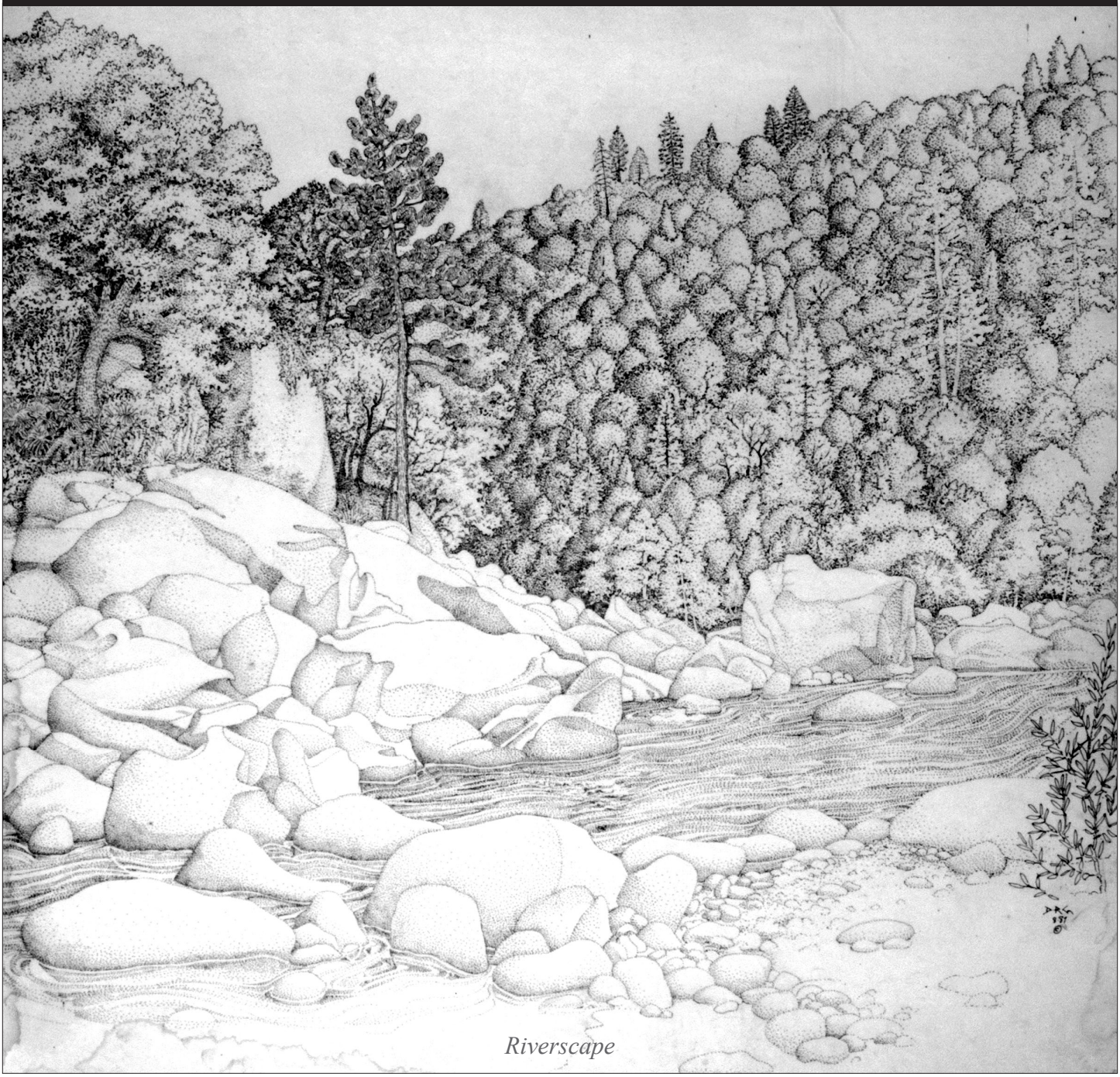
The Nature of This Place Curriculum Guide



Riverscape

Living Systems Unit Topics: To fit with the overall mission of the Yuba Watershed Institute, particular focus is given to watershed health, local ecology, and conservation by emphasizing basic identification of local flora and fauna, background on endangered and threatened species in the region, and discussion of disturbances and threats to the area such as fire and invasive species.

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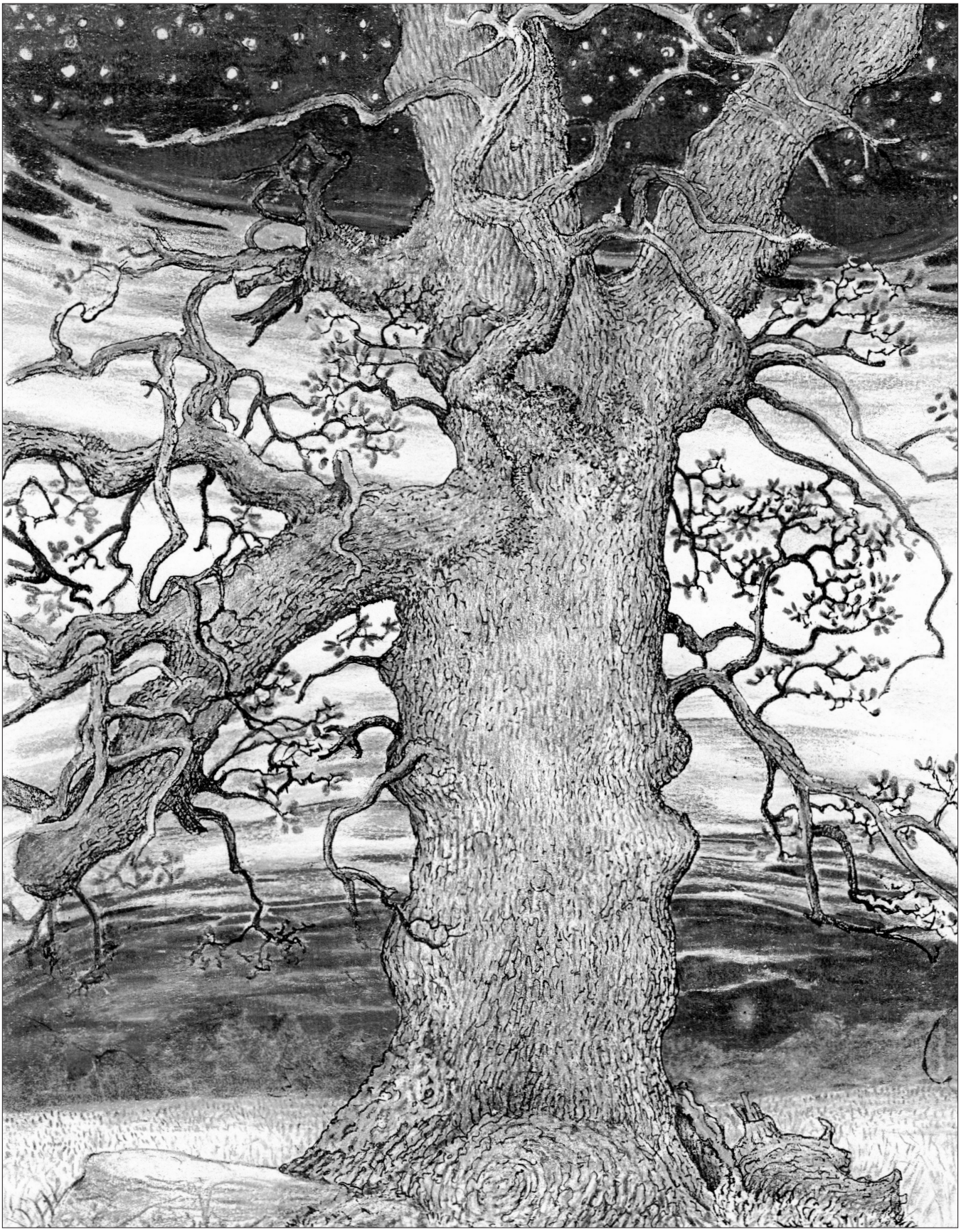
Curriculum developed for educational purposes by the Yuba Watershed Institute, www.yubawatershedinstitute.org, and written by Rachel Durben of the Sierra Streams Institute, www.sierrastreamsinstitute.org, in partnership with the Twin Ridges Elementary School District. Curriculum funded by the Teichert Foundation and published by Flicker Press, www.flickerpress.com. Illustrations by Randy Griffis.

The Oak and the Night Sky



This illustration can be copied and used for coloring.

The creation of a thousand forests is in one acorn. — Ralph Waldo Emerson

LESSON 1 Plant Ecology of the Sierra Nevada

Who Eats Acorns?

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology, Nutrition - Cross Curriculum: Art, English Language Arts, Math	use of acorns, acorn nutrition, oak diversity	K-2	Two 15-minute class periods	life cycle, nutrition, cache
Main Concepts and Overview	Students create art out of acorns and other objects from nature to demonstrate the many different types of animals that eat acorns. They discuss the importance of oak trees and the nutritional value of acorns as food.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): K: **Science** - 2a,c; 4a,b,e **Math** - K.CC **ELA** - W.K.3; L.K.6 1st: **Science** - 2a,b,c; 4a,b **Math** - 1.MD **ELA** - W.1.2,3; L.1.6 2nd: **Science** - 2b,f; 4d **Math** - 2.MD **ELA** - W.2.2,3; L.2.6			

Background Information: Acorns are the seeds from oak trees. From an acorn, an oak tree will grow, first into a tiny seedling, then into a large mature tree that will produce its own acorns. All of these stages together make up the oak **life cycle**, a series of stages through which the tree passes during its lifetime. If time permits, draw a simplified oak lifecycle on the board so students can see the progression from acorn to seedling to tree.

The acorns that oaks produce are a very nutritious food for lots of animals, including humans. So what does this mean? **Nutrition** is the process by which animals use certain elements in food (ex. fats, proteins) to help them grow and stay healthy. We can tell that acorns provide a lot of nutrition because so many different animals like to eat them. Squirrels and birds like them so much that they store them underground over the winter in special areas called caches. A **cache** (pronounced "cash") is a hiding place, usually in the ground, for food or other important items. Sometimes animals will forget the location of a cache and then the forgotten acorns can grow into an oak tree!

There are five main types of oak trees that grow in the Sierra Nevada, and all of them produce edible acorns. Native Americans in the Sierra Nevada thought that California black oak had the sweetest acorns. They used rocks to grind the acorns and then soaked them in running water to remove the bitterness. With a little more time, your class can make a flour that can be used in nutritious muffins, breads, or cookie recipes.

Preparation Time	Materials	Location
10 minutes to gather art supplies	A variety of art supplies (ex. ribbon, string, pipe cleaners, construction paper, paint), glue and/or tape, *John Muir Laws Field Guide to the Sierra Nevada* Extension activities, two rocks to crack acorns, *Living Wild*, *In a Nutshell* (see Resources)	In the classroom and outside, in an area with oak trees

Activities and Extensions:

Activity Part I: Have the students stand in a circle. Read the descriptions below and have them act out the life cycle of an oak tree.
- Curl up in a tight ball – you're a seed
- Uncurl and kneel – you've sprouted
- Stick up one arm, then the other with fists clenched – you've grown a branch
- Wiggle your fingers – you grow lots of leaves
- Stand up with feet together – you grow tall
- Spread feet apart – you spread out lots of roots
- Shake your hand – seeds are released and the life cycle begins again

Activity Part II: Brainstorm and make a list of who eats acorns (ex. deer, squirrels, chipmunks, jays, people). How many animals can you think of? Now, go outside and collect acorns! Be sure there is at least one acorn per student, but you can use as many as you like. Try to get different shapes and sizes, from under different types of oak trees. Using the *John Muir Laws Field Guide to the Sierra Nevada* (see Resources), you can identify the different oak species if you have time. Also collect other nature objects, such as pinecones, pine needles, leaves, flowers, and twigs. These will be made into your acorn eaters. Try to mostly use things that have already fallen to the ground, but if you pick living parts of plants, do so gently and sparingly to avoid damaging them.

Ask each student to make at least one acorn eater from the list. Encourage them to be creative with the objects they collected, but to try to make their acorn eaters look somewhat like the real animal. Attach one acorn to each creature using string, ribbon, pipe cleaners, or whatever art supplies are available. The bird may have an acorn in its mouth, the squirrel may hold it in its arms, and the human may have an acorn in its hand or on a plate. Display these projects together and count how many animals you created that rely on oak trees and their acorns for food!

Extension I: Demonstrate how Native Americans cracked and processed acorns to use them as a food. Set an acorn on one rock and use another rock, or hammers and cutting boards, to split the hull of the acorn. Explain that the acorn must be soaked in water for a week, changing the water twice a day, before it can be eaten. As time permits, crack acorns, rub off as much of the red skin as possible, grind them into a coarse powder, and put them in a large jar of water to soak (about ¼ acorns to ¾ water). Change the water every day for up to two weeks, and once the water is clear, taste to test for bitterness. If it is still bitter, continue daily water changes.

To make the flour, either dry in the sun, or bake in the oven at 250^{o} for 30 minutes. Finely grind the nuts, then use the flour for baking or store in the freezer. See *Living Wild*, (Resource section) for acorn recipes.

Extension II: Read aloud, *In a Nutshell* (Resource section), to explain the life cycle of an acorn.

Discussion and Take Home Message: Oak trees are important to many animals, including humans. They provide food and shelter, shade and wood. Think about ways in which you can help care for oaks and the communities that they support. What could you do as a class to support your local oak trees? (ex. plant acorns, remove invasive species, protect seedlings from being eaten by installing netting or fencing around them, recycle to reduce demand for new wood/paper products.)

Skills and Concepts: Listing, Constructing, Creative Writing, Counting

School Campus Field Guides

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Art, English Language Arts, Math, History	vegetation diversity, native and non-native species	3-5	One 30-minute class period	native plants, non-native plants, invasive plants
Main Concepts and Overview	Students draw and write descriptions of native plants to create a field guide of the school campus. They compare native and non-native species and brainstorm ways to use this information in future projects.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 3rd: **Science** - 3b,c,d; 5c **Math** - 3.MD **ELA** - SL.3.1; L.3.6 4th: **Science** - 2a,b; 3a,b,c; 6b **Math** - 4.MD **ELA** - SL.4.1; L.4.6 5th: **Science** - 6a,b,c,f,h **Math** - 5.MD **ELA** - SL.5.1; L.5.6			

Background Information: What does it mean when we talk about "native" plants? A **native plant** species is one that occurs naturally in a particular location without any type of action from humans. For example, California black oaks have been in the Sierra Nevada for thousands of years, without ever having to be planted by people. Native plants are well adapted to their environments and are part of a complex community, including the animals that depend on them, the soil that they grow in, and the other plants that grow near them. What are some other native plant species you can think of?

Native people, such as the Nisenan and Maidu Tribes, relied upon native plants for food, medicine, art, shelter, and many other purposes. They gathered acorns from oak trees and made them into a nutritious acorn meal. They used the leaves of California Bay to keep bugs away from stored acorns and built bark houses from the Incense Cedar tree. They tended and collected the native plants that provided them food and health to ensure their abundance in years to come.

In contrast with native plants that have developed over hundreds or even thousands of years to become a part of the balance of nature, humans have introduced **non-native plants** to places where they did not previously grow. Some non-native plants do not survive without continued human intervention, but some can grow very quickly and reproduce in large numbers. These are called **invasive plants** and can be very disruptive to ecosystems, taking over the landscape and harming native species. One very common invasive plant in the Sierra Nevada is Scotch broom. It produces thousands of seeds per plant, takes over entire hillsides, and is a very serious fire hazard. Can you think of other invasive plants in your area?

Using your observational skills, make a field guide to represent all of the native plants in an area of your school's campus. If time permits, create a map of all of the native and invasive plants in this area and use it to come up with future projects!

Preparation Time	Materials	Location
5-10 minutes	A variety of art supplies (ex. ribbon, string, pipe cleaners, *John Muir Laws Field Guide to the Sierra Nevada*, notebooks, pens/pencils/colored pencils	Outside, in an area with lots of plant diversity

Activities and Extensions:

Activity: Using the *John Muir Laws Field Guide to the Sierra Nevada* as an example, create a field guide to your campus plants. Go outside and choose a single plant to focus on. Each student should choose a different type of plant so you can have as much diversity as possible for your class-created field guide. Once you have chosen a plant, figure out if it is native or non-native. Make note of non-native plants, but only draw the details of native vegetation. Pay attention to any parts of the plant that may be helpful in identifying it. For example, does it have unique leaves, flowers, or bark? Does its size or shape make it different from other kinds of plants? Draw the plant in as much detail as possible and be sure to include some kind of scale. If it's not practical to measure the height, include a drawing of a person next to the tree to provide perspective on how tall the plant is compared to a person (ex. if it's a tree that seems to be the height of three adults, show a drawing of a person next to the tree and make that person 1/3 the size of the tree).

Label the drawing with as accurate a name as possible for the plant. Write some descriptive details, such as the color of flowers, texture of bark, and shape of leaves that will help with identification. Also include information on habitat. Is it growing in a shady or sunny spot? Is it rocky or sandy soil? Is it on a steep slope or in a flat area?

When you return to the classroom, assemble the drawings into one booklet. Come up with a good title and work together to design a cover page. Your class has now created a field guide to native vegetation on the school campus.

Extension: Using the information the class collected for the field guide, construct a map of the vegetation on campus. By measuring the distance between plants and from landmarks such as buildings, create the map to scale on graphing paper. Alternatively, you can make a large map on butcher paper to hang in the classroom. Keep the mapped area small so you can include lots of details. Use this map to answer some questions such as: How many oak/pine/madrone trees are there on campus? How many different types of vegetation are present? How many native plants are in the area? How many are non-natives? Do we have invasive species on the school campus that need removing? What areas need restoration work?

Discussion and Take Home Message: There is great diversity in the types of plants that grow on the school campus. This plant diversity supports a variety of wildlife, including birds, mammals, and insects. Native plants have become adapted to interacting with this wildlife, in this ecosystem for thousands of years. They have developed complex relationships with both the living (animals, other plants) and non-living (soil, water) components of their environment. Non-native plants can disrupt this balance by competing with native species and changing the interactions within an ecosystem. Protect and nurture the native Sierra Nevada plants on the school campus and help out with restoration projects to remove invasive species whenever possible.

Skills and Concepts: Observing, Drawing, Analyzing, Mapping, Comparing

Schoolyard Oak Diversity

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Math, Geography	oak identification, species diversity, data collection	6-8	One 30-minute class period	endemic, evergreen, deciduous, circumference, diameter
Main Concepts and Overview	Using observational skills and measurement tools, students identify and collect data on native oak trees. They then graph and analyze the patterns present in these data to identify characteristics of each oak species.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 6th: **Science** - 5e; 7a,b,c **Math** - 6.EE; 6.SP **ELA** - SL.6.1; L.6.6 7th: **Science** - 7a,c,d **Math** - 7.EE; 7.G; 7.SP **ELA** - SL.7.1; L.7.6 8th: **Science** - 9a,d,e,f **Math** - 8.EE; 8.G; 8.SP **ELA** - SL.8.1; L.8.6			

Background Information: Throughout California, there are more than 20 native oak species which cover around 10% of the landscape. Some of these species can be found growing in a variety of places across the country, but others are **endemic** to California, meaning they are native here and naturally occur nowhere else. Five of these species occur in the Sierra Nevada. These trees produce acorns, which are highly nutritious and provide food for a number of animals, including deer, rodents, birds, and humans. Oak trees also provide shelter and nesting sites for many animal species and are a preferred building material for many humans.

But with so many different types, how can you tell them apart? "Live" oaks, such as canyon live oak and interior live oak are considered **evergreen**. This means that they keep their leaves all year long, even in the winter. California black oak, blue oak, and valley oak are **deciduous** trees, losing their leaves in the fall and growing an entire new set of leaves in the spring. Each species of oak has a slightly different shape to its leaves and may have other distinctive features to help with identification, such as bark color and texture, tree shape and height, and acorn size and shape.

Healthy oak woodlands and forests should be made up of a variety of different species, with different age classes of each species. One way to get an idea about the variety of tree age classes is to measure certain characteristics such as height, **circumference** (the boundary around a circle), and **diameter** (the length of a straight line that passes through the center of a circle and connects two points on the circumference). You can measure the circumference of a tree trunk by encircling the trunk with a tape measure and recording the distance. The diameter can then be calculated by using the equation: Diameter = Circumference / π.

Although these measurements may vary between different environments (trees in more drought-prone areas may be smaller than trees of the same age growing in wetter climates due to limited resources), we can generally assume that within one environment (such as your school's campus), larger trees are older than smaller trees of the same species. What kind of oak diversity exists on the school campus?

Preparation Time	Materials	Location
10 minutes to gather materials, make copies of oak species identification key	sharpened pencils, tape measure, notebooks, or *John Muir Laws Field Guide to the Sierra Nevada*, chalkboard or whiteboard in classroom	on school campus in a wooded area with lots of oak trees

Activities and Extensions: In your notebook, make a table in which to record data. You will need four columns with the headings "Species," "Height," "Circumference," and "Diameter." Using a field guide, find and identify five oak trees. Record these into your notebook, under the "Species" column. Following the directions below, measure the height, circumference, and diameter of each tree you identified and record those measurements in the appropriate spaces.

While students are outside, they can collect acorns, either from the tree or directly underneath it, to ensure they are collecting acorns from the same tree they identified. Keep different oak species separate from one another. These may be used in a later lesson and can be saved until then.

Measuring Tree Height

Here is a simple way to measure the approximate height of a tree. You will need a sharpened pencil, a tape measure and a partner.

1. Starting at the base of the tree, step backward (be careful!) until you are further away from the tree than the tree's base is from its top.
2. Ask your partner to stand next to the tree's base.
3. Hold a pencil straight up by its point. Close one eye and hold the pencil so it lines up with the tree.
4. Move yourself forward and backward until the pencil looks as tall as the tree. Without moving your arm, turn the pencil sideways (keep your thumb lined up with the tree trunk) so it looks as if it is lying on the ground. The pencil is to be held from the base of the trunk to the side of the tree, so the partner walks away from the tree to either the right or left, at a right angle to the tree trunk.
5. Ask your partner to walk away from the tree in the direction of the pencil. To you it will seem as if your partner is walking along the pencil. Tell your partner to stop when it looks like he or she is lined up with the end of the pencil.
6. Measure the distance between your partner and the tree's base. This will be the approximate height of the tree.
7. Record this value in the "Height" column of your notebook.

Measuring Tree Circumference and Diameter

Review the equation for diameter: Diameter = Circumference / π

To find the circumference of a tree, stand on the uphill side of the tree's trunk and measure from the base up to 1.4 meters (4.5 feet). Then, using a tape measure or a piece of string that you will later measure circle the trunk at that height and note the measurement. Record this measurement in the "Circumference" column of your notebook. You can then calculate the diameter of the tree by dividing the circumference by π (3.14). Record this value in the "Diameter" column of your notebook.

Extension: When you return to the classroom, have all of the students decide on a hypothesis regarding a specific characteristic they recorded (ex. black oak are the tallest trees). Now, record their measurements onto the board. Organize the trees by species. Now, have the students graph the various measurements and compare: Which species has the tallest trees? Which has the greatest circumference and diameter? Why do you think this may be?

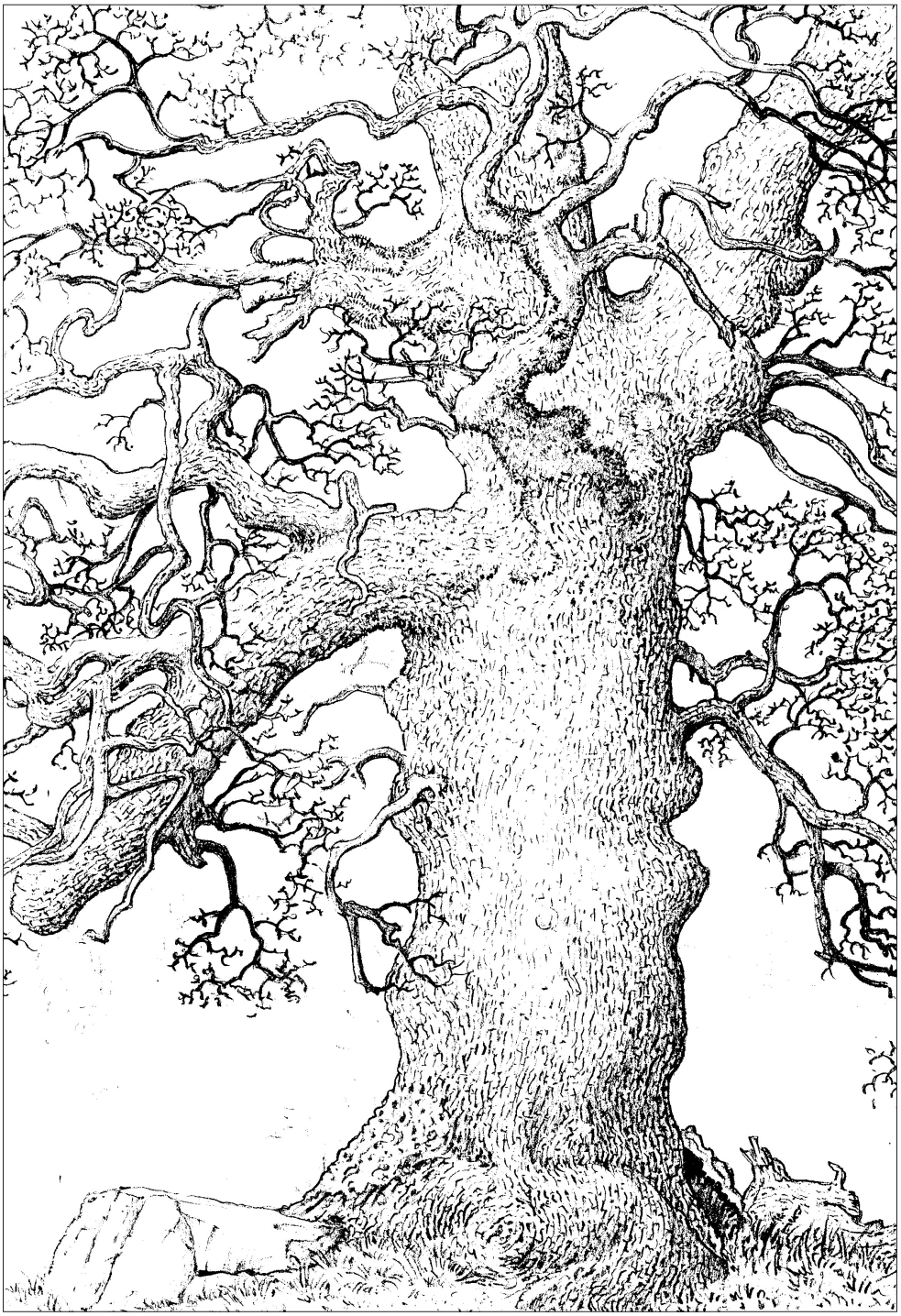
Discussion and Take Home Message: Oaks are a valuable resource for hundreds of species, including humans. The diversity of oak species and size classes within each species provides a huge variety of options for species to utilize. For example, some oaks produce huge numbers of acorns every few years (masting). If several different age classes and species of oaks exist in an environment, their masting will be staggered, producing large acorn crops at more regular intervals than would be possible if all oaks in an area were of the same species and age. Different sizes of trees are also beneficial to wildlife because some

animals prefer young, shrub-like oaks for nesting and forage, while others will only nest in tall, mature trees, and still other species (like woodpeckers) prefer to build their nests in old, decaying oak trunks.

What are some threats to oak populations (ex. development, disease, overgrazing by livestock and wildlife)?

What can you do to help declining oak populations (ex. plant acorns, protect and restore the habitat of healthy oak populations)?

Skills and Concepts: Observing, Recording, Measuring, Charting, Graphing, Computing, Comparing



Oak Tree

The cycle of the salmon's journey reminds us that all rivers flow to the same sea. — Lynn Noel

LESSON 2

Salmon Life History

A Chinook's Journey

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Art, Math	salmon life cycle, migration, and natural history	K-2	Two 15-minute class periods	life stage, estuary, smoltification, migration, redd
Main Concepts and Overview	Through constructing a visual representation of the salmon's life cycle, students learn about the different life stages, migration, and natural history of Chinook salmon.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): K: **Science** - 2a,c; 4a,b,c,d,e **Math** - K.CC **ELA** - SL.K.2; L.K.6 1st: **Science** - 2a,b,c; 4a,d **Math** - 1.MD **ELA** - SL.1.2; L.1.6 2nd: **Science** - 2a,b,c,d; 4d **Math** - 2.MD **ELA** - SL.2.2; L.2.6			

Background Information: Salmon have a very complex life cycle that starts in a river, moves to the ocean, then comes back to the river again. Each different form that the fish has in this life cycle is called a **life stage**. Chinook salmon, which are found in the Yuba River, have six different life stages: eggs, alevin, fry, smolt, adult, and spawning adult. Think of the salmon life cycle as a circle, where the eggs are both the beginning and the end of the life cycle.

First, eggs laid in the gravel hatch into baby salmon, called alevin, and begin a new life. Alevin have a yolk sac connected to their bellies that provides all the food they need for their first few weeks of life. Alevin stay in the gravel to avoid being eaten by bigger fish. Once alevin have grown and absorbed their yolk sacs, it becomes the next stage, a fry. Fry swim up out of the gravel and into the river, where they begin to journey downstream. As they're traveling downstream, fry eat small animals in the water in order to grow and become stronger swimmers.

Once the fry reach the mouth of the river, they enter a new life stage, called a smolt. The smolt stays in water that is partly fresh (from the river) and partly salty (from the ocean). This type of habitat is called an **estuary**. The smolts stay in the estuary for a few weeks to allow their bodies to gradually adapt to the salty water before they swim out to sea. Once the smolt's body has changed to allow it to live in salt water (a process called **smoltification**), it is ready to venture out into the ocean.

These adult salmon spend a few years in the ocean, eating lots of smaller fish, growing big and becoming very strong swimmers. Once they reach about five years old, they begin the long journey back to the same rivers where they began as eggs. They use their incredible sense of smell to guide them back to their home rivers. This journey from river to ocean and back again is called **migration**.

During the return migration, the adult salmon's body changes and it becomes a spawning adult. Males develop long hooked noses and both males and females turn a bright red color. The spawning adults swim upstream, to the same spot where they hatched out from their eggs years before. The female digs a nest in the gravel, called a **redd**, and lays her eggs there, covering them with more gravel to protect them. After a few weeks, the new eggs hatch and the life cycle of the salmon begins again.

Preparation Time	Materials	Location	Supplementary Materials
15 minutes to gather art supplies and make photocopies of life cycle image	Large piece of butcher paper, construction paper, various art supplies (markers, colored pencils, crayons), glue or tape to attach salmon drawings to butcher paper	In the classroom	Read aloud a children's book discussing the life cycle of a salmon, such as *Salmon Stream* (see Resources).

Activities and Extensions:

Activity Part I: Review the salmon life cycle described in the Background Information and shown in the Salmon Life Cycle chart below.

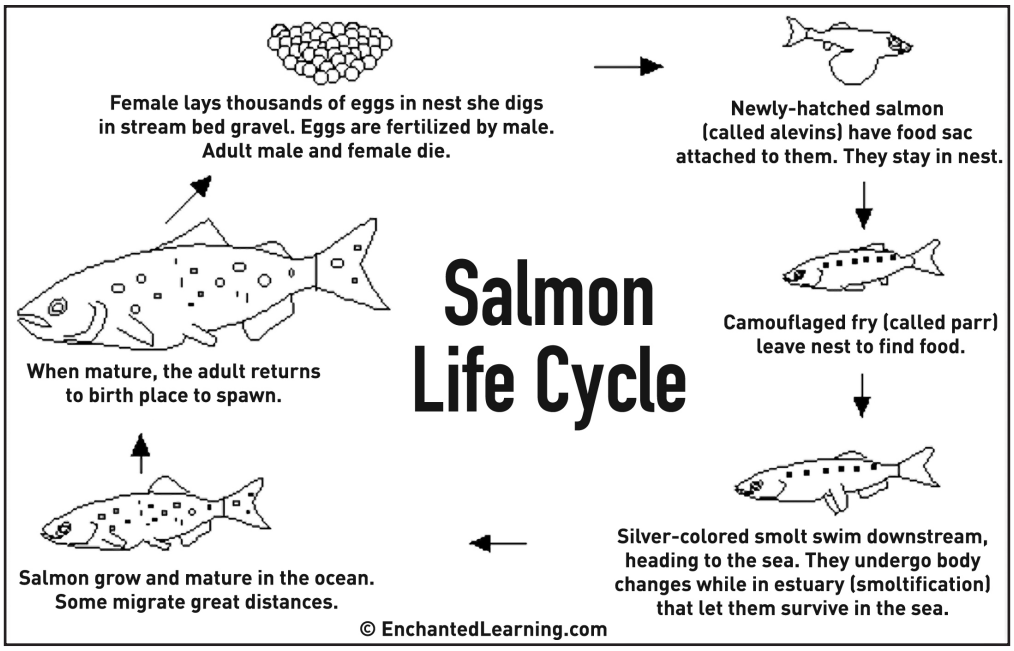
Activity Part II: Either use the Life Stage Chart as a template that students can trace or allow students to draw their own representation of their group's life stage. Depending on what is most appropriate for the class, each student can draw his or her own salmon or they can work together as a group to create one salmon per life stage. Encourage students to get creative, using lots of color and art supplies.

Attach each salmon life stage drawing to a large piece of butcher paper, making sure to put them in the correct order in a circle. If you have multiple drawings of certain life stages, they can be put together and you can remind students that the term for a group of fish is a school.

Extension I: Create a big mural. Draw the fish at the different life stages in actual size and show them in the habitats they would be using. You can collect items from outside to add to the mural, like small rocks and pieces of wood for egg, alevin and fry habitat, leaves from trees overhanging the stream to provide shade.

Ask students if they think that all of the eggs will survive to become spawning adults. If not, figure out how to represent the differences in numbers between life stages on your mural. You can use the pyramid example in the **Salmon Survival** for grades 3-5 to explain that while a single female can lay thousands of eggs, very few of those eggs will survive to become adults. Discuss some of the threats to salmon populations (predators, dams, pollution, overfishing, habitat destruction) and what kids can do to help (participate in a restoration day, keep streams clean)

Extension II: Read aloud, *Salmon Stream* (Resource Section), to explain the life cycle of a salmon.



Discussion and Take Home Message: Salmon have to make a long, difficult journey from the Yuba River to the ocean and back again. During this migration, they face many challenges, such as dams, fishermen, and predators. They are strong, fast swimmers, and very determined to make it back to their home river to lay eggs and continue their life cycle. The salmon life cycle is a circle, with six life stages. By protecting their habitat and keeping our rivers and oceans clean, we can all help the salmon in each of their stages of life.

Skills and Concepts: Drawing, Ordering, Connecting

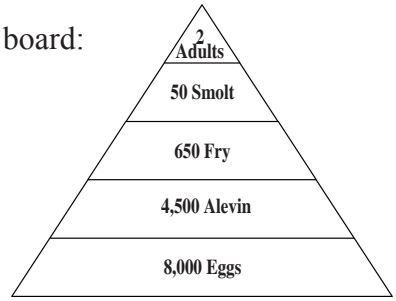
Life is Tough!

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Math	salmon life cycle, mortality, population threats	3-5	One 30-minute class period	life cycle, limiting factors, spawning grounds, mortality
Main Concepts and Overview	Using math and observational skills, students experience how difficult life is for a Chinook salmon and understand the many obstacles these fish face on their journey from river to sea and back again.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 3rd: **Science** - 3a,b,c,d; 5a,c,d,e **Math** - 3.NF; 3.MD **ELA** - SL.3.1; L.3.6 4th: **Science** - 3b; 6c,d,e **Math** - 4.NF; 4.MD **ELA** - SL.4.1; L.4.6 5th: **Science** - 6g,h **Math** - 5.NF; 5.MD **ELA** - SL.5.1; L.5.6			

Background Information: Review the **life cycle** of a Chinook salmon (see K-2 lesson, **A Chinook's Journey** for description). From the beginning of their lives as tiny eggs, salmon face many challenges to their survival. Challenges that reduce the population of an organism are often called **limiting factors**. These can be natural causes like drought, floods, predators, and starvation, or human-created causes like dams, mining, development, and overfishing. At every stage of their lives, salmon are preyed upon by many animals, including bears, people, birds, and other fish. They also have to face natural disasters like floods, and human-created obstacles to their migration like dams and development. An adult salmon has to travel hundreds of miles upstream to reach its **spawning grounds** (the part of the river where it lays its eggs, usually in the same area the salmon hatched from years before). This is an exhausting journey, during which they face countless limiting factors, use vast amounts of energy, and don't eat a single thing along the way.

When a salmon dies, this is called **mortality**. During this lesson, we will discuss factors that contribute to salmon mortality and how few fish survive from egg to adult. For every 8,000 eggs produced by a single spawning female, 4,500 alevin survive, from which 650 fry survive, from which 50 smolt survive, from which only two spawning adults survive (who produce thousands of eggs).

To explain mortality, draw this pyramid on the board:



Preparation Time	Materials	Location
20 minutes to review and set up game	a piece of blue string or rope at least 30 feet in length, four or more flags or pieces of ribbon/string/rope to delineate the ocean, a notebook and pencil for recording	Outside in an open space or in the gym; in the classroom for graphing activities

Activities and Extensions:

Activity: Set up the piece of string to represent the river, with one end as the mouth of the river (emptying into the ocean), and the other as the spawning grounds. Mark an area (about 20' x 20') with flags, cones or string to represent the ocean. Divide the string into sections:

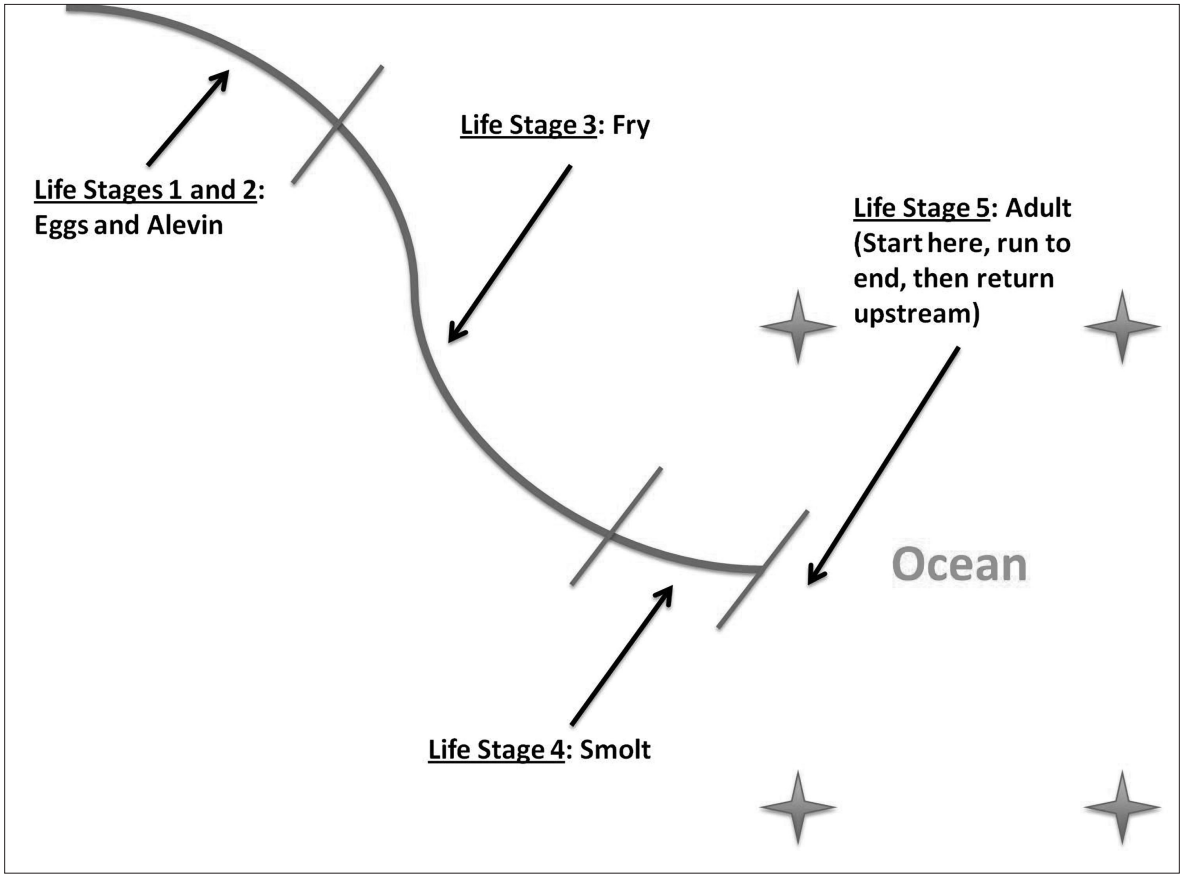
Life Stages 1 and 2: the furthest upstream section of the river is the spawning ground, where eggs and alevin live in the gravel;

Life Stage 3: immediately downstream, the fry will be making their way down the river;

Life Stage 4: at the mouth, smolt spend time adjusting to the salty water that flows in from the sea and begin their journey into the ocean;

Life Stage 5: in the ocean, adults spend several years eating, growing and gaining the strength to make the return trip upstream to spawn. See the Salmon Life Stage Chart below as an example.

SALMON LIFE STAGE CHART



As a class, decide on four "limiting factors" to this population of Chinook salmon in the Yuba River. Choose four student "taggers," who will each represent one of these limiting factors, and place them appropriately along the string (ex. a fisherman could be in the ocean or along the stream, a dam could be near the spawning grounds, a bear could be hunting mid-stream, and pollution from development could be near the mouth of the river). Spread out the taggers along the stream as much as possible. Also choose one student or a teacher's assistant to be the recorder. This student will keep track of how many students reach each life stage. Below is an example of how the recorder may set up the data chart:

LIFE STAGE	NUMBER SURVIVING		
	Round 1	Round 2	Round 3
Life Stage 1: Eggs - All of the students start as eggs, with the exception of the four taggers. Have the recorder write down this number. - As eggs, the students are unable to move much, so must take tiny steps and spin as they move to represent an egg rolling in the gravel. - They must spin in three complete circles without being tagged in order to move onto the next life stage, an alevin.			
Life Stage 2: Alevin - The alevin also have limited movement, due to the large yolk sac they carry on their bellies. - To represent this heavy burden that keeps the alevin close to the ground, students must walk on all fours for four steps without being tagged before they reach the next life stage, a fry.			
Life Stage 3: Fry - Fry are good swimmers, but they are tiny and easily carried away by strong currents. - Because of this, they often get swept downstream tail first. - Students can run as fast as they can, but must do so backwards without getting tagged until they reach the mouth of the river, where they become smolt.			
Life Stage 4: Smolt - Smolt are a bit bigger than fry, and stronger swimmers, but have the challenge of adapting their bodies to the salt water that they must live in as adults. - They spend time in the estuary (where salt and fresh water meet), gradually adjusting to the new water conditions. - To show this challenge, students must flap their arms to represent moving water through their gills. - Students must complete three arm flaps without getting tagged before they can become adults.			
Life Stage 5: Adult - Once smoltification (the process of changing from a freshwater fish to a saltwater fish) is complete, smolts turn into young adults and begin their life as true ocean fish. - Adult salmon are very fast, strong swimmers, but must spend two to four years in the ocean before they travel upstream to spawn. - Students who make it to this life stage have no limitations, but must run to the end of the ocean boundary and back, then all the way up the river again to the spawning grounds without being tagged.			

Make sure the recorder has been keeping track of how many students survived to each life stage, and how many survived the whole life cycle to become spawning adults and lay their eggs to start the next generation of Chinook salmon. You can repeat the game as many times as time permits, changing the "limiting factors", their placement and how many are present to represent different river systems and different challenges salmon populations must face.

Once back in the classroom, put the numbers from the game on the board where all students can see them, and have each student create a graph of the salmon survival throughout the life stages. Discuss how this compares with the pyramid example and where they saw the greatest mortality.

Extension: Using the numbers from the pyramid example and those from the salmon survival game have students calculate what fraction and/or percentage of salmon survive to reach each life stage (from the pyramid example: 56% of eggs become alevin, 8% become fry, 0.6% become smolt and 0.025% become adults). Compare the numbers between the example (taken from real-life survival studies) and those from the game. Did the game represent reality? If not, what was different? It's likely that in nature, salmon face far more threats than were shown in the game, but they also have amazing adaptations that allow them to avoid those threats.

Discussion and Take Home Message: Life as a migrating salmon is tough! At each stage of life, salmon face many limiting factors, or threats to their survival. Predators, development, and pollution in rivers and fishermen in the sea directly affect salmon numbers. But these fish have amazing adaptations that allow some of them to survive despite all of these challenges. Changing from a freshwater fish to an ocean fish allows salmon to live in different habitats; hiding in the gravel as eggs and alevin provides protection from predators; and growing into strong, fast swimmers means adults are very hard for most predators to catch. Now that you're aware of some of the challenges to surviving from an egg to a spawning adult, what can you do to help your local Chinook salmon?

Skills and Concepts: Graphing, Evaluating, Comparing, Recording, Observing, Organizing

Salmon Stream Design

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Art, Math, Geography, English Language Arts	salmon habitat requirements and diet, water quality, map-making	6-8	One 30-minute class period	survivorship, water quality, substrate, benthic macroinvertebrates, redd
Main Concepts and Overview	Incorporating vegetation, water quality, food sources, and spawning habitat, students design a stream that can support a healthy salmon population.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 6th: **Science** - 2d; 5a,b,c,d,e; 7a,b,d,f **Math** - 6.RP **ELA** - W.6.7; SL.6.1,6; L.6.6 7th: **Science** - 7a,b,d,e **Math** - 7.G **ELA** - W.7.7; SL.7.1,6; L.7.6 8th: **Science** - 1c **Math** - 8.G **ELA** - W.8.7; SL.8.1,6; L.7.6			

Background Information: Salmon require certain things to grow and survive, such as clean water, proper habitat, and nutritious food. Insufficient quantities or quality of any of these factors can result in low survivorship of populations. **Survivorship** is the number of individuals that reach the next year or stage of life; For example, the number of eggs that survive to become alevin.

One of the most important things to salmon survival, especially for the first life stages, is water quality. **Water quality** is a term scientists use to describe the 'health' of freshwater, as defined by measures of its physical, biological, and chemical properties. Salmon eggs need to be in streams that have cold, clean water, with high levels of dissolved oxygen and the right speed of water. Shallow riffles near a calmer, deeper area (called a pool) are the ideal spots for salmon eggs to survive. The fast moving water picks up oxygen from the air and circulates it over the eggs without sweeping them downstream. If the riffle is too fast or large (called a rapid), the eggs could become dislodged from the gravel, or substrate in which they have been laid. **Substrate** is the earthy material in which an organism lives, or the surface on which an organism grows or is attached. Since alevin stay in the gravel until they absorb their yolk sac and become fry, proper gravel size for protection and good water quality are also very important. Both eggs and alevin require cold water temperatures. Lots of native plants hanging over a stream shade the water and help to keep temperatures down. Invasive plants may not have the same structure as the native plants they replace. If they don't shade the stream, they aren't performing the same function as native vegetation and may impair the salmon's chances for survival.

Once the alevin become fry, they start to eat food that is in the stream. The biggest food source for a growing salmon fry is benthic macroinvertebrates. **Benthic macroinvertebrates** are small animals that live on the bottom of a stream (benthic), are large enough to be seen without a microscope (macro-), and have no backbone (-invertebrate). Some examples of macroinvertebrates are fly and beetle larvae, snails, clams, aquatic worms, and mayfly larvae. These benthic macroinvertebrates also have specific diet, habitat and water quality requirements. Some like very cold water, and many of them eat vegetation that drops into the stream from overhanging plants that also help to keep the water cool by providing shade. Fry also need habitat in the form of dead wood in the stream and aquatic plants to protect them from predators such as larger fish, birds, and otters. Deep pools provide refuge from the sun and are also good hiding spots.

The next life stage, a smolt, spends all of its time at the mouth of the river, gradually moving into the sea. They will still eat benthic macroinvertebrates, as well as smaller fish, but because they are still quite

small, require habitat that provides protection from larger animals that prey on them. Smolts also benefit from deeper pools, protective aquatic vegetation, and other protected hiding areas where they can remain camouflaged from their potential predators.

When adult salmon make the journey upstream from the ocean to spawn, they do not eat, so have no dietary requirements. The most important factor to their success is finding a suitable place to lay their eggs. Female salmon create a nest, or **redd**, by digging in the gravel, flinging rocks with their tails and bodies. Although they are quite strong and use the current to help them, they cannot move gigantic rocks. Chinook salmon seem to prefer making their redds in mixtures of gravel and rock that range from the size of a grape to a grapefruit. Once a female salmon builds her redd, she lays her eggs (usually several thousand!), the male fertilizes them, and she covers the redd with more gravel to protect the eggs from predation by fish and other animals. The life cycle then begins anew.

Preparation Time	Materials	Location
10 minutes to gather materials	Graphing paper, colored pencils, ruler	Near a stream, if possible. If time does not permit a trip to the creek or river, this can be done either in the classroom or in a quiet area outside.

Activities and Extensions:

Activity: Review the salmon life cycle. Which stages live in rivers (eggs, alevin, fry, spawning adults)? What do each of these life stage require for survival? Examples include clean, cold, oxygen-rich water, gravel to lay eggs in and protect alevin, overhanging vegetation to shade creek and provide benthic macroinvertebrates as food source for fry; undammed stretches to allow for migration and benthic macroinvertebrates as food for fry? Make a list on the board organized by life stage.

Now, working in pairs, incorporate all of these requirements into a stream that you design for salmon. Students can use the Mountain Stream drawing on page 16 as a template. Make sure to include at least three native plants, three different habitat features, and two water quality components. By using graphing paper or plain paper and a ruler, create a scale and draw the map to scale (ex. 1 inch = 1 yard). Also create a legend or key to correspond to different features of the stream. For example, use different patterns to indicate different water features, such as riffles or pools, and distinct colors to indicate water, stream bank, and forested areas.

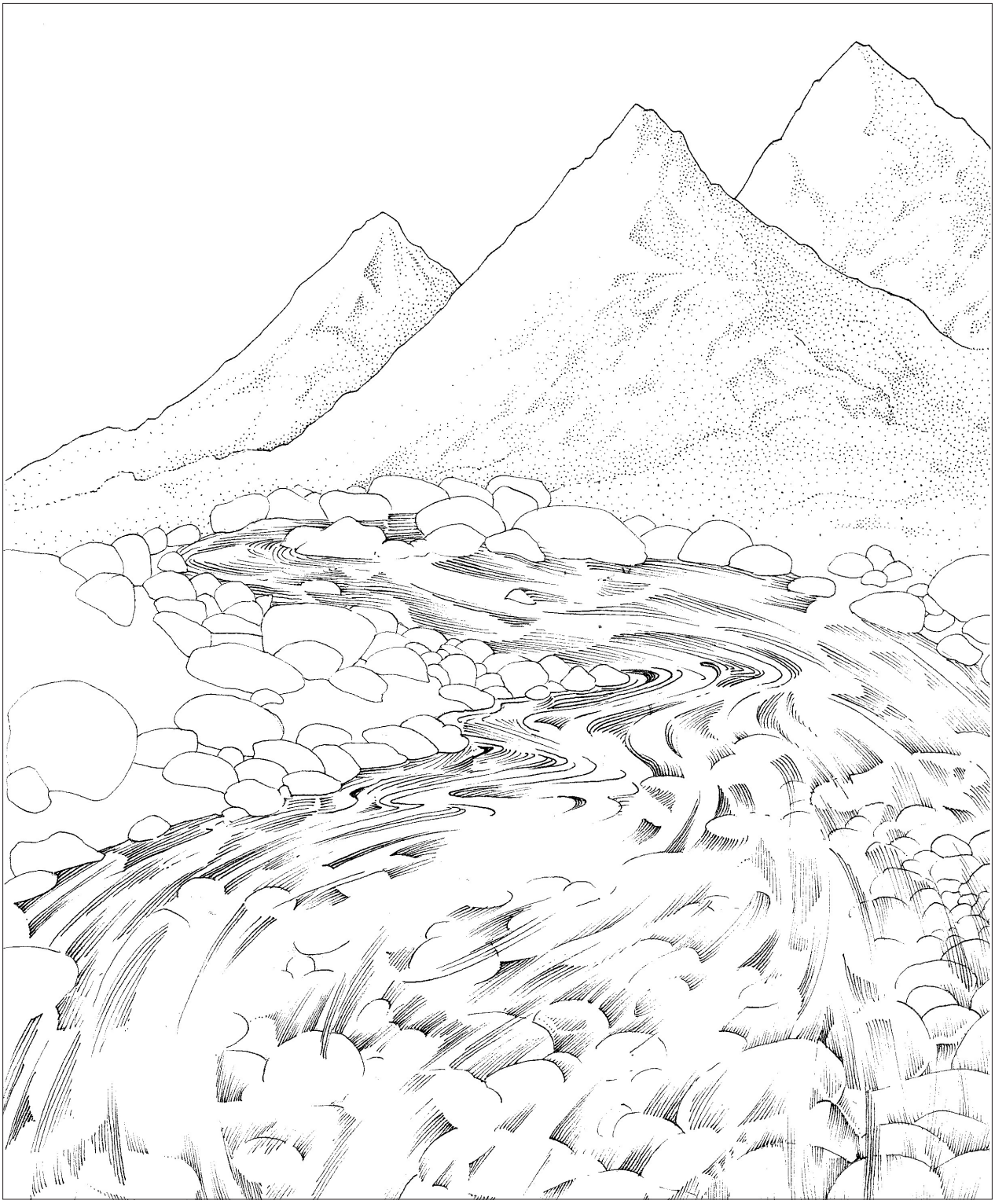
If time permits, have students share their designs in front of the class. What features are similar among all streams? Were there any unique additions?

Extension: As a class, follow the full migration route of a Chinook salmon from the Pacific Ocean to the Yuba River. Identify the major obstacles or threats to salmon along the way and determine where their final spawning grounds are located (on the Lower Yuba, below the Engelbright Dam). Have students choose a population of salmon (ex. Chinook from the Yuba or in another river system, or another species of salmon, such as sockeye in Alaska) and write a report about that population's life history and habitat requirements. Have the students share their reports with the class in the form of a short presentation. How are different populations of salmon similar? How are they different? What are some actions we can take to protect all salmon?

Discussion and Take Home Message: Salmon require cold clean water, ample nutritious food, and sufficient safe habitat in order to grow and survive in rivers. Each life stage has slightly different requirements, but many needs are the same throughout a salmon's entire life. By identifying what is important for the survival of all life stages, you can begin to evaluate potential action to improve salmon habitat and make our rivers safe, healthy homes for these amazing fish.

Think about some of the actions being taken right now to improve salmon habitat in the Yuba river watershed (ex. gravel augmentation, fishing regulations, fish passage on dams). Many of these projects are organized by local organizations and involve volunteers of all ages. There are many fun, helpful ways in which you can help in your local watershed and create better habitat for Yuba River Chinook.

Skills and Concepts: Organizing, Ordering, Evaluating, Designing, Analyzing, Interpreting, Comparing



Mountain Stream

When you try to change a single thing, you find it hitched to everything else in the universe. – John Muir

LESSON 3 Species Interactions

Healthy Forests, Healthy People

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Ecology, Biology, Sociology - Cross Curriculum: English Language Arts, Social Studies	trees, community, environmental stewardship	K-2	Two 15-minute class periods	interaction, community, ecosystem, environmental stewardship
Main Concepts and Overview	Students use observation and collection to connect trees with other organisms in the ecosystem. Students think about the communities that form around trees and how these are similar to human communities.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): K: **Science** - 2a, c; 4a, e **Math** - K.CC, K.MD, K.OA **ELA** - W.K.2; W.K.5; SL.K.1; L.K.6 1st: **Science** - 2b, c, e; 4b **Math** - 1.NBD, 1.MD, 1.OA **ELA** - W.1.2; W.1.5; SL.1.1; L.1.6 2nd: **Science** - 2f; 4a, d **Math** - 2.MD **ELA** - W.2.2, W.2.5, SL.2.2; L.2.6			

Background Information: A tree can serve many different purposes. For a bird or a squirrel, it may be a home. For a butterfly, its flowers may provide nectar for food. For people, a tree can provide shade, a fun climbing challenge, or wood for furniture and homes. Trees also hold soil in place with their roots, keep streams cool for fish by shading the water, and provide oxygen for humans and other animals to breathe. When an organism uses something for food, shelter or another purpose, that behavior is called an **interaction.** All the organisms that interact with the tree make up a group called a **community**. This community, along with all of the non-living things in the environment (rocks, water, soil) is called an **ecosystem**. When we respect and take care of the ecosystem, we practice **environmental stewardship**, or caring for the environment and all of its communities.

Think about the quote above from John Muir. What things are trees connected to? What would be affected if the trees in this area changed?

Preparation Time	Materials	Location	Supplementary Materials
15 minutes	one or two pieces of butcher paper, sticky notes or scrap paper and tape, glue or tape for attaching tree parts to paper, pens/ pencils, markers	An area with one or more trees, preferably native trees with identifiable seeds/ nuts/fruit (ex. oak, cedar, pine).	Read aloud a children's book discussing the importance of trees such as *The Lorax*, *The Giving Tree*, *The Little Creek* and *Trout are Made of Trees* (see Resources). If time permits, begin by reading the book and discuss all the ways in which trees are important to people, animals, and the environment.

Activities and Extensions:

Activity Part 1: Take the students outside to an area with trees. Tell them to collect fallen leaves, seeds, fruits, or flowers from the ground around an easily identifiable native tree such as an oak, cedar, or pine. Ask them to think of different uses/benefits of trees (ex. climbing, shade, home for bugs, food for animals, material for chairs, paper). Encourage creativity and wide thinking. Write their ideas on sticky notes (one idea per note). Pass the notes out to the students so they each have some notes to work with back in the classroom.

When you return to the classroom, have one student draw a rough outline of a tree on butcher paper. The students should glue the natural materials they collected onto the tree outline.

Activity Part 2: Tell the students to read the ideas on the sticky notes and discuss how they could group the ideas in meaningful ways. When the class agrees on some basic categories (e.g. recreation, products, habitat), write those categories on the paper in and around the tree. The students can then place the sticky notes by the appropriate headings.

Extension: Lead the students in a discussion about the importance of trees to an ecosystem. How many different organisms can they think of that interact with trees (ex. birds, rodents, insects, humans, fungi). Now what do trees need to be healthy (ex. clean water and air, sunlight, soil)? Discuss how an ecosystem is similar to a human community or neighborhood, where lots of interactions take place to maintain health, order and happiness.

Discussion and Take Home Message: People and other animals need trees – for playing, paper, wood products, food, and oxygen. In order to benefit from these trees, we need to care for them and appreciate all they do for us!

What are some things that could result in fewer trees (ex. storms, fires, construction, logging)?

Who or what might be affected by the loss of trees?

What can the students do to help preserve trees (ex. plant acorns or seedlings, recycle paper)

Skills and Concepts: Observation, Gathering, Organizing, Evaluating, Writing

What's Going on in the Garden?

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Ecology, Biology - Cross Curriculum: English Language Arts, Math, Sociology	species interactions, pollination, predation, diversity	3-5	One 30-minute class period	species interactions, ecosystem, pollination, predation
Main Concepts and Overview	Students observe and record interacting organisms in the school garden. They then write about one of these interactions from the point of view of one of the organisms involved.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 3rd: **Science** - 3c **Math** - 3.OA, 3.MD **ELA** - W.3.2&3, W.3.4 4th: **Science** - 2a, b; 3b, c; 6a **Math** - 4.OA, 4.MD **ELA** - W.4.2&3, W.4.4 5th: **Science** - 6a, c **Math** - 5.OA **ELA** - W.5.2&3, W.5.4			

Background Information: Animals and plants need each other for food, shelter, and protection. When organisms (plants and/or animals) spend time with each other, these behaviors are called **species interactions.** Plants and animals are interacting with each other and with their environment all the time. These organisms and the environment in which they live are called an **ecosystem.** There are many different types of interactions, many of them related to obtaining food. What are some terms for these?

Pollination is when an animal, usually a bird or insect, but sometimes a mammal, visits several of the same type of plant and carries pollen from one individual to another of the same species. This allows the plant to reproduce by mixing the male and female parts of different plants to produce fruits. Think about a bee visiting a flower, picking up the pollen on its legs, then flying to another flower of the same species and depositing the pollen from the first flower into this second flower.

Another type of food-related interaction is **predation.** Predation occurs when one organism hunts and kills another for food. Some examples are mountain lions hunting deer, hawks catching mice, and even preying mantis eating other bugs.

By closely and quietly observing an ecosystem, even one as small as a garden, you can witness many of these interactions occurring. What would it feel like to be one of those animals or plants?

Preparation Time	Materials	Location
10 minutes. Make a list of the different plants in the garden. Have the students choose different areas to observe.	Notebooks or several sheets of paper, pencils, colored pencils, *John Muir Laws Field Guide to the Sierra Nevada*.	The school garden or area near flowering plants

Activities and Extensions:

Activity: Take the students out into the school campus, in a location near flowering plants. Have each student bring a notebook and pencil (colored pencils too if they wish to draw). Ask them to find a spot near a plant in the garden where they can sit quietly and observe. After they sit very still for a few moments, they will notice that it's very busy in the garden! Ask them to list all of the plants and animals they see interacting with each other (they don't need to know the correct names, but should describe everything in as much detail as possible (ex. black bug with orange spots, short legs and big jaws). They should also note the type of interaction (ex. bird sitting on sunflower, caterpillar crawling on leaf).

Once they've made their list, ask them to pick two interacting organisms (ex. a butterfly pollinating a flower). Now, ask students to write a story and draw pictures if they would like from the perspective of one of these organisms. What does it feel like to be a butterfly pollinating a flower? What sounds does the butterfly hear? What can it see on the inside of the flower? What does nectar taste like? Encourage creativity as well as close observation, but remind them not to disturb the interactions taking place.

Extensions: Now, draw the whole garden ecosystem. Observe the plants and animals interacting. Which plants attract the most animals? What are those animals doing there? Why is it important to have many different types of plants in an ecosystem (ex. diversity in plants leads to diversity in the animals that interact with them)?

Discussion and Take Home Message: Interactions are taking place everywhere and if we take the time to sit still and watch closely, we can observe many of them! To an insect or mouse, your school garden is a very valuable resource, providing food, shelter, or maybe just a place to rest before moving on. Try to think about all of the activities taking place in nature and be mindful of this when you are outside. Wherever you play may be a home for an animal or plant or possibly even the source of someone's dinner. It's important to enjoy our natural places while respecting all of the other organisms that use them as well.

Skills and Concepts: Observation, Evaluation, Creative Writing

Preying Mantis

Nature Scavenger Hunt

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Ecology, Biology - Cross Curriculum: English Language Arts, Math	species interactions, adaptations	6-8	One 30-minute class period	ecology, symbiosis, mutualism, commensalism, parasitism
Main Concepts and Overview	Students go on a scavenger hunt outside to record and describe species interactions, adaptations, and diversity.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 6th: **Science** - 5c; 7d,g,h **Math** - 6.SP **ELA** - W.6.2, 4, 6, 7, 9; SL.6.1 7th: **Science** - 3e; 7b,c **Math** - 7.RP, 7.SP **ELA** - W.7.2, 4, 6, 7, 9; SL.7.1 8th: **Science** - 9a,b **Math** - 8.SP **ELA** - W.8.2, 4, 6, 7, 9; S.L.8.1			

Background Information: Ecology is the science of the relationships between organisms and their environments. There are a variety of ways in which plants and animals interact with each other and the environments in which they live. When different species that are in close proximity with each other (ex. shared habitat or range) form long-term interactions, this is called **symbiosis**. Three of the most common types of symbioses are mutualism, commensalism, and parasitism.

Mutualism is a symbiosis in which both individuals involved benefit from the interaction. Some examples are: bees pollinating flowers (bees get food, flowers can reproduce), lichen (algae and fungus growing together on a solid surface – the fungus protects the algae, and the algae provide nutrients through photosynthesis), and cleaner fish on sharks and whales (cleaner fish get food, sharks and whales have parasites removed).

Commensalism is a symbiosis in which one individual benefits from the interaction and the other is neither positively nor negatively affected. Some examples are: barnacles on whales or clams (barnacle gets a surface to live on, whale or clam not affected), cattle egrets on cows (egret gets a ride, cow not affected), and anemone fish in anemones (fish gets protection from predators, anemone not affected).

Parasitism is a symbiosis in which one individual benefits from the interaction and the other individual is harmed. Some examples are: ticks on humans or dogs (tick gets a meal, host is harmed), mistletoe on a tree (mistletoe gets a home and water from the tree, the tree is deprived of water, is weakened and may die), parasitic wasps and caterpillars (wasp lays eggs in caterpillar, so can successfully reproduce, caterpillar is weakened and eventually dies when eggs hatch).

Lead a brainstorming session to come up with more examples of each type of symbiosis. Remind the students that symbioses are **long-term interactions** that occur over the lifetime of the organism and have evolved over many generations. One-time events such as predation are still interactions, but are not considered symbioses.

Preparation Time	Materials	Location
10 minutes to make photocopies of scavenger hunt worksheet	One scavenger hunt worksheet for each student, pencils, pens, colored pencils	Anywhere outside with trees, rocks and downed logs, a diverse habitat

Activities and Extensions:

Activity: After introducing students to the concepts addressed in the Background Information, bring them outside and explain that they are going to go on a nature scavenger hunt. They will work individually (or in pairs if that's more appropriate) to find and describe each of the 12 items on the worksheet. Explain that it's very important that they pay close attention to the environment in order to find all of the items on the scavenger hunt. Also, they should try to be as quiet as possible and avoid running so they don't disturb any animals in the area or distract other students from their scavenger hunt. Then, pass out the worksheets and let them loose!

After all the students have finished with the activity (15-20 minutes), regroup and discuss their findings. Did anyone see or hear anything exciting? Was there something they couldn't identify? Were they surprised by the diversity of life just outside their classroom? Why is diversity important to ecosystem health? How are some of the organisms they observed adapted to this particular environment?

Extensions: Discuss the importance of close observation in nature and encourage them to do some research, either with classroom or library resources or on the Internet, to discover the answers to any questions that arose from the activity.

What type of simple experiment could be designed to test what might happen if the ecosystem changed and disrupted one or more of the observed interactions? Encourage creative thinking and non-destructive, controlled experiments. For example, choose a certain type of plant in the garden, put netting around some individuals but leave others alone and see what happens. If pollinators can't visit, does the plant produce fruit/seeds? How does the number of fruits or seeds on control plants compare with those on plants with nets around them? Explain that this experiment represents what may happen if certain pollinators died off or became less abundant. What would this mean for food crops as well as wild plants?

Scavenger Hunt

Look for the following things. When you find them, write or draw a description in the blanks.

1. Three different kinds of leaves. Can you name them or sketch them below?

2. An insect. Where did you find it?

3. Something living under a log or rock.

4. Something that shows an animal may have passed by (animal track, scratches, droppings).

5. A seed built to float in the air.

6. A commensal interaction (one organism benefits, the other is neutral).

7. Sit quietly with your eyes closed for a minute or two. What sounds, other than people, do you hear?

8. Something that is not native to the area (ex. trash, exotic plants) and how it got there.

9. One thing a bird eats.

10. An animal home on a tree or other plant.

11. A mutualism (both organisms benefit).

12. A parasitic interaction (one organism benefits, the other is harmed).

Discussion and Take Home Message: Complex, long-term interactions are occurring all around us, between every type of organism imaginable. Through these interactions with each other and the environment, organisms develop adaptations that allow them to survive and reproduce in their ecosystem. If these interactions are disrupted, through human influence or natural disturbance, the consequences may be disastrous, resulting in the loss of diversity and unexpected changes to the ecosystem. Reflect on the John Muir quote, "When you try to change a single thing, you find it hitched to everything else in the universe," and consider how this relates to the symbioses discussed today.

Skills and Concepts: Observation, Investigation, Evaluation, Analysis, Experimentation, Prediction, Comparison

Each species on our planet plays a role in the healthy functioning of natural ecosystems, on which humans depend. — William H. Schlesinger

LESSON 4

Ecosystem Health

Create a World for Wildlife

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Math, English Language Arts, Art	Healthy Ecosystems, Biodiversity, Habitat	K-2	Two 15-minute class periods	biodiversity, ecosystem, habitat
Main Concepts and Overview	Like us, plants and animals have certain needs that must be met in order for them to be healthy and successful. What are those needs and how can you create a place that can provide those for plants, animals and people?			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): K: **Science** - 2a,c; 3a,c; 4a,b,c,e **Math** - K.CC **ELA** - SL.K.2; L.K.6 1st: **Science** - 2a,b,c,e; 4a,b,d **Math** - 1.MD **ELA** - SL.1.2; L.1.6 2nd: **Science** - 2b,e; 3e; 4a,d **Math** - 2.MD **ELA** - SL.2.2; L.2.6			

Background Information: Plants and animals depend on each other to survive. The variety of organisms living in the world is called **biodiversity**. An **ecosystem** includes all the biodiversity in a particular area as well as the non-living elements in the environment (called **habitat**), such as climate, water, soil and rocks. An ecosystem can be very small, such as a puddle or a patch of grass, or it can be vast, such as a forest or an ocean. What are some different types of ecosystems? (lakes, rivers, forests, oceans, deserts) What types of plants and animals do you find in each of these ecosystems?

Preparation Time	Materials	Location
10 minutes to organize materials	Whiteboard or butcher paper for brainstorming and listing; paper and crayons, markers or colored pencils for each student or pair of students to draw a wildlife garden.	Outside or inside the classroom

Activities and Extensions:

Activity Part I: Brainstorm with the class and make a list of all of the components that make a healthy ecosystem. Place these into categories (ex. food, water, shelter).

Activity Part II: Now, think about how these components can be used to design a wildlife garden. Draw a plan that includes things needed by animals (food, water, shelter, safe places to raise their young), plants (clean soil, water, sunlight), and people (edible plants, places to sit, walk, play). Draw these wildlife gardens/healthy ecosystems individually or in pairs.

Extension: Share the drawings with the class. Have each student or pair of students present their wildlife garden design to the class and explain how their garden represents a healthy ecosystem. Using ideas from all students, come up with one design that incorporates all of the best plans for a wildlife garden.

Discussion and Take Home Message: Some of the elements of your wildlife garden may be used only by specific plants or animals, but many of these elements are required by all living things. What are some of these universal requirements and how are they used? (ex. humans, plants and animals all require fresh water, air, sun, food, and shelter). Think back to the Species Interactions lesson on page 17 and how so many different organisms interact with each other in an ecosystem. How can your wildlife garden design support the greatest amount of biodiversity with the simplest design (ex. fresh, clean water, many different habitat types, plants to attract pollinators, places predators can hide)?

Skills and Concepts: Listing, Grouping, Evaluating, Drawing, Connecting, Observing, Analyzing

Roots

What is a Watershed?

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology, Geology - Cross Curriculum: English Language Arts, Art, Math, Geography	components of a watershed, watershed health	3-5	One 30-minute class period	ecosystem, watershed, tributary, environmental disturbance
Main Concepts and Overview	A watershed is one type of ecosystem with which all living things interact. What makes up a watershed and what can you do to keep your local watershed healthy?			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 3rd: **Science** - 3a,b,c,d; 5d **Math** - 3.MD **ELA** - SL.3.1; L.3.6 4th: **Science** - 2b; 3a,b,c; 5a; 6c **Math** - 4.MD **ELA** - SL.4.1; L.4.6 5th: **Science** - 3d,e; 6a **Math** - 5.MD **ELA** - SL.5.1; L.5.6			

Background Information: All living things require water. Most **ecosystems**, all the living and non-living elements in a particular environment, contain water, but what makes a watershed? A **watershed** is all of the area that drains into a river or a lake. Larger watershed consists of many **tributaries**, which are streams that start at high elevations and flow into a larger stream or a lake at a lower elevation. Think of a tree, where the branches are tributaries, the trunk is the main stream or river, and the whole tree is a watershed, bounded by mountains, ridges or hills at the top where the tributaries begin. The characteristics and quality of the water in this watershed will impact all of the plants and animals that interact with it at any point.

Sometimes, events occur that change the function or quality of an ecosystem. This is called an **environmental disturbance**, and is any event that upsets the balance of an ecosystem. Disturbances can be natural (fire, flood, earthquake) or caused by humans (development, pollution, introduced invasive species). What types of disturbance could be particularly harmful to a watershed and why (ex. forest fires and the erosion that follows, human development causing polluted runoff into streams)?

Preparation Time	Materials	Location
10 minutes to organize materials and hang map	One map of the Yuba River watershed; paper and crayons, markers, or colored pencils for each student or pair of students to draw a watershed.	In classroom, but drawing and discussion can be done outside.

Activities and Extensions:

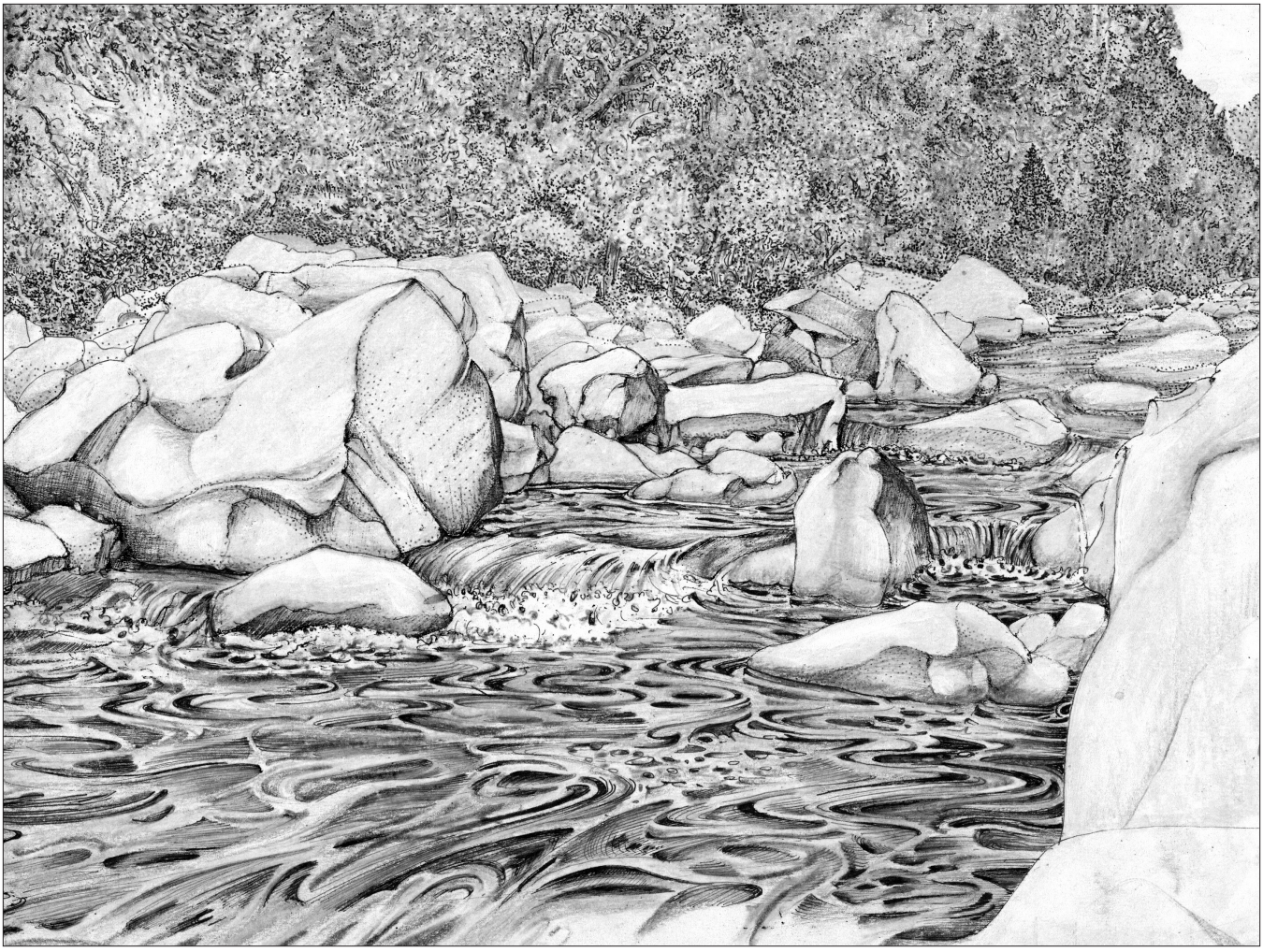
Activity: Discuss the definition of a watershed. What watershed are we a part of? What are its boundaries and some of the tributaries? Show the Yuba River Watershed map and locate some familiar landmarks.

Now, either individually or in pairs, make up your own watershed and draw it! Include at least three tributaries, one natural area, one disturbed area, and different elevations. Also, include at least three different plants and three different animals that rely on the watershed to survive. List what these plants and animals need from their ecosystem in order to be healthy and successful. If time permits, have each student or pair of students discuss their watershed drawing with the class.

Extension: How does the Yuba Watershed connect with other, larger watersheds? If possible, show maps of the Yuba River flowing into the Feather River, which flows into the Sacramento River and then to the San Francisco Bay and into the ocean. What are some events that have occurred in the Yuba and impacted other parts of the larger watershed (ex. mining caused debris to flow down the Yuba and cover farmland in the Sacramento Valley, toxins from mining are found in fish in the ocean). Discuss how upstream activities impact everything downstream and how we can be good land stewards by enhancing the quality of our local watershed to benefit our downstream neighbors. Examples include erosion control, responsible development, riparian restoration, stream cleanups.

Discussion and Take Home Message: The Yuba Watershed is our local watershed and vital to the health of all living things that interact with it. What are some threats to the Yuba? Remember that everything that happens upstream will eventually make its way downstream!

Skills and Concepts: Organizing, Evaluating, Interpreting, Comparison



Whirly River

It All Adds Up

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Math, Geography, Art	water quality, pollution sources, best management practices	6-8	One 30-minute class period	watershed, erosion, contaminant, runoff, point source pollution, nonpoint source pollution, Best Management Practices
Main Concepts and Overview	By playing a game to simulate land use on the Yuba River, students understand where pollution comes from, how it accumulates downstream, and what can be done to prevent it.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 6th: **Science** - 2a,b; 5b; 6c,h **Math** - 6.EE; 6.SP **ELA** - SL.6.1; L.6.6 7th: **Science** - 3e; 7c **Math** - 7.RP **ELA** - SL.7.1; L.7.6 8th: **Science** - 9b,d,e **Math** - 8.EE; 8.F; 8.SP **ELA** - SL.8.1; L.8.6			

Background Information: Water quality is not the same in all parts of a river. Many natural processes and human land use contribute to the quality of a **watershed** (all of the area that drains into a river or a lake). **Erosion** is the process by which the surface of the earth is worn away by the action of water, glaciers, winds, waves. Erosion can deposit soil and contaminants into a stream. A **contaminant** is something that pollutes and may be harmful to whatever source it is present in, such as toxic chemicals in rivers. Both soil and contaminants are examples of **runoff**. Runoff is the water and anything contained in the water that drains off of the land into a river or lake. Since watersheds encompass all of the area that drains into a river or lake, runoff can come from any part of the watershed.

There are two main types of pollution that land managers and scientists identify. The first, called **point source pollution** is from an identifiable location, such as contaminants from a factory or a mining operation. **Nonpoint source pollution** occurs when it's not possible to determine the exact location from which pollution is generated, such as fertilizer runoff from agricultural lands or runoff from roads and cities. Land managers and scientists encourage property owners and residents to use **Best Management Practices**, land use measures such as installing erosion control and keeping livestock out of streams, that are designed to reduce or eliminate pollution.

What types of pollution are present in our local watershed? How did they get there and what can we do to minimize them?

Preparation Time	Materials	Location
15 minutes to organize supplies, number papers, and set up "river"	a long piece of blue string to represent the Yuba River; sheets of unlined paper, consecutively numbered in the upper right hand corner; crayons, markers or colored pencils; notebook or board to keep track of "pollution" numbers; classroom items such as pencils, paperclips, and erasers to represent "pollution."	Inside the classroom or outside in a relatively flat area

Activities and Extensions:

Activity: Give each student a piece of paper with a number in the upper right hand corner. Tell them that they have just won the grand prize in a local contest: a 40-acre parcel of riverfront property on the Yuba River! They can do whatever they choose with this property, but must draw it on their sheet of paper within ten minutes.

Once students have finished drawing their dream properties, have them line up along the string in the order of the numbers on their paper. Explain that #1 represents the most upstream property, and the highest number represents the most downstream property. Starting with property #1, have each student briefly describe his or her imaginary land development. Using classroom items (pencils, paperclips) to represent pollution or erosion, determine what kind of impact each property development will have on the stream (ex. building a home right on the banks will cause erosion and equals two paperclips; having horses on the property may add waste to the river and equals one pencil). Each student passes these down to the next "property owner" downstream. If a student included something beneficial, like erosion control features or solar power, they can remove an item from the downstream flow.

Choose one student or a teacher's aide to keep a running tally of how many items are present at each property as you make your way downstream (three at Property #1, five at Property #2, nine at Property #3). What does this tell us about downstream pollution effects?

Extension: Which activities were the biggest polluters? How could they be modified to better coexist with a healthy river? What were some ideas that counteracted pollution? How can property owners implement those practices?

Graph the results of your running tally. There should be a strong positive correlation between the amount of pollution and location downstream. How do land managers and restoration ecologists use this type of information? (By looking for spikes in pollution levels, they can focus regulations, restoration and/or clean-up efforts at the location where the most damage is occurring).

Discussion and Take Home Message: Everything we do in our environment affects something else. Watersheds don't carry pollution "away"; they carry it into someone else's environment! What are some ways in which humans impact watersheds and how can we encourage positive actions?

Skills and Concepts: Analyzing, Comparison, Adding, Graphing, Evaluating

In the end, we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught. — Baba Dioum

LESSON 5 Conservation in the Sierra Foothills

Feeding Our Feathered Friends

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Math, Art	native species, biodiversity, conservation	K-2	Two 15-minute class periods	native species, ecology, migration, conservation
Main Concepts and Overview	Using the cones from native pine trees, students construct pinecone bird feeders to supplement the diet of native bird species during the harsh winter months.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): K: **Science** - 2a,c; 4a,b,e **Math** - K.CC **ELA** - SL.K.2; L.K.6 1st: **Science** - 2b,c; 4b,e **Math** - 1.MD **ELA** - SL.1.2; L.1.6 2nd: **Science** - 1e; 3e **Math** - 2.MD **ELA** - SL.2.2; L.2.6			

Background Information: The environment in which we live, the Sierra Nevada foothills, is full of life. There are many different species of plants and animals that live in this area, contributing to the great biodiversity we see when we spend time in nature. Most of the plants and animals we see here are **native species** that naturally occur here without any type of help from humans. The native species here have spent hundreds or even thousands of years interacting with other native species and the environment, forming close relationships over time. We call the science of the relationships between organisms and their environments **ecology**.

Bird ecology can be particularly interesting to study because many birds migrate long distances over the course of the year. In the salmon lesson, we learned about migration as the salmon's journey from river to ocean and back again. Since birds fly rather than swim, their **migration** is the journey they make by flying from one environment to another. Some birds migrate from the south, where they live for the winter, to the north, where they live for the summer. Other birds only migrate short distances to find food or nesting sites. Migration uses lots of energy, and during these migrations, especially the very long ones, birds can sometimes struggle to find enough food to fuel their journeys.

We can help these native birds along their journey by practicing conservation. **Conservation** is the act of preserving the environment and managing our natural resources. Big conservation actions can involve preserving forested areas for food and nesting habitat and restoring damaged areas to create new habitat. But what are some small things that you can do as a class today? Making bird feeders with high energy, nutritious food to help these traveling birds survive harsh conditions is one small step you can take to help conserve local bird species. We can do this pretty easily using birdseed, a sticky fat mixture, and native pinecones collected from the woods.

Preparation Time	Materials	Location
20-30 minutes to prepare materials and make fat mixture	- Large, open pinecones (one for every two students, plus one for demonstration) - Peanut butter, suet, vegetable shortening, or lard (½ cup for each pinecone) - Oatmeal or cornmeal (½ cup for each pinecone) - Birdseed (or make your own — see recipe ideas below) ½ to 1 cup per pinecone - String, fishing line, or twine (3-4 feet per pinecone) - One large mixing bowl - Large spoon or spatula - Scissors to cut string (you can pre-cut the string, twine, or fishing line ahead of time if you'd like) - Pie tins, plates, or cookie sheets (1 for each pinecone) - Measuring cup	Outside in an area with pine trees and in the classroom

Activities and Extensions: Look at the section on pine trees in the *John Muir Laws Field Guide to the Sierra Nevada*. Do you know which of these pine trees grow on the school campus? In this area of the Sierra, the most common native pine trees are Ponderosa, Sugar, and Gray (or Foothill) pine. Using big, open pinecones that have dropped from these trees, we will make pinecone bird feeders for our local birds and hang them on campus to see who visits. **NOTE:** It's most appropriate to do this activity when it's cool or cold outside. If it's too hot, the fat mixture may melt and won't hold the birdseed well.

Activity Part I: Go outside and collect some pinecones! Collect one for every two students, making sure to only take open pinecones so there is space for the birdseed between the scales of the cone. Using the *John Muir Laws Field Guide to the Sierra Nevada*, see if you can identify which type of pine tree your cone came from. The most common in this area are Ponderosa, Sugar, and Gray pines. Bring the pinecones back to the classroom to create your bird feeders. The fat (peanut butter, suet or shortening) that is the base of the birdseed provides necessary energy for migrating or over-wintering birds.

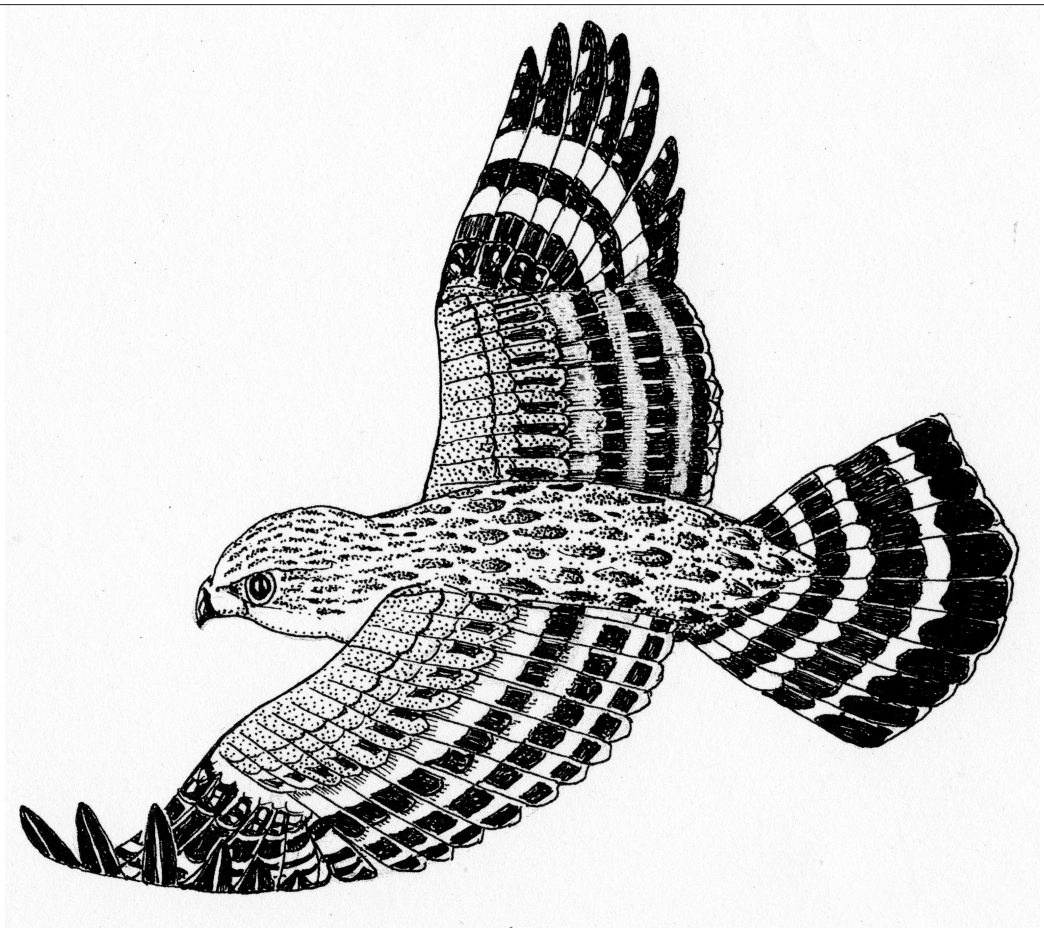
Activity Part II: Now it's time to assemble your bird feeder! First, gather together all of the supplies listed above. To save time and minimize messiness, Step 2 can be done by the teacher or a teacher's aide before class or while the students are collecting pinecones.

Step 1: Tie a piece of string around the bigger, stem end of the pinecone.
Step 2: In a mixing bowl, combine peanut butter, suet, shortening or lard with cornmeal or oatmeal until everything is blended together. Use ½ cup of fat mixed with ½ cup of meal for each pinecone, depending on size (very large pinecones may need a little more, small ones will need a little less). You can do this step beforehand to save class time if desired.
Step 3: Using a spatula or the back of a spoon, spread the fat and meal mixture over the entire pinecone, except for the stem and string.
Step 4: Pour the birdseed onto a plate, cookie sheet, or pie tin. You can add any of the supplemental feed to this mixture now too. Roll the pinecone in the seed mixture until it is fully covered.
Step 5: Hang the feeders from a tree outside. If possible, put them somewhere the students can see from the classroom. If this isn't an option, place them in areas around the campus that the students can visit regularly. To keep squirrels or other animals from eating the birdseed, try hanging the feeders away from tree trunks, with clear fishing line that is 3-4 feet long.

Extension: Using the *John Muir Laws Field Guide to the Sierra Nevada*, try to identify the birds that visit your pinecone bird feeders. How many of each type do you see? Record these observations in a journal that is kept in the classroom from year to year. Do the types and numbers of birds you see change from month to month? How about from year to year? What might be affecting these changes? Since the Sierra Nevada supports more types of bird species than any other area in California, these little bird feeders can help lots of hungry birds!

Discussion and Take Home Message: We can help our feathery friends survive harsh winter conditions and long migrations by supplementing their food supply with nutritious birdseed. This will give them the energy they need to stay warm and complete their journeys, no matter how long or short. Small conservation measures such as these can make a big difference to plants and animals. What are some other things you can do with the class or with your family to help conserve your local environment?

Skills and Concepts: Gathering, Counting, Identifying, Evaluating



Red-shouldered Hawk

Bird Seed Recipe/Supplements

Combine a variety of nuts, seeds, and dried berries. Black oiled sunflower seeds are full of oils that birds love and need for energy. If you use large nuts or berries, chop them up first so they are a manageable size for even small birds' beaks. Having a variety of foods available will attract the most bird diversity, but if you can only manage one or two items, sunflower seeds and dried cherries or raisins will be best. Mix all of the ingredients together and roll the pinecone in them until it is fully covered.

Restoring the Schoolyard

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Math, Geography, Art	restoration ecology, scientific method, experimental design, native and non-native plants	3-5	One 30-minute class period	restoration, niche, scientific method
Main Concepts and Overview	Using the field guide and map created in the Plant Ecology lesson "School Campus Field Guides", students determine a restoration project they can do on campus involving native and non-native plant species.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 3rd: **Science** - 3a,c,d; 5b,c,d,e **Math** - 3.MD **ELA** - W.3.2,7; SL.3.1; L.3.6 4th: **Science** - 3b,c; 6a,c,d,f **Math** - 4.MD **ELA** - W.4.2,7; SL.4.1; L.4.6 5th: **Science** - 6a,b,c,d,e,f,g,h **Math** - 5.MD **ELA** - W.5.2,7; SL.5.1; L.5.6			

Background Information: Ecological **restoration** is the process of helping the recovery of an ecosystem that has been degraded, damaged, or destroyed. There are lots of different ways to do ecological restoration, but one of the simplest and most common is by removing undesirable plants such as invasive species and replanting the area with native plants. When doing this sort of restoration it's important that ecologists consider the niche of both the species that they remove and the niche of the species they use to re-plant. A **niche** is the role an organism plays in its community (ex: an oak tree provides food in the form of acorns, habitat for birds, mammals and insects, shade, soil stabilization). Restoration ecologists have the most success when they re-plant with species that fill a similar ecological niche to those that they remove.

All scientists use a certain way of thinking and working to formulate their research projects. This way of thinking is called the **scientific method**. The scientific method is a way to ask and try to answer scientific questions by making observations, doing research, and conducting experiments. It consists of six steps:

Step 1: Ask a question.
Step 2: Do background research on your question.
Step 3: Construct a hypothesis. A good hypothesis is one that can be reasonably answered by conducting an experiment. Try to keep it simple.
Step 4: Test your hypothesis by doing an experiment. Again, keep your experiment simple, by changing only one measurable factor, or variable.
Step 5: Analyze your data.
Step 6: Draw a conclusion.

If your results support your hypothesis, then that is the end of the scientific method for this particular question. If they do not, then go back to Step 3 and construct a new hypothesis to test. Using the scientific method, work as a class to design a restoration project involving native and non-native plants that can be done on campus.

Preparation Time	Materials	Location
none	*John Muir Laws Field Guide to the Sierra Nevada*	In the classroom and outside in the same area where students made their field guides

Activity: Today, the class is going to be acting as restoration ecologists, planning a restoration project on the school campus. As restoration ecologists, you must be rigorous in planning this project by using the scientific method. The first thing to do is identify a problem to be solved (ex. too many non-native plants on campus). Next, gather background information about the problem. What species can you identify? What are their ecological niches? What can they be replaced with? Then, form a hypothesis to be tested, such as, removing invasive plant species and replanting with natives will attract more pollinating insects to the area.

Now, design an experiment to test this hypothesis. To get started, use the field guide and map you constructed in the Plant Ecology lesson to make a list of all of the native plants you identified in the study area. Now, make a list of all of the non-native plant species you identified. Think about the ecological function of each plant and try to choose natives that fill a similar niche as the non-natives. For example, English ivy, Himalayan blackberry, and vinca are all groundcover plants that prefer shade and prevent soil erosion. You can plant low-growing natives that fulfill the same role, such as honeysuckle, native raspberry or miner's misery. Design this project in detail and think of the long-term effects of your restoration work. Your experiment could involve restoring one plot and comparing the number of insects that visit plants in the restored area with the number of insects that visit plants in the area that hasn't been restored.

Although there may not be time in this lesson to actually conduct the restoration, think about how you would analyze data and draw conclusions. Could you compare the total number of insects that visit the restoration plot with the number that visit the unrestored plot and make a conclusion as to which plot supports the greatest diversity based on those numbers? Maybe you could make a post-restoration map of the area from the School Campus Field Guide lesson on page 3, and see how different the two look. Restoration ecologists and land managers do work like this all the time to measure the results of their projects, make sure their projects are successful, and determine what works best for future research.

Extension: Have students do a research project on the ecological niches of the plants you identified in the lists above. What type of role does each plant play in the ecosystem? What animals does it interact with? How does it contribute to or harm the environment? What conditions does it need to survive and grow? You can use this information to inform the restoration design or on its own to talk about similarities and differences between native and invasive plants in the area.

Discussion and Take Home Message: Although conserving healthy, intact environments to prevent them from becoming damaged is ideal, it's not always possible. When environments have been damaged or destroyed due to human or natural causes, we can help to repair them by conducting restoration projects. Restoration is a long-term process. Lots of research and thought goes into designing projects and evaluating their successes and challenges. In this lesson, you played the role of a restoration ecologist and used the scientific method to design and evaluate a research project. What are other ways in which you use the scientific method?

Skills and Concepts: Hypothesizing, Designing, Experimenting, Analyzing, Comparing

Let it Burn?

Subjects	Topic/ Focus of Lesson	Grades	Time	Vocabulary
- Biology, Ecology - Cross Curriculum: Math, History	fire ecology, oak woodlands, land management	6-8	One 30-minute class period	oak woodlands, fire regime, land management, understory plant community
Main Concepts and Overview	Graphing activities and discussion introduce students to the role of wildfire in oak woodlands and the influence of human activities on wildfire frequency and intensity.			
California Standards Met	(Science as well as Common Core State Standards for Math and English Language Arts): 6th: **Science** - 3b; 5d; 7c,d,h **Math** - 6.SP **ELA** - W.6.7; SL.6.1,6; L.6.6 7th: **Science** - 7a,b,c,e **Math** - 7.SP **ELA** - W.7.7; SL.7.1,6; L.7.6 8th: **Science** - 9b,e **Math** - 8.SP **ELA** - W.8.7; SL.8.1,6; L.8.6			

Background Information: Oak woodlands are plant communities found throughout California and Baja California. They are dominated by native oak trees, but also include other deciduous and evergreen trees, as well as grasses and other native plants. These plant communities have adapted to wildfire and are dependent on certain fire regimes to maintain healthy communities.

A **fire regime** is a combination of the frequency at which fires occur, the intensity with which a fire burns, and the amount of fuel a fire consumes. Under a natural fire regime, oak woodlands and other fire-adapted plant communities thrive. Both mature oak trees and young seedlings can survive low intensity fires, and many will re-sprout vigorously after being burned. If a high intensity fire, such as one caused by lightning, does kill all or part of an oak tree, the cavities created by the burn provide great habitat, especially for nesting birds such as woodpeckers.

Fire has been used for centuries in **land management**, which is the process of managing the use and development of land resources in a sustainable way. As the first human inhabitants of oak woodlands, Native Americans burned these plant communities regularly to improve access for hunting and gathering, to encourage new growth from fire-adapted plants like manzanita that they used for crafts, and to increase habitat for game animals. The early European settlers burned oak woodlands and neighboring chaparral communities approximately every eight to ten years to increase the growth of forage plants and to maintain open areas for their livestock.

As California's population grew in the early 1900s, homes began to appear in areas that used to be ranches, in the heart of many oak woodlands. In the 1950s, due to the growing number of residential properties in fire-adapted environments, the forest service introduced Smokey the Bear and began encouraging fire suppression. This resulted in a very large increase in the **understory plant community**, or the community of plants such as grasses, shrubs and forbs that grow underneath the canopy of other plants. This created an excess of fuel and led to high intensity fires that burn longer and hotter than those from the historic fire regime. Since oak woodlands are adapted to low intensity, high frequency fire regimes, these high temperature fires are extremely destructive and can damage or even destroy entire woodlands.

Recently, land managers have begun to change their land management practices and are again considering fire to be a necessary component to healthy ecosystems. Controlled burns are now a regular occurrence and help to eliminate the excessive understory growth that contributes to high intensity, destructive wildfires.

Preparation Time	Materials	Location
10 minutes to make copies of data table or write on board	Data table, paper (graphing, unlined, or ruled), pencils	In the classroom

Activities and Extensions:

Activity: Now that you know the background of fire ecology in the Sierra, you will get the opportunity to act as a scientist and study data gathered by fire researchers interested in learning about how fire influences oak communities. The data in the table "Fire Frequency in Sierra Foothill Oak Woodlands" page 38 were compiled from a variety of sources to evaluate how frequently fires occurred from 1660 to 2010 in the Sierra Nevada foothills near Sacramento. Either copy the table onto the board where all students can see, or make a copy for each student to work with.

What sort of historical events occurred during this time period? Between 1660 and 1830, California was mostly inhabited by Native Americans. What were their attitudes towards fire? European settlers began colonizing California around 1770, and introduced larger scale ranching and farming operations. How do you think this may have affected the fire regime? When Americans began moving west in large numbers (1830-1940), the environment changed even more and the human influence became even stronger. Between 1940 and 1990, our philosophy regarding fire became focused on suppression, made famous by the teachings of Smokey the Bear. More recently, between 1990 and the present, we've begun to realize that preventing all fires is not actually beneficial to oak woodlands and the communities they support and have started to gradually shift management practices. The large human population in California, however, means that most fires are still put out to prevent damage to property, much of which is located in oak woodlands.

Create a bar graph to interpret the data. What data will go on the X axis? (X axis = decade). What about the Y axis? (Y axis = number of fires).When were the most fires in this area? What may have caused them? As a class, discuss how you think the frequency of wildfire has affected this particular stand of oak trees. How may it also influence animals and plants in the area? What kind of effects may fire suppression have on oak woodlands and their associated communities? What is the role of wildfires in nature? As a class, make a list of ways that fire affects plants, animals, and the ecosystem.

Fire Frequency in Sierra Foothill Oak Woodlands

Decade	Number of Fires*
1660	1
1680	1
1700	0
1720	2
1740	0
1760	1
1780	1
1800	0
1820	0
1840	4
1860	3
1880	2
1900	2
1920	3
1940	0
1960	0
1980	0
2000	0

* Sacramento Area

Extension: What other fire-dependent plant communities are in the Sierra? Using as many reliable resources as are available, do research and write a short report on another fire-adapted community such as chaparral, lodgepole pine or redwood forests. Do they have similar historical patterns as oak woodlands? Share your findings with the class and compare the responses of these different communities.

Discussion and Take Home Message: Fire has been a vital part of many ecosystems for centuries. Natural fire regimes are beneficial to plants and animals in the community, and fire has been used as a land management tool since Native Americans first inhabited California. When fire is suppressed, fuel builds up in the understory and can result in very large, destructive fires that destroy plant, animal, and human communities. Land managers are learning from the successes and mistakes of past land management practices and again beginning to incorporate regular, low intensity burns into their management practices. Can you think of an area nearby where there has been a wildfire recently? What kind of role do you think fire played in that specific area?

Skills and Concepts: Graphing, Evaluating, Comparing, Analyzing, Applying

Resources

Reference Materials

- *Map of the Yuba River Watershed*, available from http://yubariver.org.
- *John Muir Laws Field Guide to the Sierra Nevada* by John Muir Laws.
- *Living Wild—Gardening, Cooking and Healing with Native Plants of the Sierra Nevada* by Alicia Funk and Karin Kaufman.
- *The Nature of this Place: Investigations and Adventures in the Yuba Watershed* by The Yuba Watershed Institute.

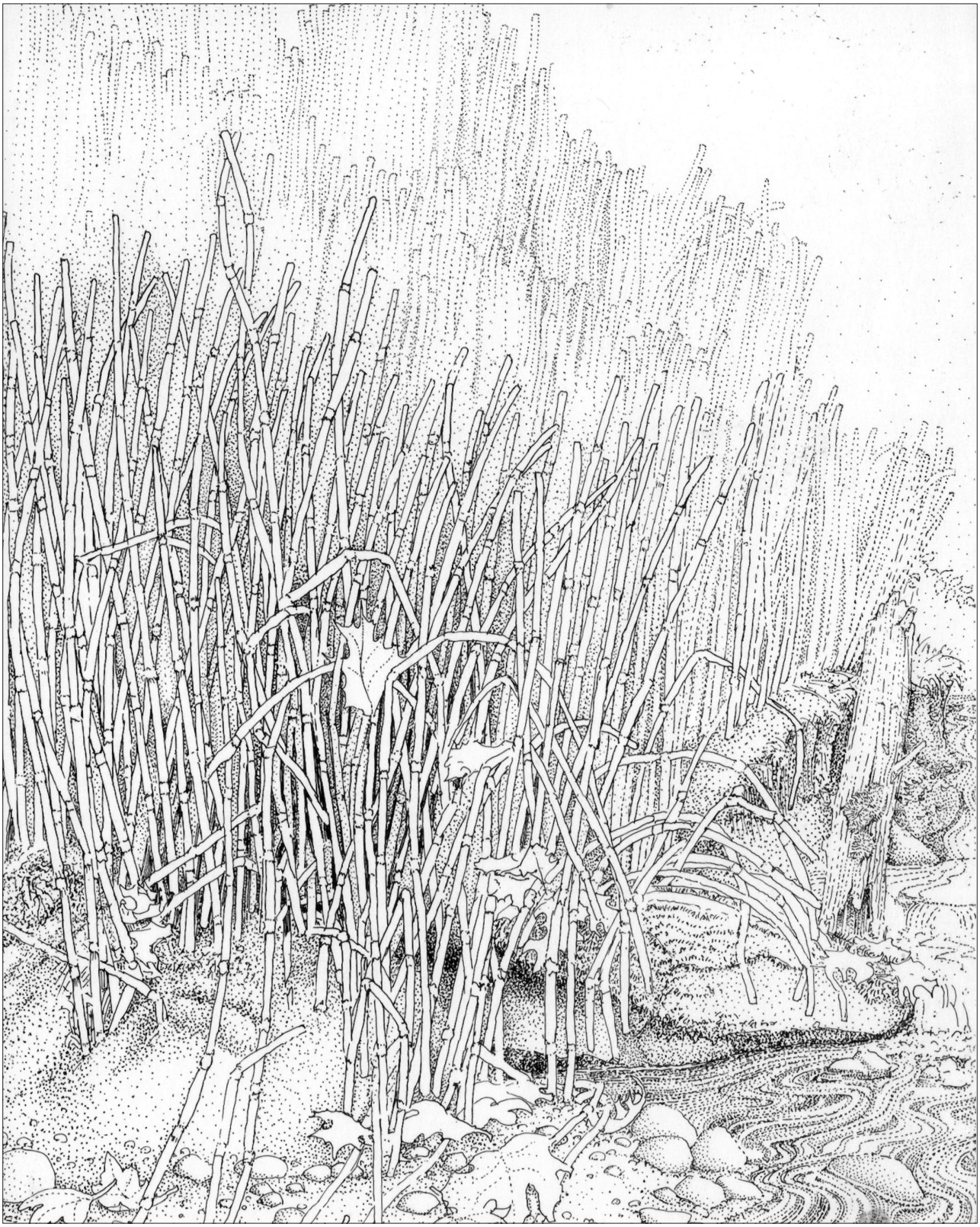
Children's Books

- *In a Nutshell* by Joseph Anthony
- *I Know the River Loves Me* by Maya Christina Gonzalez
- *Miss Rumphius* by Barbara Cooney
- *Salmon Stream* by Carol Reed-Jones
- *The Giving Tree* by Shel Silverstein
- *The Little Creek* by Jennifer Ward
- *The Lorax* by Dr. Seuss
- *Trout are Made of Trees* by April Pulley Sayre

Circle of Birds

This illustration can be copied and used for coloring.

Reeds



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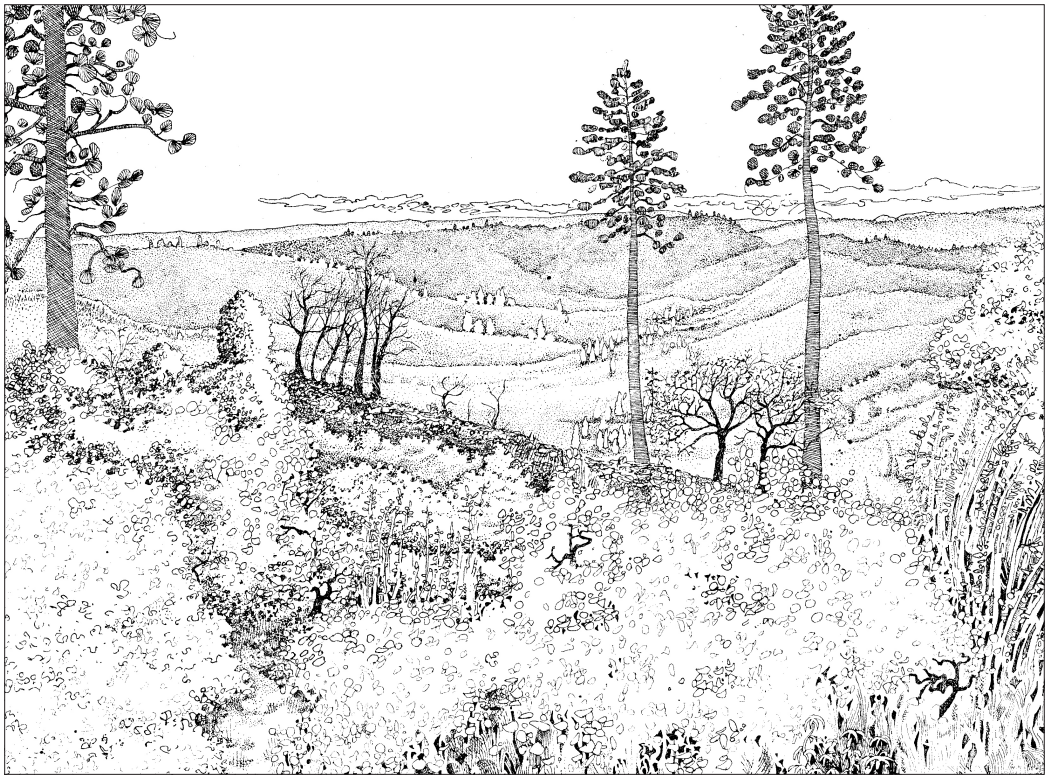
Butterfly

Panorama



These illustrations can be copied and used for coloring.

Fern