TUALATIN RIVER
National Wildlife Refuge

On-Site Field Trip Activities

Nature Bingo K-2

Overview
Students will try to identify as many animals and plants from their Bingo game as they can while visiting the Tualatin River Refuge.

Duration
Approx. 2 hours/Length of visit

Grades
K-2

Benchmarks
- Organisms
- Diversity/Interdependence
- Collecting & presenting data

Key Concepts
The Tualatin River National Wildlife Refuge provides a safe habitat for many different plants and animals.

Objectives
Students will be able to:
- identify familiar animals and plants found on the refuge
- become aware of unfamiliar types of animals and plants they observe through help of parents, volunteer naturalists, other students and teachers
- complete their Bingo handouts by crossing off each animal or plant when they observe them at the refuge

Materials
- Bingo student handout
- pencil
- clipboards

Background Information

The Tualatin River National Wildlife Refuge is home to many different populations of plants and animals. Students will be able to observe familiar plants and animals such as squirrels, geese, ducks, oak trees, maple trees, etc. With help from teachers, parents and volunteers, students will begin to see the amazing variety of living things at the refuge. They will be able to observe many different kinds of birds, squirrels and ducks that they are familiar with, but with closer observation they will see even more populations that call the refuge their home. Looking a little closer, students will be able to see beyond the obvious and find evidence that plants or animals live nearby. Students may observe bird feathers, insect holes in a tree trunk, leaves fallen from nearby trees, bones from an animal, owl pellets or even tracks left by a wandering raccoon. Taking time to use the senses of sight, sound, and smell will help students discover many exciting things about the plant and animal life at the NWR.

Suggested Procedure

Give each student a copy of the Nature Bingo on a clipboard to carry with them while walking around that entire NWR. Before you begin your activities, discuss with students what they may see and what items are on their Bingo cards. Tell students that they are to cross off the picture of the plant or animal when they spot it. Older students can write where they saw the plant or animal or even evidence that led them to the plant or animal.

Remind students that they need to stay on pathways and not disturb the plant or animal life around them. Discuss with students that some of the items may be easily spotted, while they may need to look for "evidence" of others. They may not see a deer but they may see some hoof prints of a deer. They may not see a frog but they may hear a frog. Emphasize that they need to stop for several minutes at each station and be quiet to carefully observe and listen for any signs of animals or plants around them.

See if students can find every item on their Bingo sheet by the end of their visit. Invite older students to draw or write the names of any plants or animals that they enjoyed, but that were not on the bingo game, on the back of the paper.

Assessment Ideas

Ask students the following questions:

1. Which items on your bingo sheet were the easiest to find?
2. Which items were the hardest to locate?

3. Which items did you not find?
4. Which items did you find only by "evidence" but did not actually see?
5. What did you find by the pond?
6. What did you find by the forest?
7. What did you observe that was not on your bingo game?

5. Did you see any signs of life in or around the tree?
6. What color and shape are the leaves?
7. What do you think will happen to the leaves through the seasons?

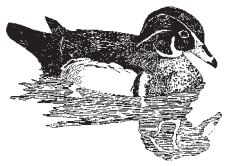
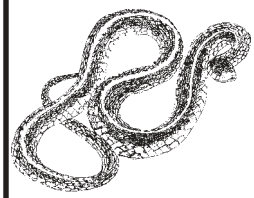
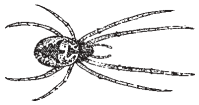
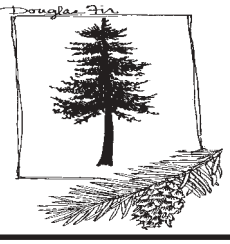
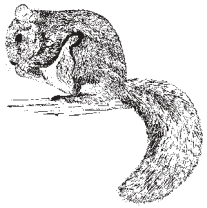
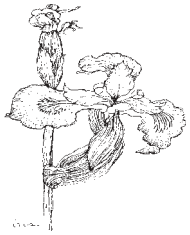
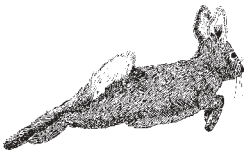
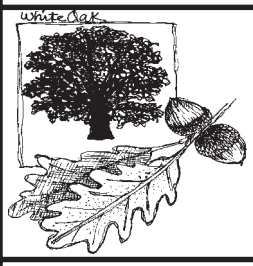
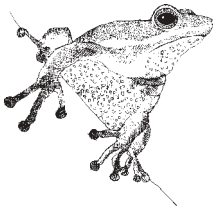
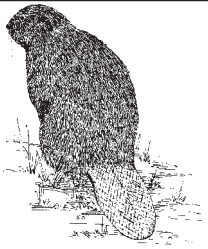
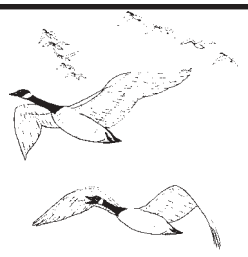
References

Golden Guide Series. *Pond Life; Insects; Reptiles and Amphibians.*

Peterson's Field Guide Series. *Western Birds; Mammals.*

Pojar & MacKinnon. *Plants of the Pacific Northwest Coast.*

Nature Bingo

				
				
		**FREE**		
				
				

Nature Bingo 6-8

Overview
Students will compare the riparian forest to other habitats and form hypotheses about the populations living there.

Duration
20 min

Grades
6-8

Benchmarks
- Forming a question/ hypothesis
- Diversity/interdependence
- Collecting & presenting data

Key Concepts
The riparian forest provides a diverse habitat for many different animals and plants.

Objectives
Students will be able to:
- enhance their awareness and observation skills
- make predictions about the diversity of plants and animals living in different habitats
- become aware of biological factors that change populations in an area

Materials
- paper
- pencils
- clipboards
- student handout "Nature Bingo"
- field guides

Background Information

The riparian forest is home to a diversity of living things. The layered tree canopy provides shelter for organisms dwelling in high, medium and low areas of the forest. Trees such as the broad leaf maple require sunlight to survive. Their ability to grow tall quickly makes this forest area favorable for their survival. Their long roots are able to absorb water from deep underground. Vine maple trees, which are much shorter, don't require as much sunlight so they have adapted to shady areas under the tall broad leaf maples. Ferns, mosses and other native plants found here don't require as much sunlight either. The shade from taller trees keeps the forest floor moist and protected from wind, which is preferable for all of the organisms living here. The large amount of biomass provides food and shelter for both large and small animals year round and allows a high carrying capacity. As the seasons change, the balance of plant and animal populations change. The length of daylight and change in temperature triggers the circadian rhythms of living things: deciduous plants lose or grow leaves; insects lay eggs, die or burrow underground; birds migrate and mammals hibernate or become more active.

Vocabulary

Scat—animal feces

Lichen—a plant-like organism consisting of fungus and algae

Riparian forest—a forest that borders a creek, river or other body of water

Circadian rhythm—a biological clock in living things that controls daily cycles of life such as sleeping, eating, breeding, hibernating, etc.

Biomass—organic matter that contains stored energy

Canopy—trees, and shrubs grow to different heights depending on the space and sunlight available. Tall trees provide a canopy or shelter overhead where a large number of species live.

Carrying capacity—the largest population that a specific environment can support over a long period of time

Suggested Procedure

Stand together in a group. Tell students to look around and take notice of all of the living and non-living components (things) that are part of the forest. How is this riparian forest is different than a grassland or pond? Share and discuss some of the background information with your students. Be sure they notice the tree canopy

and understand its function.
Give students the "Nature Bingo" blank grid. Have them randomly write the following words in the squares:

1. bird nest
2. flower with 5 petals
3. dried seed
4. feather
5. bird resting
6. animal track (not human)
7. rotting log
8. lichen
9. spider web
10. berry
11. moth or butterfly
12. mold
13. spider
14. trash
15. fern
16. really tall tree
17. moss on the north side of a tree
18. dead bug (not one you just killed!)
19. chewed leaf
20. really small tree
21. animal scat
22. leaf with brown spots
23. sign of the wind
24. bird flying

Show students the boundaries that they must stay within. Remind them to stay on the trail. Students may work in pairs or alone. When they find an item they should put an "X" in the square. When they have found all of the items, tell them to come and show you. When all students are ready, say "Ready, Set, GO!"

When students are finished, gather together in a large group and wrap up the activity by discussing the assessment questions.

Note: To save time on the Refuge, have students fill out their Bingo sheet at school or on the bus!

Assessment Ideas

Ask students the following questions:

1. If you played this bingo game by the pond or in the Oak Savannah area, would you have been able to find all of the items? Why?
2. Why can more species of plants and animals be found in this area?
3. What types of animals do you think live in this kind of forest?
4. If you came back in 6 months and played this bingo game, would it be easier or more difficult to find all of the items? Why?
5. Why do the populations of different plants or animals change throughout the year?

Nature Bingo

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Wildlife Inventory K-2

Overview
Students will observe wildlife in one area of the NWR for a period of time. They will concentrate on different sections of the same area, breaking their observations up into what they observe in the air, on land, in the water, and in the trees.

Duration
20 min

Grades
K-2

Benchmarks
- Designing an investigation
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
The refuge is home to a wide variety of animals that changes depending upon the time of year. Wildlife can be found everywhere one looks at the refuge: the trees, ponds, river, creeks and landscape are always busy with different populations of animals.

Objectives
Students will be able to:
- observe wildlife around them using the senses of sound and sight
- record their observations on handouts either in writing or drawing
- share and discuss their observations with their classmates

Materials
- pencils
- student handouts (choose one for your students) "Wildlife Inventory", "Wildlife/ Plant Inventory"
- clipboards

Background Information

The NWR is home to a wide variety of plants and animals. There are many changes at the refuge throughout the year depending on the season. Many animals make the refuge their home year round while other animals migrate to the refuge for a season. At any time of year the refuge will be busy with wildlife.

Wildlife at the refuge is not used to human contact. Students will be observing most wildlife from a distance and will need practice with binoculars before their visit. Students should be familiar with the variety of wildlife and plant life found at the refuge to make their identification and observations easier. It would be helpful for students to have practice at quietly observing wildlife and recording their observations before a visit to the refuge.

Suggested Procedure

Students will need a copy of either the worksheet "Wildlife/Plant Inventory" or "Wildlife Inventory" and a clipboard. You can use these worksheets in any area at the refuge.

Discuss with students how to make an observation and what they may see. Review how to look all around and see what is happening in the air, in the water areas, and on the land. Have students sit or stand quietly for at least five minutes in a given area. Have them draw their observations on the worksheets for what they observed in the air, water areas, and on land. For the worksheet "Wildlife/Plant Inventory", also have students draw what they observed in the trees in a given area.

Older students can do their observations a little differently using the worksheet "Wildlife Inventory". Besides drawing their observations, they can focus on one particular type of animal to count in a given area.

Assessment Ideas

Discuss with students what they observed and allow time to share their drawings. Put students in small groups to share and have them discuss what is the same and what is different in their observations even when they were looking at the same given area. Discuss why some may have seen different animals that others missed.

Ask students:

1. What was your favorite animal that you observed?
2. Why do you think the animals live here at the refuge?
3. What would happen if there were more animals here?
4. What would happen if fewer animals lived here?
5. Why do you think some animals spend more time in the water, in the air, on land or in the trees?
6. Which animals do you think live here all year? Why?

References

Golden Guide Series. *Pond Life; Insects; Reptiles and Amphibians.*

Peterson's Field Guide Series. *Western Birds; Mammals.*

Pojar & MacKinnon. *Plants of the Pacific Northwest Coast.*

Wildlife Inventory

Stand in one place and look around you. What do you see? What do you hear? Use binoculars to get a closer look. Observe one area for five minutes. In the boxes below, draw what you observed. Choose a type of bird or animal to observe. How many of this type of animal did you see? Write the number in the bottom of the box.

Air

Total Number_____

Water

Total Number_____

Land

Total Number_____

Wildlife/Plant Inventory

Draw pictures of any animals or plants that you find in a given area. Stand and watch for five minutes to find any signs of life. You many use binoculars for a closer look. Listen for any signs of life around you.

Air	**Land**
Water	**Trees**

Wildlife Inventory 6-8

Overview
In this activity students will look for a variety of wildlife and record their sightings on a data sheet. They will identify species of animals found on the Refuge by using field guides.

Duration
20-60 min

Grades
6-8

Benchmarks
- Diversity/interdependence
- Forming a question/ hypothesis
- Collecting & presenting data
- Analyzing & interpreting data

Key Concepts
Animals can be classified into different groups according to their characterstics. The Refuge is home to a wide variety of animals, which migrate to find food, water, or safe nesting grounds.

Objectives
Students will be able to:
- classify animals by observing specific characteristics
- determine the diversity and abundance of wildlife on the Refuge
- make predictions about yearly fluctuations of animal populations

Materials
- binoculars
- clipboards
- pencils
- field guides
- student handouts "Wildlife Inventory," "Refuge Animals," and "Classifying Animals"

Background Information

The wetlands, ponds, savannah grassland and forested areas found on the Refuge provide homes for numerous animals. Some of the animals migrate in the fall or spring while others stay here year round. Wildlife can be seen more frequently in the early morning hours. It is important to be quiet while moving through the Refuge since the animals are easily disturbed by people in their habitat.

Using binoculars to spot a moving object can be difficult for even the most experienced naturalist. If you have binoculars available at your school, it would be helpful to let students practice viewing moving and non-moving objects before you arrive at the Refuge.

Before you arrive, use field guides and/or websites to view pictures of the animals listed below that have been seen on the Refuge. Help students be aware of the similarities and differences in the bird species such as size, coloration, beak and wing shape, movement, etc.

Suggested Procedure

Give students the "Wildlife Inventory Data Sheet," "Refuge Animals," and "Classifying Animals" sheets and other materials. Have students spread out and sit alone, quietly in one place for at least 20 minutes to observe wildlife. They should make tally marks in the "Number of Individuals Observed" box on their data sheet to keep track of how many animals they see. Be sure not to count the same animal more than once. If students have problems identifying specific species, have them record "Additional Information" such as habitat, coloration, sound, etc. to help identify them later.

Assessment Ideas

Ask students the following questions:

1. Which type of Refuge animals did you see most often?
2. Why do you suppose this type of animal is so abundant on the refuge?
3. Would you expect the number of animal populations to change throughout the year? Why or why not?
4. Do you think that all the animals on the Refuge are native to this area? Why or why not?
5. Do non-native animals have an affect on native populations? Why or why not?

References

Oregon Department of Fish and Wildlife. *The Stream Scene: Watersheds, Wildlife and People*.

Sherwood Middle School Refuge Club. *Tualatin River National Wildlife Refuge Field Guide: by Kids – for Kids*.

National Audubon Society. *The Sibley Guide to Bird Life and Behavior.*

Refuge Animals

Songbirds	Black-capped Chickadee	Red-winged Blackbird
	Marsh Wren	Downy Woodpecker
	American Robin	Barn Swallow
	Common Yellowthroat	Western Bluebird
Upland Birds	Mourning dove	
	Quail	
	Pheasant	
	Western Meadowlark	
Wading Birds	Great Blue Heron	
	Great Egret	
Shorebirds	Sandpiper	
	Yellowlegs	
	Killdeer	
Waterfowl	Western Canada Goose (large)	American Coot
	Cackling Canada Goose (small)	Northern Pintail
	Mallard	
Raptors	Red-tailed Hawk	Bald Eagle
	Peregrine Falcon	American Kestrel
	Osprey	
	Common Barn Owl	
Reptiles	Northwestern Garter Snake	
	Common Red-Spotted Garter Snake	
	Alligator Lizard	
	Painted Turtle	
Amphibians	Rough-skinned Newt	
	Chorus Frog	
	Long-toed Salamander	
	Red-legged Frog—*native species of concern; prey of Bullfrogs, short breeding period, needs both aquatic and forested habitats for survival*	
	Bullfrog—*non-native problem species; eat Red-legged Frogs and tadpoles, adaptable to many habitats*	
Mammals	Beaver	River Otter
	Black-tailed Deer	Raccoon
	Mink	Vole
	Coyote	Little Brown Bat
	Nutria—*non-native; originally introduced for the fur industry but is a problem species today. They can breed up to 3 times per year!*	

Classifying Animals

Songbirds

Body Adaptations: small, often colorful birds; called “perching birds” since the shape of their feet and toes are adapted to holding onto branches.
Habitat: live mainly on land, in trees and vegetated wetlands.
Food: eat a variety including insects, seeds, berries, nectar and fruit.

Upland birds

Body Adaptations: range in size; rounded, plump body; long toes, and legs for walking and scratching.
Habitat: live in dry, grassy, brushy areas on the ground; adapted to ground nesting.
Food: eat seeds and insects.

Wading Birds

Body Adaptations: medium to large in size; long legs, neck and bill; short tail, long wings.
Habitat: live in aquatic areas, especially wetlands.
Food: carnivores; eat fish, crustaceans, amphibians, small mammals such as voles and chicks.

Shorebirds

Body Adaptations: small to large in size, long toes, tapered wings, bill shapes vary—very long, short, curved, straight, flat; long legs with no webbing between toes.
Habitat: usually live near water such as wetlands, beaches or river banks; sometimes grasslands.
Food: eat crustaceans, aquatic invertebrates, worms, insects, seeds.

Waterfowl

Body Adaptations: heavy body, large head, flattened bill, short tail, webbed feet and long wings; males often colorful and females gray and brown (to camouflage with surroundings) depending on age and species.
Habitat: live in aquatic habitats such as seasonal wetlands, ponds, lakes, and rivers.
Food: eat aquatic grasses, pond weeds, wetland seeds, tiny crustaceans and fish eggs.

Raptors

Body Adaptations: medium to very large in size; usually colored to camouflage with surroundings; strong legs with large, powerful, grasping feet with sharp talons for catching prey; large hooked bill to tear prey; binocular vision that is 4 – 8 times better than humans; excellent hearing in order to detect prey.

Habitat: live in open country in a variety of habitats—forests, deserts, wetlands, pastures, fields.

Food: carnivores; birds of prey that eat a wide variety of living or dead animals—fish, birds, reptiles, amphibians, mammals.

Amphibians

Body Adaptations: cold-blooded with thin, smooth, moist skin; usually colored to camouflage with surroundings but poisonous ones are colorful; develop from egg in water, then can move onto land as adults.

Habitat: aquatic or damp areas such as wetlands, ponds, forests.

Food: eat insects, worms.

Reptiles

Body Adaptations: cold-blooded with thick, scaly dry skin; usually colored to camouflage with surroundings.

Habitat: varies depending on species—dry desert areas, aquatic areas, grasslands.

Food: eat insects, worms, fish, eggs, plants (crocodiles and alligators eat turtles, birds and mammals).

Mammals

Body Adaptations: warm-blooded, vertebrates, with hair and mammary glands, variety of shapes and sizes

Habitat: live on all continents of the world; habitats and climate range varies—desert, tundra, mountains, ocean, grassland, tropics, etc.

Food: can eat meat and/or plants depending on the species.

Wildlife Inventory Data Sheet

Location:_____ Observer:_____

Date:_____ Weather:_____

Time:_____ _____

Category	Number of Individuals Observed (make tally marks)	Species (optional)	Additional Information
Songbirds			
Upland Birds			
Wading Birds			
Shorebirds			
Waterfowl			
Raptors			
Reptiles			
Amphibians			
Mammals			

Signs of the Seasons

Overview
Students will discuss the four seasons and observe an area of the Refuge for signs of the current season. Students will then predict the appearance of the wetland during other seasons of the year.

Duration
20-30 min

Grades
K-2

Benchmarks
- Organism
- Diversity/Interdependence
- Collecting & presenting data
- Analyzing & interpreting results
- Dynamic Earth

Key Concepts
Signs of the approaching seasons are found in all areas of the wetlands.

Objectives
Students will be able to:
- identify patterns of the four seasons
- observe a given area looking for signs to indicate the present season
- predict and draw changes that may occur for the area over the four seasons

Materials
- crayons
- student handout "Four Seasons in a Wetland"

Background Information

The wetlands undergo many changes during the four seasons of the year. Students will observe changes in deciduous trees, migratory birds, plant life, water levels, etc. Deciduous trees change throughout the year, losing their leaves in the fall and growing new leaves in the spring. Coniferous trees are green all year. The wetlands are a stopping place for many different types of migratory birds. The winter months are very active as many different migratory birds come to feed.

Suggested Procedure

1. Starting at any station of the wetlands, have students observe the area around them. Discuss the current season and have students look for signs of the season. Remind students to look at plant life, trees, birds, animals, etc. Students may want to use binoculars for a closer look of the area.
2. Have students draw the current season on the worksheet "Four Seasons in a Wetland".
3. Have students recall all four seasons. Discuss signs and patterns of the seasons like weather changes, leaves changing, animals storing food, birds migrating to warmer areas, new plants growing, water levels higher or lower, etc. Introduce the terms deciduous, coniferous and migration.
4. Help students predict what the area that they drew will look like in all the seasons. Remind students to keep in mind weather changes, water levels, colors of the grasses and plants, changes in leaves, bird activity and animal activity.
5. Have students complete the worksheet "Four Seasons in a Wetland". Students should show several different changes in each season to indicate an understanding of what may happen to a given area over time.

Assessment Ideas

1. What will happen to the deciduous trees throughout the seasons?
2. What will happen to the coniferous trees throughout the seasons?
3. What animals do you think live in the wetlands year round?
4. What weather changes happen in each season?
5. What birds do you think migrate to the wetlands?
6. Why do birds and animals migrate?
7. What happens to the ponds throughout the year?

8. When would you see a heavier population of birds and animals at the wetlands?
9. What are the four seasons?
10. Have students share their worksheets, explaining reasons why they put some specific details in their pictures. Students can add ideas from others to expand their drawings.

References

Gibbons, G. *The Reasons For Seasons*.

Branley, F. *Sunshine Makes the Seasons.*

Maestro, B. & Krupinski, L. *Why Do Leaves Change Color.*

Van Laan, N. *When Winter Comes.*

Ehlert, L. *Red Leaf, Yellow Leaf.*

Four Seasons In a Wetland

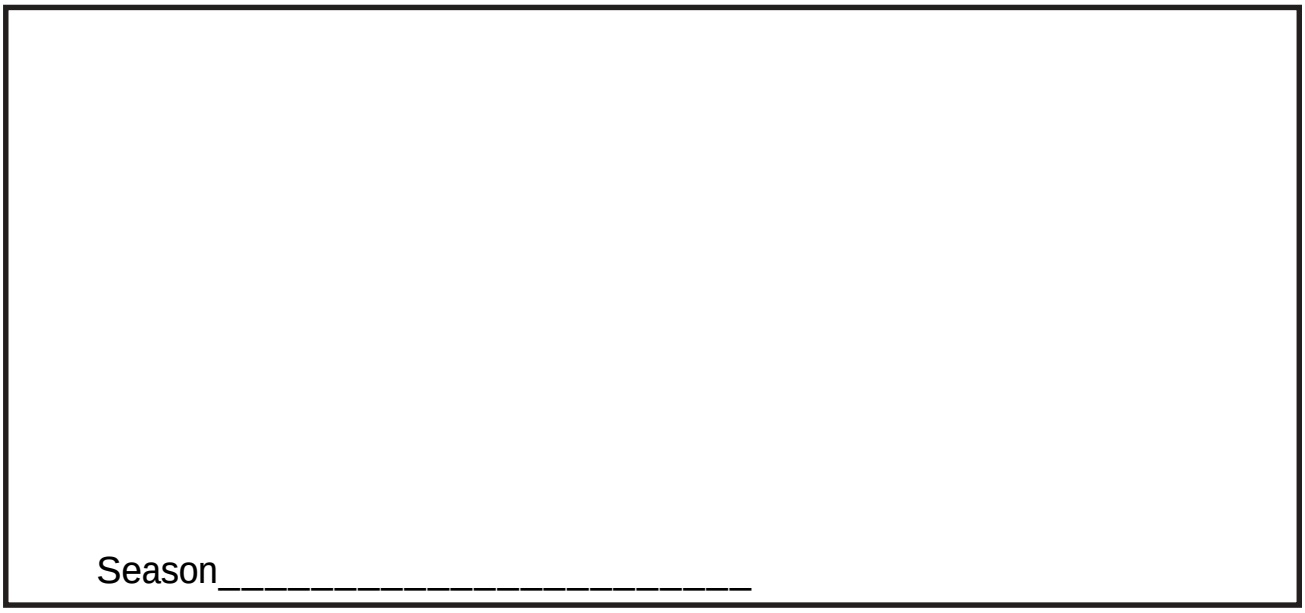
Draw one area of the wetland. Stop and look around you. Do you see any plants, trees, or animals? Be sure and include signs of the season in your picture.

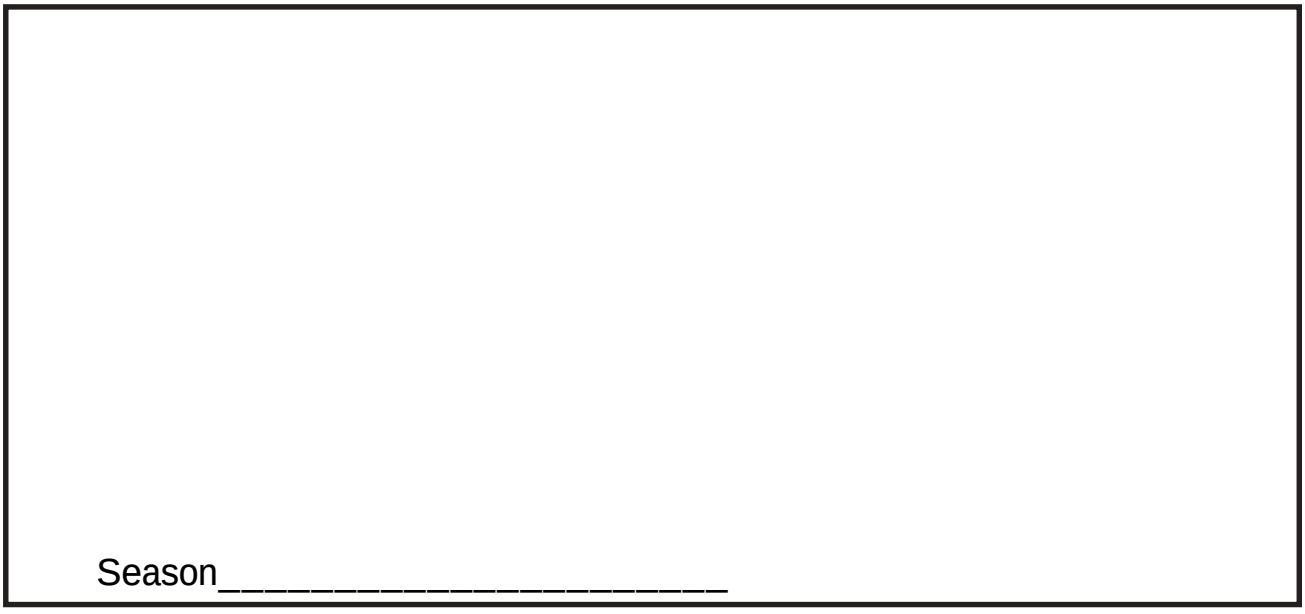
Season_____

Now draw what this area might look like in the other seasons.

Season_____

FALL WINTER SPRING SUMMER





FALL WINTER SPRING SUMMER

Don't Just Do Something, Sit There!

Overview
Students sit, observe, and reflect on the Refuge to gain a better appreciation for nature and the beauty of the area. Brain studies show that people learn best when given time to reflect on new material and new experiences.

Duration
30 min

Grades
3-8

Benchmarks
• Communicate ideas across subject areas using oral, visual, and multimedia forms

Key Concepts
Learning to appreciate the beauty, diversity, and interconnectedness of nature will help students respect and care for the Refuge and other wilderness areas.

Objectives
Students will be able to:
• Choose from a variety of multiple intelligence activities
• Express their observations of the Refuge in a creative way.

Materials
• directions and activity-choices sheet
• blank paper
• clipboards
• pencils
• field guides

Background Information

It's important for students to have time to just enjoy and experience the grandeur of the Refuge. It is hoped the first time visitor as well as those returning many times will be personally touched and nourished by nature ad be inspired to love and respect the Refuge. As Japanese conservationist Tanaka Shozo wrote, "The care of rivers is not a question of rivers, but of the human heart." (Taken from *Where the River Begins* pg. 123)

Suggested Procedure

NOTE: It would be best if the teacher discussed the various activity choices before the field trip and perhaps even practiced them at school. If this is done prior to the trip then the students are already familiar with the directions and choices when they sit down to reflect.

1. Choose a large area for this activity so that students can spread out and not disturb others. Choose from the 5 Study Stations (#1 Wetland Ponds, #2 Oak Savanna, #3 Habitat Edges, #4 Rock Creek, and #5 Riparian Forest) on the Refuge and break students into smaller groups within these Stations.
2. Students find a place to sit down that will be comfortable for the next 20-30 minutes.
3. Students work independently and silently.
4. Remind students to take time to just sit and appreciate what they are observing. Guide them to not only use their sight, but also their sense of hearing, smell, and touch.
5. These activities should be done as quietly as possible. Students choose one of the multiple intelligence categories, and then choose an activity within that category to complete.

Choose one of the following categories to express your observations of the Tualatin River National Wildlife Refuge.

Verbal/Linguistic:

1. Use words to describe what you observe.
2. Create a cinquain poem about the refuge:
   Line 1: a noun
   Line 2: Two adjectives
   Line 3: 3 verbs ending in "-ing"
   Line 4: a phrase
   Line 5: another word for the noun

   Example:
   Dalmatian
   spotted, happy
   running, barking, jumping
   a wagging tail on the end
   Fire Dog!
3. Write a letter to your parents describing this wildlife refuge to them. Use as many *sensory* details as possible, as well as adjectives and adverbs.

Visual/Spatial:

Draw what you observe.

1. Draw one of the habitats of the Steinborn Refuge. Give as many specific details as you can.
2. Draw a close up of flower, insect, etc. Use a lot of details in your drawing.

Musical:

Close your eyes; listen carefully to as many sounds as you can: rhythm of bird songs, water, insects.

1. Imagine the lyrics of the bird song (what are the birds saying with their chirping?). Write these lyrics down. With your teacher's help, try to identify the bird that is singing.
2. Compose a song or melody inspired by sounds/sights of the refuge.

Logical/Mathematical:

1. Count the number of deciduous trees in a small area, then the number of coniferous trees. Compare the 2 numbers (ratio).
2. Using a 1-meter string, make a small, circular transect and count the different types of plants in it. What are the percentages of each? ¼, ½, ¾, etc. (For instance, ¼ of the transect is moss, ½ is grass, ¼ is a bush).

Bodily/Kinesthetic:

(this would also be a logical / mathematical activity): Without disturbing your classmates:

1. From the ground area you are sitting on collect at 5-8 different types of leaves. Classify or sort them into two different groups using different properties. For instance, leaves with smooth edges and leaves with jagged edges. Dark leaves and lighter colored leaves. Trace each leaf or do leaf rubbings on your paper and write why you classified them into your different groups. Re-sort them (move them around) into 3 different groups using different properties.

After 20 minutes or so (depending on group) have students get into small groups and share their reflections with others. Or the reflections can be shared back at school.

Plant Diversity

Overview
Students will look at plants in open water, at the water's edge, in the oak savannah, and in the riparian forest, and will study the differences between plants in these different habitats.

Duration
10 min per station

Grades
3-8

Benchmarks
- Diversity/interdependence
- Dynamic Earth
- Forming a question/ hypothesis
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
Plants in different habitats develop various means to survive and thrive in that habitat.

Objectives
Students will be able to:
- describe at least two differences between plants that live in different habitats
- describe how these differences allow the plants to thrive in their habitats
- explain two reasons for plant diversity

Materials
- copies of student handout "Plant Diversity"
- pencils
- clipboards
- meter sticks
- hip boots (optional)

Background Information

The diversity of plant life exists partly because environmental conditions differ from habitat to habitat and change throughout the year. One of the major factors influencing plant adaptations is the amount of water available in a particular area. This can easily be seen by comparing the structures of plants that grow in open water, at the water's edge, in an oak savanna, and in a riparian forest.

Open water

These plants must survive very wet conditions and have a mechanism for either floating above the water to get sunlight (sometimes called floating plants), or being able to survive in the water column below the surface (sometimes called submerged plants), using diluted sunlight. For example, water lilies grow on the surface, and elodea grows below the surface.

Water's Edge

The dominant plants are those that can keep their roots wet during the high-water time of the year, and then survive dry conditions when the water is low. At least part of the plant is above water level (sometimes called emergent plants). Cattails are an example of plants found in this zone.

Oak Savanna

These plants must suck up moisture from the ground through their roots, and then give off water vapor through their leaves (transpiration). They must be able to stand upright without the support of surrounding water. Some of these plants have woody, not soft, trunks and branches.

Riparian Forest

The forest is distinct for its layers of plant habitat. The canopy plants must suck up moisture from the ground through their roots, and they compete with each other for sunlight. The shrubs and bushes below rely on the forest canopy for shelter and moisture, but if the canopy is too dense, lack of sunlight will kill most of these plants. Mosses and lichen thrive on the moist environment provided by the canopy. Low-lying plants and vines do well in shaded, nutrient-rich soil available in the riparian forest.

Suggested Procedure

1. Tell the students they are going to go on a discovery walk to learn about plant diversity. They will be looking at the conditions in which plants live and how their structural adaptations help them to live there. Help the students brainstorm a list of some of the different conditions in which a plant could live (e.g., moisture levels, wind conditions, temperature, oxygen levels, amount of sunlight, nutrient levels, etc.).
2. Divide the students into teams of 2 –3. Give each team a copy of the Student Page. Have them answer the questions on the first page.
3. Send the students to investigate the plants in the different habitats found at each study site. Remind them to carefully record their observations.
4. After students have visited the sites, bring the group back together. Discuss the environmental conditions found in each area. Help them to draw the connections between the structure of the plants and the conditions in which they grow. How does this tie in with plant diversity? Do not get caught up in identifying plants – focus on plant adaptations.
5. Repeat this activity at each station.

Extension/Adaptations

If your group has been working on plant identification, have students examine features of the plants that they think might aid in identifying the plant. Have the students key out a few of the plants using a guide.

Make exploration more quantitative by having the students walk (and wade) a transect line that goes through the different habitats and count the plants touching the transect line, noting their basic characteristics.

Assessment Ideas

Access student responses to Student Page – "Plant Diversity"

Have students use photographs to compare/contrast the structural adaptations of plants that live in other habitats (for example: tundra, rain forest, and desert).

References

Rhythms of the Refuge: Educators Guide. (adapted from Salt Marsh Manual: An Educators Guide)

Plant Diversity

Before you go and look at the plants, answer the following questions about where the plants live:

	Open Water	Water's Edge	Oak Savannah	Riparian Forest
Soil: Is the soil in this area usually wet, usually dry, or sometimes wet and sometimes dry?				
Sunlight: How much sunlight can a plant get in this area?				
Design a plant: Design and draw a picture of a plant that could survive in these conditions. Label two of the adaptations that would help your plant survive in this area.				

Now, begin exploring, and record your observations:

	Open Water	**Water's Edge**	**Oak Savannah**	**Riparian Forest**
How many different types of plants do you see? Do not try to name the plants, just note the differences.				
Draw or describe the most numerous plants in this area. (How tall is it? What shape are its leaves? Does it have woody stems?)				
How tall are the tallest plants in this area? How short is the shortest plant in this area?				
Other observations?				

Refuge Expedition

Overview
Students explore the refuge as though they were a scientist specialized in a particular field.

Duration
20 min per station

Grades
5-8

Benchmarks
- Diversity/interdependence
- Dynamic earth
- Forming a question/ hypothesis
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
We must have a basic understanding of earth, life, and physical sciences in order to fully understand the complex ecosystem found at a National Wildlife Refuge.

Objectives
Students will be able to:
- describe how the earth and its processes affect this ecosystem
- describe how animals interact with this ecosystem
- describe how plants are an integral part of this ecosystem

Materials
- student handouts "Expedition Data Sheets"
- pencils
- clipboards
- field guides
- hand lenses
- maps of the refuge
- hip boots, spotting scope (optional)

Background Information

See page 4 for overview of Tualatin River National Wildlife Refuge habitats. The following lesson is a suggestion for how to organize the students for the field trip. Requires prework found on page 81, and postwork found on page 251.

Suggested Procedure

1. Before arriving at the refuge, break up the students into their groups. For large classes, you will have more than one type of team. Tell the students they are going on an expedition to explore an unknown territory. They will be on an expedition team with three members. When they return from the expedition, their team will be expected to give a full report of their findings.
    a. Zoologist team – scientists who study animals
    b. Botanist team – scientists who study plants
    c. Earth science team – scientists who study the earth and its processes
2. At the refuge, hand out the Expedition Data Sheets according to the teams. **Each team should have enough data sheets to do a survey at each study station.** Discuss the responsibilities of each expedition member by having one student read each role description aloud (found at the top of the Expedition Data Sheets). You will also want to review the Nature Observation Skills (found on page 41) you practiced at school.
3. Give the students maps of the refuge indicating the area boundaries. Go over consequences of not staying within these boundaries.
4. Students should write their answers to all of the questions on their Expedition Data Sheet so they can share when they return to school. You may want to assign groups appropriate tasks from other lessons in this manual. For example, the botanist can do the "Plant Diversity" lesson (found on page 129) as part of their tasks to accomplish.
5. Point out the tools that the students have to help them explore their territory. The hand lenses will allow them to see plants and small animals in greater detail.
6. Remind students where they should return to after they have completed their expedition, and send them out to explore. Allow 15 – 25 minutes for exploration at each station.

7. Look at post activity “Specialist Teams” (found on page 251).
8. Student Handout to conclude this activity back in the classroom.

Assessment Ideas

Look over the Expedition Data Sheet for completeness. Remind students that they will need to refer to these sheets when reporting to the class. As scientists they will want to report as much detail about the habitat they are studying as possible.

References

Rhythms of the Refuge: Educators Guide. (adapted from Salt Marsh Manual: An Educators Guide)

Name _____

THE ROLE OF THE EARTH SCIENTIST
(Scientist who studies the earth and its processes)

1. Describe how the land looks. (Is it flat or hilly? Are there cliffs in the area? Is it open fields, forest, etc.?)
2. Describe the climate. (What would a typical spring, summer, fall and winter be like here? Is it mostly sunny or cloudy? How cold would it be? Would it be windy or calm?)
3. Describe the soil. (Is it coarse, medium or fine? Is the soil moist or dry? Warm or cold? What can live in this soil?)

EXPEDITION DATA SHEET – Earth Scientist

1. Describe the area:

2. Climate: For a typical year, describe what you think it would be like in the area in the following seasons. (Would it be windy, wet, dry, cold, hot, etc.?)

a. Spring

b. Summer

c. Fall

d. Winter

3. Soil (Circle your choice)

a. Texture:	Coarse	Medium	Fine
b. Soil Moisture:	Wet	Moist	Damp

c. The soil is cooler/warmer than the air.
d. Are layers visible?

4. What does this habitat have to offer plants and animals? Does it have areas that provide food, water and shelter?

Name _____

THE ROLE OF THE BOTANIST
(Scientist who studies plants)

1. Describe the plants in this habitat. Are they fuzzy, smooth, sticky, etc.
2. Describe the size, color and shape of the leaves and flowers.
3. What makes them different from each other?
4. How have they adapted to get enough water?

EXPEDITION DATA SHEET – Botanist

1. How do plants get their food?

2. Draw and describe the plants growing in your study area. Record the features of the plant – size, color, shape of leaves and flowers (fuzzy, smooth, woody, waxy, etc.).

3. Where could plants find water and shelter in this area?

4. How do you think the features you described above help the plants to live in this habitat?

Name _____

THE ROLE OF THE ZOOLOGIST
(Scientist who studies animals)

1. Describe animals you find by color, size, shape and body parts.
2. Look for signs of animals that live here (scat, tracks, holes, webs, etc.).
3. Name all animals that appear to live here.
   a. Describe the food chain for each animal: What do they eat? What eats them?
   b. Where do animals find water and protection?

EXPEDITION DATA SHEET – Zoologist

1. Draw and describe the animals you found in your study area. Record special features you observe (color, size, shape, specialized mouth parts, camouflage, and protective parts like horns or quills).

2. Draw and describe any animal signs found in your study area (scats, tracks, holes, webs, etc.).

3. Where could animals find food, water and shelter in this area?

4. Draw a food chain for one of the animals you described above.

Bird Adaptations

Overview
Students will examine different adaptations and make predictions about their uses.

Duration
15-20 min

Grades
6-8 (can be adapted for 3-5)

Benchmarks
• Under Construction

Key Concepts
Different species of birds have a wide variety of adaptations that allow them to thrive in their environment.

Objectives
Students will be able to:
• identify specific adaptations in observed bird species
• describe and explain several of the adaptations of the birds that live in the wetlands

Materials
• student handout "Bird Adaptations"
• binoculars
• bird field guide
• pencils

Background Information

Species develop adaptations that help them survive in specific environments. Animals need to adapt to different environments for a variety of reasons. It may be to find a new food source or nesting ground.

We can see a wide variety of birds that are specifically adapted to their environments. Ask students what different traits or variations they see in different bird species.Why do we see such variations? Why is it advantageous for species to be different? Then ask students to list adaptation or differences among different bird species for these variations. You may want to have students focus on beaks, feet, legs, wings and coloration. For example, some birds have long wingspans while others have shorter wingspans. What would a longer wingspan enable a bird to do compared to a species with a shorter wingspan? Make a list and discuss these adaptations with them before you go out to the field, using the chart below as a guide. This can be done in conjunction with an art collage where students cut and paste birds from magazines listing their specific adaptations.

	ADAPTATIONS	ADVANTAGES
BEAKS	pouch-like	can hold fish
	long, thin	can probe shallow water and mud insects
	pointed	can break and probe bark of trees for insects
	curved	can tear solid tissue, like meat
	short & stout	can crack seeds and nuts
	slender & long	can probe flowers for nectar
FEET	webbed	aids in walking on mud and moving through water
	long toes	aids in walking on mud
	clawed	can grasp food when hunting
	grasping	aids in sitting on branches & roosting

	ADAPTATIONS	ADVANTAGES
LEGS	flexor tendons	aids perching and grasping
	long & powerful	aids in running
	long & slender	aids in wading
	powerful muscles	aids in carrying prey
WINGS	large	soaring for long periods
	short	short bursts of flight
COLORATION	bright	helps males attract females
	same as environment	helps with camouflage

Suggested Procedure (in field)

1. Have students locate 2 to 3 different bird species. This may require binoculars depending on the time of year. Field guide books may also be necessary.
2. Explain to students that they will be examining the specific characteristics of the birds they choose and making a prediction of how that characteristic might be used in this bird's lifestyle/niche. Observations should be recorded on the Bird Adaptation Worksheet.

Extension/Adaptations

1. Students can do further research to determine whether or not their prediction was correct. This can either be a short one-paragraph response or a report that goes into more detail about the species of bird.
2. Once in the classroom ask students to list the different bird species and adaptations they saw. Have them work on classifying them into groups based on shared characteristics. They can further research how closely their classification scheme matched up with ornithologists.
3. Have students design their own species of bird based on specific habitat and food restraints.

Assessment Ideas

Have students share their finding with pairs or groups. The have students share one bird they found interesting with the class. Collect handouts.

References

Kavanagh, J. *Pocket Naturalist: Guide to Portland Birds.*

Stokes, D., & Stockes, L. *Stokes Beginner's Guide to Birds: Western Region.*

National Audubon Society. *The Sibley Guide to Bird Life and Behavior.*

Name_____

Bird Adaptations

Directions: Look for two different species of birds. If you can, identify the bird by its correct name. Make observations about the following bird characteristics. You can either write out your answers or illustrate. Try to identify the purpose of this feature for the bird.

Bird_____

Shape of beak: Purpose:

Shape of feet and legs: Purpose:

Shape of wings: Purpose:

Coloration pattern: Purpose:

Bird_____

Shape of beak: Purpose:

Shape of feet and legs: Purpose:

Shape of wings: Purpose:

Coloration pattern: Purpose:

Walkin' the Line Transect

Overview
Students will observe, count, and record plant and animal populations on a line transect map.

Duration
30 min

Grades
6-8

Benchmarks
- Diversity/interdependence
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
A line transect provides a sampling of biotic and abiotic parts of a community. Populations living next to a path must adapt to changes throughout the year in order to survive.

Objectives
Students will be able to:
- identify a sampling of organisms in a community
- learn the purpose and function of a line transect

Materials
- 30 m of string, rope, or tape measure
- meter stick
- pencils
- Nature Journal or paper
- sample transect line

Background Information

Each organism has a specific niche or role that it plays in a community. Its niche includes where it lives, what it eats, its role in the food chain, or basically, what it does for a living. Populations of organisms living together in a community must maintain equilibrium in order to survive. If one population multiplies too quickly and takes over the niche of another, the community will be in danger. A line transect is an accurate representational survey of a small community.

Vocabulary

organism—a plant or animal

population—a group of organisms that are the same species

community—populations of plants and animals that live together in the same area

niche—the role an organism plays in its community

Suggested Procedure

Have students position the 30-meter rope or tape measure along the edge of the path. Students should be spaced at least 2 meters apart with their feet facing (perpendicular to) the line. Tell them that they should focus their observations along this line, plus 1 meter in front of them and 1 meter above the line. Demonstrate the space of 1 square meter using the meter stick. Students should move to the right as they map the transect.

All plants and animals within this space should be identified, counted and recorded on their map. Stress the importance of up close observation so that small organisms are not missed. If students are unable to identify an organism, they should draw a picture of it. Students can make a key using symbols and/or words to represent each species.

Be sure that students stay on the path so that they don't step on the organisms along the transect line.

Extension/Adaptations

After you return to your classroom, have students consolidate their data on a long sheet of butcher paper. Have each student draw or write about their observations in the section of the transect they observed. Make conclusions and answer the assessment questions using their findings.

This activity can be repeated on your school property or other natural area.

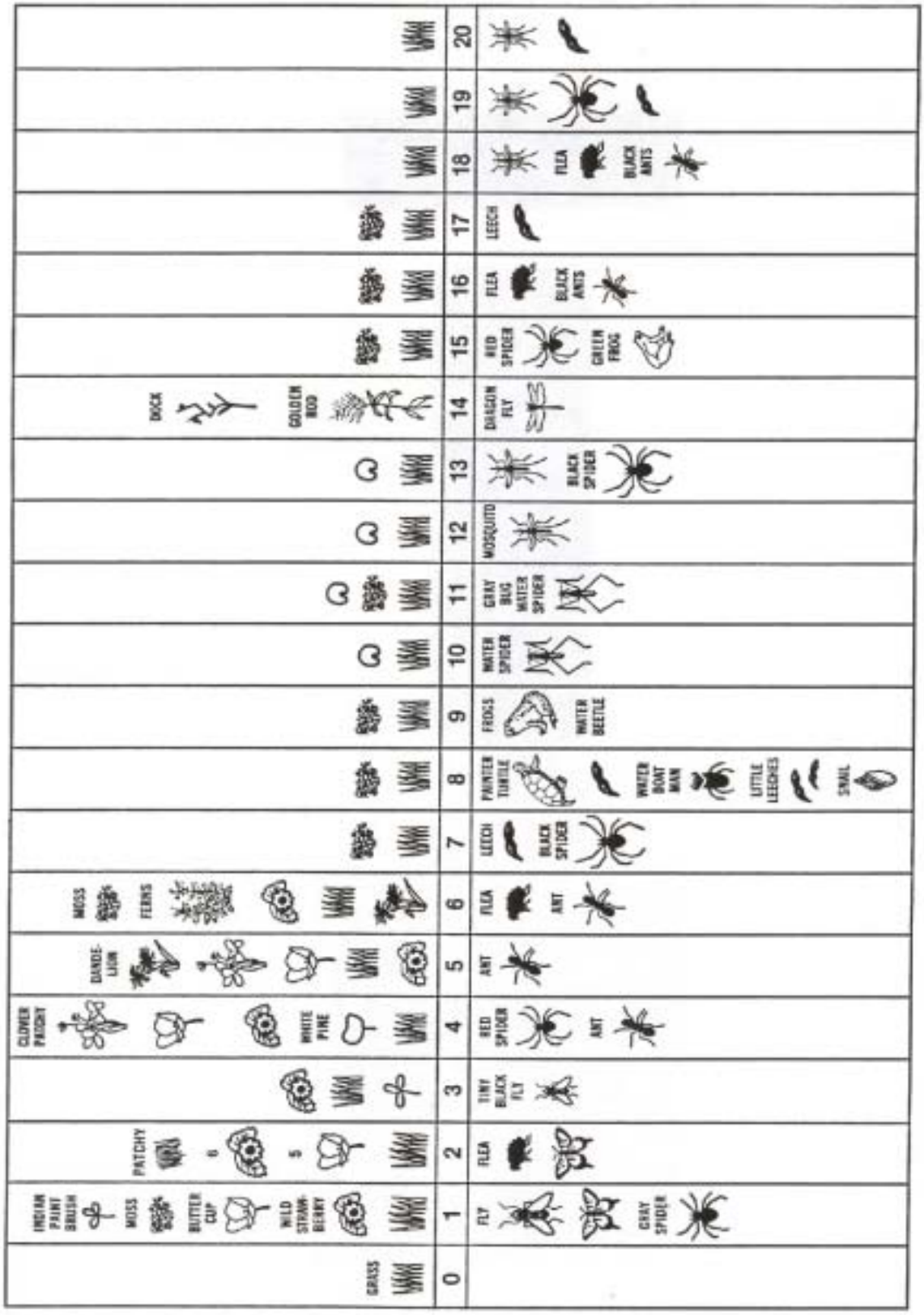
Assessment Ideas

1. Name the two most abundant plants and animals along the line transect.
2. What factors make these populations successful living here?
3. Do you think you would observe different organisms along the line transect 6 months from today? Why or why not? What would you expect to see?

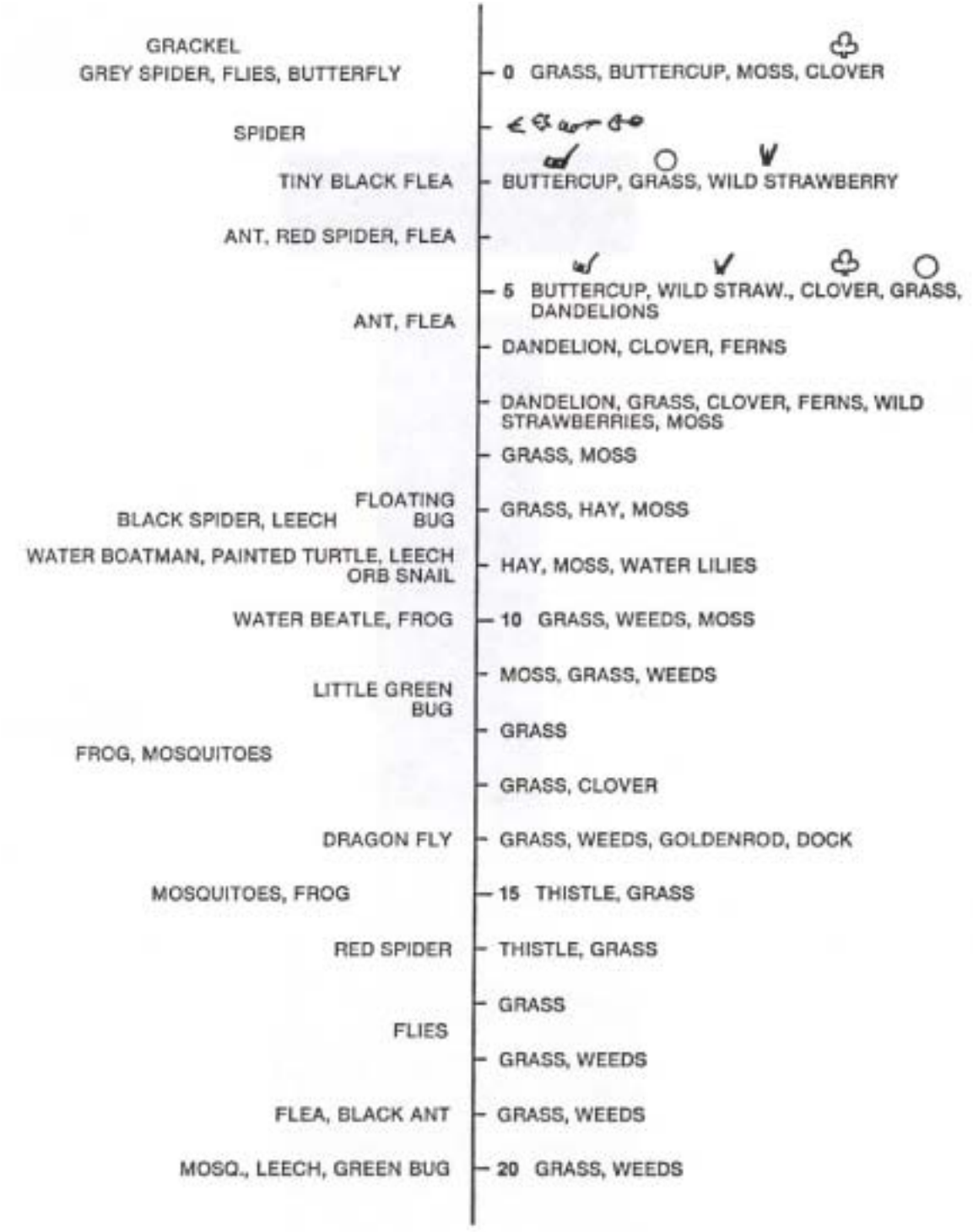
References

Western Regional Environmental Education Council. *Project Wild.*

Sample Line Transect A



Sample Line Transect B



Life in a Pond

Overview
NOTE: Ponds are seasonal: dry in the Summer and into early Fall. Call Refuge about status of water level in ponds for Fall field trips. In this lesson, students will visit a pond site and observe the plant and animal life in and around the pond, as well as examine a water sample from the pond.

Duration
20 min

Grades
K-2

Benchmarks
- Organism
- Heredity
- Diversity/Interdependence
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
A pond is an important habitat for many plants and animals as well as a stopping place for migrating animals or animals that live nearby.

Objectives
Students will be able to:
- observe a pond site looking for familiar plants and animals
- view a water sample from the middle of the pond
- draw their observations of the layers of a pond in their journals or on a handout

Materials
- journals or student handouts
- pencils
- plastic bucket
- scooping spoons
- large tub
- magnifying insect containers
- small trays
- Pond field guide
- hand lenses

Background Information

Note: Due to the delicate nature of the pond study ecosystem, a volunteer naturalist must accompany field trips that utilize this study. During the reservation process, please request a volunteer naturalist to accompany and lead this lesson.

A pond is a small, shallow body of water surrounded by land. A pond may form naturally or can be man made. A layer of clay or rock under the pond's muddy bottom keeps the water from soaking into the ground below the pond. Ponds are shallow, allowing the sunlight to reach down where plants and animals live and grow. The plants in and around the pond provide food and shelter for the pond animals.

A pond has three layers. The surface of a pond has tiny animals that live on it. The open water of a pond is filled with many animals such as minute zooplankton. Fish may live in the open water, as well as frogs and salamanders. Decomposers are hard at work in the muddy bottom of the pond. Decomposers help recycle nutrients back into the pond water for new growth. At the bottom of a pond you may find snails, tiny worms or crayfish.

Many plants and animals live around ponds and depend upon each other for survival. Around a pond you may see ducks, beavers, raccoons, and many more animals that stop by for food and water. In the air you may see song birds, and flying insects such as dragonflies, damselflies and mosquitos.

Suggested Procedure

1. Take students to the pond site. Discuss what grows and lives around a pond. Have students point out living and nonliving things that they see around the pond. Ask students to start a drawing of the pond in their journals or on a worksheet, first drawing only what they see around the pond. Remind students that while observing the pond they need to stay on the path to avoid damaging plants and animals that live around the site.
2. Review with students the layers of the pond. Have them observe the surface layer, looking for any movement or growing things. Point out any insects or plants that you can find. Have students add to their drawings anything they have noticed on the surface of the pond.
3. Volunteer Naturalist only: use a bucket and take a water sample from the pond reaching as deep into it as you can. Put a sample of the water into the large tub for the students to see. If there are a variety of insects, put these and water into the smaller trays so students can see them up close. Use the spoon to transfer them over. Discuss what

they may find in the open water of the pond and how some things need to be magnified to see them clearly. Ask students what else may live in the pond that didn't show up in the water sample. Remind students about larger plant and animal life that they many see. Have students draw in their journals or on the worksheet a picture of what they observed in the water sample. Next ask students to draw what else may live in the open water of a pond that they may not have observed.

4. Discuss with students what the bottom of a pond looks like. Have them add to their drawings the bottom of the pond.
5. Have students add any animal life that may visit a pond. Discuss why a pond is important to the plant and animal life around it. Have students add to their drawings any visitors that a pond may have.
6. Discuss their drawings and allow time to share what they put in the different layers of a pond.
7. When you have finished observing the water sample from the pond, pour the water back into the pond. Remind students that it is important to leave the pond like they found it so that plants and animals have a chance for survival.

Assessment Ideas

1. Have your class paint a watercolor picture of a pond. Include plant and animal life around and in the pond.
2. Have students choose a favorite pond animal. Ask students to write a story about how that animal lives at the pond or have the animal go on an adventure.
3. Let students build a model of a pond in a glass jar. Add mud, small rocks, plants, etc. to make the layers of a pond.
4. Have students draw a pond habitat mural together, assigning groups to do the surface area, open water, muddy bottom and area around a pond.

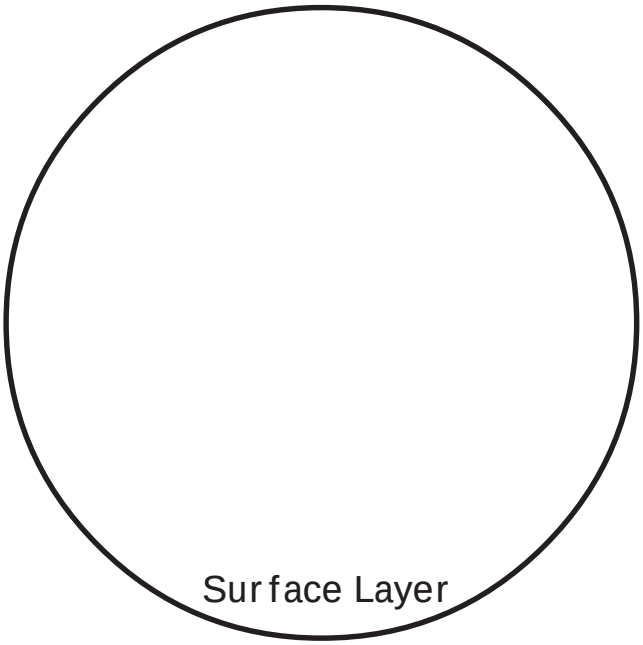
References

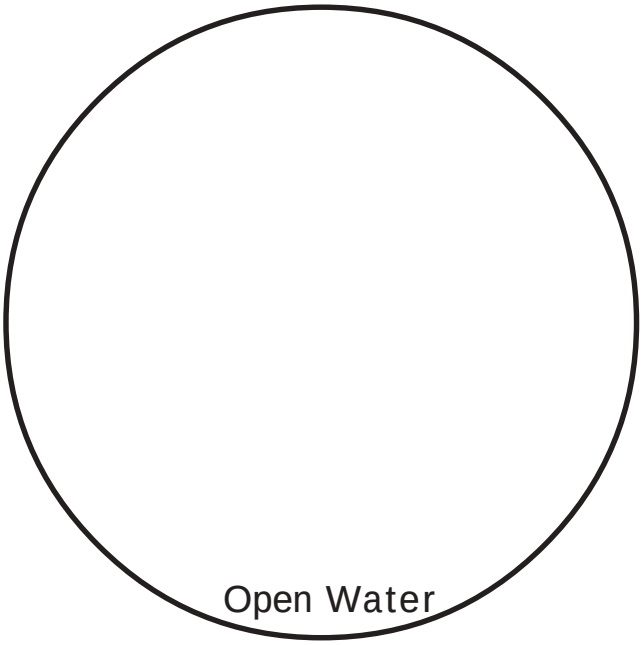
King, J. & Krogman, E. *Rivers and Ponds - A Thematic Unit.*

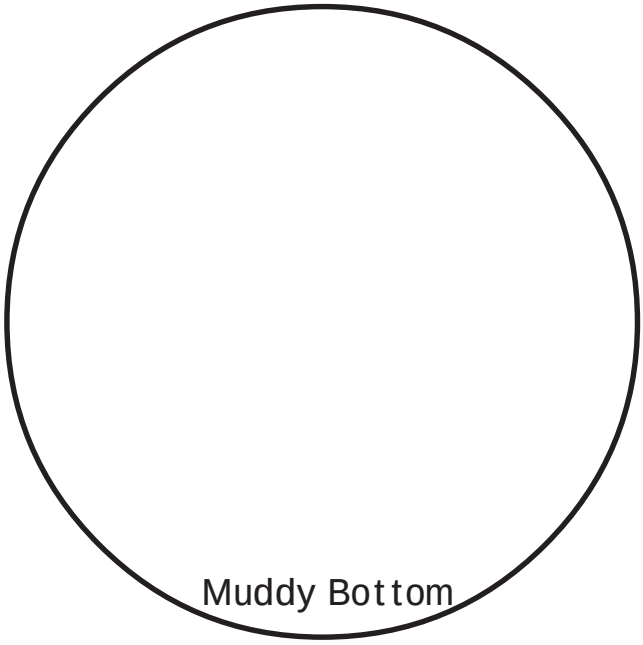
Norris, J. *Pond and Stream Habitats, A Complete Thematic Unit.*

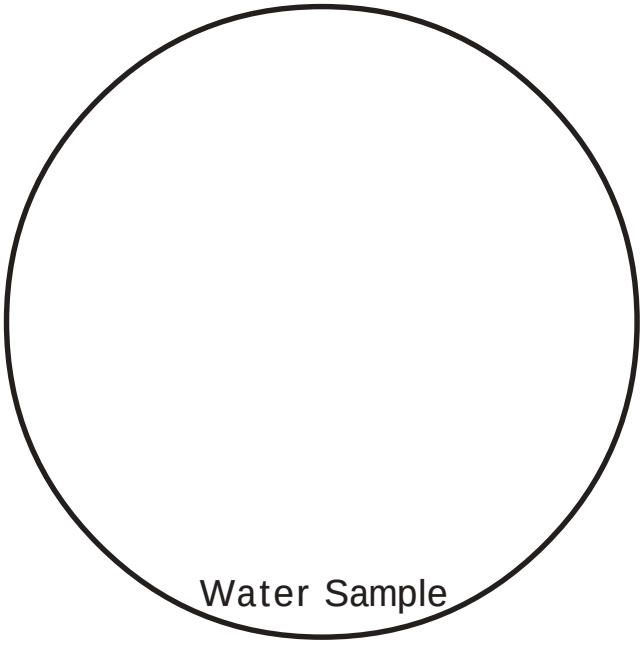
POND LIFE

Draw what you observed in and around each layer of the pond.

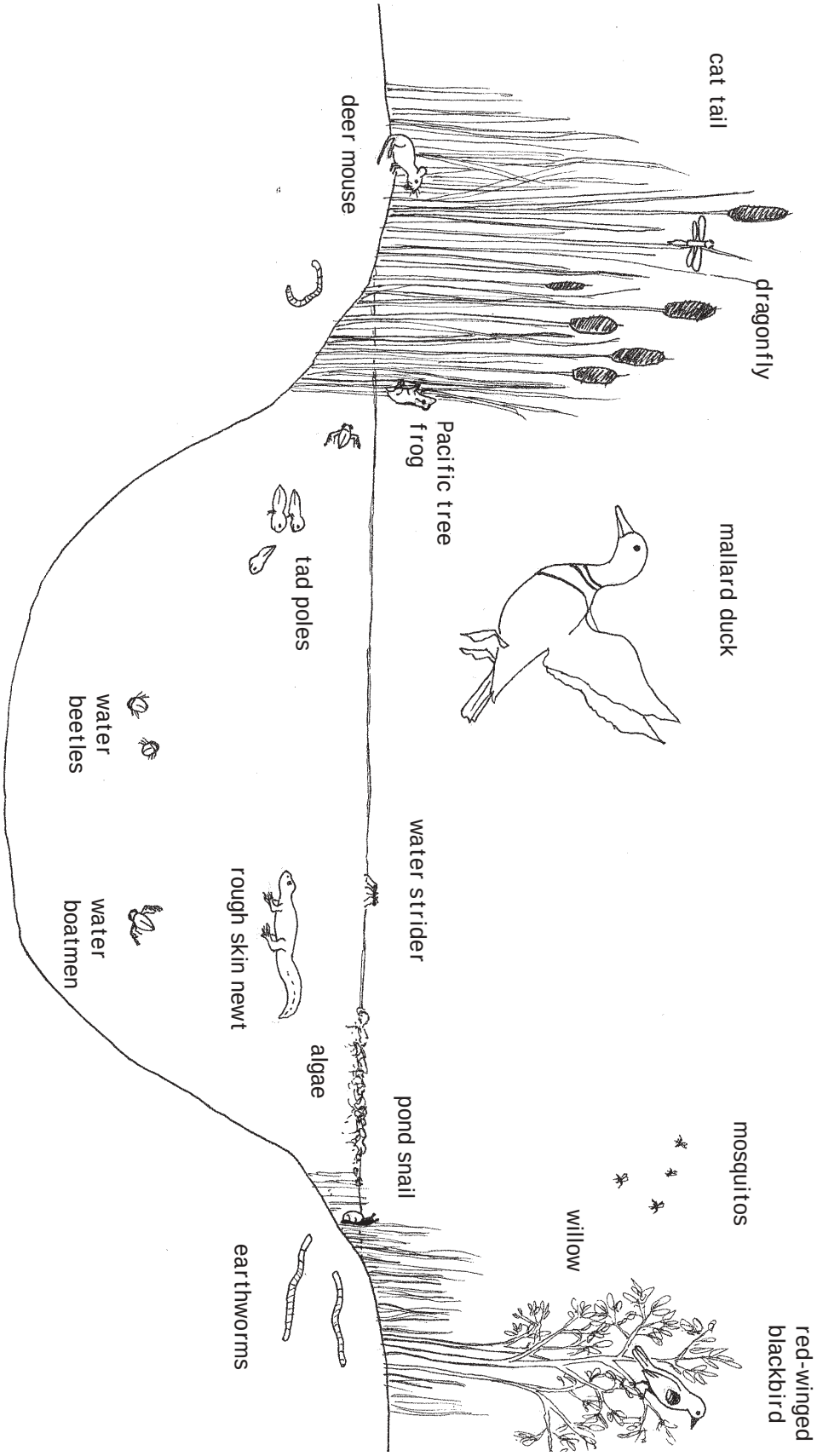








POND LIFE


cat tail
deer mouse
dragonfly
Pacific tree frog
mallard duck
tad poles
water beetles
water strider
rough skin newt
water boatmen
algae
pond snail
mosquitos
willow
red-winged blackbird
earthworms

Wetland Wonders -Pond Study

Overview
NOTE: Ponds are seasonal: dry in the Summer and into early Fall. Call Refuge about status of water level in ponds for Fall field trips. Students will be in two groups. One group will do a transect study of the pond area and the other group will do a water quality study. Through both of these studies students will become aware of the necessary components of a healthy pond.

Duration
40-60 min

Grades
3-6

Benchmarks
- Organisms
- Diversity/Interdependence
- Collecting & Presenting Data
- Analyzing & Interpreting Results

Key Concepts
Water quality determines what kind of organisms can live in certain aquatic habitats. The area surrounding the pond has many components, both abiotic and biotic. Studying the water quality, biotic, and abiotic factors of a pond can help to assess the overall health of the wetlands and Refuge.

Objectives
Students will be able to:
- Identify the four parts of a habitat for the wetland pond
- Use 3 water quality tests (temperature, pH, dissolved oxygen) and discuss the results in relation to the health of the pond and habitat edges
- Complete a transect study of the habitat edges area which includes biotic and abiotic factors

See next page for Materials

Background Information

Note: Due to the delicate nature of the pond study ecosystem, a volunteer naturalist must accompany field trips that utilize this study. During the reservation process, please request a volunteer naturalist to accompany and lead this lesson.

The pond and its surrounding area is an ideal habitat for a multitude of organisms. A habitat is a place in which a particular type of organism lives and must contain four required elements: food, water, shelter, and space. A group of living things and the environment in which they live and interact with one another is called an *ecosystem*.

There are 5 different habitats in a pond ecosystem: the air directly above the surface of the pond, the surface of the water, the open water, the bottom of the pond, and the shallow water at the edge of the pond.

On the surface live insects that can walk on water without sinking. Free-floating plants, such as duckweed, also live on the surface. Larvae from many insects reside on the surface of the pond water.

Hovering above the surface of the pond are mosquitoes, flies, and other insects. Birds are also found on the surface of the pond feeding on plants, insects, and other aquatic organisms.

The open water of a pond is home to fish, turtles, frogs, and other tiny organisms.

The habitat at the bottom of a pond contains decomposers such as snails, tiny worms, insects, or crayfish.

The shallow water at the edge of a pond is another unique habitat. Plants in this area need moist places to grow, so the pond provides a perfect habitat. Plants here may include aquatic grasses, horsetail, algae, reed canary grass, cattails, etc. Animal life includes painted turtles, long-toed salamanders, roughskin newts, Pacific tree frogs, worms, snails, birds, and mammals (such as mice and raccoons) that feed and drink here.

Water quality is determined by many factors. Three of the most basic factors include temperature, dissolved oxygen concentration (DO), and the pH value.

The temperature of the water in a creek or pond is very important for the plants and animals that live there. Many kinds of fish and aquatic life cannot live in warm water and will die or migrate if the water gets too warm or cold. Warmer water makes it harder for many aquatic organisms to fight off disease caused by pollutants and parasites. Water temperature also affects the amount of dissolved oxygen water can hold. The warmer the water, the less oxygen it can hold. The less oxygen, the less living things there will be. Temperatures ranging from 55 ^{o}F – 68 ^{o}F or 14 ^{o}C – 20 ^{o}C are good for most aquatic organisms.

Materials
Group 1
• clipboards
• student handout "Wetland Pond"
• pencils
• field guides
• 2 meter pieces of string for transect study
• thermometers: one for air temp. and one for soil temp.
• hand lenses

Group 2
• one water thermometer
• small containers to collect water samples
• water quality tests: dissolved oxygen & pH
• clipboards
• student handout "Wetland Pond"
• pencils
• field guides

The amount of oxygen found in water is called the dissolved oxygen concentration (DO) and is measured in milligrams per liter of water (mg/l) or an equivalent unit, parts per million of oxygen to water (ppm). Levels of 5-6 ppm are usually required for most organisms to live. A reading of 8 - 9.5 mg/l is excellent for fish to survive. A reading of 6.5 –8 mg/l is still sufficient to support life.

The concentration of hydrogen ions in a solution is called pH and determines whether a solution is acid or alkaline. A pH value shows the intensity of acid or alkaline conditions. The pH scale ranges from 1 (very acidic) to 14 (very basic or alkaline).
"7" is neutral on the pH scale. A pH range of 6.5 – 8.2 is the best for most organisms.

Vocabulary:

pond—body of standing water which is smaller than a lake

habitat—a place where a plant or animal can get the *food, water, shelter* and *space* it needs to live

biotic—pertaining to life or living organisms in a habitat

abiotic—nonliving elements that impact the growth, composition, and structure of a habitat (e.g., soil, weather, sunlight, oxygen and other gasses, etc.).

food chain—the relationship between plants and animals that shows who eats what. Energy is transferred from one organism to another through the food chain.

Suggested Procedure

Gather students into two learning groups.

First group: Pond/Habitat Edges transect study

(Station #3 Habitat Edges)

1. Observe the wetland pond and habitat edges area and discuss the four parts of the habitat that they see (shelter, food, water, space).
2. Divide this first group of students into smaller groups of 2-3 students. Find an area in Station #3 to create 2- 3 transect study plots depending on how many smaller groups you have (have one adult for each transect study plot).
3. Use the 2-meter string to make a line on the ground at the edge of the path and grass.
4. Observe the soil, sunlight, and other abiotic factors. Write down the abiotic components of your transect line on your handout.
5. Take the temperature of the air and of the soil. Record your results on your handout.
6. Study the transect area looking at everything from the bushes and

smaller plants, to the sticks on the ground. How many different kinds of plants are there along your transect line?

7. Determine the approximate percentage of the vegetation along your transect line (i.e.: ¼ bush, ½ grass, ¼ shorter grass).
8. Sketch your transect line including any abiotic components (rocks, soil, etc.). Identify and label any plants that you can. Be sure to draw any insects you see.
9. Do you see any birds, insects, or signs of other living organisms besides the plants in this area? Write down any that you observe on your handout.
10. Carefully look down to the soil along the transect line. Use hand lenses, do you see any insects? Earthworms? Any other living creature?
11. How are these creatures important to this habitat edges ecosystem?
12. With the things you've observed in your transect, as well as any other wildlife you can see in this area, discuss 2-3 different food chains unique to this area.
13. Students write down 2-3 food chains on the worksheet using organisms observed here.
14. Before continuing on the field trip be sure to remind students to leave this area as they found it.

Second Group: Pond water study

(Station #1 Wetland Ponds)

1. Observe the immediate pond area for types of plants and animals present in and around the pond. Write them on the handout. Also make note of any animal sign that is observed (sounds, scat, tracks, etc.).
2. Briefly discuss the 5 distinct habitats of the pond and the organisms found in each (information is given in the background section of this lesson):
   - The air immediately above the surface
   - The surface of the pond
   - The open pond water
   - The bottom sediment and mud of the pond
   - The shallow water at the edge of the pond
3. Take the temperature of the pond water and record it on the handout page.
4. The volunteer naturalist or teacher carefully dips a small container into the pond to get a water sample.
5. Use this water sample to do a pH test and dissolved oxygen test following the instructions in the kits. Write down the data from the tests on the handout.
6. If time permits, collect water samples from a different location of the pond and have different students perform the two tests. Are the results all the same from the different areas?
7. Compare your results with the desired pH levels and dissolved oxygen levels given in the background information.
8. If time permits, sketch a cross section of the pond on the backside of the student worksheet. Include and label all 5 habitats. Add organisms found in those habitats.
9. Discuss the food chains that are a part of this wetland pond with the organisms found here.
10. Students write down 2-3 food chains on the wetland pond page of their refuge journal.
11. Before continuing on the field trip, properly dispose of the water samples and fix any other disturbance to the area students may have caused. Remind them to leave this area as they found it.

References

Department of Energy. *Kids in the Creek*.

Pond Transect Study (group #1)

Air temperature: _____ °C or _____ °F
Soil temperature: _____ °C or _____ °F

<u>Abiotic (nonliving) parts of this habitat:</u>

1. _____

2. _____

3. _____

<u>Living organisms observed here:</u>

1. _____

2. _____

3. _____

4. _____

<u>Plants identified along transect:</u>

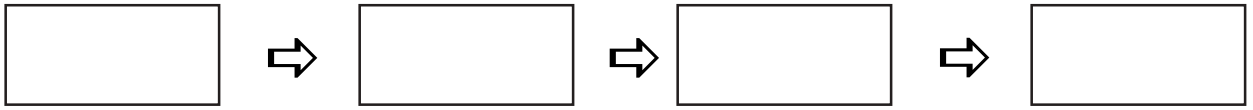
1. _____

2. _____

3. _____

4. _____

<u>Transect Drawing:</u>



Producer → Consumer → Consumer → Decomposer

Pond Water Study (group #2)

If time permits, use the backside of this sheet to draw a cross section of this pond, including the five habitats of the pond.

Pond water temperature: _____ ***°C or*** _____ ***°F***
pH of pond water: _____
Dissolved Oxygen (DO) in pond water: _____

Types of plants in the pond:

1. _____

2. _____

3. _____

Living organisms observed here:

1. _____

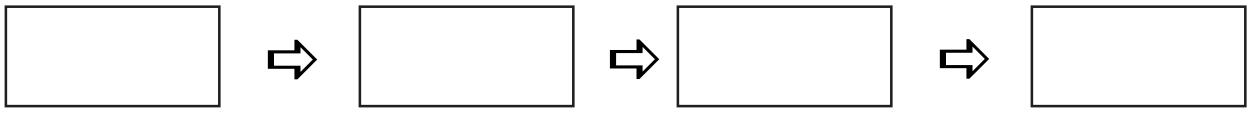
2. _____

3. _____

4. _____

5. _____

Food chain found in this pond area (use arrows to show energy flow)



It's a Small World After All

Overview
NOTE: Ponds are seasonal: dry in the Summer and into early Fall. Call Refuge about status of water level in ponds for Fall field trips. Rock Creek study station has water year round. Students will use microscopes to observe tiny aquatic plants and animals.

Duration
30 min

Grades
6-8

Benchmarks
- Diversity/interdependence
- Collecting & presenting data

Key Concepts
Microorganisms play an important role in aquatic ecosystems. Higher organisms are dependent on those below them in the food pyramid.

Objectives
Students will be able to:
- explore a microscopic ecosystem
- differentiate between plants and animals

Materials
- folding table
- microscopes
- eyedroppers
- magnifying insect containers
- small bucket
- large tubs
- small plastic trays
- depression slides
- scooping spoon
- journal or white paper
- pencils
- paper towels

Background Information

Note: Due to the delicate nature of the wetland ponds and Rock Creek ecosystems, a teacher, chaparone or volunteer naturalist must lead this study. During the reservation process, you can request a volunteer naturalist to accompany and lead this lesson if you are unsure of how to perform the water quality tests.

See Water Characteristics background sheets.

Vocabulary

evergreen—trees that have leaf needles (such a fir and pine) and remain "green" all year long

deciduous—trees that have broad leaves (such as oak or maple) and lose their leaves in the fall

riparian area—the strip of land (20 m or more) that borders a pond, creek, river or other aquatic area

abundant—a large amount

moderate—a medium amount

sparse—a small amount

ppm—parts per million

saturated—a liquid or gas that has so much of an element (like oxygen), that it can't hold any more.

aquatic—water or river

culvert—pipe which stormwater travels through

Suggested Procedure

Tell the students that at this site they are going to be "water quality specialists". Their job is to test the water in the pond and creek. They will keep track of their data on the "Water Quality Survey" sheet. After they have tested the water at both sites, they will share their findings with classmates, analyze the data and make conclusions regarding the water quality at both sites. (Follow up with the "Post Activity—Water Quality Survey Analysis" when you return to school.)

Give each student a "Water Quality Survey" sheet. Fill in the first half of the sheet together as a group. When you get to the "Water Characteristics" section, STOP and divide into teams.

When students are in teams of two, tell them they are now going to specialize in testing different water characteristics. Each

If using flat slides, remind students that they only need one drop of water.

Since protists move, eat, respirate, excrete waste and reproduce, students may be able to view them carrying on these life processes. Have students make a detailed drawing in their journal of at least one plant and one animal that they find. If students find some interesting specimens, be sure they show their classmates.

When students are finished, pour all water back into the pond/creek. Wipe off slides and equipment before storing.

Assessment Ideas

1. Draw a food pyramid and include protists.
2. Why are plankton and zooplankton so important?
3. Name four animals that rely on protists as a food source.
4. How does pollution in ponds, creeks and streams affect the organisms that live there?

References

Oregon Museum of Science and Industry
Portland, Oregon.

Water Quality Survey

Overview
NOTE: Ponds are seasonal: dry in the Summer and into early Fall. Call Refuge about status of water level in ponds for Fall field trips. Rock Creek has water year round. Students will test and compare water quality in two different aquatic areas: Refuge pond and Rock Creek.

Duration
20-30 min

Grades
6-8

Benchmarks
- Diversity/interdependence
- Forming a question/ hypothesis
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
There are many factors that affect water quality. Water quality can be determined using several chemical and physical tests. Populations of aquatic plants and animals are affected by the quality of water in their habitat.

Objectives
Students will be able to:
- learn proper water quality testing techniques
- determine the water quality by analyzing the results of their water tests
- hypothesize about the reasons for variation in water quality

Materials
- 2 water thermometers (°C)
- meter stick
- 50 m tape measure
- water quality test kits
- small bucket
- student handouts

Background Information

Note: Due to the delicate nature of the wetland ponds and Rock Creek ecosystems, a teacher, chaparone or volunteer naturalist must lead this study. During the reservation process, you can request a volunteer naturalist to accompany and lead this lesson if you are unsure of how to perform the water quality tests.

See Water Characteristics background sheets.

Vocabulary

evergreen—trees that have leaf needles (such a fir and pine) and remain "green" all year long

deciduous—trees that have broad leaves (such as oak or maple) and lose their leaves in the fall

riparian area—the strip of land (20 m or more) that borders a pond, creek, river or other aquatic area

abundant—a large amount

moderate—a medium amount

sparse—a small amount

ppm—parts per million

saturated—a liquid or gas that has so much of an element (like oxygen), that it can't hold any more.

aquatic—water or river

culvert—pipe which stormwater travels through

Suggested Procedure

Tell the students that at this site they are going to be "water quality specialists". Their job is to test the water in the pond and creek. They will keep track of their data on the "Water Quality Survey" sheet. After they have tested the water at both sites, they will share their findings with classmates, analyze the data and make conclusions regarding the water quality at both sites. (Follow up with the "Post Activity—Water Quality Survey Analysis" when you return to school.)

Give each student a "Water Quality Survey" sheet. Fill in the first half of the sheet together as a group. When you get to the "Water Characteristics" section, STOP and divide into teams.

When students are in teams of two, tell them they are now going to specialize in testing different water characteristics. Each team will be doing a different test (dissolved oxygen, pH, phosphates,

water color, depth and width, temperature and turbidity). When they are finished, they will share their data with each other, so be accurate!

Give each pair of students a "Water Characteristics Background" sheet for the water characteristic they will be testing. Allow 5 – 10 minutes reading time. When they are finished with the background information, give them the "Test Kit" and "Procedure" sheet explaining how to do the test.

When teams are sure they understand the procedure, they may begin with the aid of teacher, chaparone or volunteer naturalist.

After students have collected data, you may want to extend this activity by doing Water Quality Survey Analysis, in Post-Field Trip section on page 243.

Student Handouts

1. Water Quality Survey
2. Water Characteristics Background (for the water quality being tested)
3. Percent Saturation Chart

Assessment Ideas

1. Which had the "best" water quality: pond or creek? Why?
2. Name 5 factors that affect water quality.
3. What could be done to improve the water quality of the pond and/or creek?
4. If you made these improvements, what affect would they have on the animals and plants that live there?
5. Draw a picture in your journal of a "perfect" riparian area.
6. How does water quality affect the balance of a population in a pond, creek or river? Give specific examples.

References

Bonneville Power Administration. *Kids in the Creek.*

LaMotte Testing Company.

Watercourse. *Healthy Water, Healthy People.*

Oregon Department of Fish and Wildlife. *The Stream Scene: Watersheds, Wildlife and People.*

Water Quality Survey

River System: *Tualatin* Location: *Tualatin River*

Pond or Creek Name:_____ *National Wildlife Refuge*

Surveyor *(YOU)*_____ Date_____

State: *Oregon* Time of day_____ am _____ pm

Riparian Area (Make a check in the box to rate the amount of each type of vegetation)

Type of vegetation	***Abundant* (+)**	***Moderate***	***Sparse* (-)**
Evergreen trees			
Deciduous trees			
Grass, plants or shrubs			

Percentage of Shaded Water

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Erosion Points

Severe (explain)_____

Moderate (explain)_____

Slight (explain)_____

Instream Debris and Barriers (circle those present)

logs limbs root wads brush dam
culvert leaves falls trash other (specify)

Water Characteristics

Stream Width: _____(meters) Stream Depth: _____(centimeters)

Water Color: clear___ greenish___ yellow/brown___ red___ dark brown___

Temperature: air _____^{o}C surface_____ ^{o}C *creek bottom_____ ^{o}C

Dissolved Oxygen: 0 ppm _____ 4 ppm _____ 8 ppm _____

Dissolved Oxygen Percent Saturation: _____%
(use the *creek bottom temperature and the Percent Saturation Chart to find the %)

Turbidity: 0 JTU (excellent)____ >0 to 40 JTU (good)____
>40 to 100 (fair)____ >100 (poor)____

Phosphate Level: 1 ppm (excellent) 2 ppm (good) 4 ppm (fair)

pH: 3 = really bad 5 = poor 6 = good 7 = excellent 8 = good 9 = poor 11 = really bad

1	2	3	4	5	6	7	8	9	10	11	12	13	14

1 = most acid 7 = neutral 14 = most alkaline

Stream Width and Depth

Water Characteristics Background

Water in some streams moves slowly while in others it moves fast. The surface of some streams is smooth and flat but others may have lots of rapids. The stream may be wide and the bank may be straight, or the stream may be narrow and the bank may curve. These characteristics have an effect on the water quality. Slow moving, shallow water is warmer than fast moving, deep water. Water that moves quickly and has lots of rapids usually contains more dissolved oxygen. Different plants and animals prefer different types of streams.

Factors that affect Stream Width and Depth

The path that a stream follows and its width and depth can change over time and during different seasons of the year. The amount of water that travels downstream in a stream depends on the headwaters, or source, of the water. Does the water come from snowmelt, an underground spring, another creek or rainwater? The farther away a pond or stream is from the source of the water, the more the depth and width will change throughout the year. Streams that get most of their water from rainfall are more shallow and narrow in drier months of the year. A pond that gets its water from an underground spring will usually remain the same width and depth all year long. The volume, or amount, of water that moves in a stream also determines its width and depth.

Vocabulary

dissolved oxygen—oxygen that can be found in water

headwaters—the beginning or source of a stream, river or pond

Materials

tape measure

meter stick

Water Color

Water Characteristics Background

The color of pond or river water can help you find the "productivity" of the water. The number of plants and animals that are living in a body of water at any given time is called "productivity." Water that has low productivity has few living things and is poor water (scientifically speaking), but it is considered "clean" and good for a water supply or recreation. Water that has high productivity has many living things and can be both good and bad depending on if you're a human or a fish. Humans consider water with a strong odor or filled with weeds and algae to be a problem. However, fish such as catfish, bass or sunfish would like this type of water because of all the food that would be available to them.

Factors that affect Water Color

The color of water in a pond, creek or river is affected by both living and non-living things. Living things include both plants and animals such as algae and microorganisms. Non-living minerals such as sulfur, iron and calcium also affect water color.

Vocabulary

productivity—the number of plants and animals that are living in a body of water at any given time

algae—tiny plants that live in water

microorganisms—tiny animals that sometimes live in water

sulfur, iron and calcium—minerals sometimes found in rocks

Materials

small test tubes

Dissolved Oxygen

Water Characteristics Background

Aquatic animals need "dissolved oxygen" to live. Fish, invertebrates, plants and some kinds of bacteria require oxygen for respiration. Oxygen in the air dissolves easily into water until the water is saturated. Once the oxygen is dissolved in water, it is released very slowly and depends on the movement of the water. Oxygen is also produced by plants and algae living in the water.

The amount of oxygen needed for different plants and animals varies according to the species and stage of life. Dissolved oxygen levels below 2 or 1 ppm (parts per million) will not allow fish to live. Dissolved oxygen levels below 3 ppm are very stressful to most aquatic organisms. Levels of 5 – 6 ppm are usually required for most organisms to live.

Dissolved Oxygen Percent Saturation is an important measurement of water quality. Cold water can hold more dissolved oxygen than warm water. For example, water at 28° C will be 100% saturated with 8 ppm dissolved oxygen. However, water at 8°C can hold up to 12 ppm of oxygen before it is 100% saturated. High levels of bacteria from sewage or rotting plants can cause the percent saturation to decrease.

Factors that Affect Dissolved Oxygen Concentration

Since temperature directly affects the amount of oxygen in water (the warmer the water the lower the amount of oxygen), then all factors that affect water temperature affect dissolved oxygen. Industrial factories and power plants sometimes release warm water into rivers. Organic material from dead plants and animals, animal and pet waste, woody debris and leaves, fertilizers, urban stormwater runoff, agricultural runoff, and wastewater treatment discharge all decrease the amount of dissolved oxygen in water.

Vocabulary

dissolved oxygen—oxygen that can be found in water

respiration—to exchange gases such as oxygen and carbon dioxide; to breathe

saturated—a liquid or gas that has so much of an element (like oxygen) that it can't hold any more

invertebrate—small animal without a backbone like a clam, snail or crayfish

aquatic—something that lives in water

organism—an animal

stormwater—rainwater that falls on streets, and roofs that ends up in streams and rivers

Materials

Test Kit for dissolved oxygen

percent saturation chart

bucket for wastewater

Dissolved Oxygen
Percent (%) Saturation

high % saturation = more oxygen = better water quality

Temperature (°C)	0 ppm	4 ppm	8 ppm
2	0	29	58
4	0	31	61
6	0	32	64
8	0	34	68
10	0	35	71
12	0	37	74
14	0	39	78
16	0	41	81
18	0	42	84
20	0	44	88
22	0	46	92
24	0	48	95
26	0	49	99
28	0	51	102
30	0	53	106

Example: If the water sample temperature is 16 °C and the Dissolved Oxygen test result is 4 ppm, then the water is 41% saturated with dissolved oxygen. This means that less than half of the water has oxygen in it, which is poor water quality.

Dissolved Oxygen (% Saturation)	Test Results
91-110	excellent
71-90	good
51-70	fair
less than 50	poor

Temperature

Water Characteristics Background

The temperature of the water in a creek or pond is very important for the plants and animals that live there. Many kinds of fish and aquatic life cannot live in warm water and will die or migrate if the water gets too warm or cold. Warmer water makes it harder for many aquatic organisms to fight off disease caused by pollutants and parasites.

Water temperature also affects the amount of dissolved oxygen water can hold. The warmer the water, the less oxygen it can hold. The less oxygen, the less living things there will be.

Factors that affect Water Temperature

Removing trees and plants next to streams or lakes takes away shade. Shade does not cool water, but keeps it from heating as quickly. Fast moving water is cooler than slow moving water. Water that is slowed down to use for dams and irrigation heats up more quickly. Heated water from factories and power plants can cause water temperature changes that upset the balance of entire ecosystems.

The amount of water in a pond or creek also influences its temperature. Shallow water warms faster than deep water. The deeper the water, the cooler its temperature. When water is dammed it creates a pond, reservoir, or wide area with a larger surface area. When this large area of water is exposed to the sun, it absorbs more energy and the water temperature rises.

Vocabulary

migrate—move to a different place

aquatic—something that lives in water

pollutants—something that causes pollution in water such as sewers, chemicals, trash and animal waste

parasites—tiny living things that can cause diseases or kill other animals

dissolved oxygen—oxygen that can be found in water

irrigation—water used on crops such as corn and wheat

ecosystem—all living and non-living things in an area such as fish, plants, rocks, water and insects

reservoir—water storage area

surface area—the top of the water

Materials

2 thermometers (^{o}C)

pH

Water Characteristics Background

The pH test is one of the most common types of water tests. People test the pH in swimming pools, hot tubs, drinking water and creeks. pH is a measurement of the activity of hydrogen ions in a water sample. The pH scale ranges from 0 – 14. Water samples with a pH below 7.0 are said to be "acidic." Water pH above 7.0 is "basic" or "alkaline." Water with a 7.0 pH is considered "neutral."

A pH range of 6.5 to 8.2 is the best for most organisms. Most creeks and ponds have pH levels from 5.0 to 8.5. Acidic, freshly fallen rainwater may have a pH of 5.5 to 6.0. Alkaline soils and minerals can raise the pH to 8.0 to 8.5. Salty ocean water usually has a pH value close to 8.0.

pH Scale

1 = most acidic 7 = neutral 14 = most alkaline

3 = really bad 5 = poor 6 = good 7 = excellent 8 = good 9 = poor 11 = really bad

1	2	3	4	5	6	7	8	9	10	11	12	13	14

Factors that affect pH Level

Air pollution from car exhaust and burning fossil fuels increases the amount of sulfur and nitrogen oxides in the air. Then when it rains, these chemicals combine with the water in the air and turn it into "acid rain." This rain increases the acid level, which lowers the pH, of lakes and streams.

Fast growing algae and plants remove carbon dioxide (CO_2) from the water during photosynthesis. This can result in a large increase in pH.

Runoff that contains wastewater from neighborhood lawns and streets, farms and factories sends pollutants to creeks and ponds, which raise or lower pH levels.

Vocabulary

acidic—containing acid (examples: lemon juice, vinegar)

basic or alkaline—the opposite of an acid (examples: soap, bleach)

neutral—not acidic and not basic; right in the middle (examples: clean water)

runoff—rain water that moves across land and picks up pollutants

pollutants—something that causes pollution in water such as chemicals, trash, and animal waste

algae—tiny plants that live in water

photosynthesis—the process in which plants make their own food by using the sun's light

minerals—elements found in rocks

fossil fuel—petroleum products such as oil and gasoline

sulfur and nitrogen oxides—chemicals

Materials

Test Kit for pH

bucket for waste water

Turbidity

Water Characteristics Background

Turbidity is the measurement of how "clear" water is. Turbid water is caused by sediments such as clay, silt and microscopic plants and animals. Sediments can carry nutrients and pesticides which lower the water quality. Sediments can settle to the bottom of streams, smothering aquatic life and fish spawning areas. Tiny particles of clay can remain floating in water for many, many years before finally settling on the bottom of a river.

Turbidity should not be confused with color, since dark colored water can still be clear and not turbid. Turbid water may be the result of soil erosion, urban run-off, algal blooms and bottom sediment disturbances, which can be caused by boat traffic and abundant bottom feeders.

Factors that affect Turbidity

When trees and plants are removed from riparian areas, soil erodes and falls into the water making it turbid. Cattle and other animals that are allowed graze and drink near streams break down the edge of the riverbank, allowing soil to fall into the water too. Runoff from neighborhood lawns and streets, farms, logging, mining and building areas sends sediments into creeks and ponds, making the water more turbid.

Vocabulary

turbidity—how "clear" the water looks

turbid—water that looks "cloudy"

sediments—tiny pieces of soil, clay or sand

nutrients—food

pesticides—chemicals which kill animals

aquatic life—plants and animals that live in water

spawning—places on the bottom of a stream or river where fish lay their eggs

riparian area—the strip of land (20 m or more) that borders a pond, creek or river

erode—to break down

runoff—rain water that moves across land and picks up sediments

Materials

Test Kit for Turbidity

Phosphates

Water Characteristics Background

Phosphates are found in a mineral called “apatite” which occurs naturally in some rocks. Rocks with a lot of apatite are called “phosphate rocks.” The natural weathering and erosion of these rocks makes tiny particles of phosphates that can easily be carried by water to ponds and creeks.

Phosphorus can be found in ponds and creeks in the form of phosphate (PO_4). Phosphorus is a nutrient that acts like a fertilizer for aquatic plants. When plants and algae get a lot of nutrients, they grow very fast and spread out creating water quality problems. The fast growing plants prevent the sun’s light from passing through the water, which eventually kills other plants living deeper in the water. When large amounts of plants begin to die and decay, bacteria eat the plants, grow and multiply which uses up the dissolved oxygen in the water.

Factors that affect Phosphates

More than half of the phosphates found in lakes, streams and rivers are the caused by human activity. Animal and human waste, fertilizers from farms and lawns, logging and mining activities all increase the phosphate level in creeks and ponds. More than half of the phosphate in ponds, streams and rivers is from soap and detergent.

Vocabulary

phosphates or phosphorus—chemicals found in lawn fertilizer and some rocks

weathering and erosion—wearing away or breaking down into smaller pieces

nutrient—food

fertilizer—chemical that gives nutrients to plants

aquatic—something that lives in water

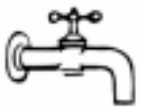
algae—tiny plants that grow in water

dissolved oxygen—oxygen that can be found in water

Materials

Test Kit for Phosphates

bucket for waste water



Fact Sheet

Relationship of Water Color to Productivity

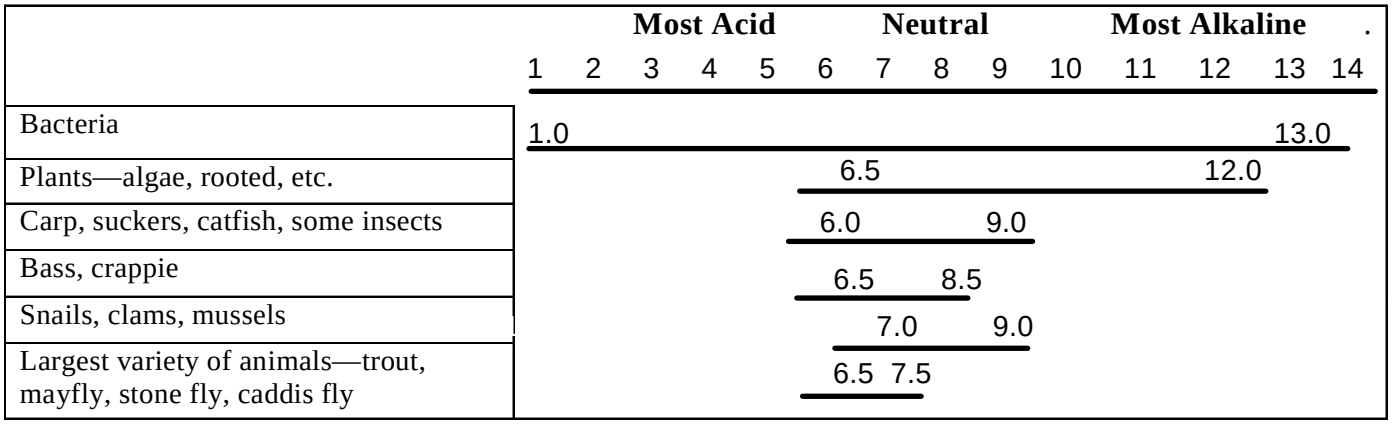
The quantity of life that may be present in a body of water
and be available for other organisms to eat is often referred to as the "productivity" of the water.

Color of Water		Most Likely Cause	Fish Food Productivity
Clear		Absence of algae and microorganisms	Low
Greenish hue		Blue-green algae	Moderate
Yellow to Yellow-brown		Diatoms—microscopic, one-celled algae	Moderately High
Red		Micro-crustaceans	High
Dark brown		Peat, Humus	Low
Geological Factors that Affect Color			
In limestone geology	Green	Abundant calcium	Moderate
In volcanic geology	Yellow-green Red	Abundant sulfur Abundant iron	Low Moderate

Temperature Ranges (Approximate) Required for Organisms

Temperature	Examples of Life
High Range—warm water Greater than 68°F or 20°C	Much plant life, many fish diseases. Mostly bass, crappie, bluegill, carp, catfish, caddis fly
Middle Range 55°F - 68°F 14°C - 20°C	Some plant life, some fish disease. Salmon, trout, stone fly, mayfly, caddis fly, water beetles
Low Range—cold water Less than 55°F or 14°C	Trout, caddis fly, stone fly, mayfly

pH Ranges That Support Aquatic Life



Oak Savanna History

Overview
Students will reflect on the past and predict the future of Oaks in their nature journal.

Duration
20-30 min

Grades
6-8

Benchmarks
- Dynamic Earth
- Forming a question/ hypothesis
- Speaking & listening

Key Concepts
Landscapes change over time due to natural causes and because of human activities. Changes cause plant and animal populations to increase and/or decrease. Oak savannah lands are one of the most endangered ecosystems in the U.S.

Objectives
Students will be able to:
- learn the history of the oak savanna lands of the Willamette Valley
- realize that both time and humans make changes to the land
- make predictions of the future for this site

Materials
- nature journals (or paper)
- clipboards
- pencils
- pens, colored pencils (optional)

Background Information

See "The Majestic Oak" story (found on page 170).

Vocabulary

prairie—flat grassland

savanna—grassland containing scattered trees

woodland—a forested area

crown—the top branches and leaves of a tree

Suggested Procedure

Tell students you are going to read them a story about the "The Majestic Oak." It's about the history of the Oregon White Oak trees over there (point) and the prairies, savannahs and grasslands (point) that were common in this area. (Define vocabulary for students.) As you read, tell them to picture or visualize in their mind how this area would have looked a long time ago. Were there people here? What kind of animals lived here? How has this area changed over time? (Read story)

After the story, ask them to guess the age of the old oak tree over there (point). Ask for some guesses. (It's about 350 years old!) That means it began life from an acorn about the year 1654. If that tree could talk, it would tell you about all of the changes it has experienced over those 350 years. What do you think it would tell you?

In your journal, title your page Oregon White Oak and make a drawing of the tree. On the next page, write what you think the oak would tell you about its life story. Think about some of the things you just heard in "The Majestic Oak" story. (If you have time, students can make another drawing of what they predict this area will look like 350 years from now.)

Assessment Ideas

Ask students the following questions:

1. Why are Oregon White Oak trees so important?
2. Do you think that the people who manage the Refuge should use the practice of burning the grass like the Native Americans did? Why or why not?
3. Name some factors that have changed the balance of animal populations in this area.

References

Morris, K. *Interpretive Outline for the Tualatin River National Wildlife Refuge.*

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Oregon State University. *Willamette Valley Prairies.*

Pokorny, Kim. *Plain talk; The Oregonian.* August 12, 2004
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The Majestic Oak

Oregon White Oak **(*Quercus garryana*)**

The prairies of Oregon's Willamette Valley are some of the most endangered ecosystems in the United States. Recent research from Oregon State University and elsewhere is helping us understand the need for the conservation, management, and restoration of these fascinating ecosystems.

Oak woodlands once covered many of the foothills in this area, but today only a few remain in the Willamette Valley. As the lion symbolizes courage, the oak tree stands for strength. Nearly 2,000 years ago, the huge oaks inspired the Roman poet, Virgil, to write: "Full in the midst of his own strength he stands, stretching his brawny arms and leafy hands." (Look at the huge oak in the distance. Do you see "the brawny arms and leafy hands"?)

What happened to all of the oak trees and grasslands? About 10,000 years ago at the end of the last ice age, the climate in this area was much hotter and drier. Scientists think that these prairie grasslands evolved naturally in this type of climate. The prairie began changing again 4,000 years later when a huge ice dam in Montana broke, causing a massive flood (Missoula Flood) that carried tons of water, rocks and debris, which carved out the Willamette Valley as it traveled southward.

After this event, the climate became more cool and moist, similar to the climate we have today, and the grasslands once again began to flourish. Left to its own devices, this oak savanna prairie would have eventually progressed into a dense forest, but instead humans learned to manage the land with fire.

Manipulation of habitat can benefit both humans and wildlife. Prairie and oak savannah habitats in the Willamette Valley were created and maintained by the people who lived there. Without human influence the entire Willamette Valley would have become forested.

The savannas of grassland and large, widely scattered Oregon White Oak trees thrived because of frequent, low-intensity fires set by Native Americans (Kalapuyans). The fires removed competing brush, conifers and even oak seedlings. This made it easier for the people to collect seeds, bulbs, roots, berries and other plants they relied on for food. The burning also encouraged the growth of tender grasses and other plants that were favored by elk and deer. Fire was also used to herd deer or other prey into confined areas to make hunting easier. Without competition from other trees and shrubs, this left scattered, older oaks to grow to an impressive size, with a huge spreading crown.

When Euro-Americans arrived in the early to mid-1800's, agriculture and development put a stop to burning and much of the native prairie was plowed under, leaving the land as we

see it today. The oak savannas have been replaced by Douglas fir and mixed species of trees. Sadly, the savannas and oak woodlands are disappearing due to a variety of other causes too. Oak woodlands have been cut for agricultural, forestry and residential land uses and for firewood. Oak woodlands now tend to be small and isolated, and less than 1 percent of former prairie acreage now remains.

Fortunately, oak woodlands can be managed and even restored to provide wildlife habitat throughout the Valley. Land ownership in the Willamette Valley is mostly private, so the survival of majestic oak trees and the associated wildlife will depend on local voluntary efforts to preserve these trees. The oldest oak tree on the Refuge is approximately 350 years old. "Garry Oak" is another common name for this tree. Nicholas Garry was secretary of the Hudson's Bay Company and helped botanist David Douglas, so Douglas remembered him by adding Garry's name to the scientific name of this tree.

The Oregon White Oak in the Willamette Valley provides a unique habitat for breeding, feeding, hiding and resting for over 100 species of wildlife. Woodpeckers, owls and bats use the hollow oak cavities for nests. Squirrels and deer rely on the highly nutritious acorns for food. Migrating songbirds hide in leafy oak crowns to rest before continuing their trip. The deeply furrowed bark offers a refuge for insects and a feeding site for wildlife. The multi-forked limbs allow for placement of stick nests for birds. Dead wood, especially large logs, provide essential habitat for salamanders and lizards. The leaves of the White Oak have a protein content nearly equal to alfalfa hay and are eaten by deer and other animals.

Mistletoe and poison oak, which grow on oak trees, provide important food for birds such as western bluebirds, cedar waxwings and American robins. However, heavy infestations of mistletoe can kill oak trees.

The spotted gall wasp is an insect that lives only on Oregon White Oak. This gall wasp is a non-stinging insect that lays its eggs on the underside of an oak leaf. The chemicals in the egg cause the leaf tissue to change and form a gall or "popper," which is a hollow ball that serves as a protective shell around the maturing larvae. As the wasp matures, it chews its way out. In the mid-to-late summer, an oak grove that has many gall wasps may rattle with the sound of the larvae trying to break out of this protective covering.

Oak Savanna Ecosystem

Overview
The group will take a closer look at the unique oak savanna ecosystem.

Duration
20-25 minutes

Grades
3-5

Benchmarks
- Organisms
- Diversity/Interdependence
- Collecting & Presenting Data
- Analyzing & Interpreting Results

Key Concepts
Dead trees provide an abundance of resources for a variety of living things, including animals, fungi, and other plants.

Objectives
Students will:
- Identify the basic parts of a tree and their functions.
- Demonstrate an awareness of how we use trees, as well as how beneficial trees are to other plant and animal life
- Identify 2-3 different food chains that are unique to an area with an oak tree by observing the surrounding area for plant and animal signs.

Materials
- student handouts
- pencils
- hand lenses

Background information:

Oak woodlands once covered much of the Willamette Valley foothills. These "savannas" of large, widely scattered oak trees thrived because of frequent, low-intensity fires set by Native Americans. These fires removed competing bush, conifers, and even oak seedlings, allowing a few scattered, older oaks to grow to an impressive size with spreading crowns. Sadly, these savannas and other oak woodlands are disappearing due to a variety of causes. As wildfire has been stopped, closed-canopy oak woodlands and dense Douglas fir or mixed-species forests have replaced the oak savannas. Oak savannas now tend to be small and isolated.

Fortunately, oak savannas can be managed and even restored, to provide a unique ecosystem and wildlife habitat throughout the Valley. In the Willamette Valley over 100 wildlife species use Oregon white oak trees for breeding, feeding, hiding, and resting. For example, woodpeckers, owls, and bats need hollow oak cavities for nests. Squirrels and deer rely on acorns for food. Migrating songbirds hide in leafy oak crowns to rest before continuing their trip.
The spotted gall wasp is an insect that thrives only on Oregon white oak. This gall wasp is a non-stinging insect that lays its eggs on an oak leaf causing the leaf tissue to change and form a protective shell (popper) around the maturing grub.

Many of the Willamette Valley's oaks are 300 years old. Occasional giants are over 400 years old. Large oak trees, which could live for hundreds of years, may die within twenty years, if conifers over-top them. Oak seedlings, starting as acorns, can grow six feet tall in just three years and twelve feet tall in five years.

As students carefully observe an oak tree, it is hoped that they will gain an appreciation for the wide variety of ways trees help all wildlife and us.

Vocabulary:

photosynthesis—the conversion of carbon dioxide (CO_2) and water (H_20) into sugar using sunlight and chlorophyll

roots—give support to the tree, provide food storage, and get nutrients and water from the soil for the tree

bark—old phloem cells, protects tree from insects, diseases, injuries

phloem—carries food *from leaves* to rest of plant

xylem—carries food (water, nutrients) up from roots to rest of plant

heartwood—old xylem cells, now used as support for the tree

food chain—the relationship between plants and animals that shows who eats what. Energy is transferred from one organism to another through the food chain.

producer—green plants that can produce food from sunlight, carbon dioxide and water (photosynthesis)

consumer—an organism that obtains its food by eating other organisms

decomposer—any organism that breaks down dead plant and animal matter into nutrients. For example, mushrooms, earthworms, etc.

Suggested Procedure:

Make sure students understand what a basic food chain is before doing this on your field trip.

1. Observe one of the large oak trees in this area. Tell the students that some of these oaks are over 350 years old!
2. Ask students to identify the major parts of the oak tree and explain their functions.
    - **Roots**- support tree, store food for tree, get nutrients & water for tree
    - **Trunk** – supports tree (heartwood), protects tree (bark), carries food to different parts (phloem, xylem, cambium
    - **Branches** – extensions of trunk, form the buds that make future leaves
    - **Leaves**-make food from the sun (photosynthesis); leaf veins transport food to rest of plant
    - **Acorn** – the seed which will create a new oak tree if planted with the right conditions

Have students sketch and label the oak tree they are observing on their student handout.

3. Brainstorm with students about how a tree helps us:

    Provides beauty

    Cools, freshens, and cleans the air

    Produces oxygen

    Provides shade

    Provides wood and paper for our use

    Prevents erosion

    Reduces noise pollution

    Provides homes and food for wildlife

Have students list on their handout 3-5 ways that trees help us.

4. Ask students to carefully observe the area for signs of animals, insects, and birds that use this tree for a home or for food. Look for hollowed cavities, nests, galls, insect damage, etc.
5. Brainstorm what decomposers there are in the area as well. Create a group list of all wildlife using the tree in this area. Some decomposer ideas: earthworms, and fungi
6. Using the wildlife list students generated, have students give examples of food chains from this area. They need to say which part of the chain is the producer, the consumer, and the decomposer. For example: **Producer** - oak tree; **Consumer** - squirrel (eats the oak tree's acorns); **Consumer** - hawk (eats squirrel); **Decomposer** - earthworm (breaks down the body of dead hawk further after it has already been decomosing
7. Students write one or two of the food chains they've discovered for this area in their journal.
8. If there's time students could do leaf rubbings with oak leaves and other leaves of the area. Have students write the name of the plant with each rubbing.
9. If there's time:
    - Discuss what the tree would look like in each of the four seasons
    - Discuss the many ways we use trees (paper, wood, etc.)
    - Discuss ways we can save more trees (recycle paper, use both sides of paper, cloth shopping bags, use rags instead of paper towels, etc.)

References

U.S. Fish and Wildlife Service. *Oregon White Oak: A Landscape Legacy.*

Oak Savanna Ecosystem

Sketch a picture of the big oak tree and label its main parts (roots, trunk, branches, leaves, acorns).

How do trees help us?

1.
2.
3.
4.
5.

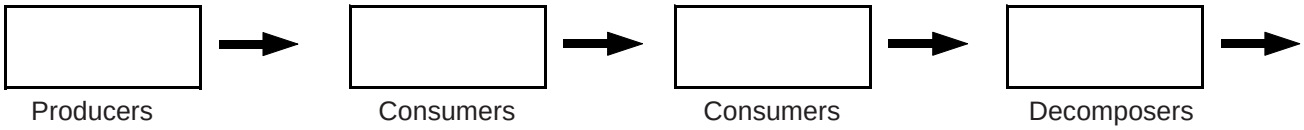
List the producers, consumers, or decomposers you observe from this area:

Producers:

Consumers:

Decomposers:

Create a food chain using the organisms you've found in the oak savannah:



Good Oak

Overview
Listen to Aldo Leopold's essay on "Good Oak," and use this knowledge to analyze an oak stump.

Duration
25 min

Grades
3-8

Benchmarks
- Diversity/interdependence
- Dynamic earth
- Forming a question/ hypothesis
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
Although tree stumps are often overlooked, they can tell quite an intriguing story.

Objectives
Students will be able to:
- identify some of the important structures of a tree cross section
- relate the characteristics of annual growth rings to environmental conditions present at the time of their growth
- determine the age of a tree and how the annual rings are related to historical events

Materials
- student handout - Aldo Leopold's essay "Good Oak"
- tree stumps, preferably oak and year of cutting identified
- hand lenses
- student handouts
- pencils
- clipboards

Background Information

The essay "Good Oak" describes the cutting and splitting of an oak tree into firewood. As the annual rings of the wood are cut, Leopold relates important moments in conservation history. The student worksheet outlines some of the structures found in a tree cross section.

In the Willamette Valley, over 100 wildlife species use Oregon white oak trees for breeding, feeding, hiding and resting. For example, woodpeckers, owls, and bats need hollow oak cavities for nests. Squirrels and deer rely on acorns for food. Migrating songbirds hide in leafy oak crowns to rest before continuing their trip.

Oak woodlands once covered much of the Willamette Valley foothills. These "savannas" of large, widely scattered oak trees thrived because of frequent, low-intensity fires set by Native Americans. Fires removed competing brush, conifers, and even oak seedlings, allowing a few scattered older oaks to grow to an impressive size with spreading crowns. Sadly, these savannas and other oak woodlands are disappearing due to a variety of causes. As wildfire has been stopped, these oak savannas have been replaced by closed-canopy oak woodlands and dense Douglas fir or mixed-species forests. Oak woodlands now tend to be small and isolated. Fortunately, oak woodlands can be managed, and even restored, to provide wildlife habitat throughout the Valley.

Many of the Willamette Valley's oaks are 300 years old. Occasional giants are over 400 years old. The spotted gall wasp is an insect that thrives only on Oregon white oak. This gall wasp is a non-stinging insect that lays its eggs on an oak leaf, causing the leaf tissue to change and form a protective shell (popper) around the maturing grub. Over 100 species of lichen grow on Oregon white oak. *Usnea*, common oak lichen, has medicinal value as an antibacterial agent. Most other lichens have not been studied.

Suggested Procedure

1. If possible, locate an oak tree stump. If not available, use tree cross sections.
2. Be sure students understand all the important structures of a tree cross section. Have them observe the cross sections and complete the student sheet.
3. Show students how to count annual rings from the bark to the pith. Have them relate this information to historical events and environmental conditions.
4. Conclude the lesson by discussing the spiritual danger of supposing that heat comes from the furnace (as mentioned by Leopold in the essay).

Assessment Ideas

Students are given a sample tree cross-section. Ask them to make up a history for that tree's life that would explain the variations in the width of annual growth rings

Have them label the parts of a tree cross-section and then graphically correlate the annual rings to a time line.

References

Oregon Department of Fish and Wildlife

Websites:
Oregon Department of Land Conservation & Development

Oregon Government

State of Oregon

Oregon Department of Fish and Wildlife

Good Oak

Aldo Leopold

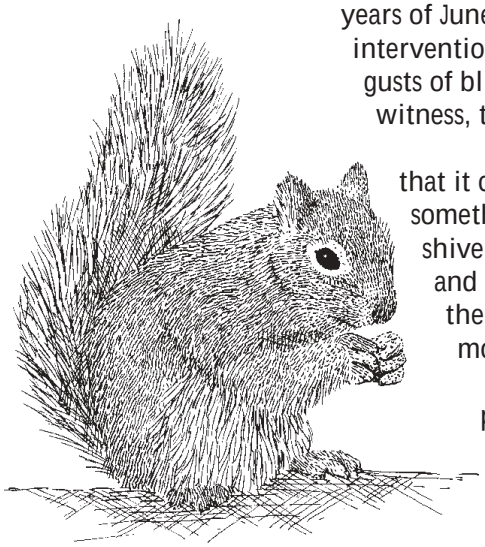
There are two spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes from the furnace.

To avoid the first danger, one should plant a garden, preferably where there is no grocer to confuse the issue.

To avoid the second, he should lay a split of good oak on the andirons, preferably where there is no furnace, and let it warm his shins while a February blizzard tosses the trees outside. If one has cut, split, hauled, and piled his own good oak, and let his mind work the while, he will remember much about where the heat comes from, and with a wealth of detail denied to those who spend the weekend in town astride a radiator.

The particular oak now aglow on my andirons grew on the bank of the old emigrant road where it climbs the sandhill. The stump, which I measured upon felling the tree, has a diameter of 30 inches. It shows 80 growth rings, hence the seedling from which it originated must have laid its first ring of wood in 1865, at the end of the Civil War. But I know from the history of present seedlings that no oak grows above the reach of rabbits without a decade or more of getting girdled each winter, and re-sprouting during the following summer. Indeed, it is all too clear that every surviving oak is the product of either rabbit negligence or of rabbit scarcity. Some day some patient botanist will draw a frequency curve of oak birth-years, and show that the curve humps every ten years, each hump originating from a low in the ten-year rabbit cycle. (A fauna and flora, by this very process of perpetual battle within and among species, achieve collective immortality.)

It is likely, then, that a low in rabbits occurred in the middle sixties, when my oak began to lay on annual rings, but that the acorn that produced it fell during the proceeding decade, when the covered wagons were still passing over my road into the Great Northwest. It may have been the wash and wear of the emigrant traffic that bared this roadbank, and thus enabled this particular acorn to spread its first leaves to the sun. Only one acorn in a thousand ever grew large enough to fight rabbits; the rest were drowned at birth in the prairie sea.



It is a warming thought that this one wasn't, and thus lived to garner eighty years of June sun. It is this sunlight that is now being released, through the intervention of my axe and saw, to warm my shack and my spirit through eighty gusts of blizzards. And with each gust a wisp of smoke from my chimney bears witness, to whomsoever it may concern, that the sun did not shine in vain.

My dog does not care where heat comes from, but he cares ardently that it come, and soon. Indeed he considers my ability to make it come as something magical, for when I rise in the cold black pre-dawn and kneel shivering by the hearth making a fire, he pushes himself blandly between me and the kindling splits I have laid on the ashes, and I must touch a match to them by poking it between his legs. Such faith, I suppose, is the kind that moves mountains.

It was a bolt of lightning that put an end to wood-making by this particular oak. We were all awakened, one night in July, by the thunderous crash; we realized that the bolt must have hit nearby, but, since it had not hit us, we all went back to sleep. Man brings all things to the test of himself, and this is notably true of lightning.

Next morning, as we strolled over the sandhill rejoicing with the cone-flowers and the prairie clovers over their accession of rain, we came upon a great slab of bark freshly torn from the trunk of the roadside oak. The trunk showed a long spiral scar of barkless sapwood, a foot wide and not yet yellowed by the sun. By the next day the leaves had wilted, and we knew that the lightning had bequeathed to us three cords of prospective fuel wood.

We mourned the loss of the old tree, but knew that a dozen of its progeny standing straight and stalwart on the sands had already taken over its job of wood-making.

accumulated on the snow before each kneeling sawyer. We sensed that these two piles of sawdust were something more than wood: that they were the integrated transect of a century; that our saw was biting its way, stroke by stroke, decade by decade, into chronology of a lifetime, written in concentric annual rings of good oak.

It took only a dozen pulls of the saw to transect the few years of our ownership, during which we had learned to love and cherish this farm. Abruptly we began to cut the years of our predecessor the bootlegger, who hated this farm, skinned it of residual fertility, burned its farmhouse, threw it back into the lap of the County (with delinquent taxes to boot), and then disappeared among the landless anonymities of the Great Depression. Yet the oak is no respecter of persons.

The reign of the bootlegger ended sometime during the dust-bowl drouths of 1936, 1934, 1933, and 1930. Oak smoke from his still and peat from burning marshlands must have clouded the sun in those years, and alphabetical conservation was abroad in the land, but the sawdust shows no change.

Rest! cries the chief sawyer, and we pause for breath.

Now our saw bites into the 1920's, the Babbittian decade when everything grew bigger and better in heedlessness and arrogance—until 1929, when stock markets crumbled. If the oak heard them fall, its wood gives no sign. Nor did it heed the Legislature's several protestations of love for trees: a National Forest and a forest-crop law in 1927, a great refuge on the Upper Mississippi bottomlands in 1924, and a new forest policy in 1921. Neither did it notice the demise of the state's last marten in 1925, nor the arrival of its first starling in 1923.

In March 1922, the "Big Sleet" tore the neighboring elms limb from limb, but there is no sign of damage to our tree. What is a ton of ice, more or less, to a good oak?

Rest! cries the chief sawyer, and we pause for breath.

Now the saw bites into 1910-20, the decade of the drainage dream, when steam shovels sucked dry the marshes of central Wisconsin to make farms, and made ash-heaps instead. Our marsh escaped, not because of any caution or forbearance among engineers, but because the river floods it each April, and did so with a vengeance–perhaps a defensive vengeance–in the years 1913-16. The oak laid on wood just the same, even in 1915, when the Supreme Court abolished the state forests and Governor Phillip pontificated that 'state forestry is not a good business proposition.' (It did not occur to the Governor that here might be more than one definition of what is good, and even of what is business. It did not occur to him that while the courts were writing one definition of goodness in the law books, fires were writing quite another one on the face of the land. Perhaps, to be governor, one must be free from doubt on such matters.)

While forestry receded during this decade, game conservation advanced. In 1916 pheasants became successfully established in Waukesha County; in 1915 a federal law prohibited spring shooting; in 1913 a state game farm was started; in 1912 a 'buck law' protected female deer; in 1911 an epidemic of refuges spread over the state. 'Refuge' became a holy word, but the oak took no heed.

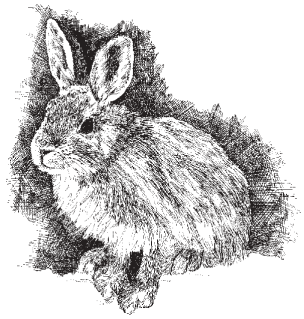
Rest! cries the chief sawyer, and we pause for breath.

Now we cut 1910, when the great university president published a book on conservation, a great sawfly epidemic killed millions of tamaracks, a great douth burned the pineries, and a great dredge drained Horicon Marsh.

We cut 1909, when smelt were first planted in the Great Lakes, and when a wet summer induced the Legislature to cut the forest-fire appropriations.

We cut 1908, a dry year when the forests burned fiercely, and Wisconsin parted with its last cougar.

We cut 1907, when a wandering lynx, looking in the wrong direction for the promised land, ended his career among the farms of Dane County.



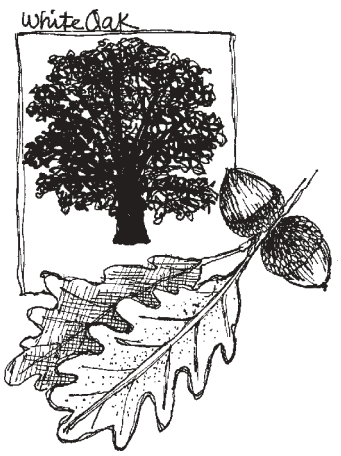
We cut 1906, when the first state forester took office, and fires burned 17,000 acres in these sand counties; we cut 1905 when a great flock of goshawks came out of the North and ate up the local grouse (they no doubt perched in this tree to eat some of mine). We cut 1902-3, a winter of bitter cold; 1901, which brought the intense drouth of record (rainfall only 17 inches); 1900, a centennial year of hope, of prayer, and the usual annual ring of oak.

Rest! cries the chief sawyer, and we pause for breath.

Now our saw bites into the 1890's, called gay by those whose eyes turn cityward rather than landward. We cut 1899, when the last passenger pigeon collided with a charge of shot near Babcock, two counties to the north; we cut 1898 when a dry fall, followed by a snowless winter, froze the soil seven feet deep and killed the apple trees; 1897, another drouth year, when another forestry commission came into being; 1896, when 25,000 prairie chickens were shipped to market from the village of Spooner alone; 1895, another year of fires; 1894, another drouth year; and 1893, the year of 'The Bluebird Storm,' when a March blizzard reduced the migrating bluebirds to near-zero. (The first bluebirds always alighted in this oak, but in the middle' nineties it must have gone without.) We cut 1892, another year of fires; 1891, a low in the grouse cycle; and 1890, the year of the Babcock Milk Tester, which enabled Governor Heil to boast, half a century later, that Wisconsin is America's Dairyland. The motor licenses which now parade that boast were then not foreseen, even by Professor Babcock.

It was likewise in 1890 that the largest pine rafts in history slipped down the Wisconsin River in full view of my oak, to build an empire of red barns for the cows of the prairie states. Thus it is that good pine stands between the cow and the blizzard, just as the good oak stands between the blizzard and me.

Rest! cries the chief sawyer, and we pause for breath.



Now our saw bites into the 1880's; into 1889, a drouth year in which Arbor day was first proclaimed; into 1887, when Wisconsin appointed its first game wardens; into 1886, when the College of Agriculture held its first short course for farmers; into 1885, preceded by a winter 'of unprecedented length and severity'; into 1883, when Dean W.H. Henry reported that the spring flowers at Madison bloomed 13 days later than average; into 1882, the year Lake Mendota opened a month late following the historic 'Big Snow' and bitter cold of 1881-2.

It was likewise in 1881 that the Wisconsin Agricultural Society debated the question, 'How do you account for the second growth of black oak timber that has sprung up all over the country in the last thirty years?' My oak was one of these. One debater claimed spontaneous generation, another claimed regurgitation of acorns by southbound pigeons.

Rest! cries the chief sawyer, and we pause for breath.

Now our saw bites the 1870's, the decade of Wisconsin's carousal in wheat. Monday morning came in 1879, chinch bugs, grubs, rust, and soil exhaustion finally convinced Wisconsin farmers that they could not compete with the virgin prairies further west in the game of wheating land to death. I suspect that this farm played its share in the game, and that the sand blow just north of my oak had its origin in over-wheating.

This same year of 1879 saw the first planting of carp in Wisconsin, and also the first arrival of quack-grass as a stowaway from Europe. On 17 October 1879, six migrating prairie chickens perched on the rooftree of the German Methodist Church of Madison and took a look at the growing city. On 8 November the markets at Madison were reported to be glutted with ducks at 10 cents each.

In 1878 a deer hunter from Sauk Rapids remarked prophetically, "The hunters promise to outnumber the deer."

On 10 September 1877, two brothers, shooting Muskego Lake, bagged 210 blue-winged teal in one day.

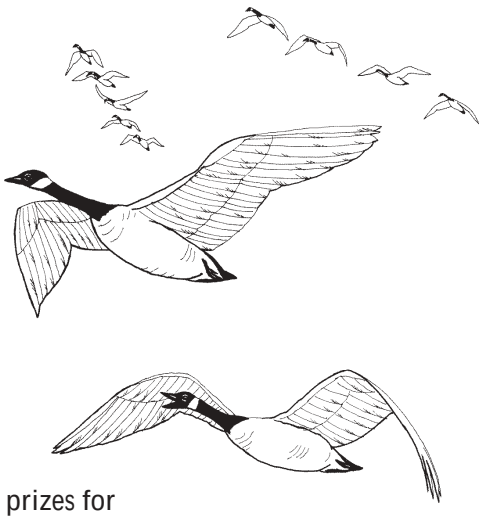
In 1876 four hunters killed 153 prairie chickens at York Prairie, one county to the eastward. In the same year the U.S. Fish Commission planted Atlantic salmon in Devil's Lake, 10 miles south of my oak.

In 1874 the first factory-made barbed wire was stapled to oak trees; I hope no such artifacts are buried in the oak now under saw!

In 1873 one Chicago firm received and marketed 25,000 prairie chickens. The Chicago trade collectively bought 600,000 at $3.25 per dozen.

In 1872 the last wild Wisconsin turkey was killed, two counties to the southwest.

It is appropriate that the decade ending the pioneer carousal in wheat should likewise have ended the pioneer carousal in pigeon blood. In 1871, within a 50-mile triangle spreading northwestward from my oak, 136 million pigeons are estimated to have nested, and some may have nested in it, for it was then a thrifty sapling 20 feet tall. Pigeons hunters by scores plied their trade with net and gun, club and salt lick, and rainloads of prospective pigeon pie moved southward and eastward toward the cities. It was the last big nesting in Wisconsin, and nearly the last in any state.



This same year 1871 brought other evidence of the march of empire: the Peshtigo Fore, which cleared a couple of counties of trees and soil, and the Chicago Fire, said to have started from the protesting kick of a cow.

In 1870 the meadow mice had already staged their march of empire; they ate up the young orchards of the young state, and then died. They did not eat my oak, whose bark was too tough and thick for mice.

It was likewise in 1870 that a market gunner boasted in the *American Sportsman* of killing 6,000 ducks in one season near Chicago.

Rest! cries the chief sawyer, and we pause for breath.

Our saw now cuts the 1860's, when thousands died to settle the question: Is the man-man community lightly to be dismembered? They settled it, but they did not see, nor do we yet see, that the same question applies to the man-land community.

This decade was not without its gropings toward the larger issue. In 1867 Increase A. Lapham induced the State Horticultural Society to offer prizes for forest plantations. In 1866 the last native Wisconsin elk was killed. The saw now severs 1865, the pith-year of our oak. In that year John Muir offered to buy from his brother, who then owned the home farm thirty miles east of my oak, a sanctuary for the wildflowers that had gladdened his youth. His brother declined to part with the land, but he could not suppress the idea: 1865 still stands in Wisconsin history as the birthyear of mercy for things natural, wild, and free.

We have cut the core. Our saw now reverses itself in orientation in history; we cut backwards across the years, and outward towards the far side of the stump. At last there is a great tremor in the great trunk; the saw-kerf suddenly widens; the saw is quickly pulled as the sawyers spring backwards to safety; all hands cry "Timber!"; my oak leans, groans, and crashes with earth-shaking thunder, to lie prostrate across the emigrant road that gave it birth.

Now comes the job of making wood. The maul rings on steel wedges as the sections of trunk are up-ended one by one, only to fall apart in fragrant slabs to be corded by the roadside.

There is an allegory of historians in the diverse functions of saw, wedge, and axe.

The saw works only across the years, which it must deal with one by one, in sequence. From each year the raker teeth pull little ships of facts, which accumulate in little piles, called sawdust by woodsmen and archives by historians; both judge the character of what lies within by the character of the samples thus made visible without. It is not until the transect is completed that the tree falls, and the stump yields a collective view of a century. By its fall the tree attests the unity of the hodge-podge called history.

The wedge, on the other hand, works only in radial splits; such a split yields a collective view of all the years at once, or no view at all, depending on the skill with which the plane of the split is chosen. (If in doubt, let the section season for a year until a crack develops. Many a hastily driven wedge lies rusting in the woods, embedded in unsplittable cross-grain.)

The axe functions only at an angle diagonal to the years, and this only for the peripheral rings of the recent past. Its special function is to lop limbs, for which both saw and wedge are useless.

The three tools are requisite to good oak, and to good history.

These things I ponder as the kettle sings, and the good oak burns to red coals on white ashes. Those ashes, come spring, I will return to the orchard at the foot of the sandhill. They will come back to me again, perhaps as red apples, or perhaps as a spirit of enterprise in some fat October squirrel, who, for reasons unknown to himself, is bent on planting acorns.

Name _____

Introduction:
This essay is one of the most quoted essays in *A Sand County Almanac*. In this essay, Leopold relates events that occurred during the life of an oak tree being cut down for firewood. In doing so, Leopold eloquently connects the heat received from the firewood to the land, and demonstrates why there is spiritual danger in "believing that heat comes from the furnace."

What to do:
1. Locate a tree stump or tree cross section ("beaver cookie") for use in the experience.
2. The following is a description of the cross section of a tree stump.

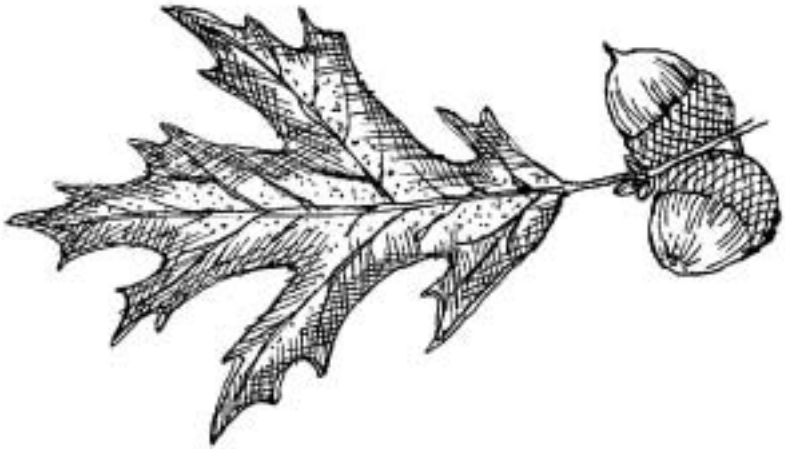
The outside of the stump is covered by bark. In older stumps, the bark has two shades of color. The outer bark is scaly and provides protection; the inner bark is the living part in which food is carried down through the trunk toward the roots. To accomplish this, the inner bark contains vessels known as phloem. In young tree stems, the bark is the same color and the scaly part is missing, not yet developed.

Most of the stump is made up of wood cells, or xylem. The darker wood in the center of an old stump is heartwood, which helps support the tree; the lighter colored wood around the heartwood is the sapwood, which carries water and food up the tree from the roots to the leaves. In the center of the trunk is the small pith, which is a food and water storage area.

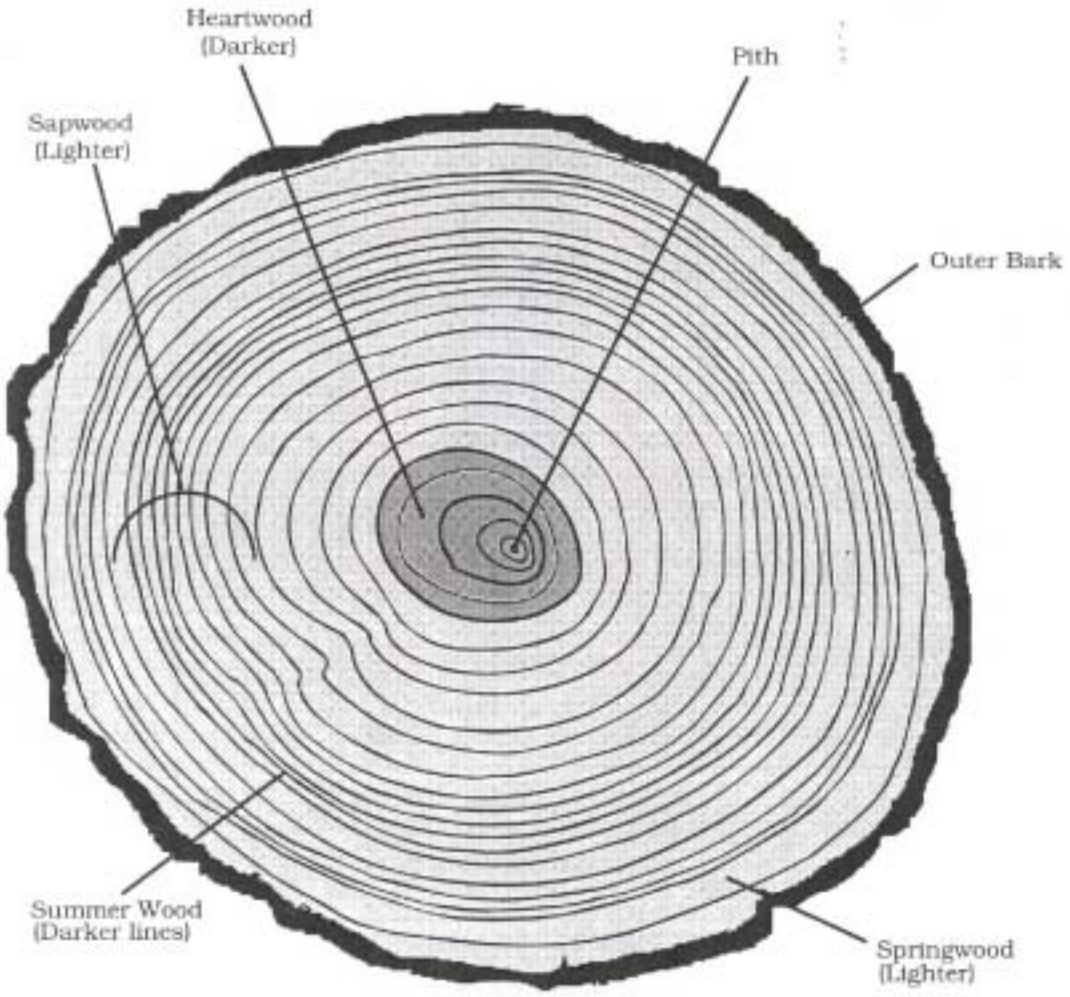
Some trunks have lines, which radiate from the center pith like spokes of a wheel. These lines are vascular rays, which carry food inward from the inner bark (phloem) to the wood cells (xylem).

By looking closely at the cross section, you will see a number of circles called annual rings, one of which is formed each year by the cambium located between the wood and bark.

Use a hand lens to examine an annual ring closely, and notice the large pores (cells) making up the first wood produced in the spring (springwood); this layer is generally much narrower than the rest of the annual ring. The summerwood is the second layer of wood in an annual ring, made up of small cells. A complete annual ring is made up of springwood and summerwood. By counting the number of annual rings, you can tell the age of the tree. The elongation of buds along the twigs accomplishes growth in the length of branches.



Name_____


Heartwood
(Darker)
Pith
Sapwood
(Lighter)
Outer Bark
Summer Wood
(Darker lines)
Springwood
(Lighter)

Name _____

1. When you were six years old, you may have enjoyed swinging from a tree branch that was five feet off the ground. How far above the ground was the branch when you were twelve years old? Explain.

2. Sketch the details of the stump (beaver cookie), and label all the structures listed in the description of a tree cross section.

3. How old was Leopold's oak tree?

4. How old is the tree cross section you are studying?

5. Did the tree grow the same amount each year?

6. Give reasons for differences in the width of annual rings. Using this information, write a brief history of your tree.

7. What tools did Leopold use to cut and split the good oak?

    a. What tools are used today?

    b. Speculate what tool was used to cut the cross section you are studying.

8. Why do you think Aldo Leopold wrote an essay about an old oak?

9. What does spiritual danger mean to you?

10. What spiritual danger is there in supposing that heat comes from a furnace?

11. Why do you think Leopold called the oak “good”?

Environmental Contrasts

Overview
The group will view the "U-Pull-It" car-recycling yard next to the refuge and discuss the importance of reducing, reusing, and recycling.

Duration
20-25 minutes

Grades
3-8

Benchmarks
- Understanding the properties and limited availability of the materials which make up the Earth.
- Analyzing & Interpreting Results

Key Concepts
We are all consumers using both non-renewable resources and renewable resources. Everyone must get into responsible habits to care for our planet by saving resources, especially by reducing, reusing, and recycling. Caring for the environment also includes appreciating and taking care of our trees and forests.

Objectives
- Discuss consumption and the problem of waste disposal
- Demonstrate an awareness of conservation and protection of renewable and non-renewable resources.
- Realize the value of recycling

Materials
- "Recycling Discovery Kit" from Refuge or make your own
- student handouts
- clipboards
- pencils

Background information:

The car-recycling yard next to the refuge provides a stark contrast to the beauty of the Refuge. It also provides a perfect teachable moment for reminding students about the importance of reducing, reusing, and recycling.

Vocabulary:

consumption—buying and using goods and services

renewable resource—a natural resource that comes from an endless or repeating source (i.e. the sun, wind, water, fish, trees, cotton, etc.) as long as the source is managed responsibly

non-renewable resource—a natural resource that cannot be re-made or re-grown (i.e., fossil fuels such as coal, petroleum, and natural gas)

reduce—to cut back on or lessen the amount of things we buy or consume

reuse—to find a new function for an item that has outgrown its original use; use again

recycle—using waste as material to manufacture a new product. Recycling involves altering the physical form of an object or material and making a new object from the altered material

Suggested Procedure:

1. Facing east, have the group view U-Pull-It car recycling yard next to the Refuge
2. Ask: "What comes to mind when you look at this car yard after viewing the big wetland, the pond, or the oak savannah behind us?"
3. Discuss the contrast between the two scenes and student feelings that arise as the scenes are viewed. Most students will probably mention how messy or junky the car yard looks.
4. Guide the discussion to what the bigger problem is (disposing of old cars and other waste)
5. What causes this problem? *Consumption*: buying new cars, new bicycles, new clothes and having to throw away the "old" items
6. Connect this problem to the students' own lives: "On a smaller scale, where is this problem in our life?" (Trash disposal at home and at school)
7. Teacher: "How can we help to solve this problem?" (Reduce, Reuse, Recycle)

8. Remind students of the definitions of each, as well as what a renewable and non-renewable resource is.

9. Teacher: "Why is it important to conserve or take care of our resources?"

10. "What could be some good things that are happening at this car yard?

    • They drains all of the fluids from the cars (therefore, there is no leaking of toxic fluids into the Refuge).

    • Numerous car parts are reused and recycled when people need a specific part for their type of car.

11. "How does recycling help places like this wetland?" (Brainstorm ideas)

12. "What are ways that we can use these '3 R's' in our school? At home?"

Have 2-3 "secretaries" for the group write down all the ideas on their worksheet, while students are brainstorming. On the bus, during a rest period, or back in the classroom, the rest of the class can copy down what the "secretaries" have listed.

13. Recycling Discovery Kit: As you take items out of the Discovery Kit, be sure to share the following information with students to reinforce the necessity of recycling. Have them write down on their student handout what the different items become when recycled.

    • Many **old car tires** become new playground surfaces to play on. Did you know? *Old tires are shredded to make new athletic surfaces (for instance the track we run on), playground surfaces, and is mixed with other things to make stronger asphalt to pave our highways.*

    • One **aluminum can** becomes a new soda can. Did you know? *Recycling soda cans kept 1.7 billion pounds of them out of our landfills. Recycling aluminum cans saves 95% of the energy used to make aluminum cans from new ore mined from the Earth.*

    • One piece of **paper** recycled becomes new paper. Did you know? *Paper is the number one material that we throw away. For every 100 pounds of trash that we throw away, 39 pounds is paper. Newspapers take up about 14% of landfill space, and paper in packaging accounts for another 15% - 20%.*

    • A **2-liter pop bottle** becomes clothing that we wear. Did you know? *Here is how many recycled soda bottles it takes to make new items of clothing:*

Belt	*1.5 bottles*
Socks	*1.5 bottles*
T-shirt	*4 bottles*
Sweatshirt	*6 bottles*
Fleece Jacket	*15 bottles*

    • Brainstorm other items that can be recycled **OR** have 3-4 items in the Discovery Kit that small groups can brainstorm unique new ways to reuse them (for example: a metal spoon or lunch milk carton – "What are new ways we can reuse these items?")

This could lead to further discussion back in the classroom about concrete ways the students can make an effort to reduce waste at school and at home. Or this could have already started in a pre-field trip discussion.

References

U.S. Fish & Wildlife Service. *Oregon White Oak: A Landscape Legacy.*

Websites:
California Department of Conservation. *10 Easy Ways to Buy Recycled.*

Can Manufactures Institute. *Fun Facts*

Energy Information Administration. *Energy Kid's Page.*

Ohio Department of Natural Resources. *Recycling Tires.*

Car-recycling yard

Wow! Look at what happens when we recycle...

A plastic bottle becomes a:

Old tires become:

An aluminum soda can becomes a:

Paper becomes:

What are ways we as a class can reduce, reuse, and recycle in our school? In our homes?

1.

2.

3.

4.

5.

My Special Tree

Overview
In this activity students will choose one tree to observe. Students will gain an awareness of the parts of a tree and how animals and insects depend on trees for survival.

Duration
30-45 min

Grades
K-2

Benchmarks
- Heredity
- Diversity/Interdependence
- Collecting & presenting data

Key Concepts
Trees are found in many different habitats. To be healthy, trees need food, water, and clean air just like humans. Trees provide habitats for many different animals, plants, and insects.

Objectives
Students will be able to:
- identify the parts of a tree, including: roots, trunk, bark, branches, crown, and leaves
- observe a tree and take inventory of any animals, plants, or insects in and around the tree

Materials
- crayons
- pencils
- journal paper
- hand lenses

Background Information

Trees are an important part of our environment. They provide habitats for plants and animals as well as many benefits for humans.

Suggested Procedure

Have students choose a tree to observe or share one tree as a group. Review the worksheet pages with the students and talk about how to make observations. Remind students to use their five senses. Using their eyes to observe, walk around the tree and look up, down and around the tree for any signs of activity from insects or animals. Use the magnifying glasses and binoculars for a closer look. Using their sense of hearing have students stand still for a few minutes and listen for sounds in and around the tree. Try to identify what is making the sounds. Using touch, have the students feel the bark of the tree and any leaves or branches that they can reach.

Have the students smell the tree and the area around the tree. Remind the students to never use their sense of taste on unfamiliar things in nature.

Have students complete the first worksheet called “My Tree”. Encourage students to include their observations in the drawing of their trees. If a leaf from their tree is too large to fit in the box on the worksheet, have students draw a picture of their leaf instead.

Discussion Questions

When students are finished with their drawings and rubbings, have them share what they observed about their tree.

Discuss the following questions:

1. What did you find around the tree on the ground?
2. What did you notice about the trees trunk?
3. Did you see anything on the trunk of the tree”
4. What did you notice in the trees branches?
5. Did you see any signs of life in or around the tree? Remind students this can include holes in the bark or leaves, footprints, nests, etc.
6. What color and shape are the leaves?
7. What do you think will happen to the leaves through the seasons?
8. Would this tree be a good home for any animals or insects? Remind students that a habitat is an area that provides everything a plant or animal needs to survive. A tree may be an entire habitat for an

animal or it may provide just food and shelter.

Have students complete the next worksheet called “All About My Tree”. Remind students to use words from the word box to help them. Have students share their descriptions of their trees. Discuss why the tree may be a good habitat for some animals and not for others.

Assessment Ideas

1. Walk around school grounds and have students find a tree to do a similar observation on. Have students compare the original tree at the wetlands and a second one on the school grounds. How are they alike or different?
2. Have students make up a story of an animal living in the tree they observed.
3. Provide tree identification books for students and have them try to identify the type of tree they observed. Remind students to use the shape of the leaves as a guide when looking up their tree.
4. Have students do a watercolor painting of the tree they observed including the area around where the tree was found.

References

Copycat Magazine, Sept./Oct. 2003

Mailbox Magazine, Aug./Sept 2002

Project Learning Tree Environmental Education Activity Guide.

Mellett, P. *Trees (Fantastic Facts).*

Seifert, P. & Doherty, P. *Exploring Tree Habitats*.

My Tree

Here is a picture of my tree. It has a trunk, branches, and leaves.

Here is a rubbing of my tree's bark. The bark protects my tree from animals, bugs, and weather.

Here is a rubbing of a leaf from my tree. Every tree has a special shape of leaf. Leaves make food for the tree.

All About My Tree

Word Box: tree tall short brown green rough smooth grassfield bushes bark leaf branch crown moss bird squirrel nest roots seeds insects ants

Where did you find your tree?

Describe what your tree looks like.

How does the bark feel?

Every kind of tree has its own special leaf. The leaves make food for the tree to grow. Tell what your leaf looks like.

Look for signs of animals or bugs that might live in your tree. Can you find tracks, chew marks, or nests? What might live in your tree?

Tree Cookies

Overview
Students will learn about trees by looking at the growth rings on a tree cookie. By observing the rings, students can see how the tree's environment affects the tree's growth over the years.

Duration
20-30 min

Grades
K-2

Benchmarks
- Organism
- Heredity
- Diversity/Interdependence
- Collecting & presenting data
- Analyzing & interpreting results

Key Concepts
The growth rings of a tree tell a story about the tree: age, weather, fires, disease, and floods. Scientists can tell a lot about both the tree and the environment by studying the growth rings.

Objectives
Students will be able to:
- identify a tree's growth rings
- infer from a tree's growth rings what might have occurred during a tree's life
- draw the annual growth rings of a pretend tree and be able to tell a story about their tree

Materials
- tree cookies
- hand lenses
- student handout "story of a Tree"
- pencils

Background Information

You can tell the age of a tree by counting its growth rings. The rings tell a story about what has happened to the tree over the years, including weather, fires, disease, and floods. The growth rings may be far apart or close together depending on the growing conditions for that year. If a tree's growth rings are close together, that can mean a poor growing year for the tree because of many factors like drought, disease, or some sort of growing stress. A good growing year will be shown by a wider growth ring.

Suggested Procedure

1. Take students to an area where there are a few trees in various shapes and sizes. Ask students to estimate how old those trees are. Explain that they are going to be looking at a tree "cookie," which is a cross-sectional slice of a tree trunk. On the tree cookie they will see circles or "rings" that help tell how old a tree is.
2. Show the students the tree cookie and have students estimate how old the tree was before it was cut down.
3. Pass the tree cookie around, having students count the rings. Discuss how old the tree was and why that tree may have been cut down.
4. Have students look at the rings with hand lenses and discuss why some rings are close together and some are far apart. See if students notice any holes in the sapwood. Sap and water travel through these holes up the trunk and into the branches of the tree. The holes should be visible with the hand lenses.
5. Explain to students how there are many things that affect the growth of a tree. When it is a harder year for a tree to grow because of less water, severe weather or disease, the rings are closer together. When it is a good growing year because of good weather and lots of water, the rings will be farther apart. Let students come up with reasons that may affect a tree's growth and discuss these.
6. Give each student the handout called "The Story of a Tree". Give time for students to fill in the annual rings of a pretend tree and remind them to think about good growing years and slow growing years for their tree. Remind students to be able to tell the reason that the rings are far apart or close together. Have them put the age of their tree at the bottom of the page.
7. Have students meet in small groups or with partners and tell each other the story of their tree from their tree cookie.

Assessment Ideas

1. Give each student a paper plate and tell them it is a tree cookie for them to create and tell the story about. The bumpy outside ring of the paper plate is the bark. Remind students to show years of rapid or slow growth for their tree. Have students write a story about their tree and why it grew fast or slow some years.
2. Cut a large onion in half to use as a tree "cookie". Have students make prints from the onion, dipping the onion in paint and pressing it on paper. The onion print should look like a tree cookie. Have students tell about their tree and count the rings to tell how old the tree is.
3. Have students create a tree cookie on a paper plate that is the same age as they are. Instead of telling about a tree, have the students tell about themselves for each annual ring. For example, the first ring could be when they walked, three could be the start of preschool, the fifth ring could be the start of kindergarten, etc.
4. Ask students what we can learn about a tree from the growth rings. Check their worksheets for accuracy in the drawings and in the numbers of years that they say their tree has been alive. Older students can write their tree's story on the back of their paper.

References

Gibbons, G. *Tell Me, Tree – All About Trees For Kids.*

Lauber, P. *Be a Friend to Trees*.

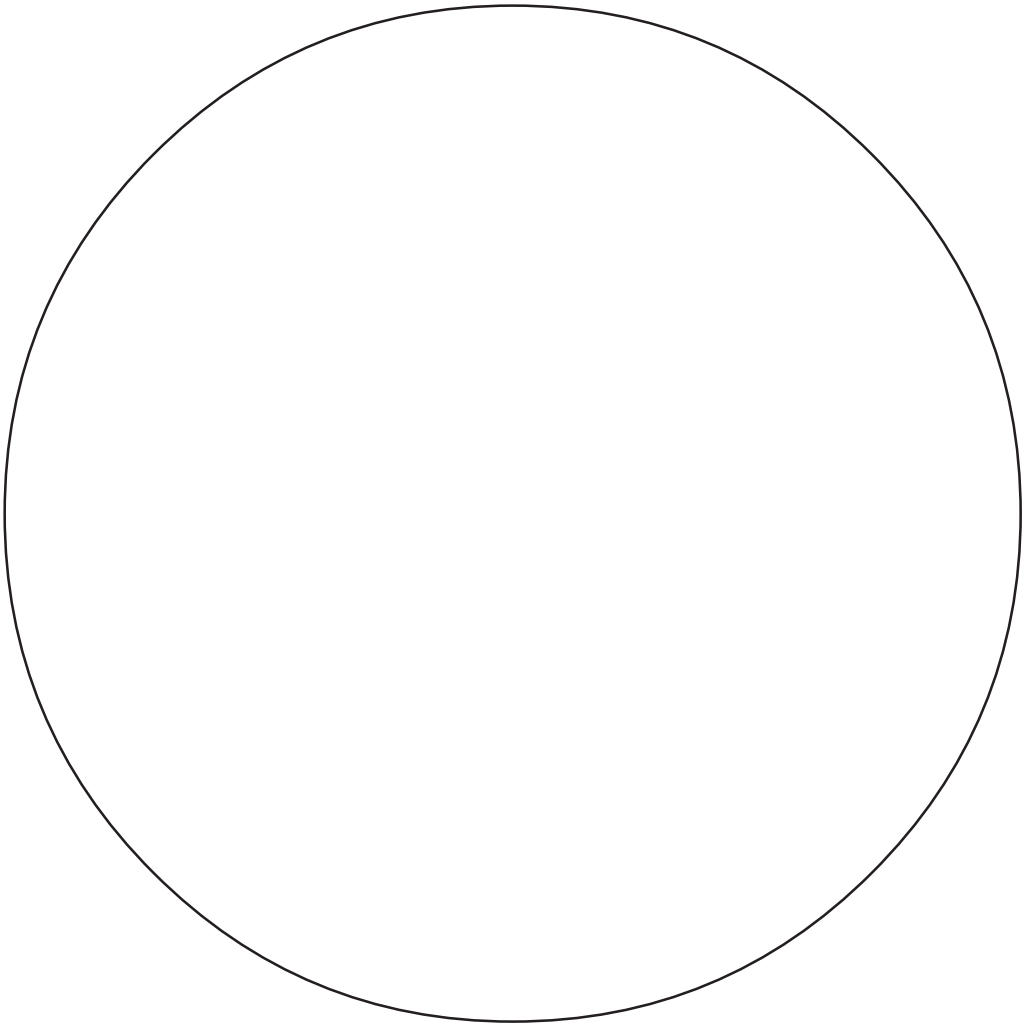
Balla, C.R. *A Tree is a Plant*.

Mellett, P. *Trees (Fantastic Facts).*

Project Learning Tree Environmental Education Activity Guide.

The Story of a Tree

Draw the annual rings of a pretend tree. How old is the tree? Tell a partner the story of your tree. Be sure and tell why your tree grew slowly some years and fast other years. Add bark to your tree cross section.



My tree is _____ years old.