Guidance for Classroom Teachers
How to prepare to bring your class to Wildfires & Us!

Thank you for taking on extra work and increased responsibility to bring your students to the museum and to the forest classroom at Squilchuck State Park.

Introductory Considerations:

- Most of the citizens of North Central Washington have a new understanding about what it means to live in a fire-adapted ecosystem. Our recent summers of wildfires have brought forth new problems for our community to solve. We have an urgent need to better prepare our homes, businesses, and cities for future wildfires.
- You can model good citizenship for your students as you share the steps you are taking to learn about fire-adapted ecosystems. We urge you to do your own adult-level learning about our Eastside Cascades Ecosystem and discuss this with your students.
- For most of your students, this will be a first-ever hike in a forest and Squilchuck State Park is a place they can return to with their families. We want children to experience the magic of being outside in a lovely forest and to depart wanting to return to do more exploration.
- The museum is serving a wide-range of ages (2rdgrade-high school) so you need to adjust and adapt the complexity of the issue to best match your own students.
- Museum docents understand that you will not have much classroom time for preparation.
- At both the museum and at Squilchuck State Park, you will take care of your student discipline needs and assist the docents with activity implementation.
- During the guided hike, you will be the time-keeper, and we ask you to give a 5-minute warning. It is ok if your class doesn't have time to do every "STOP", but you must end each hike sessions on time.
- We want to model "Leave no Trace" practices and staying on the trail.
- We want students to feel like each is on a fun hike in the woods- not rushed.
- The museum has created tree-like "Groots" – a popular cartoon character- to be at strategic points to provide levity and fun, and also directional arrows for you.
- A set of waterproof mini-posters will be used at each Interpretive Stop. These are available at: http://www.wenatcheevalleymuseum.org/2015/our-dry-forests-field-trip-teaching-resources/

Tips: Ideas about how to prepare yourself for *Wildfires & Us*!

- **Stop by the museum after school to see the exhibit –for Free!** Identify yourself as a classroom teacher attending the field experience. Spend 1 hour reading the text and viewing the photographs in the *Wildfires & Us* exhibit. **The museum is open 10-5PM, Tuesday-Saturday**. Dr. Paul Hessberg served as the technical adviser for the project and here is his list of the key themes:
    1. We live in a fire-prone environment: wildfire and smoke are inevitable
    2. Fires were temporarily excluded (40-50 years)- now they are back with a vengeance
    3. The climate is warming too- making fires much larger and more severe
    4. But we can change the way fire comes to us- by being pro-active
    5. We don't have a fire suppression problem- we have a community and landscape preparedness problem.

- As an adult learner, watch an excellent 12-minute video that summaries the themes of the exhibit: http://videos.firelab.org/ffs/Other/ConEd/ManageFire/ManageFire-caption/ManageFire-caption.html
  Watch a 3-minute video to understand 3 types of wildfire: http://videos.firelab.org/ffs/Other/ConEd/KindsofFire/KindsofFire-caption/KindsofFire-caption.html

- As an adult learner, Review the PDFs posted on the museum's website: http://www.wenatcheevalleymuseum.org/2015/our-dry-forests-field-trip-teaching-resources/
  1. Eastside Cascades Dry Forests and Wildlife – background for adults learners
  2. Eastside Cascades Shrub-steppe and Wildfire – background for adult learners
  3. Script for the "Our Dry Forests" film- (Link to film will be sent to teachers)
  4. The Visiting Squilchuck Guidebook.
  5 Classroom lesson options for Pre- and Post field trip (Lessons 1-6)
  6 Forest Classroom Hike Visuals 2015
  7 Eastside Cascades Fire Ecology History and Patterns -background for teachers
  8 Forest Plant and Animal Life Histories (Lesson 1)
  9 Forest Plant Life History Additions Grand Fir & Bitterbrush (Lesson 1)
  10 Houses in the Urban Interface Photo Series (Lesson 6)

- Read a current New York Times article, Dr. Paul Hessberg quoted near end of text http://www.nytimes.com/2015/09/22/science/as-fires-grow-a-new-landscape-appears-in-the-west.html?action=click&pgtype=Homepage&module=c-column-middle-span-region®ion=c-column-middle-span-region&WT.nav=c-column-middle-span-region&_r=0

- Attend a 5-week, evening dinner lecture series "Living with Wildfires" offered by Wenatchee River Institute featuring local research scientists. Clock hours available. http://www.wenatcheeriverinstitute.org/adult-education/workshops-field-courses/living-wildfire-speaker-series

- Review the set of suggested lessons (pgs. 3- 21 of this document) to use with your class as pre- and post-field trip extensions. The main ideas imbedded in the field experience & this set of six lessons are:

1. Historically, health Eastside forests experience frequent low-intensity wildfire than resulted in a clumpy-patchy distribution of trees and low levels of ground fuels. The native trees, plants and animals are adapted to thrive in a fire-prone environment.

2. Fire has been excluded from our forest for a long time (50-100 years). We have higher density of trees, fewer Ponderosa pines and more Douglas-fir and Grand fir. More trees competing for limited resources (Light, Air, Water, Soil nutrients) mean trees are less able to fight off insects and disease.

3. Because fire has been absent, our forests today have more fuels so fires burn hotter and bigger. Wildfires now are high-intensity and burn over large areas. We can work to recreate the historical structure of our forests by using prescribed burning, often preceded by removal of ground fuels and tree thinning.

Suggested Lessons: Pre- and Post-field Trip

Compiled by Dave Spies & Susan Ballinger, Co- Coordinators & Curriculum Designer for WVMCC *Wildfires & Us* forest classroom hike 2015

For over 30 years, Dave has been a facilitator for teacher trainings introducing teachers to Environmental Education curricula, including *Project Learning Tree* and *Forests of Washington*. Dave was a wildland fire-fighter for ten seasons and serves on the board for Columbia Breaks Fire Interpretive Center (CBFIC). Dave devoted his career to being a classroom teacher and librarian for Eastmont School District. Now retired, he volunteers extensively, teaching and leading outdoor field experiences for CBFIC. Dave compiled the following set of lessons that can adapted to any grade level and taught in a short amount of time. These lessons provide a basic introduction to fire ecology. Dave recommends these as either pre-trip r post-trip activities to enable students to get the most out of their *Wildfires & Me* field forest classroom hike.

LESSON 1. *Forest Structure: What's There?* Summary: Students create a forest mural that includes Eastside forest communities of plants and animals and their inter-dependency within a fire-adapted ecosystem.

LESSON 2. *Demonstrate a Rain Shadow:* Summary: Demonstrate why the climate of Eastside Cascade forests is drier than Westside Cascade forests.

LESSON 3. *The LAWS.* Summary: all plants require light, air, water, soil. to grow and survive. The guided forest hike at Squilchuck will focus on this idea, related to conifer tree health, and how trees are adapted to a fire-prone environment.

LESSON 4. *Parts of a Plant*: Summary: The types of plant structures- roots, stems, and leaves,-allow plants to survival in the extreme climate of the Eastside Cascade Mountains.

LESSON 5. *What We Can Learn About Fire History from a "Cat Face"* Summary: Scientists examine cross-sections of dead trees to learn about tree growth rates and frequency of wildfires the tree experienced during its life. We will examine a real 'Cat Face" and count tree rings on a "cookie" like the one used during the guided forest hike at Squilchuck.

LESSON 6: *Fire Safety in the Urban Interface* Summary: Identify the urban-interface as a place where human homes and wildlands meet. Evaluate homes for their risk of future wildfire.

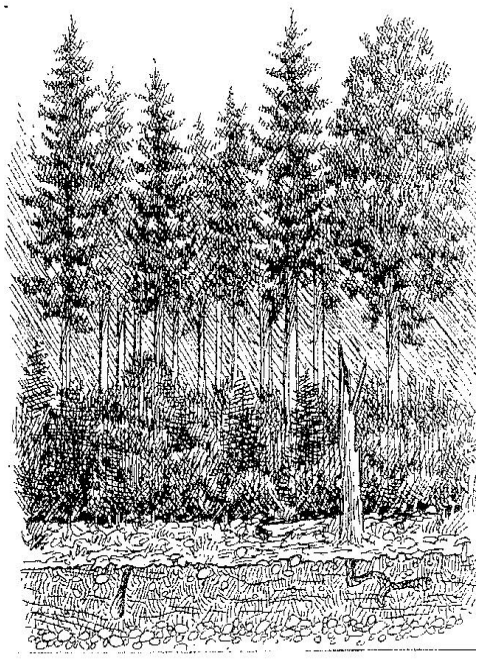
LESSON 1:

Forest Structure: What's There?

Purpose: Before understanding fires and forests, students must first see what is in the forests. This activity can be used as 1) a preliminary activity to help the teacher discover what students already know, 2) an instructional tool upon which students may display their learning, and 3) a class assessment tool to demonstrate what the students have learned. The students will create a forest mural and place in it what they think is there. As they learn about "Eastside Forests" in both the classroom and via field trips, they will add or subtract components of that forest. Once they have made all their discoveries and established their forest, they will make community decisions about how to manage their forest. This activity has no limits. It can last a day, or a week, or a whole year, depending upon how far the teacher wants (or has time) to pursue the topic.

Learning Outcome: Students will be able to describe the four general habitat layers of a Washington Forest and identify some of the plants and animals that live there.

Background information: When studying forests and forest habitats, the concept of layers is often used. For the purposes of this activity, these four layers are identified.



The Canopy: This layer comprises tree tops and overlapping branches of large trees.

The Understory: This layer is made up of smaller trees, shrubs, bushes, snags – everything between the canopy and floor.

The Forest Floor: Includes leaf litter, stones, fallen logs, ground cover plants, stumps, flowers

The Subfloor: Comprised of soil, rocks, roots, fungi, bacteria, invertebrates and tunnels – everything under the ground

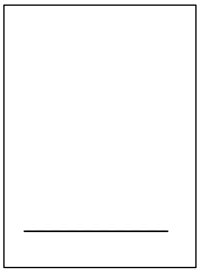
Washington forest animals usually inhabit one of these layers, although some animals use more than one. For example, they may raise their young and find shelter in the canopy and forage the understory, forest floor and even the soil for food. When studying the forest animals, remember to include all forms of wildlife (fish, insects, slugs, worms, spiders -- not just birds and mammals.

Native Plant and Animal Reference Materials:
You can print out a class set of life history narratives for 30 common plants and animals that live in a fire-adapted forest ecosystem. Two additional Cascade species have been added (Grand fir and Antelope Bitterbrush). Reading level: 5th-12th
Forest Plant and Animal Life Histories
Plant Life History Additions: Grand Fir and Bitterbrush
PDFs are embedded in this link: http://www.wenatcheevalleymuseum.org/2015/our-dry-forests-field-trip-teaching-resources/ Source: USFS Wildfires! Curriculum PDF at http://www.firelab.org/document/fireworks-curriculum

Outline pictures of selected animals and plants like sagebrush, bitterbrush, and flowers. (It can save a lot of time and frustration for students who cannot draw very well). Native plant line drawing "coloring pages" at:
http://www.fs.fed.us/wildflowers/kids/coloring/colorofflowers.shtml
Narratives and illustrations of native Washington mammals and birds at:
http://wdfw.wa.gov/living/species/

Butcher paper (End rolls from newspaper printing process work great), crayons, colored markers, yarn, tape, colored construction paper, glue sticks, and a wall space long enough to accommodate 10 to 15 sheets of butcher paper taped side by side.

Learning Procedure
1. Make a forest mural: Create an Eastern Washington forest mural on butcher paper. Divide the students into groups of 2 or 3. Give each group a sheet of paper that is about 3 to 4 ft. tall. Have the students draw a horizontal line 6 to 8 inches from the bottom of their strip to represent the level of the forest floor. The teacher may want to do this to make the line uniform. The lines will be aligned as the posters are later added to the wall. The strips will look like this:



2. With very little class discussion beforehand, each team's task is to draw 2 or 3 trees from below ground level to the canopy. Each tree may be as tall as they wish. Along with the trees, they need to draw everything else that they think is part of a forest, except for the animals…they will be added later. They also don't need to draw streams, or mountains , or the sun…they will be added when the forest is taped together on the wall.

3. Tape the posters side by side on the wall to make a forest. At this time, the teacher or a student who can "see the whole picture" should draw any stream (s) that may run through the forest and draw a mountain skyline in the background.

4. Students will then discuss and make a list of "things," both living and non-living, that make up a forest…such as large trees, groundcover (grasses and flowers), small trees, leaf litter (fallen needles & leaves), snags (dead trees), fungi (both below and above ground), fallen logs, rocks, shrub, roots, lichens, mosses, soil. Depending upon time, the students go to a forest or search books and web sites in the classroom, looking for more information on forests. They will add their "discoveries" to the mural as they learn.

5. Discuss what you know about the Ponderosa Pine, the traditionally dominant species of tree in the eastside forests. How has it adapted to this environment…what are its needs and its structural adaptations?
Optional: Have student adopt a plant from the list to discover how it has adapted itself to survive in harsh conditions of eastern Washington.

4. As the students do their research, they will also search for animals that live in each layer of the Eastern Washington forests…and make a list. Each student will adopt one or two of those animals from the master list and do an in-depth study about that animal. Their main goal will be to find out everything that animal needs to survive in their forest, and how that animal is able to survive in this climate….what adaptations do they have to make?

5. After their research is complete, each student will draw and then glue their animal on the forest mural in a location in which they know that animal can survive. (It may be helpful to have outline drawings of the animals, since most students cannot draw them well enough to be recognized) They will also add anything that is not already in the mural which that animal needs.

Optional: Have each student give an oral summary of their animal and have the class help them place it on the mural.

6. Once their forest is complete, each student will take a length of yarn, tape one end of it to their animal and the other end to something in the forest to which it is "connected." You can do this as many times as you wish. Eventually the entire forest will be covered with yarn to show the interdependency of everything in the forest. You can also reverse the process and show what happens when one of the components of a forest is eliminated for one reason or another. Your mural will look like a mess, but the learning opportunity is worth it.

7. The final component: Tell the students that there is one more component that has been left out. What is it?…Fire. Discuss how fire has always been a part of the eastside ponderosa/shrub-steppe ecosystems…and always will be. Move to the ***What we can Learn About Fire History from a "Cat Face."*** Lesson. Ask the students how fire will affect their forest. What parts of it will survive? What parts of it need low-intensity fire? What will happen to both the plants and the animals of this forest if a lot of small trees are allowed to grow? Is there anything they can do to their forest to protect it from a high-intensity fire and be able to survive a low-intensity fire?

Optional: You may add many more small shade-tolerant trees, such as grand fir and Douglas fir, to the forest mural before you begin the fire discussion.

LESSON 2: Demonstrate a Rainshadow

Purpose: This activity helps students understand the climate to which plants and animals have to adapt in the forests of Eastern Washington and the rest of the state. It will help them understand why it is so much drier here than on the west side of the Cascades.

Materials: map of Washington State showing the mountain ranges, chalk (if on black top), sticks (if on the dirt or gravel), long rope (if on the lawn or any surface), sponges, bucket of water. In the classroom or gym, paper confetti may be used instead of water.

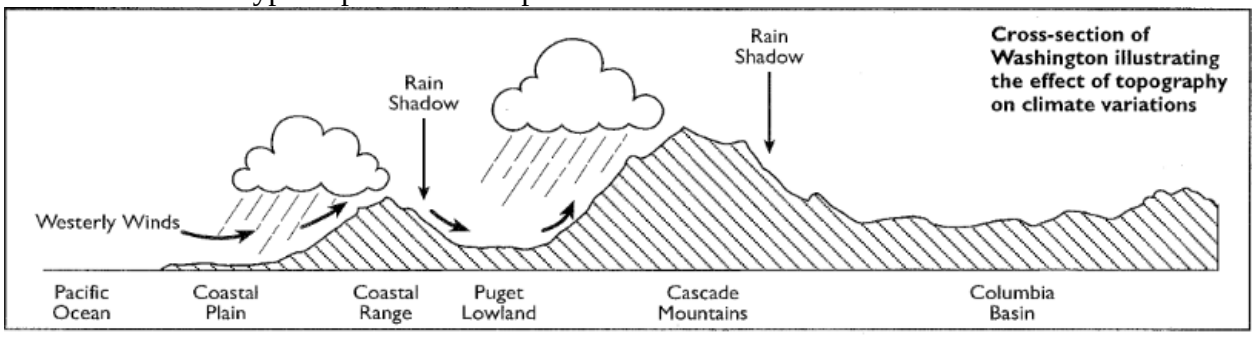
Procedure:

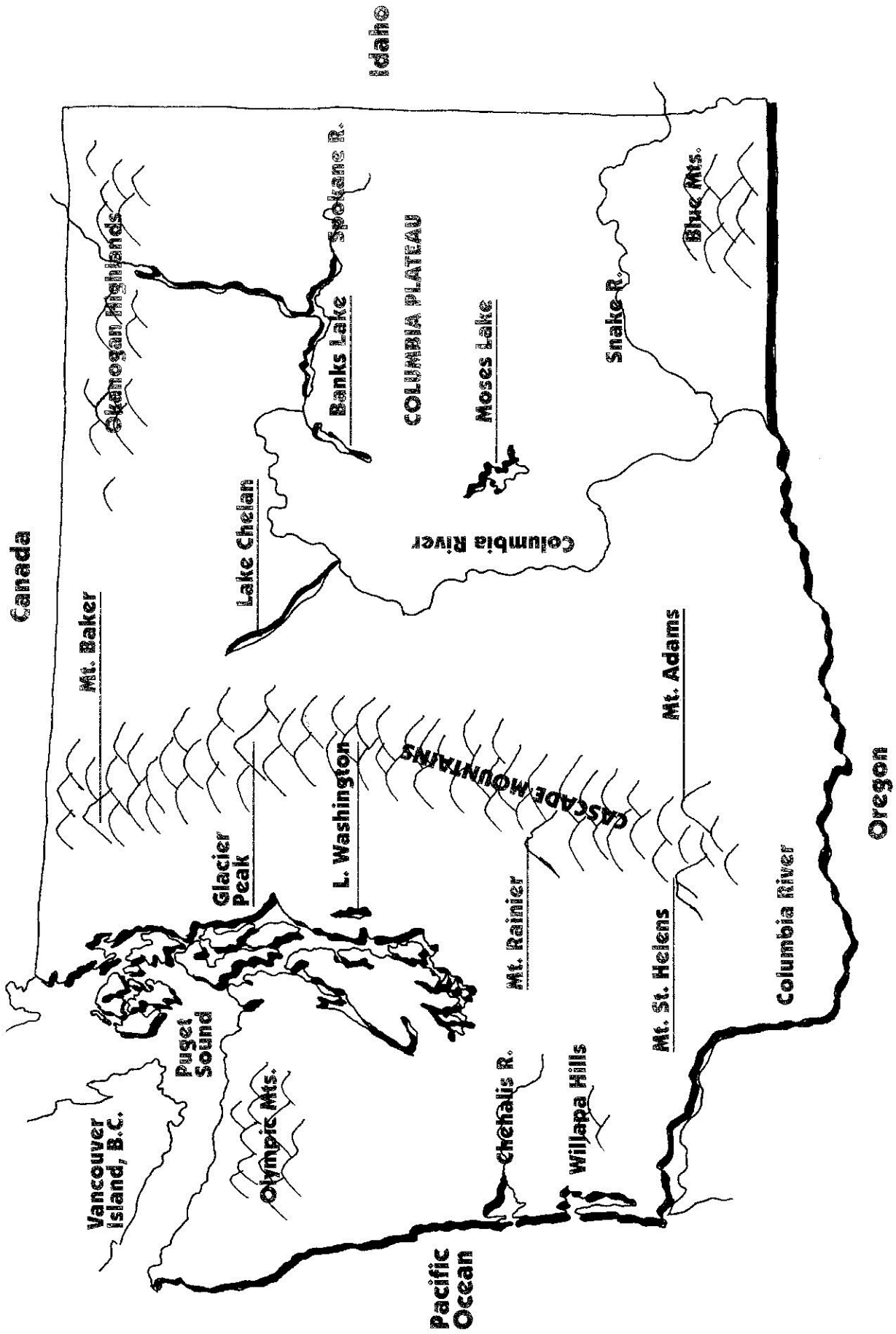
1. Preliminary activity: The students should be familiar with the water cycle so that they understand why moisture-laden clouds form rain as they are forced up over the mountains…and there is less rain as they move down the eastern slopes. They should understand that water molecules slow down and condense as warm air rises into a cooler atmosphere higher from the surface of the Earth.

2. Take students to an outside play area (or to the gym or commons area if there is nothing available outside). Have them draw a rough outline map of Washington State using the chalk, stick, or rope. The next step will depend upon how well students can control themselves (Instead of students, you may want to use rocks or other large objects to represent the mountains.) Have a few students crouch along the coast to represent the lowland hills (e.g. Willapa Hills). Have other students stand to represent the Olympics, the Cascades, the Okanagon Highlands, and the Blue Mountains.

3. (The teacher should verbally lead the students through this part of the activity, explaining what is happening to the water molecules / clouds as they move across the state.) The remaining students are to represent clouds: each of them will stand west of the state in the Pacific Ocean. They will have a saturated sponge and begin their journey west toward the coast. As they approach the lowland hills, they begin to "lose" some of their water by slightly squeezing the sponges. As they encounter the Olympics they lose additional water and more as they approach the Cascades, and yet more as they approach the Blue Mtns. and Okanagon Highlands and the mountains of Idaho. The "clouds" will squeeze very little water as they move to the eastside of each range. (Instruct the students not to squeeze water over the mountains unless you are using rocks or chairs for the mountains. After a few passes of "low fronts" have moved over the state, have all the students step off the map to see where the wet areas and the dry areas are in the state.

Discussion: The water pattern on the ground should provide the evidence as to where the dry / wet areas are in Washington State. Merely ask the students what they see and how the amount of moisture and cloud cover will affect what type of plant/animal species live in each area.




Canada
Idaho
Oregon
Pacific Ocean
Okanogan Highlands
Spokane R.
Banks Lake
COLUMBIA PLATEAU
Moses Lake
Snake R.
Blue Mts.
Lake Chelan
Columbia River
Mt. Baker
Glacier Peak
L. Washington
CASCADE MOUNTAINS
Mt. Rainier
Mt. Adams
Mt. St. Helens
Columbia River
Puget Sound
Olympic Mts.
Chehalis R.
Willapa Hills
Vancouver Island, B.C.

LESSON 3: The L A W S

Purpose: Before All plants in close proximity to each other compete for these necessities. If there are too many plants and not enough of any one of the LAWS, then some species will weaken, become more susceptible to disease, and die. Indeed, the whole plant community may weaken or die and become more prone to high-intensity wild fire. The LAWS can serve as a point of focus to help students to understand how plants have adapted to eastside forest conditions, including fire.

Procedure: Ask the students to write LAWS down the left hand side of their paper. Tell them that this word is an "acronym" where each letter of the word is the first letter of another word. "The four words I need are the four things that most plants require in order to survive." As they guess each word, discuss how the plant, especially trees, obtain that component and why they need it.

L ight
A ir
W ater
S oil

Light: Plants use light in photosynthesis to make their "food." You can go into as much detail about photosynthesis as you wish, depending upon the age and knowledge of the students. The light is collected mostly by the leaves…in the case of evergreens, the needles are the leaves (It's amazing how many students don't realize that leaves grow in many different shapes, including needle-shaped. The shapes are adaptations that enable the plants to adapt to specific conditions and compete with other plants.) Trees growing on this side of the mountains like a lot of light (ponderosa). Trees requiring less light (firs) will grow in the shade of larger trees.

*Air***:** Explain the Oxygen/Carbon Dioxide cycle…the need for carbon dioxide in photosynthesis and one of the by-products being oxygen.

*Water***:** Discuss the need for water in transporting nutrients and energy to different parts of the plant. Review different types of root systems and how they are adapted for eastside conditions.

Soil: What nutrients do plants get from the soil? (carbon, nitrogen…)

Follow-up discussion: To demonstrate why our crowded forests are unhealthy, hold up one gallon of water. Ask the students to imagine what would happen if the whole class had to share only this amount of water for one day, every day. Provide one bag of M&M's and give each student one piece and ask the same question. Would they become weak and susceptible to disease? What would happen if more students were added to the class to share the same resources? If the class was a forest and a forest manager had to figure out how to make the forest healthier, what could he do? Later, when you are discussing how fires have played a vital part in keeping our forests healthy by removing a lot of young growth, remind the students of this discussion.

LESSON 4: Parts of a Plant

Purpose: 1) To compare the basic structure of different plants, 2) to understand how plants are built to adapt to a specific environment and how they survive the changes in that environment (such as extreme heat and cold and wildfires), 3) to understand how plants in a specific environment have evolved to get the LAWS they need.

Materials: 1) Drawing tools such as pencils, pens, markers 2) samples of ponderosa pine, grand fir, Douglas-fir, deciduous leaves and branches (like maple, lilac, willow 3) tap roots (like knapweed or dandelions), fibrous roots (like any grass clump),) 4) young twigs / branches that have thin bark and can be scraped with the side of scissors or pen knife. If you can cut up some twigs into short 1" sections for each student, they can scrape the bark away with their fingernails to reveal the green cambium layer. 5) tree ring handout. 6) examples of tree barks of various thickness, especially ponderosa and fir. 7) photos of tree cookies from various trees that show the thickness of the bark. 8) Glossary of tree part terms (see end of lesson)

Procedure: The purpose of this exercise is to provide general information, not detailed scientific plant anatomy.

1. Have the students draw a horizontal line about ¼ way up on a sheet of notebook paper. Tell them that they are going to draw the parts of a tree, shrub, and grass. Everything below the line is below ground.

2. Ask what general kinds of plants are found growing in a forest: trees, shrubs, grasses, flowers, fungi

3. Ask them what is below ground: the **Roots**. Draw some squiggly lines below the line on the paper. Ask the students why a tree needs roots: an anchor/support, water/mineral absorption, food storage, propagation of new plants. Explain that there are different types of roots, three of which we are concerned:

Primary Tap root: most trees and shrubs in arid regions. Show an example of a tap root such as the dandelion. These roots grow quickly and deeply. Ask the students how this adaptation would help a plant survive in areas of low precipitation: The root is able to get down below the dry surface and reach moisture that is protected deeper underground. Ask the students (or demonstrate outside) if they have ever dug into dry soil in the summer time, only to find damp soil deeper down. Draw the root on the paper below the ground line. Ask the students how this adaptation might help the plant during low-intensity fires: Often the top of the plant will burn, leaving the thick, deep root with nutrients stored in it….allowing for new growth from the top of the root (root crown). This root may go down 60 feet or more on some trees.

Lateral roots: Draw smaller roots branching off the primary root. These roots allow the plant to spread its search for water in a broader, horizontal direction.

Fibrous Surface roots: Show an example of a clump of grass. Have the students draw them below the ground level near the tree and ask how these plants survive hot, dry climates and fire: Notice how shallow and matted the root system is. They are typical of grasses, like your lawn. These

kinds of plants generally have a short growing period…when moisture is available. Their roots are numerous and can quickly absorb water, even in the lightest rain showers. They produce a lot of seeds, many of which survive during a low-intensity fire. The plant may be destroyed, but the seeds continue the survival of the species. And like your lawn, some grasses can grow dormant during a drought, storing nutrients in the root crown until moisture returns. Have the students draw the grass above the roots.

4. Ask the students what grows above the roots: **Trunks and stems**: They 1) support everything above ground, including the branches which reach for the sun 2) provide a highway by which water and non-organic minerals travel up the tree to the leaves and food travels from the leaves to the rest of the plant. Have the students draw a tall trunk with branches. Give the students the "tree cookie" handout. Ask the students what each ring represents. Parts:

Pith: The first year ring in the center of the tree.

***Cambium layer*:** Demonstrate with a branch or give each student a length of twig. Scrape off the thin layer of bark to expose the green cambium layer. Tell the students that this is the only growing, living area of the trunk and is right under the bark. It provides inner cells that transport water up the trunk (xylem) and outer cells that transport food down the trunk (phloem). If this layer of cells, which goes all the way around the trunk and branches, is destroyed, the tree will die. Each year the cambium layer grows a new layer and leaves behind a "ring." You can tell how old a tree is by counting the rings. Have the students color the ring (green, if you have enough crayons for everyone) on the handout that is next to the bark.

Optional: 1) Ask the students how old the tree is? Ask them to put an "X" on the ring that shows how big the tree was when they were born…without telling them how. Half the students will begin counting the rings from the center to the outside…the other half will start with the outside ring and count inward. 2) Ask the students if the rings can tell them anything about the growing condition. Can the rings tell anything about the LAWS available from year to year. Why are some rings wider than others?

***Bark*:** What does the bark do for a tree? It protects. What does it protect? It protects the cambium layer next to the bark. Protects it from what? Insects that lay their eggs in the cambium or eat the cambium directly; harmful fungi; and fire whose heat can destroy the cambium layer.

If you have examples available, show the students the difference in thickness between ponderosa bark and lodgepole pine or a hardwood bark. Ask the students what tree is most likely to survive a wildfire: the ponderosa because the bark acts as an insulator against the heat of the fire, and the cambium is not destroyed. Fire cannot burn through a mature ponderosa pine bark. Ponderosa is adapted to fire-prone areas.

5. Ask the students what important part is left off our drawing: **the Leaves**. Why do trees have leaves? Because that is where the food is produced…sugars are produced in the leaves through photosynthesis. The leaves gather light which serves as a catalyst for the minerals and water and chlorophyll (It's what makes the cambium green) and carbon dioxide to produce those sugars. The leaves also collect the carbon dioxide. They emit oxygen as a by-product of photosynthesis, which all animals need. The tree cannot grow or survive without the leaves.

Hold up a deciduous (maple, etc.) branch. Ask the students if they see any leaves. Show the students a ponderosa and a fir bough. Ask them if they are looking at leaves. Yes…needles are leaves…they are shaped to get the maximum amount of sunlight with minimum water loss.

Again, ponderosas are adapted to a fire-prone environment. As the tree matures, it tends to drop its lower branches where fire might reach the leaves. It is more difficult for fire to climb up the fire-resistant bark and get into the upper branches where the leaves (needles) are.

6. Hold up examples of ponderosa and Douglas-fir **cones** (or any other kind). Ask how they help a tree species survive. They house and protect the seeds. The cones hold the seeds tightly when they are growing. A special resin holds the cone together. When the seeds are mature, the heat from the sun helps the resin to soften and the cone to open up, releasing all its seeds. Some cones are so tight, that it takes the heat from a forest fire to open them up (lodgepole pine).

GLOSSARY: Tree Part Vocabulary

bark: the outside covering on a tree's trunk and branches, the tree's "skin."

Branch: limb of a tree or shrub that grows out from the trunk.

Bud: There are two kinds of buds. One kind is the flower bud. The second kind is the starting point for plant growth and it is the one we use when discussing wildfires. These buds grow at the tips of tree and shrub branches, at the tips of roots, and sometimes in other places. Buds have lots of living cells.

Cambium: a layer of living cells under a tree's bark. This layer of a tree's trunk, branches, & roots produces the *xylem* and *phloem,* the cell layers that together carry water & nutrients between roots & leaves.

Cell: the smallest living part of a plant that can make new living parts.

Cone: the "package" in which a conifer stores its seeds.

Conifer: the kind of tree that stores its seeds in cones and have needle-like leaves. Most keep their needles through the winter.

Crown: a tree's top, where most of the buds and leaves grow.

Duff: the upper layer of soil in a forest. Duff is made up of dead, rotting plant parts. Litter is the layer of dead plant parts, not yet rotted, on top.

Leaf: the green part of a plant that uses sunlight, water, and minerals to provide energy to the tree. Leaves can be wide and as flat as paper, or they can be shaped like needles or scales.

Mineral soil: soil that has very little dead plant material in it. In a forest, it is usually below the duff.

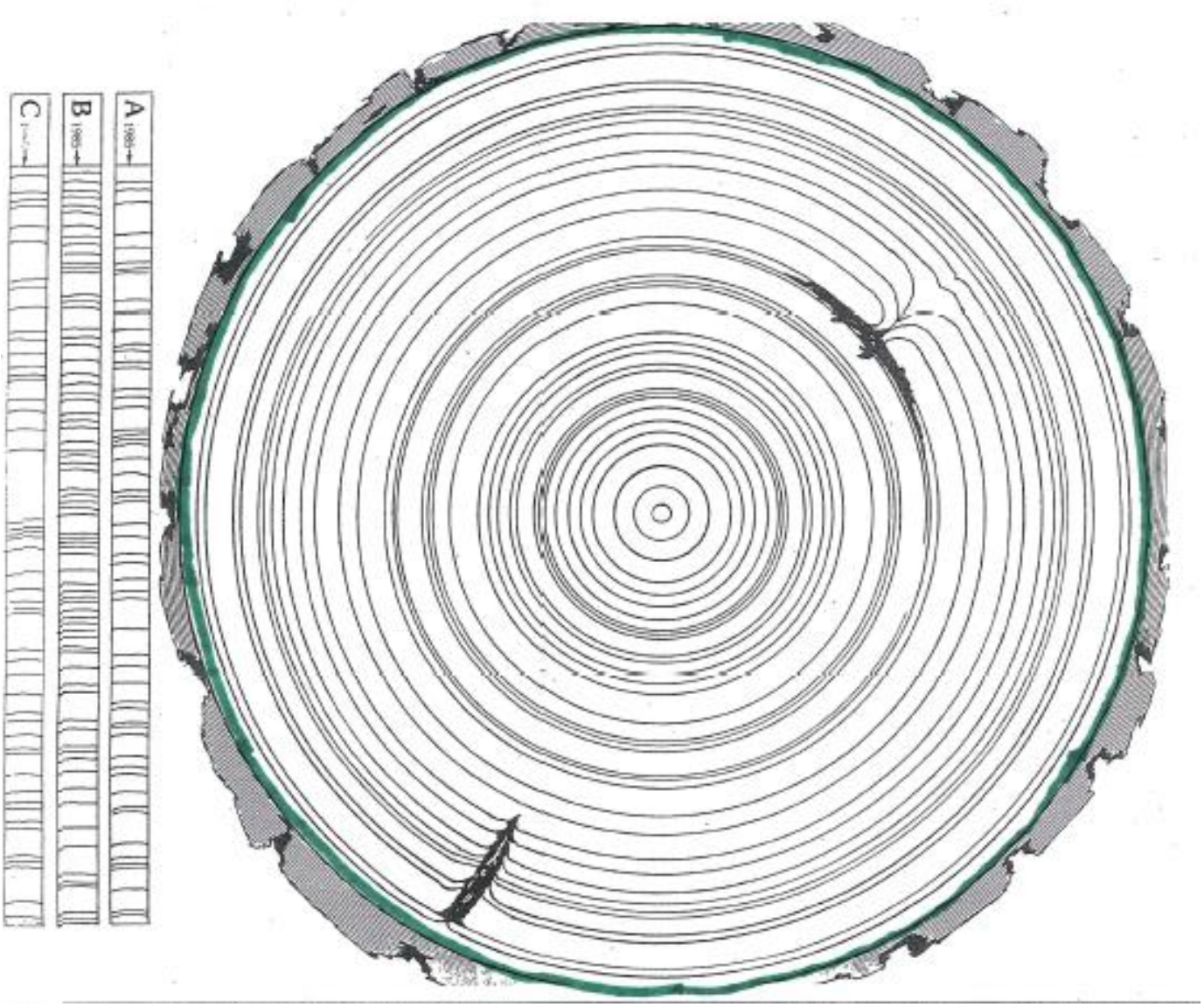
Needle: leaf of a conifer. Needles contain very busy living cells. Most needles live three years or longer, then fall off.

Root: the part of a plant that lives underground. Roots collect water & minerals from the soil & carry them into the stem of the plant. Roots support the plant & have living cells at their tips & under their "bark."

Seed: a very tiny, living plant; just waiting to grow, and its protective covering, filled with nutrients. Some seeds have fluffy or scaly "wings" to catch the wind as they fall. The seed needs just the right temperature, water, sunlight, and soil conditions before it can grow.

Trunk: the part of a tree that connects leaves and branches in the air to roots in the ground. People often call the trunk of a small tree its "stem."

Wood: the strong material inside a tree's bark and cambium that supports the tree and helps carry water from roots to leaves. Wood consists mainly of cells produced in past years that have died and become hollow.


A
B
C

LESSON 5: What We Can Learn About Fire History from a "Cat Face"

Purpose: Students have been told that fire has always been a part of Eastside Forests, and that it is just as much a part of this environment as the plants and animals and rocks and streams and everything else found in the forest. Historically, fire has been a necessary component for a healthy ecosystem in this part of the West. To support this premise with evidence, students will use the science of dendrochronology, the science of learning about trees and climates from tree growth rings.

Materials: A cat-faced wedge with fire scars, if available; a handout showing a cat-faced wedge with dates noted for each fire scar or plastic laminated photos / posters of cat faces; optional handout for recording number of tree rings/years between fire scars.

Background Information:

A "fire scar" is formed when a part of the tree's cambium (the ring of living cell under the bark) is killed by heat from a fire. If the cambium is damaged only part-way around the tree, the tree often survives. Fire scars are made by low-intensity surface fires that are not severe enough to kill a tree. In years after the fire, new wood forms at the edge of the damaged area.

From the outside, the fire scar looks like a triangular wound coming up from the ground and it is sometimes called a "cat's face." Typically, wildfires burn hotter and longer on the uphill side of a ponderosa pine. They are able to burn in a pocket that may form at the base of the trunk where the roots emerge from the ground, or where the tree has been damaged and flammable pitch oozes from the wound. Year after year, new rings of cambium are formed that gradually curl over the edges of the damaged area and begin to cover it. When the next fire comes along, the fire burns again in the same spot, probably because of pitch that has built up in the wound…and leaves another scar. These scars are not always visible, because over time the bark will also curl over the scars. All the scars become visible when the tree is cut down for some reason, and a wedge is cut from the trunk. (The shape of that wedge resembles a cat's face).

By counting the rings between each scar, we can determine the frequency of fires in the historic forest. After studying 100's of cat-face wedges, scientists have determined that surface, low-intensity fires burned every 6 to 20 years in most locations prior to 1900. Very seldom were there crown fires in the ponderosa pine/fir forests. Very little ground fuel built up on the forest floor and trees were well spaced. After the devastating fires of 1910 in northern Idaho and western Montana, there was a concerted effort to stop every fire that started. Since 1900, people in the West have done a great job of suppressing most wildfires; thus, changing the fire interval pattern. The forests became denser (more trees packed together), more ground fuels built up, and ladder fuels grew under the larger trees. Logging was suspended in most National Forests and lumber mills were shut down which also contributed to denser forests. More trees competing for the LAWS resulted in diseased and dying forests. After 100 years of suppression and lack of any kind of thinning of the forest fuels the forests became more volatile and susceptible to high-intensity fire storms that burned through the crowns of trees…killing most everything.

Procedure: Do not discuss the background information before the students do this activity.

1. Explain to the students the term dendrochronology.

2. Show them the real cat-faced wedge with fire scars and/or provide them with the handout of the wedge.
3. Explain what fire scars are.
4. Tell them that they are going to determine the intervals between fires by looking at the dates of the fire scars. Explain to them that the rings were counted using microscopes with high magnification since the rings are so close together.
5. How old was the tree when it died?
6. Tell the students that ponderosa pines are well-adapted to dry, eastside forest conditions and that fires cannot normally kill them. Review how ponderosas are able to resist fires. However, this tree was finally killed by fire after 300+ years. How did that happen? (The fire got into the canopy and burned the needles…why?)
7. From the evidence of fire scars, we know that fires burned every 6 to 20 years. However, when the last fire burned and killed this tree, it had been over 100 years since the previous fire. Why? What changed the interval pattern? (Settlers moved into the western states & began stopping the fires and the forests became more dense with ladder fuels, and ground fuels, and diseased trees)
8. We now have a dilemma…how can we restore our forests to their natural state? Another discussion for another time…with the understanding that there is no one solution that works for all forests all of the time…

Fire Interval Calculations Student worksheet: See next page (page 14)
Photograph of Cat-Face Tree Cookie (page 15)

Example Fire Interval Calculations
ANSWER KEY

Poster ACTUAL SIZE 13.5 INCHES (4.5 inches in diameter, pith to inner bark).
Birth Year = 1810
Death year= 1994
1994 – 1810 = 184 years old.
Age at first fire: 1822 - 1810 = 12 yrs.

		Fire return interval
# Years between 1st and 2nd fires:	1828 - 1822 =	6 yrs.
# Years between 2nd and 3rd fires:	1834 - 1828 =	6 yrs.
# Years between 3rd and 4th fires:	1854 – 1834 =	20 yrs.
# Years between 4th and 5th fires:	1863 - 1854 =	9 yrs.
# Years between 5th and 6th fires:	1881 – 1863 =	18 yrs.
# Years between 6th and 7th fires:	1886 - 1881=	5 yrs.
# Years between 7th and 8th fires:	1895 - 1886=	9 yrs.
# Years between 8th and 9th fires:	1929- 1895=	34 yrs.
# Years between 9th and 10th fires:	1994 - 1929=	65 yrs

A series of tree cookies with marked fire scars and companion student activity sheets is available at USFS Wildfires! Curriculum PDF, http://www.firelab.org/document/fireworks-curriculum See lessons starting on pages 98
Download the "Fireworks Tree Cookie Book" – a set of fire scar tree cookie photographs at: http://firelab.org/sites/default/files/images/fireworks/Materials_listed_by_curric_activity/chap5_activities/activity5_1/tree_cookies/cookie_book/cookie_book.pdf

Fire Interval Calculations

Photograph of a ponderosa pine tree "cookie" with "Cat Face" scar, collected after the 1994 Tyee Wildfire near Ardenvoir, WA. The "cookie" has an actual size is 13.5 inches in diameter. The diameter of pith to inner bark is 4.5 inches.

1. Find the last ring of growth, next to the bark. (Death year) _____
(minus) -

2. Find the tiny ring at the center of your tree (pith) showing the tree's first year of growth: (Birth year) _____
equals =

3. Subtract the first year of growth from the last year of growth. How old was this ponderosa pine when it was killed by a crown fire? (Tree age) _____ _____

If we start at the pith we can calculate **fire return intervals**, the number of years between each wildfire. Finish the math in the problems below:

(1st fire year) _____	(Year of 2nd fire) _____
(Year of birth) -	(Year of 1st fire) -
Age of tree at first fire _____	Years between 1st & 2nd fires _____
(Year of 3rd fire) _____	(Year of 4th fire) _____
(Year of 2nd fire) -	(Year of 3rd fire) -
Years between 2nd & 3rd fires _____	Years between 3rd & 4th fires _____
(Year of 5th fire) _____	(Year of 6th fire) _____
(Year of 4th fire) -	(Year of 5th fire) -
Years between 4th & 5th fires _____	Years between 5th & 6th fires _____
(Year of 7th fire) _____	(Year of 8th fire) _ _____
(Year of 6th fire) -	(Year of 7th fire) -
Years between 6th & 7th fires _____	Years between 7th & 8th fires _____
(Year of 9th fire) _____	(Year of 10th fire) _____
(Year of 8th fire) -	(Year of 9th fire)
Yrs between 8th & 9th fires _____	Yrs. between 9th & 10th fires _____

Describe the pattern of wildfire experienced by this tree in the 1800s compared to the 1900s.

What could explain decreased number of wildfires between 1929-1994?

Lesson 6: Fire Safety in the Urban Interface

BACKGROUND INFORMATION

Urban Interface: Issues and Actions

The term **urban interface** describes places where people built homes in close proximity to flammable fuels found naturally in wildlands. These wildlands can be forests, hillsides, and valleys. Across most of the western U.S., we see increasing numbers of vacation and permanent homes being built in urban interface areas.

Most forest and urban areas in Washington are served by two types of fire protection agencies. These differ in their response time, equipment, and fire-fighting strategies:

1. City or rural fire departments funded by taxes paid by property owners to protect structures.
2. Wildland government agencies with fire-fighters trained to control wildland fires, with a lower priority to protect structures.

As more homes are built in the urban interface, increasing demands are placed on both types of fire protection agencies.

People living in an urban interface region must understand three essential facts:

1. The presence of their home is a threat to wildlands. People can cause fire.
2. Even one home that is improperly protected from fire can put an entire community or wildland at risk.
3. Living near wildlands involves fire risks not found in urban areas.

People living in urban interface areas have a responsibility to their neighbors and to the environment to protect their home. Home-owners must choose a fire-safe location, design and build fire-safe structures, and protect their surrounding property by practicing fire-safe landscaping and home maintenance. The term **defensible space** is used to describe the property surrounding a home that has been made fire-safe.

Suggested websites to explore:
Firewise Communities: Read the basics of "Defensible Space" at
http://www.firewise.org/wildfire-preparedness/be-firewise/home-and-landscape.aspx

The National Fire Protection Association, to discover steps that homeowners can take to improve their readiness for a wildland fire.
http://www.nfpa.org/safety-information/for-consumers/emergency-preparedness/natural-disasters/wildfires

Lesson 9: Fire Safety in the Urban Interface

TEACHER BACKGROUND, continued

This table was directly excerpted from the USFS *Fireworks!* Curriculum. It explains how the safety checklist used in this activity relates to key fire ecology concepts.

Table 12—Relationship of safety checklist to fire ecology concepts.

No.	Safety Checklist Point	*FireWorks* concepts
1	Is the roof metal or shingle? NOTE that home photo 2 shows shakes, 4 shows shingles, and 9 shows metal roofing.	Fires need fuel. Wood shakes, especially untreated ones, are great fuel.
2	Is firewood and other wood stored away from the house, not touching walls or deck?	Although big logs would be hard to ignite, they would burn long and hot.
3	Are weeds cleared away from the sides of the house?	Weeds dry out in late summer. Dead, dry, “fluffy” material burns easily.
4	Are tree limbs cleared from the roof and around the chimney?	A single match can start a fire. So can a spark from a chimney.
5	Are dead leaves and needles cleaned from the roof and rain gutters?	Fire needs fuel. Dead leaves and needles burn well.
6	Are trees and shrubs 5 m apart or more?	For fire to spread, heat must reach new fuels.
7	Are "ladder fuels" and low branches cleared from underneath big trees?	Heat rises. Saplings and low branches increase chance of crown fire.
8	Is the lawn watered and green, even in late summer?	Green fuels burn less readily than dead, dry fuels.
9	If the house is at the top of a slope, is the "safety zone" 30 m or more?	Heat rises....
10	Is the house on a flat place, or set back from the top of a slope?	Heat rises....
11	Is the road wide enough for a car going out to pass a fire engine going in?	

Lesson 9: Fire Safety in the Urban Interface

SUGGESTED PROCEDURE

Set-up:

- Download and print color copies of the *Houses in the Urban Interface Photo Series* at http://www.wenatcheevalleymuseum.org/2015/our-dry-forests-field-trip-teaching-resources/

- Spread out the photo series (1-12) around the room so students can easily rotate between them.
- NOTE: The photo series, student worksheet, and answer page have been taken directly from USFS *Fireworks!* Curriculum, available as a PDF download at: http://www.firelab.org/document/fireworks-curriculum

- Make extra photocopies of the student worksheet so some students have the option to evaluate additional homes.

Presentation:

1. Introduce and explain the term, **urban interface**. Ask students to think if their own family home or someone they know is situated in an urban interface area. Discuss the recent wildfires that impacted local communities.

2. Explore websites, such as
   The National Fire Protection Association, to discover steps that homeowners can take to improve their readiness for a wildland fire.
   http://www.nfpa.org/safety-information/for-consumers/emergency-preparedness/natural-disasters/wildfires

   Firewise Communities: Read the basics of "Defensible Space" at
   http://www.firewise.org/wildfire-preparedness/be-firewise/home-and-landscape.aspx

3. Now it is the students' turn to evaluate fire risk for urban interface homes.
4. Advise students that they may not be able to answer every question for every picture because the photo only shows some of the features on the checklist. It's all right to check "can't tell" on the checklist.
5. Allow students to move around the room to view the 12 photos.
6. Upon completion, ask for a report for each photo as a class activity. Invite students who evaluated a home to identify one feature of the home that needs to be fixed to make it fire-safe.

ASSESSMENT-WRITING

OPTION 1: Ask students to select one of the homes from this activity. Write a letter to the home-owner. Explain your observations. If you think the home's safety needs improvement, tell the home-owner how to improve it.

OPTION 2: Ask students to evaluate their own home using the checklist. Write a letter to your parents. Explain your observations. If you think the home's safety needs improvement, tell your parents how to improve it.

Lesson 6: Fire-safety in the Urban Interface

Photo Number: _____

Put a check in the "yes," "no," or "can't tell" column.

		Yes!	No!	Can't tell
About the House:				
1	Is the roof covered with metal or asphalt shingles (not wood shakes)?			
2	Are firewood and other wood stored away from the house, not touching walls or deck?			
3	Are weeds cleared away from the sides of the house?			
4	Are tree limbs cleared away from roof and chimney?			
5	Are dead leaves and needles cleaned from roof and rain gutters?			
Around the House (safety zone, within 10 m):				
6	Are trees and shrubs 5 m apart or more?			
7	Are ladder fuels and low branches cleared from underneath big trees?			
8	Is the lawn kept green, even in late summer?			
9	If the house is at the top of a slope, is the safety zone 30 m or more?			
About the Location:				
10	Is the house on a flat place, set back from the top of a slope?			
11	Is the road wide enough for a car going out to pass a fire engine coming in?			
Count the checks in each column:				

Write a list of action steps would you recommend to this homeowner in order to decrease the future fire risk for this home?

Lesson 9: Fire-safety in the Urban Interface

ANSWER KEY- Photos 1-12 Checklists

Table 13—Assessment of fire hazards around wildland homes. Numbers in the table refer to numbered safety criteria in Table 12, at the beginning of this lesson.

***Question marks indicate that the criterion was difficult or impossible to assess from the photo.**

Home No.	"Yes!"—Looks safe because...	"No"—Needs improvement because...	Can't tell or doesn't apply
1	2, 3, 5, 6(?*), 8, 10	1, 4(?*), 7	9, 11
2	2(?*), 5, 8(?*), 10	1, 3, 4, 6, 7	9, 11
3	8, 10	1(?), 2, 3(?), 4, 5, 6, 7	9, 11
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	none	none
5	10(?)	3, 4, 6, 7, 8	1, 2, 5, 9, 11
6	3, 4(?), 7, 10	1, 2, 5, 6, 8	9, 11
7	1, 2(?), 4, 5, 6, 7, 10	3, 8	9, 11
8	1(?), 2, 10	3, 4, 5, 6, 7, 8	9, 11
9	1, 3, 5, 10	2, 6, 7, 8	4, 9, 11
10	2(?), 4, 8	3(?), 7, 9, 10	1, 5, 6, 11
11	1, 2, 3, 4, 5, 6, 7, 8, 11(?)	none	9, 10

Introduction Example, using photo 12:

12	4(?*)	1,2,3,5,6,7,11(?*)	8, 9, 10,