it affects trees and forests:

What trees it affects most:

How it reproduces:

Under what conditions it thrives:

What people do to control it or reduce its impact:

Photo or illustration of pest:

Photo showing its effect on a tree or forest:

Sources of your information:

33: The Effects of Climate Change on Oregon's Forests

Overview

Students read a report on climate change in the Northwest to learn about its effect on forest ecosystems and then use graphic organizers to summarize the cause, effects and implications for forests and people.

Time Considerations

Preparation: 30 minutes

Procedure: One to two 50-minute class periods

Learning Objectives

Students will be able to

- Read and understand scientific information on the effects of climate change on forest ecosystems.
- Explain how climate change affects forest ecosystems, as well as people and other organisms that depend on them.
- Present information to their peers using graphic organizers.

Standards Connections

Next Generation Science Standards

- Performance Expectation – HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Common Core State Standards – English Language Arts

- Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

- Speaking and Listening Standards— SL.11-12.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Oregon Forest Literacy Program Concepts

- Theme 3, C.8. Sustainable management of forests includes maintaining forest health, productivity and diversity, and conserving a forested land base for the needs of present and future generations.
- Theme 3, D.3. Issues that can arise from forest management decisions include: the effects of timber harvest; impacts on water quality, air quality and carbon sequestration; wilderness designation; recreational uses; erosion; salvage; livestock grazing; harvest methods; forest roads; forest taxation; and many others.

Materials

- “Chapter 5: Forest Ecosystems,” from *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, Oregon Climate Change Research Institute, 2013. Available at <http://occri.net/wp-content/uploads/2013/11/ClimateChangeInTheNorthwest.pdf>
- “Climate Change Graphic Organizer” student page
- Sheets of butcher paper and marking pens, or access to presentation software

Background Information⁷⁸

According to a report by the Oregon Climate Change Research Institute, global climate change is already affecting Oregon forests, and will continue to have profound effects. As this report states:

“Climate directly affects tree growth in forests through temperature and moisture controls, and indirectly through its influence on disturbances such as wildfires, insects, and diseases. The spatial distribution of suitable climate for many important Northwest tree species and vegetation types may change considerably by the end of the 21st century. Some vegetation types, such as subalpine forests, will become extremely limited.

⁷⁸ Source: “Two-Page Summary Report, Climate Change in the Northwest: Implications for Our Landscapes, Water, and Communities,” M. M. Dalton, P. W. Mote, and A. K. Snover, eds. <http://occri.net/reports>.

“Large forested areas have been affected by disturbances in recent years, and climate change is probably one major factor. One study estimated area burned will rise by roughly 900 sq miles by the 2040s, or a factor of 2.5 from the 1980-2006 average.

“Climate is a major driver of insect outbreaks that affect millions of forest acres. Insect life stage development and mortality rates are influenced by temperature, and drought can cause host trees to be more vulnerable to insects. Recent mountain pine beetle and other insect outbreaks were facilitated by higher temperatures and drought stress, and the frequency of such outbreaks is projected to increase, particularly in high-elevation forests.”

Key Vocabulary

cause

distribution *

effect

event

global climate change *

implication

solution

*included in Glossary

Preparation

Make copies of “Chapter 5: Forest Ecosystems,” from *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, or plan for students to have on-screen access to it.

Procedure

1. Introduce the lesson by posing true or false statements to students about climate change, (without telling them the answers) such as
 - Climate change is something that will affect future generations, but is not happening now. (False)
 - Forests will not be affected by climate change because trees are very resilient. (False)
 - Wildfires will be more intense and more frequent in the future. (True)
 - Oregon forests may be more productive with climate change, as the trees are exposed to more CO₂ and longer growing seasons. (True)

2. Explain to students that they will find the answers by reading a report about the effects of climate change on forest ecosystems in the Pacific Northwest. Give students copies of the “Climate Change Graphic Organizer” student page and explain that they will use it to summarize the report. Using the example on the student page, model how they might complete the graphic organizer.
3. Divide the class into groups of three or four students, and assign each group a section of the report on which to focus. Explain that as they read their section of the report, they should draft their graphic organizer.
4. Provide each group with a piece of butcher paper or access to presentation software for developing their graphic organizer in a format to present to the class.
5. Allow time for groups to make their presentations. Post the graphic organizers for all to see.
6. After the presentations, direct students to work in their groups to create an overall concept map showing the causes and effects of climate change on forest ecosystems.

Assessment

Use students’ graphic organizers and concept maps to assess student learning.

Extension Ideas

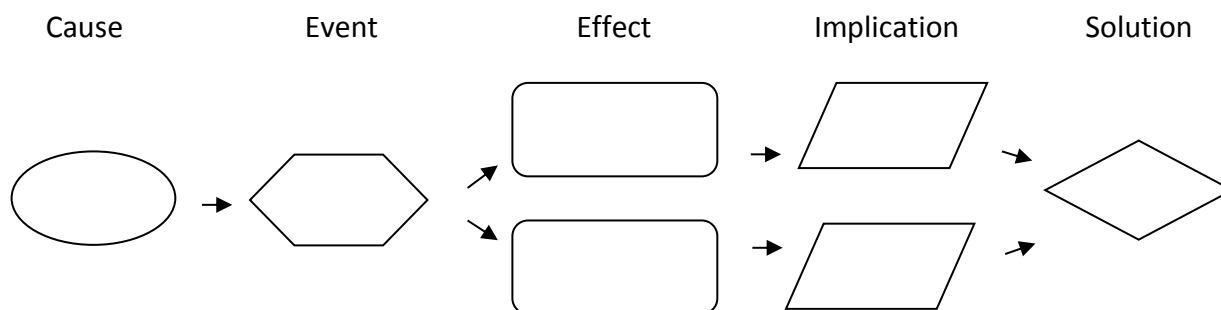
- Students look up one or more of the articles referenced in the report and analyze the research underlying the conclusions presented.
- Students choose a topic related to climate change and forests on which to write a research paper.

Student Page

Lesson 33

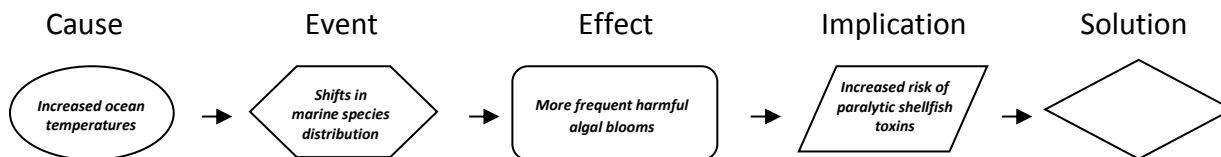
Climate Change Graphic Organizer

As you read about the effects of climate change on forest ecosystems, complete a graphic organizer like the following to summarize the information. Note that not all the elements may be present in the report for a given cause or event, and that there may be more than one event, effect, implication or solution for a given cause.



Example:

*Ocean temperatures off the Northwest coast are likely to increase in the future, causing shifts in the distribution of marine species and contributing to more frequent harmful algal blooms, increasing risks associated with paralytic shellfish toxins.*⁷⁹



⁷⁹ Excerpt from “Executive Summary,” *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, Oregon Climate Change Research Institute, 2013, page xxvii. Available at <http://occri.net/wp-content/uploads/2013/11/ClimateChangeInTheNorthwest.pdf>.

34: Community Views on Forest Management Issues

Overview

Students consider the pros and cons of one forest management practice that is sometimes controversial – clearcutting. They then develop and conduct an opinion survey on forest management issues to learn about the views of people in their community.

Time Considerations

Preparation: 20 minutes

Procedure: One to two 50-minute class periods, plus time for conducting the survey

Learning Objectives

Students will be able to

- Articulate pros and cons of one forest management practice: clearcutting.
- Identify other forest management practices for which the public may have a variety of opinions.
- Develop an opinion survey around those practices.
- Conduct the survey and analyze the results.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-ESS3.C. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Science and Engineering Practice – 3. Planning and Carrying Out Investigations: Plan and conduct an investigation individually and collaboratively to produce data to serve as the 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.

Common Core State Standards – English Language Arts

- Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects – WHST.9-12.5. Develop and strengthen writing as needed by planning, revising, editing,

rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Common Core State Standards – Mathematics

- High School: Number and Quantity – HSN-Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Oregon Forest Literacy Program Concepts

- Theme 3, C.3. The type and intensity of forest management are dependent on the purposes for which the forest is managed, as well as the forest type, ownership, size and location.
- Theme 3, C.8. Sustainable management of forests includes maintaining forest health, productivity and diversity, and conserving a forested land base for the needs of present and future generations.
- Theme 3, D.2. Forest management can be controversial because of safety issues, aesthetic impact, differences between past and current practices, and insufficient communication with those affected.
- Theme 3, D.3. Issues that can arise from forest management decisions include: the effects of timber harvest; impacts on water quality, air quality and carbon sequestration; wilderness designation; recreational uses; erosion; salvage; livestock grazing; harvest methods; forest roads; forest taxation; and many others.

Materials

- *Forest Fact Break:* [Clearcutting](#) video (1:51 minutes)
- Equipment for sharing video
- *Forest Fact Sheet:* [Why Are Some Forests Clearcut?](#)
- “Sample Forest Management Opinion Survey” student page (optional)
- Strips of paper (approximately 3" x 18")
- Marking pens
- Tape

Background Information

Managing Oregon forests is often a balancing act that requires foresters to consider the environmental, economic and social impacts of their decisions. Controversy over these decisions can sometimes arise because stakeholders or the public may not know, understand or agree with them.

One forest management topic that most Oregonians have an opinion about is clearcutting, particularly because clearcuts are often readily visible. Many people believe that clearcutting is not only unattractive, but that it actually harms the forest ecosystem and threatens water supplies. What they may not realize is that Douglas-fir seedlings, the species that predominates west of the Cascades, grows best in full sunlight, and that many of the forests seen today in western Oregon were established after clearcutting. Current Oregon laws include many measures that regulate the use of clearcutting on Oregon's private and public lands.

In this lesson, students will poll members of their community to learn what they think about various forest management issues. They may use this information as a basis for a project in Lesson 36: Service-Learning Project.

Survey Questions Compared

Question Type	Example	Advantages	Disadvantages
True/false or yes/no	Do you enjoy visiting forests? yes/no	<ul style="list-style-type: none">• Fast and easy to complete.• Easy to tally and analyze.	<ul style="list-style-type: none">• Only useful for items that have yes/no or true/false response.• Lacks detail and depth.
Multiple choice	Which of the following is the best way for you to learn new material? A. Lecture by teacher B. Assigned readings C. In-class videos D. In-class interactive exercises	<ul style="list-style-type: none">• Easy format for respondents to understand.• Allows comparison of different options.	<ul style="list-style-type: none">• Limited response options.• May omit a respondent's preferred answer.• Lacks detail and depth.
Rank Order	Rank the following ice cream flavors by order of preference: __ chocolate __ vanilla __ strawberry __ cookies 'n' cream	<ul style="list-style-type: none">• Enables respondents to indicate relevant importance of choices.• Allows comparison of different choices.	<ul style="list-style-type: none">• More difficult to answer.• Limits number of response options.• May omit a respondent's preferred answer.

Rating Scale	How strongly do you agree or disagree with this statement: Forests are critical to Oregon's future. 1=strongly agree 2=agree 3=neutral 4=disagree 5=strongly disagree	<ul style="list-style-type: none"> • Respondents can give more specific information about their thoughts. • Provides a more precise measure than yes/no or true/false items. 	<ul style="list-style-type: none"> • Each item must be scored separately. • You have to have a specific question about each thing you want to know about. • Respondents are more likely to put neutral responses.
Open-ended	What is the most important issue facing Oregon today?	<ul style="list-style-type: none"> • Identifies issues and ideas most relevant to respondents. • Generates new ideas about the topic. • Clarifies respondents' positions. • Provides depth and detail. 	<ul style="list-style-type: none"> • Requires more time and communication skill to complete. • May generate incomplete or irrelevant data. • May be difficult to analyze and summarize.

Key Vocabulary

clearcutting
open-ended
rank order
rating scale

Preparation

Depending on your class's time and interest, you may choose to have students create a survey either from scratch or by building on or modifying the "Sample Forest Management Opinion Survey" student page. They may also simply use the sample survey as is.

Procedure

1. Ask students what the term "clearcutting" means. Ask students for a show of hands on whether their view of clearcutting as a forest management practice is positive, negative or neutral.
2. Show the *Forest Fact Break: Clearcutting* video or have students read the *Forest Fact Sheet: Why Are Some Forests Clearcut?* Ask students whether their opinion about clearcutting

changed after watching the video or reading the fact sheet. What additional information might they need for a more informed opinion?

3. Point out that many different forest management practices require weighing trade-offs and making decisions based on a variety of factors. Forest management can sometimes be controversial, as people with different perspectives on an issue may also be affected differently.
4. Ask students what they expect the people in their community would say about clearcutting or another forest management issue.
5. Invite students to learn more about their community's ideas about forest management practices by creating and conducting a survey. Discuss the possible topics the survey might explore and, if you like, give students copies of the "Sample Forest Management Opinion Survey" as a starting point.
6. Discuss the different question formats that surveys employ and the advantages and limitations of each, including true/false, rating scale, multiple choice, or open-ended questions. (See the Background Information for a comparison.)
7. Divide the class into small groups of three or four students, assigning each group one of the topics chosen. Groups should draft three or four possible questions on their topic, using a marking pen to write each question on a strip of paper.
8. Direct the groups to tape their question strips on the board. As a class, look at the questions to remove any duplicates, combine ones that make sense to do so, revise any that may need fine-tuning, and decide on a question order, moving the strips as necessary.
9. When a draft survey is complete, have students do a dry run by answering the questions themselves in order. Make any adjustments and then ask a couple of volunteers to type it up. Give students copies of the final survey to administer to friends and family members.
10. After students have conducted the survey, have them tally and analyze the results in class. Discuss:
 - What does the survey tell us about our community's views on forest management?
 - How were the results the same or different from what you expected?
 - Which of the results were particularly interesting?
 - If you were a forest manager, how might you use these results in your work?
 - Which do you think is more important in determining forest policy on forest management issues: public opinion or scientific findings? Why do you think so?
 - Is there anything we can do to further educate our community about these forest management issues?

Assessment

Ask students to write a couple of paragraphs describing the survey and what they learned from it. Use their writing to assess their learning.

Extension Idea

Have students prepare a report about their survey and findings to present to forest managers or other decision-makers in your area.

Sample Forest Management Opinion Survey

1. How familiar are you with the forests in our area?

Not at All Familiar

Very Familiar

1

2

3

4

5

2. In your opinion, what are the three most important things that you and others gain from Oregon's forests?

☐ Carbon storage

☐ Recreation

☐ Clean air

☐ Solitude

☐ Clean water

☐ Spiritual renewal

☐ Green spaces

☐ Wilderness

☐ Jobs

☐ Wood products

3. Clearcutting is a practice foresters sometimes use to harvest trees for wood products. It involves removing most of the trees in an area and then replanting seedlings over the whole area, and must follow Oregon laws. What is your opinion of clearcutting in Oregon? Please choose the best response.

☐ I am unfamiliar with clearcutting and do not have an opinion at this time.

☐ I don't see a problem with clearcutting and think forest owners should use it whenever they like, within the law.

☐ I think clearcutting has its place, but forest owners should use it only after considering other options.

☐ I don't think clearcutting should ever be used.

4. In Oregon, 60 percent of the forestland is owned by the federal government and 34 percent is privately owned. But 75 percent of Oregon's harvested timber comes from privately owned lands. What conclusion do you draw from this information?

5. According to a report by the Oregon Climate Change Research Institute, global climate change is already affecting Oregon forests and will continue to have profound effects on them. These impacts include changes in where and how trees grow and increases in forest

fires and pest outbreaks. How concerned are you about the effects of climate change on our forests?

Not at All Concerned

Very Concerned

1

2

3

4

5

6. What do you think is the most pressing issue facing Oregon forests today?



OUR RESPONSIBILITY TO OREGON'S FORESTS

35: Forest Sustainability
36: Service-Learning Project

Section
7



Sustainable
Forestry **PLANTED 1988**

Section 7 – Our Responsibility to Oregon’s Forests

35: Forest Sustainability

Overview

Students examine forest certification as one approach for ensuring forest sustainability and then identify other ways to be stewards of Oregon forests.

Time Considerations

Preparation: 20 minutes

Procedure: One 50-minute class period

Learning Objectives

Students will be able to

- Articulate what parameters they think would be important to include in a forest certification scheme.
- Identify the pros, cons, benefits and drawbacks of three forest certification systems.
- Communicate other ways that Oregonians can be stewards of our forests.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS4.D. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Common Core State Standards—English Language Arts

- Reading Standards for Literacy in Science and Technical Subjects – RST.11-12.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations)

into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Oregon Forest Literacy Program Concepts

- Theme 3, C.7. Management decisions attempt to integrate the social, economic and ecological dimensions of sustainability.
- Theme 3, C.8. Sustainable management of forests includes maintaining forest health, productivity and diversity, and conserving a forested land base for the needs of present and future generations.
- Theme 4, A.1. Everyone has a responsibility to treat forests with respect and become a conscientious steward of Oregon forests and forest resources.
- Theme 4, B.4. Changing demands and expectations for the forest, as well as unexpected events, will affect decisions about forest resource use. Sound management based on scientific research, economic analysis and public involvement will be required.

Materials

- “Forest Certification Systems Compared” student page
- Colored markers
- Access to websites for American Tree Farm System Certification (<http://treefarmssystem.org>), Forest Stewardship Council (<http://fscus.org>), and the Sustainable Forestry Initiative (<http://sfiprogram.org>)

Background Information⁸⁰

Nearly all forest landowners want to manage their lands to sustainably produce environmental, social and economic benefits. Forest certification is a market-based approach to recognizing sustainable forest management by labeling forests and the wood products from those forests as being certified. Having forestland certified under the American Tree Farm System (ATFS), the Sustainable Forestry Initiative (SFI) or the Forest Stewardship Council (FSC) lets people know that landowners are proudly managing their forests sustainably and are in it for the long haul.

⁸⁰ Source: “Forest Certification Demonstrates Sustainability.” Oregon Forest Resources Institute. <http://oregonforests.org/blog/forest-certification-demonstrates-sustainability>.

In the mid-1990s the Forest Stewardship Council (FSC) was created by the World Wildlife Fund and other conservation groups as a way to certify that wood products were sustainably managed to meet conservation goals. The American Forest and Paper Association (AFPA) followed with the development of the Sustainable Forestry Initiative (SFI), to demonstrate sustainability while meeting industrial wood-production goals.⁸¹ The American Tree Farm System, which has been around since 1941, also developed a certification system to demonstrate sustainability while meeting a diverse set of family forestland goals.

Today these private, independent programs apply third-party standards to wood and manufactured products from the forest. This level of transparency gives consumers, architects, engineers and builders credible evidence that the products were produced through responsible forestry practices. Certified products earn the right to display an “eco-label” seal of approval. In total, nearly 4.7 million acres of private Oregon forestlands are certified by one of the three systems. FSC certifies about 567,000 acres; the ATFS certifies about 887,000 acres; and the SFI certifies about 3,229,000 acres.

Key Vocabulary

afforestation

conservation value

forest certification

sustainable forest management*

tenure and use rights

*included in Glossary

Preparation

Make copies of the student page or plan for students to have on-screen access to it.

Procedure

1. Ask students whether they’ve ever received a certificate for completing a program or taking a class and ask them to describe what it means to “certify” something. List some of their ideas on the board. Ask whether they have heard of forests being certified, and what they think that might mean.

⁸¹ SFI subsequently separated from the AFPA, reorganizing as a nonprofit organization governed by an independent board.

2. Explain that forest certification is one approach to ensuring forest sustainability: when a particular forest meets certain criteria, the forest and products that come from it can be labeled as “certified” to help consumers make more sustainable purchases.
3. Have partners or small groups create a list of criteria they would include in a forest certification program. Challenge them to consider the social, economic and environmental aspects of the forest or forest product.
4. Invite groups to share elements from their list with the class.
5. Explain that there are currently three different forest certification systems that forest landowners use in Oregon. Give students a copy of the “Forest Certification Systems Compared” student page and direct them to use the student page to compare the three different systems. Allow them to look at the organizations’ websites to learn more about the three systems.
6. Discuss:
 - How does forest certification help Oregon forests?
 - What are the benefits of certification for forest landowners?
 - What are the benefits for consumers?
 - What might be drawbacks to certification?
7. Point out that forest certification is just one way that Oregonians can be stewards of our forests. Challenge students working in pairs or small groups to create a list of things that they and others can do to ensure the sustainability of forests.
8. Invite groups to share some of their ideas.

Assessment

Use student responses to the student page to assess their understanding of the material.

Extension Idea

Conduct a study of local stores to find out what certified wood products are available and whether they differ in quality, cost or other features from noncertified products. Use a data collection sheet, such as

Location (Store)	Wood Type	Size	Cost	Certification System	Quality or Other Observations

Forest Certification Systems Compared

Compare the standards and principles from the three forest certification systems commonly used in Oregon: the American Tree Farm Certification System, the Sustainable Forestry Initiative, and the Forest Stewardship Council. Check the website for each system to learn more about their approach and their overarching goals.

1. For each standard or principle, mark whether it focuses on environmental (EN), economic (EC) or social (SO) aspects of sustainable forestry.
2. Looking at the three different systems, use colored markers to color-code the standards and principles that are the same or similar.
3. What are the overarching goals for each of the three systems? In what ways are these goals the same, and how do they differ?
4. What differences do you note among the three systems?
5. What are the strengths and weakness (or pros and cons) of each system?
6. Why might someone choose one certification over another?

American Tree Farm System (ATFS) Certification Standards⁸²

Standard 1: Commitment to Practicing Sustainable Forestry. Forest owner demonstrates commitment to forest vitality by developing and implementing a sustainable forest management plan.

⁸² Source: American Forest Foundation 2010-2015 Standards of Sustainability for Forest Certification.

https://treefarmssystem.org/stuff/contentmgr/files/1/b6def982f32878ce457388c59ba57a4b/misc/final.aff_2011standards_brochure_high_9_21.11.pdf.

Standard 2: Compliance with Laws. Forest management activities comply with all relevant federal, state and local laws, regulations and ordinances.

Standard 3: Reforestation and Afforestation. Forest owner completes timely restocking of desired species of trees on harvested sites and non-stocked areas where tree growing is consistent with land use practices and the forest owner's management objectives.

Standard 4: Air, Water and Soil Protection. Forest management practices maintain or enhance the environment and ecosystems, including air, water, soil and site quality.

Standard 5: Fish, Wildlife and Biodiversity. Forest management activities contribute to the conservation of biodiversity.

Standard 6: Forest Aesthetics. Forest management plans and management activities recognize the value of forest aesthetics.

Standard 7: Protect Special Sites. Special sites are managed in ways that recognize their unique historical, archeological, cultural, geological, biological or ecological characteristics.

Standard 8: Forest Product Harvests and Other Activities. Forest product harvests and other management activities are conducted in accordance with the management plan and consider other forest values.

SFI (Sustainable Forestry Initiative) Principles⁸³

SFI requires Program Participants to have a written policy (or policies) to implement and achieve the following principles.

1. Sustainable Forestry: To practice sustainable forestry to meet the needs of the present without compromising the ability of future generations to meet their own needs by practicing a land stewardship ethic that integrates reforestation and the managing, growing, nurturing and harvesting of trees for useful products and ecosystem services such as the conservation of soil, air and water quality, carbon, biological diversity, wildlife and aquatic habitats, recreation and aesthetics.

⁸³ Source: *SFI 2015-2019 Standards and Rules*. Sustainable Forestry Initiative. January 2015. <http://sfiprogram.org/files/pdf/2015-2019-standardsandrules-web-lr-pdf/>.

2. Forest Productivity and Health: To provide for regeneration after harvest and maintain the productive capacity of the forestland base, and to protect and maintain long-term forest and soil productivity. In addition, to protect forests from economically or environmentally undesirable levels of wildfire, pests, diseases, invasive exotic plants and animals, and other damaging agents and thus maintain and improve long-term forest health and productivity.
3. Protection of Water Resources: To protect water bodies and riparian areas, and to conform with forestry best management practices to protect water quality.
4. Protection of Biological Diversity: To manage forests in ways that protect and promote biological diversity, including animal and plant species, wildlife habitats, and ecological or natural community types.
5. Aesthetics and Recreation: To manage the visual impacts of forest operations, and to provide recreational opportunities for the public.
6. Protection of Special Sites: To manage lands that are ecologically, geologically or culturally important in a manner that takes into account their unique qualities.
7. Responsible Fiber Sourcing Practices in North America: To use and promote among other forest landowners sustainable forestry practices that are both scientifically credible and economically, environmentally and socially responsible.
8. Legal Compliance: To comply with applicable federal, provincial, state and local forestry and related environmental laws, statutes and regulations.
9. Research: To support advances in sustainable forest management through forestry research, science and technology.
10. Training and Education: To improve the practice of sustainable forestry through training and education programs.
11. Community Involvement and Social Responsibility: To broaden the practice of sustainable forestry on all lands through community involvement, socially responsible practices, and through recognition and respect of Indigenous Peoples' rights and traditional forest-related knowledge.
12. Transparency: To broaden the understanding of forest certification to the SFI 2015-2019 Forest Management Standard by documenting certification audits and making the findings publicly available.

13. Continual Improvement: To continually improve the practice of forest management and to monitor, measure and report performance in achieving the commitment to sustainable forestry.

Forest Stewardship Council Principles⁸⁴

The ten FSC Principles require the forest owner or manager to do the following:

Principle 1: Compliance with laws and FSC Principles - to comply with all laws, regulations, treaties, conventions and agreements, together with all FSC Principles and Criteria.

Principle 2: Tenure and use rights and responsibilities – to define, document and legally establish long-term tenure and use rights.

Principle 3: Indigenous peoples' rights – to identify and uphold indigenous peoples' rights of ownership and use of land and resources.

Principle 4: Community relations and worker's rights – to maintain or enhance forest workers' and local communities' social and economic well-being.

Principle 5: Benefits from the forest – to maintain or enhance long-term economic, social and environmental benefits from the forest.

Principle 6: Environmental impact – to maintain or restore the ecosystem, its biodiversity, resources and landscapes.

Principle 7: Management plan – to have a management plan, implemented, monitored and documented.

Principle 8: Monitoring and assessment – to demonstrate progress towards management objectives.

Principle 9: Maintenance of high conservation value forests – to maintain or enhance the attributes which define such forests.

Principle 10: Plantations – to plan and manage plantations in accordance with FSC Principles and Criteria.

⁸⁴ Source: "The 10 Principles." Forest Stewardship Council. <https://ic.fsc.org/the-10-principles.103.htm>.

36: Service-Learning Project⁸⁵

Overview

In this lesson, students plan and carry out a service-learning project related to Oregon forests.

Time Considerations

Preparation: One hour or more

Procedure: The duration of this lesson depends on the specific project, and may range from one class period to an entire term

Learning Objectives

Students will be able to

- Identify and assess their community's needs.
- Develop and implement an action plan.
- Practice problem-solving skills.

Standards Connections

Next Generation Science Standards

- Disciplinary Core Idea – HS-LS4.D. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Other relevant standards depend on the specific project.

⁸⁵ Source: This lesson was adapted from “Service-Learning and Forests” in *Oregon Forest Literacy Program*, page 15. Oregon Forest Resources Institute.

Oregon Forest Literacy Program Concepts

- Theme 4, A.1. Everyone has a responsibility to treat forests with respect and become a conscientious steward of Oregon forests and forest resources.
- Theme 4, A.2. There are many opportunities for individuals to experience and connect with forests in Oregon.
- Theme 4, A.3. Ways individuals play a part in sustaining our forests include volunteering for projects in and around forests, becoming informed and active voters, attending public meetings and making wise consumer choices.

Materials

- “Service-Learning Planning Template” teacher page
- “Sample Service-Learning Projects” teacher page
- Any materials needed for the planned project

Background Information⁸⁶

Service-learning is a teaching method that combines service to the community with meaningful and relevant learning experiences. According to the National Youth Leadership Council, high-quality service-learning actively engages students in meaningful and personally relevant service activities. It is an intentional instructional strategy used to meet learning goals or content standards.

To be effective, service-learning incorporates ongoing reflective activities that prompt deep thinking and analysis about one’s relationship to society. It provides students with a strong voice in planning, implementing and evaluating their service-learning experiences. It also gives students the opportunity to demonstrate what they learned from the project or how the service affected them.

Preparation

- “Service-Learning Planning Template” teacher page to map out possible service-learning projects, taking into account your community’s needs. Identify your instructional goals, any assessment you plan to incorporate into the project, and any time or space constraints. See the Use the “Sample Service-Learning Projects” teacher page for possible projects.

⁸⁶ Source: Adapted from “Service-Learning and Forests” in *Oregon Forest Learning Program*, page 18. Oregon Forest Resources Institute.

- Check other resources for project ideas and opportunities, including SOLVE Oregon (<http://solv.org/>), Oregon Metro (<http://oregonmetro.gov/how-metro-works/volunteer-opportunities>), and a list of volunteer opportunities on Oregon Forest Resources Institute's website (<http://oregonforests.org/content/volunteer>).
- Consider having students invite community leaders, stakeholders, or local media for a presentation about the completed project.

Procedure

1. Explain to students that service-learning is an opportunity to apply what they learn in school to the real world. Ask for their ideas of service-learning projects that would both help the community in some way and enable them to apply their learning about forestry. See the "Sample Service-Learning Projects" teacher page for ideas.
2. As a class, look at the list of project ideas and combine or eliminate any, as appropriate. Discuss what sector of the community each project remaining on the list would serve, how the project might meet the community's needs, and what knowledge and skills students would be able to demonstrate. Vote on one project, or use another method for determining which to undertake.
3. As a class, develop an action plan for the selected project. The plan should include a timeline, materials needed, budget, community resources and steps required to carry out the project. It should also include a way for students to demonstrate their learning.
4. Implement the action plan, making sure that all students have meaningful roles. Encourage students to problem-solve any issues that arise.
5. After the project, take time for students to reflect on their learning and celebrate their accomplishments.

Assessment

Build into the project a way for students to demonstrate what they have learned and then use that to assess their learning.

Lesson 36

Forest-Related Project Idea:

Sample Service-Learning Projects

Forest Stream Monitoring. Students monitor a nearby forest stream and riparian zone for the local watershed council. They map the area using GPS units, take ongoing water quality samples, keep photo journals, analyze their results and develop a multimedia presentation of their findings.

Invasive Species Removal. Students remove invasive plants from a nearby forest area, after assessing the prevalence of invasive species. They learn about the impact of invasive species on forest ecosystems, practice identifying some of the most prevalent invasive species, learn the best methods for removal, document the effectiveness of the treatment and communicate with others in the community about the problem of invasive species.

Forest Interpretive Trail. Students develop an interpretive trail for the community that goes through a local forest. Students learn about the local ecosystem; research interesting facts about plants, animals or historical figures; work with government agencies and businesses; and create signs or a brochure for the trail.

Forest Species Living Lab. Students design an outdoor forest species living lab for their school community. They research Oregon native plants and what they need to thrive, organize fundraising efforts for suitable plants and needed supplies, create planning maps of the lab site and then plant and care for the plants.

Forest Field Day. Students plan and carry out a field day to teach elementary students about the local forest ecosystem. They research topic areas, plan activities and demonstrations, practice teaching their lessons and present them to elementary students.

Tree Planting and Monitoring. Students work with a local park or government agency to plant trees and then monitor the trees' development over time. They plan what, where and how many trees to plant; organize fundraising efforts to buy the trees; and carry out their planting plan. Then, over time, they collect data on the newly planted trees to monitor their growth and impact.



APPENDICES

Glossary
Supplies List
Standards Connections
Oregon Forest Literacy Concepts

Glossary⁸⁷

Abiotic (adj.) – a nonliving factor or element in the environment; e.g., light, water, heat, rock and gases.^{PLT}

Active management – attaining desired forest objectives and future conditions using silvicultural operations and forest management practices.

Bearing (as in compass) – the direction of a point with respect to another or to the compass.

Biotic (adj.) – an environmental factor related to or produced by living organisms.^{PLT}

Broadleaf – a plant with wide, flat leaves, such as an oak or maple.^{PLT}

Canopy – a forest layer formed by the leaves and branches of trees or shrubs.^{PLT}

Carbon cycle – the circulation of carbon in nature. Plants absorb carbon dioxide (CO₂) from the air; by photosynthesis, they convert CO₂ to carbohydrates, giving off oxygen as a byproduct. Animals then eat the plants and return the carbon to the air by exhaling and through decay.
^{PLT}

Carbon sequestration – the long-term storage of carbon in trees and other organisms, soil and oceans.

Conifer – a plant that bears its seeds in cones.^{PLT}

Conservation – using natural resources in a way that ensures their continuing availability to future generations; the intelligent use of natural resources for long-term benefits.^{PLT}

Consumer – (1) an organism that obtains energy by feeding on other organisms and their remains; (2) any person using goods for his or her needs.^{PLT}

Contour – a line on a map joining points of equal height above or below sea level.

Crown – the top branches of a tree.^{PLT}

⁸⁷ Terms marked “PLT” came from *Project Learning Tree PreK-8 Environmental Education Activity Guide*, © 2006, from *Project Learning Tree Global Connections: Forests of the World Secondary Environmental Education Module*, © 2008, and from *Project Learning Tree Exploring Environmental Issues: Focus on Forest Secondary Environmental Education Module*, © 2011, and are used with permission from the American Forest Foundation. Educators can receive these guides by attending a PLT workshop. For more details, contact Oregon Natural Resource Education Program at 541-737-9121 or onrep@oregonstate.edu.

Deciduous – periodically losing all leaves, typically in autumn. Most North American broadleaf trees are deciduous.

Development – the act of growing, progressing or changing something from a more simple (natural) state to a more complex state (for example, changing farmland into a housing subdivision).^{PLT}

Diameter at breast height (DBH) – the diameter of a tree as measured at breast height. Standard DBH is measured at 4.5 feet (approximately 135 cm) above the ground.^{PLT}

Distribution – the spatial arrangement of members of a population.^{PLT}

Ecology – the scientific study of the relations of living things to one another and to their environment.^{PLT}

Economic benefit (or economic value) – a measure of the goods and services provided by an entity and generally measured in terms of money. For example, forests provide employment and a variety of products that offer economic benefits to society.

Ecosystem – the interacting system of a biological community and its nonliving environment; also, the place where these interactions occur.^{PLT}

Ecosystem (ecological) services – the services that humans derive from environmental functions such as oxygen production, photosynthesis (food), water purification and so forth.^{PLT}

Energy flow – the one-way passage or transfer of energy through an ecosystem according to the laws of thermodynamics.^{PLT}

Environment – the sum of all external conditions and influences that affect the development and, ultimately, survival of an organism or group of organisms.^{PLT}

Erosion – the wearing away of the land surface by wind or water. Erosion occurs naturally from weather or runoff, but is often intensified by some human practices.^{PLT}

Evergreen – a plant that has foliage that remains green and functional through more than one growing season.^{PLT}

Fire suppression – preventing a forest fire from burning.^{PLT}

Forest – a large area of land primarily covered with trees, as well as the other organisms, soil, water and air associated with them. Or an ecosystem characterized by a dominance of tree

cover and the presence of a wide variety of other organisms (e.g., other plants and animals).
PLT

Forest health – the ability of forest ecosystems to remain productive, resilient and stable over time and to withstand the effects of periodic natural or human-caused stresses such as climatic changes, disease, drought, flood, insect attack, resource demands and resource management practices.^{PLT}

Forest management – the practical application of scientific, economic and social principles to the administration of a forest.^{PLT}

Forest product – any item or material derived from forests for commercial use, such as lumber, paper, mushrooms or forage for livestock.

Forest type – groups of tree species commonly growing in the same stand because their environmental requirements are similar.^{PLT}

Forestland – a portion of land in which forest is the most dominant element.

Forestry – the principles and practices for managing, using and enjoying forests. Forestry includes a broad range of activities: managing timber, fish, wildlife, range and watershed; protecting forests and timber products from diseases, insects and fire; harvesting, transporting, manufacturing, marketing, preserving and protecting wood and other forest products; maintaining water and air quality; and maintaining the well-being of society as it is influenced by forests.^{PLT}

Free to grow tree or stand – a tree or stand that has a high probability of remaining vigorous, healthy and dominant over surrounding grasses and brush.

Germination – the process by which a plant or fungus emerges from a seed or spore and begins to grow.

Global climate change – the long-term changes in air mass movements, moisture and temperature occurring globally as a result of changes in Earth's atmosphere.^{PLT}

Habitat – an area that provides an animal or plant with adequate food, water, shelter and living space in a suitable arrangement.^{PLT}

Harvest – see “Timber harvest.”

Invertebrate – an animal lacking a backbone, such as an insect. Invertebrates make up about 95 percent of animal species.

Leaf litter – dead plant materials, such as bark, leaves and twigs that have fallen to the ground.^{PLT}

Live crown ratio – the percentage that the crown height represents of the total tree height.

Macronutrient – a chemical element that plants need for growth and development, such as nitrogen (N), phosphorus (P), and potassium (K).

Nutrient – a substance required for growth and development. Plants, for example, need water and minerals to grow and reproduce.^{PLT}

Oregon Forest Practices Act – a comprehensive set of laws and rules governing harvest practices and other forest management operations in Oregon.

Organic – referring to or derived from living organisms; in chemistry, any compound containing carbon.^{PLT}

Organism – any living form of life.^{PLT}

Pacing – a way to measure distance by counting one's steps. In forestry and ecology, a pace is two steps, or the distance one foot travels from the point it leaves the ground until it touches the ground again.

Passive management – managing a forest area by letting nature take its course.

Perennial – a plant that lives for several years and, when mature, usually produces seeds each year.^{PLT}

Photosynthesis – the process by which green plants manufacture simple sugars in the presence of sunlight, carbon dioxide and water.^{PLT}

Prescribed fire – or – Prescribed burning – the practice of using regulated fires to reduce or eliminate material on the forest floor, to prepare seedbeds or to control competing vegetation. Prescribed burning simulates one of the most common natural disturbances.^{PLT}

Private ownership – ownership of land or other property by individuals or firms.

Producer – an organism that synthesizes organic compounds from inorganic substances via photosynthesis (by green plants) or chemosynthesis (by anaerobic bacteria).^{PLT}

Public ownership – ownership of land or other property by a government entity.

Reforestation – the restoration (planting) of a forest that had been reduced by fire or cutting.^{PLT}

Regeneration – the renewal of vegetation by natural or artificial means.^{PLT}

Renewable resource – a naturally occurring raw material or form of energy that has the capacity to replenish itself through ecological cycles and sound management practices.^{PLT}

Riparian – of, on, or relating to the banks of a river or other natural water course.

Salvage – the removal of timber damaged by fire, storms, flooding or other conditions.

Silviculture – the science and art of cultivating forest crops based on the study of the life history and general characteristics of forest trees.^{PLT}

Snag – a standing dead tree. Snags frequently provide homes for wildlife.^{PLT}

Soil – the mixture of organic material and disintegrated rock found on the Earth's surface, in which plants grow.

Soil pH – a measure of the acidity or basicity of a soil sample.

Stand – a community of trees sufficiently uniform in species age, arrangement, composition and condition to be distinguishable as a group from the forest or other growth on the adjoining area.^{PLT}

Stand density index (SDI) – a measure of the density of a stand of trees based on the number of trees per unit area and diameter at breast height of the average-sized tree.

Stand development – the changes in a stand of trees over time. A stand develops as trees grow, compete for resources and die at different times.^{PLT}

Succession – the gradual replacement of one community by another.^{PLT}

Sustainable forest management – managing forests to meet the needs of the present without compromising the ability of future generations to meet their needs.^{PLT}

Terrestrial ecosystem – all living and nonliving elements of a land-based environment, and the relationship between them.

Timber – a forest stand containing trees of commercial size and quality suitable for sawing into lumber.^{PLT}

Timber harvest – removal of trees from a forest to restore ecological health or to obtain income from the wood products.

Topographic map – a map showing physical features of a landscape, including altitude contours.

Tree – a woody perennial plant, usually 12 feet (4 meters) tall or more, with a single main stem and a more or less distinct crown of leaves. ^{PLT}

Tropical forest – a forest that grows in tropical climates with high year-round temperatures and generally high annual rainfall.

Understory – a plant layer growing underneath the forest canopy. ^{PLT}

Value – (1) the monetary or relative worth of something; (2) a principle, standard or quality regarded as worthwhile or desirable.

Watershed – the land area that delivers runoff water and sediment to a major river or stream and its tributaries. ^{PLT}

Wetland – an area that is regularly wet or flooded, where the water table stands at or above the land surface for at least part of the year, and that has a plant community comprising species that require wet soil. ^{PLT}

Wilderness – (1) a natural environment that has not been significantly modified by human activities; (2) land designated by the U.S. Congress for preservation and protection in its natural condition.

Wildfire – a fire out of control.

Wildland urban interface (WUI) – the area where houses and other structures are built in or near woodlands, forests or other wildlands.

Wildlife—a loosely defined term that includes nondomesticated animals, especially birds, fish, and mammals. ^{PLT}

Working forest – Forests, either public or private, that are actively and sustainably managed for the production of forest products while protecting natural resources.

Supplies List

NOTE: Please note that this list does not include copies of student pages, teacher pages, videos, or other print or web resources listed in the materials sections. Please see the Resources section for a list of materials included as digital materials with this curriculum.

Overall Curriculum

- Internet access
- Equipment for sharing websites, videos, and teacher pages with class
- Journals or electronic tablets

Section 1 – Oregon’s Forest Heritage

- Tracing graph paper
- Highlighters, optional

Section 2 – Forest Basics

- Tree branchlet
- Labels for tagging trees, optional
- Woodland stick
- String
- Measuring tape or ruler
- Labels for tagging trees, optional

Section 3 – Environmental Importance of Oregon’s Forests

- Soil filtration model materials, per group:
 - 2-liter plastic bottle
 - 6-oz can taller than wide
 - Stopwatch (or stopwatch app for smartphone or tablet)
 - Clear plastic cups or other containers
- 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
- Thermometer
- Markers (such as pencils or wood stakes with ribbon or flagging tape tied to one end)

- Graph paper
- Clipboards
- Measuring tape
- Flagging
- Transect lines (ropes marked at one meter, five meters, or other distance along their length), optional

Section 4 – Economic Importance of Oregon’s Forests

- An assortment of items made from trees (for example, a piece of paper, a swatch of rayon fabric, a piece of cellophane, a disposable diaper, and a bottle cork), one each
- Syngas lab equipment, per group:
 - Safety goggles
 - Lab coats
 - Latex or nitrile gloves
 - Fume hood (if possible)
 - 35-55 mL test tube with matching one-hole rubber stopper
 - Two ring stands with metal test tube clamp and clamp for Erlenmeyer flask
 - Three pieces stainless steel or glass tubing, each approximately 5 cm long
 - 250 mL Erlenmeyer flask with matching two-hole stopper
 - Three pieces rubber or Tygon tubing, two approximately 60 cm long and one just shorter than the Erlenmeyer flask
 - Bunsen burner and lighter
 - Sink with faucet connection for tubing
 - Wood pellets (enough to fill test tube approximately 3/4 full)
 - Regular-sized marshmallow (not mini-sized)
 - Skewer for roasting marshmallow
 - One large sealable bag for test tube disposal
- Syngas lab equipment, per class
 - One pair leather gloves
 - Acetone (optional, for cleanup)
 - Additional marshmallows

Section 5 – Forest Management

- 100-foot measuring tape
- Stakes, flags or other markers for course
- Orienteering compasses, one per pair of students

- Graph paper (or gridded lab notebook)
- Soil lab equipment, per class:
 - 12" soil core samples from two or more sites, dried
 - Leaf litter samples from the same sites
 - 1-gallon sealable bags and garbage bags
 - Asbestos gloves
 - Tongs
 - Digital balance
- Soil lab equipment, per lab group:
 - Safety goggles
 - Porcelain crucible with cover
 - Needle probe
 - Bunsen burner
 - Ring stand and clamp (for crucibles)
 - Matches
 - Asbestos pad
 - Soil test kit (for testing pH, nitrogen, phosphorous and potassium levels)
 - Large aluminum tray
 - Several screw cap vials
 - Tweezers or forceps
- 16x16-stud Lego® baseplates, one per individual or pair
- Assortment of different-sized Lego® bricks: 1-stud⁸⁸, 2-stud, 4-stud, 6-stud, and 8-stud ones
- Camera, optional
- Flagging tape
- Stakes
- Measuring tapes
- Calculators, optional

⁸⁸ The “studs” are the extensions on the bricks and the platform that enable them to hold together. The number of studs denotes brick size.

Section 6 – Forest Health and Forest Management Issues

- Index cards (4x6 or other size)
- Sheets of butcher paper and marking pens, optional
- Strips of paper (approximately 3" x 18")
- Colored marking pens
- Tape

Section 7 – Our Responsibility to Oregon's Forests

- Any materials needed for the planned service-learning project

Standards Connections at a Glance

Standards Connections at a Glance

Lesson:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
Next Generation Science Standards																																						
Performance Expectations																																						
HS-LS2-2. Ecosystems: Interactions, Energy, and Dynamics								X						X									X	X														
HS-LS2-5. Ecosystems: Interactions, Energy, and Dynamics														X																								
HS-ESS3-1. Earth and Human Activity	X	X																				X																
HS-ESS3-3. Earth and Human Activity																												X										
HS-ESS3-5. Earth and Human Activity																																		X				
Disciplinary Core Ideas																																						
HS-LS1.A. Structure and Function							X		X	X																												
HS-LS2.B. Growth and Development of Organisms														X																								
HS-LS2.C. Organization for Matter and Energy Flow in Organisms		X						X					X	X									X															
HS-LS4.D. Biodiversity and Humans				X	X	X																												X	X			
HS-ESS3.A. Natural Resources	X	X	X														X	X	X																			
HS-ESS3.C. Human Impacts on Earth Systems																			X	X				X	X	X	X	X	X	X	X	X	X	X				
Science and Engineering Practices																																						
2. Developing and Using Models															X								X															
3.Planning and Carrying Out Investigations									X				X																					X				
4. Analyzing and Interpreting Data	X	X						X		X	X												X															
5. Using Mathematics and Computational Thinking				X																	X	X			X													
6. Constructing Explanations and Designing Solutions																												X					X					
8. Obtaining, Evaluating, and Communicating Information			X		X	X	X						X																X			X	X					

Oregon Forest Literacy Program Concepts at a Glance

Oregon Forest Literacy Program Concepts at a Glance

Lesson:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Theme 1: What is a Forest?																																				
A.2. Definition of a Forest																																				
B.1. Trees as Part of the Forest																																				
B.2. Trees as Part of the Forest																																				
B.3. Trees as Part of the Forest																																				
B.4. Trees as Part of the Forest																																				
C.3. Forests as Ecosystems																																				
C.4. Forests as Ecosystems																																				
C.7. Forests as Ecosystems																																				
C.8. Forests as Ecosystems																																				
Theme 2: Why Are Forests Important?																																				
A.1. Historical Importance																																				
A.2. Historical Importance																																				
B.1. Environmental Importance																																				
B.2. Environmental Importance																																				
B.4. Environmental Importance																																				
C.3. Social Importance																																				
D.1. Economic Importance																																				
D.2. Economic Importance																																				
D.3. Economic Importance																																				
Theme 3: How Do We Sustain Our Forests?																																				
A.3. Forest Ownership																																				
A.4. Forest Ownership																																				
B.1. Forest Management																																				
B.2. Forest Management																																				
B.3. Forest Management																																				
B.4. Forest Management																																				
C.3. Forest Management Decisions																																				
C.4. Forest Management Decisions																																				
C.7. Forest Management Decisions																																				
C.8. Forest Management Decisions																																				
D.1. Forest Management Issues																																				
D.2. Forest Management Issues																																				

Oregon Forest Literacy Program Concepts at a Glance

Oregon Forest Literacy Program Concepts at a Glance

Lesson:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
D.3. Forest Management Issues																																					
Theme 4: What Is Our Responsibility to Oregon Forests?																																					
A.1. Our Role in Sustaining Oregon Forests																																				X	X
A.2. Our Role in Sustaining Oregon Forests																																				X	
A.3. Our Role in Sustaining Oregon Forests																																				X	
A.7. Our Role in Sustaining Oregon Forests																			X			X															
B.4. The Future of Our Forests																																					X