13. Tree Identification: Create a Dichotomous Key

Lesson Overview: In this activity, students use photographs and botanical specimens to create a *dichotomous key* for 12 tree species native to montane forests of the Sierra Nevada.

Lesson Goal: Increase students' ability to identify some of the important tree species native to the montane forests of the Sierra Nevada and to increase their understanding of characteristics that can be used to identify trees.

Subjects: Science, Speaking and Listening, Writing
Duration: One 30-40 minute session
Group size: whole class/groups
Setting: Classroom
New FireWorks vocabulary: *dichotomous key*

Objectives:

- Students will use species names, botanical specimens, and photographs to create a dichotomous key for 12 tree species.

Standards:		9th	10th	11th	12th
CCSS	Reading: Informational Text	2,4,10		2,4,10	
	Reading: Science and Technical Subjects	2,4,7,9,10		2,4,7,9,10	
NGSS	Interdependent Relationships in Ecosystems	LS4.C			
EEEGL	Strand 1	B,C,E,F,G			

Teacher Background: A wildland ecosystem is characterized by diversity. The diversity of tree species is an important characteristic of forests and influences to the kinds of fire that occur in those forests. To understand the complexity of fire's role in forests, students must be able to distinguish among tree species. In this activity, students use their observation skills to create a dichotomous key for 12 important trees in the montane forests of the Sierra Nevada. An example of a key for these 12 species is included at the end of the activity, but each student's (or team's) dichotomous key will be unique, depending on their observations.

In the activity, students actually construct 3 keys:

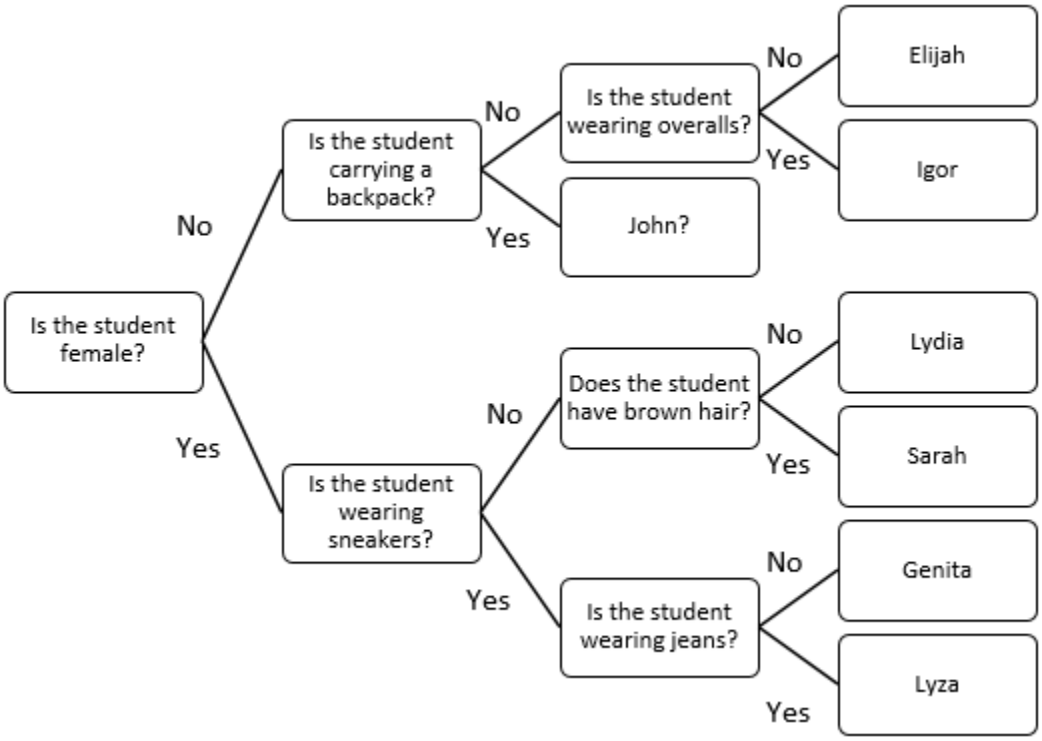
- a key to be used by a new student for identifying some members of the class;
- a key that could be used to identify different types of pasta (this one is optional – may not be needed by your students – see Steps 8-10 below);
- and finally, a key for identifying 12 tree species.

Materials and preparation:

- Decide how you will have students work on the keys – individually, in pairs, or in larger teams. This will determine how many cups of mixed pasta you need to prepare for Steps 8-10.
- Assemble 12 stations in the classroom, each with the following items for each tree species (all in the trunk):
    - Photos for that species from **H13_TreePhotoPacket.pdf** (also available online). Two pages of photos for each species, labeled with the species name.
    - Tree Bark/trunk specimen
    - Cone or flower specimen
    - Foliage specimen
    - Species name label
    - Ruler
- Provide some field guides of your own or from a library for students to examine – or find examples online.
- Obtain:
    - Empty cups or bowls (1/student or team)
    - Uncooked pasta (at least 4 different types), enough so each student/team can get at least 1 piece of each type of pasta
- Put a mixture of pasta types in each cup (1 cup/student or pair or team)

Procedure:

1. Ask: What tree species live on the mountainsides of the Sierra Nevada? Open-ended discussion. You could list species names on the board. Names of classes of trees (pines, oaks, firs, etc.) would also be good.
2. Ask: When you see a person in school or a tree in the woods, how can you identify him/her/it? We use distinguishing characteristics, that is, traits that are unique to that person or thing or group.
3. Let's figure out a way to help a new student at school identify some of our class members. We're going to build a *dichotomous key.* The new student will be able to go through a series of yes-no choices about characteristics of the class members. The choices will lead the new student to the right name for each person in the key.
4. Select eight volunteers. Write the key on the board as it develops. Provide the first question (e.g., "Is the student female?") and have students create the rest of the key until all eight students are identified. Here is an example of a dichotomous key for identifying 8 students:



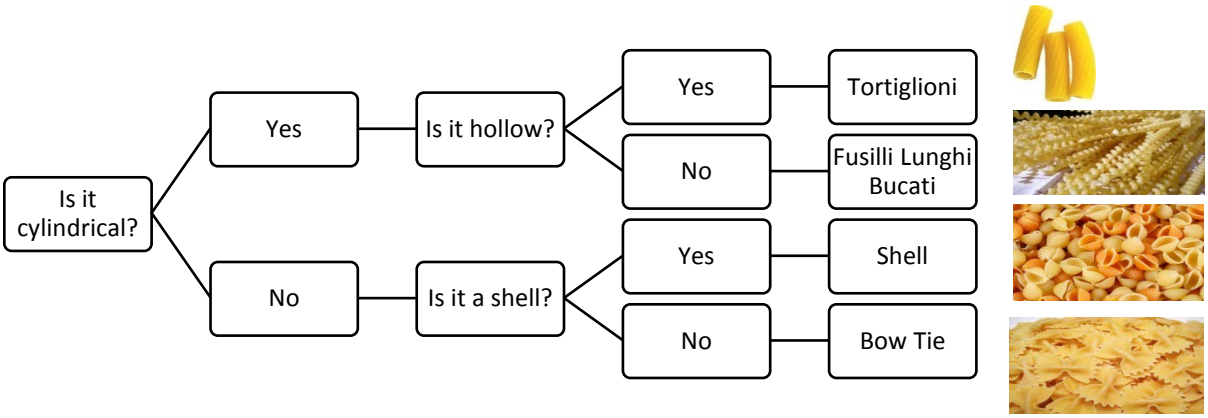
5. Explain: Dichotomous keys usually contain additional information in a narrative description that can be used to verify the identification. What additional information would you offer so the new student can confirm his/her identifications and learn more about his/her new classmates? Example narrative for the key above to describe Igor: "Igor is a male student who is 6 feet tall, has brown hair, and lives in Quincy, CA. Igor does not carry a backpack and wears overalls."

6. Ask: Do you see any problems the key you created? For example, will it work tomorrow if everyone changes clothes? … if they dye their hair or shave their heads? A key should be based on characteristics that do not change much from day to day or season to season or even year to year (unlike the example provided).

7. Explain: We've just built a key for identifying **individual people**. In the sciences, keys are used for identifying whole **groups of things** – people, rocks, plants, animals, micro-organisms, etc.

8. **TEACHER: IF YOU THINK STUDENTS ARE READY TO MAKE A KEY FOR 12 (or 6) TREE SPECIES, GO TO STEP 11. IF YOU THINK THEY NEED SOME PRACTICE, DO THIS PASTA-IDENTIFICATION ACTIVITY:** Let's practice by building a key for 4 types of pasta. The key will consist of a series of two choices (hence "dichotomous" - from Greek, *dich-* ("in two") and *temnein* ("to cut")) that will lead the user to the correct name for each kind of pasta. At each choice point, the user examines a characteristic of the pasta and picks the answer that best describes it ("yes" or "no"). This brings the user to a new choice point, and the process continues until the user can identify the unknown pasta.

9. Give each student (or team) a cup containing at least four different types of pasta. Ask them to create a dichotomous key for the types of pasta in the cup and – for 2-3 kinds - to create a narrative description 2-4 sentences long. Here's an example:



Example Descriptions:
Tortiglioni: A pasta that is cylindrical and hollow. It is often eaten with tomato sauce.
Fusilli Lunghi Bucati: A pasta that is cylindrical but not hollow. It takes 8 minutes to cook.

10. Have students or teams exchange keys, use them to sort the pasta, and comment on how well they worked, any points that were confusing, etc.
11. Explain: We're going to work individually (or in teams) to create a dichotomous key for some important tree species that grow in montane forests of the Sierra Nevada. We'll identify only 12 species, even though the keys used by professionals (land managers, ecologists, botanists, wildlife biologists, microbiologists) cover ALL of a kind of organism – often hundreds or even thousands of kinds.
12. Either distribute copies of a few field guides with dichotomous keys or show examples from the internet. Pass them around so students can see what a dichotomous key looks like and how it is used.

Assessment:

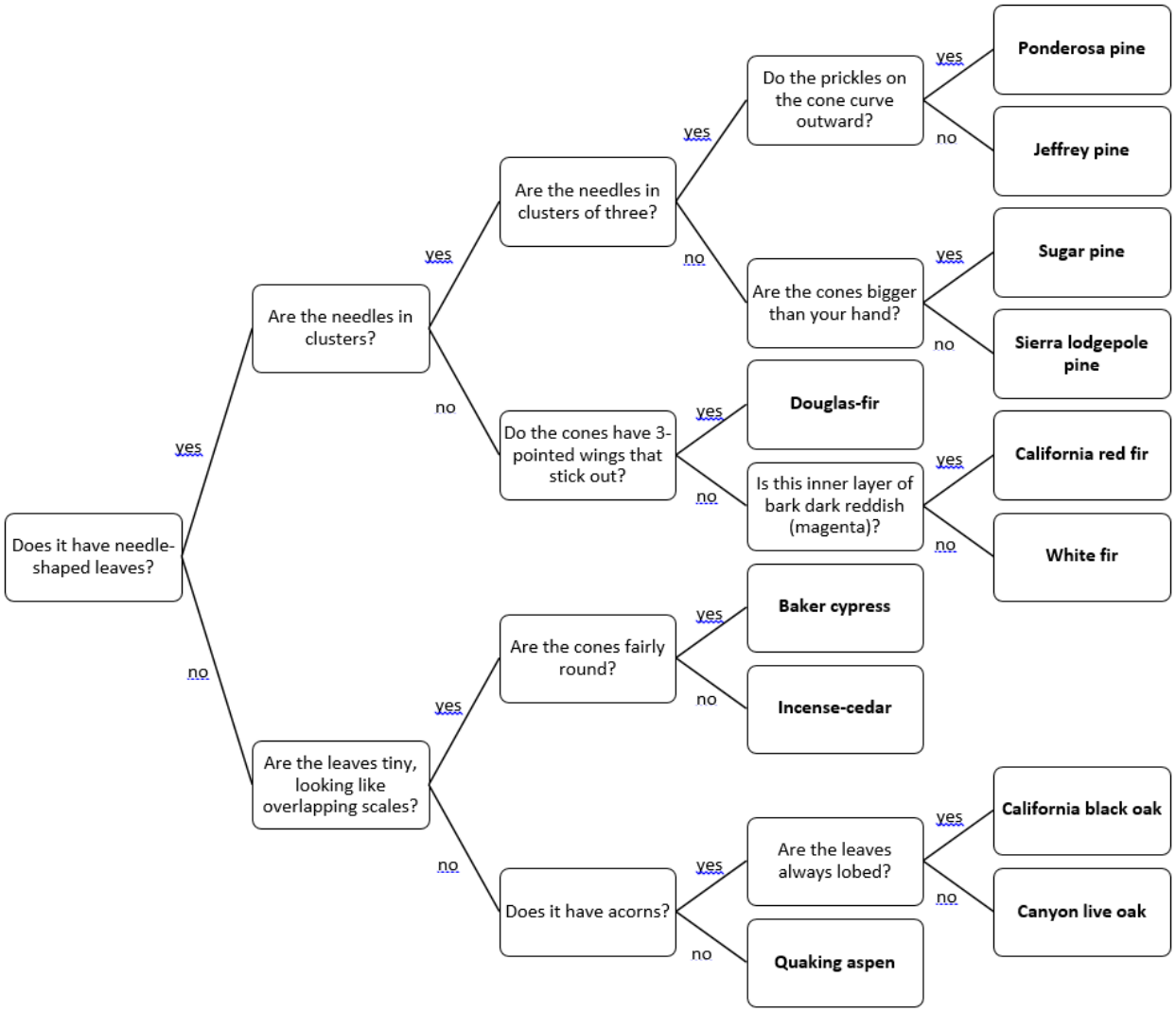
1. Explain: You will create a dichotomous key for 12 important tree species that occur in montane forests of the Sierra Nevada. Alternatively, split the class and the specimens into two groups, and have students create a key for six of the tree species. We'll refer to the trees often in the rest of our fire-related activities, because they all have different ways of dealing with fire. Each station has 2 pages of photos that show characteristics of 1 species and also the species name, plus a collection of botanical specimens (cones/flowers, bark, and foliage) for that species.

2. Circulate among stations to observe characteristics that are unique to a few species or even a single species. Take notes on these distinguishing characteristics.
3. Work with paper and pencil to create a draft of your key. Go back to the photos and specimens to fine-tune the key. The process will probably require several iterations and some erasing.
4. When you think you're done, have another student or team try your key out to see if it is accurate and can be used easily. If you split the class into two groups, have students exchange keys with someone in the other group to see if it can be used easily.
5. Make a clean copy of your key for evaluation. It can be digital[1] or done by hand. It can use text only (like most field guides), or include graphics (like the pasta example).
6. Along with your key's diagram, provide a narrative description of each tree species (2-4 sentences) that can be used to confirm the identification.

Evaluation:	**Excellent**	**Good**	**Fair**	**Poor**
Dichotomous key	Created clear and accurate key and descriptions for 11-12 (or 5-6) species.	Created clear and accurate key and descriptions for 9-10 (or 4-5) species.	Created clear and accurate key and descriptions for 7-8 (or 3-4) species.	Created key and descriptions for 6 (or 3) or fewer species. ~or~ Created an inaccurate and confusing dichotomous key.

[1] Tip: If students want to create their keys in Microsoft Word, they can use the *Insert* tab, select *SmartArt* in the *Illustrations* box, select *Hierarchy*, and then select *Horizontal Hierarchy*. This will set up a template similar to the one used in the examples used in this activity, but students will still need to learn the basics of adding shapes (mostly by "add shape below") and formatting to make it into a dichotomous key.

Teacher's Example:
Dichotomous key and tree descriptions for 12 tree species



Narrative Descriptions

Baker cypresses have tiny leaves that look like overlapping scales. The trees' bark is thin and reddish-brown. The cones are round and are sealed closed by a hard, waxy coating.

California black oaks have leaves with lobed (curvy) edges. The leaves fall off each winter. Adult trees have thick, rough bark. Like all oaks, they produce has acorns.

California red firs have short needles and brown, furrowed bark. If you break off a chunk of bark, you will see a deep red color. The buds at the ends of their twigs are round. Cones are on the top of

the tree, and they stick straight up. The cones fall apart easily, so you rarely see whole cones on the ground. California red fir needles are typically shorter than those of white fir.

Canyon live oak leaves are often oblong and have smooth edges, but they can also have pointy teeth along their edges. The leaves are evergreen, so they do not fall off in the winter. The trees' bark is thin and flaky. Like all oaks, the trees produce acorns.

Douglas-firs have short, flat needles and brown, furrowed bark. The buds at the ends of their twigs are pointy. Their cones have little, 3-pointed "wings" that stick out from under the cone scales. It looks like tiny mice are trying to burrow in, but they can't hide completely!

Incense-cedar leaves look like overlapping scales, and their twigs look a little like fern fronds. Adult trees have thick reddish-brown bark with deep furrows. Narrow strips hang loose from the trunk. Cones are at the tips of leaves. Male cones are small and roundish. Female cones are a little larger; at the end of the summer, they flare open and release their seeds. Then they look like stiff brown flowers.

Jeffrey pines have long needles that usually grow from the twig in clusters of 3. Their cones are big. The cones have prickles that point inward. The trees' bark is yellowish or brown, sometimes even orange. It falls off in pieces that look like they belong in a jigsaw puzzle. Jeffrey pines produce a vanilla-like smell, especially in the springtime. Jeffrey pine needles and cones are typically bigger than those of ponderosa pine.

Ponderosa pines have long needles that usually grow from the twig in clusters of 3. Their cones are big. The cones have prickles that point outward. The trees' bark is yellowish or brown, sometimes even orange. It falls off in pieces that look like they belong in a jigsaw puzzle. Ponderosa pines produce a vanilla-like smell, especially in the springtime. Ponderosa pine needles and cones are typically smaller than those of Jeffrey pine.

Quaking aspens have roundish leaves with a pointed tip. Their leaves move almost constantly because they are very sensitive to wind. The leaves turn yellow and fall off in the fall. The trees' bark is mostly grayish-white and smooth, although old trees can have furrowed bark down near the ground. Aspen seeds are packaged with cottony fluff that helps them float on wind and water.

Sierra lodgepole pines have needles that grow from the twig in clusters of two. They have fairly thin, rough bark. The cones are about as long as the needles, and they open when their seeds are ripe. Sierra lodgepole pines grow high in the mountains.

Sugar pines have needles that grow from the twig in bundles of five. The trees grow tall and have thick, furrowed reddish-brown bark. Their cones are very long, often longer than a foot. Their branches spread wide from the trunk, and the cones dangle from the ends of the branches.

White firs have short needles. The bark on young trees is gray and smooth. The bark on old trees is gray with deep furrows that have orange streaks inside. If you break off a chunk, you will see a yellowish or orange color. The buds at the ends of their twigs are round. Cones are on the top of the tree, and they stick straight up. The cones fall apart easily, so you rarely see whole cones on the ground. White fir needles are typically longer than those of California red fir.