DISCOVER

WETLANDS

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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printed on recycled paper

DISCOVER WETLANDS

A Curriculum Guide

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Ecology would like to know what you think of *Discover Wetlands.* Please send comments and suggestions for improving this guide to:

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Table of Contents

Glossary of Terms

Appendices

Discover Wetlands
Introduction

Wetlands have an image problem. For years they have been held in low regard, viewed as worthless swamps, bug-infested wastelands and havens for mythical monsters of the mire. With the pressures of an expanding human population, wetlands have been diked, drained, filed, and dredged as we make room for industry, agriculture, and commercial and residential development. There is seldom any doubt about the value of what we have gained-yet, what have we lost? In the past two decades, we have begun to discover the many values of wetlands, not only to wildlife, but to people as well. Despite this growing knowledge, we continue to lose tens of thousands of acres of wetlands a year.

Discover Wetlands has been developed to provide educators in Washington State teaching materials on wetlands. This collection of activities focuses on our wetlands, what makes them valuable, and how human actions have affected them.

This copy of ***Discover Wetlands*** is a thorough revision of the original 1988 version. It has been expanded from a target age of grades 4-8 to include activities for kindergarten through twelfth grade. All activities are cross-referenced to the Washington curriculum goals in the areas of science, social studies, language arts, and environmental education. This should prove useful to teachers seeking to integrate environmental education into their curriculum, as directed by the Washington State Office of the Superintendent of Public Instruction. This will also aid teachers seeking multidisciplinary approaches to instruction in general (refer to Appendices B & C). Teachers will also find suggestions for sequencing varying lengths of wetlands units (Appendix D).

With its expanded field studies unit, this guide will be of great interest to the many schools who have discovered a nearby wetland to use as a study site. Many wetland areas are being developed for study, such as the Hood Canal Wetlands, Nisqually Refuge, Padilla Bay, and the ***Little*** Spokane River. (The Department of Ecology publication ***Wetland Walks*** lists numerous sites open to public access.) Teachers may find field studies can be enhanced with handy plant and animal cards (Appendices G & H), and tips for making your own field study tools (Appendix I).

This version of ***Discover Wetlands*** includes a very special theme - frogs! Frogs are often a memorable part of a child's life. The chorus of peepers in spring, a quick splash alerting one to their presence, glimpses of their lightning-fast and accurate tongues, surprise at their shiny green, well-camouflaged cloak.

Frogs around the world are disappearing. Although we are not certain why, we have some clues as to how our actions are affecting these wetland neighbors. As we begin to understand their life cycle, learn about their unique adaptations, and learn about their habitat needs we can begin to see the interconnectedness within the ecosystem, as well as how our actions affect the balance. Frogs need our help in protecting their fragile habitat.

"Frogs" are the unifying theme throughout this curriculum. They are an easy wetland representative to find and even raise in the classroom. They are a sure source of delight and, most importantly, frogs are an indicator of the health of their wetland home. Our hope is that the understanding gained through studying this much-loved character will transfer to all wetland creatures and will foster a sense of caring and responsibility towards our precious natural heritage. Imagine a world without frogs...

Format for Discover Wetlands Activities

Each activity in this guide includes the following information:

Grade **Level:** suggests appropriate learning levels:
1) Primary level (K-2) 2) Upper elementary level (3-5)
3) Middle School (6-8) 4) High school (9- 12)

Time range: length of activity, in minutes or hours

Setting: suggested site, such as indoors/outdoors/requirements i.e., a small stream, a playground puddle

Subject Areas: disciplines to which the activity applies

Vocabulary: terms defined in glossary

Objectives: qualities or skills students should possess after participating in the activity

Methods: summary of the activity

Teacher Background: relevant information about activity concepts or teaching strategies

Materials: supplies needed to conduct the activity

Procedures: step by step directions for the instructor

Grade Level Variations: most activities are written for the middle school level, with adaptations suggested for upper and lower grades

Extensions: ideas for exploring the activity in greater depth

Evaluation: assessment activities or questions

Related Activities: other activities in this curriculum that closely relate to this one

Resources: relevant people, books, periodicals, agencies, multimedia resources (see Appendix A)

Unit I: Washington's Wetlands

Introduction

Wetlands, commonly called marshes, swamps, or bogs, are land areas that are saturated or covered with water for at least some part of the year. They can be found throughout the state of Washington - along river corridors; as ponds, lakes, and potholes; along the shoreline of Puget Sound and the Pacific Coast; and in shallow depressions in the land where water collects. They are found from high, mountainous areas, to the valleys and basins of the lowlands and from the wetter areas of western Washington, to the most arid parts of eastern Washington. These beautiful, diverse lands are so productive and perform such important functions in our watersheds, that their value to people is immense.

Topic A: **Washington's Wetlands: What Are They?**

Activity **1: Wetland Types**

Grade Level: 3-8, with variations for K-2 and 6-12
Time: 60 - 90 minutes
Setting: indoors
Subject Areas : Art, Life Science, Environmental Education, English, Language Arts
Vocabulary: wetland, marsh, swamp, estuary, bog (for 9- 12: riverine, lacustrine, palustrine, marine, and estuarine)

Objectives

Students will be able to define the terms: wetland, swamp, marsh, estuary, and bog; and understand the similarities and differences among types of wetlands found in Washington.

Methods

Students will participate in drawing, discussion, brainstorming questions, and viewing a video tape.

Teacher Background

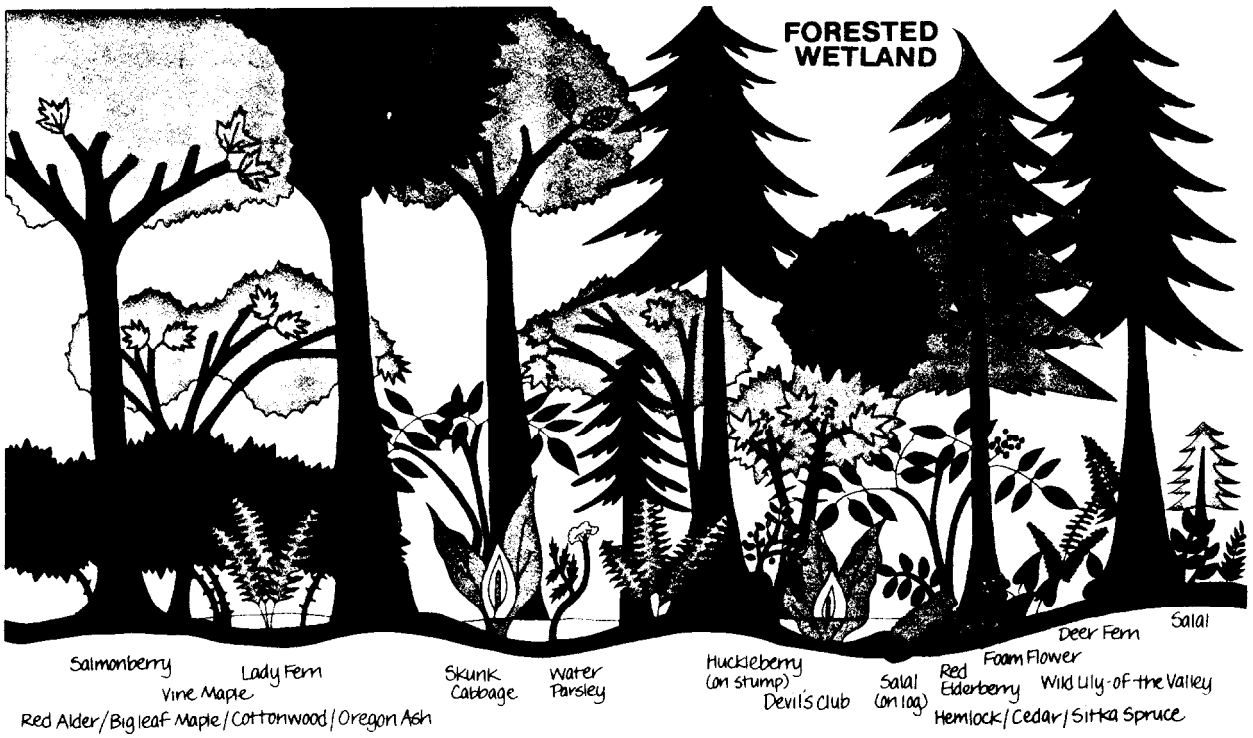
Wetland Types: There is one common element to all wetlands; the key to all life...water. The presence of water alters the soil chemistry which determines the type of plants and ultimately the species of animals which live there. Despite this important commonality, Washington wetlands differ vastly in the makeup of their plant and animal communities.

Marshes: Salt or freshwater marshes are wetlands dominated by grasses and herbs (plants with fleshy stems that usually die back at the end of the growing season). Freshwater marshes are found all over the state. Some of the largest areas of freshwater marsh are found in Eastern Washington in the Turnbull Wildlife Refuge. These productive marshes are important breeding areas for several species of birds, including the ruddy duck, the Caspian tern, and the great blue heron.

Freshwater marshes also serve as important stopover sites where migratory birds can rest and “refuel” during their arduous journey.

Salt marshes are most often found along the shores of an estuary. An estuary is the place where the river meets the sea; usually a semi-enclosed body of water with open or partial access to the sea, where fresh and salt water mix. The hardy, salt-tolerant plants of a salt marsh, such as saltgrass and pickleweed, are covered by the tides twice a day and then left exposed, often to the hot sun. These seemingly harsh conditions suit these plants well; in fact, salt marshes are often more productive (produce more plant material) than well-tended agricultural lands. Salt marshes are also important to wildlife, including birds, fish, shellfish, and mammals. They provide feeding, breeding, rearing, resting, and refuge areas. The marshes of Willapa Bay and the Skagit River Delta are some of the largest remaining salt marshes in Washington.

Forested Wetlands: Forested wetlands, also called swamps, are wetlands dominated by trees and shrubs, including western red cedar, Sitka spruce, red alder, black cottonwood, Oregon ash and willows. They are typically found in Western Washington and often along river courses. Forested wetlands are characterized by a dense understory of rich, green vegetation such as skunk cabbage and lady fern making these areas enticing to wildlife because of an abundance of food and cover. Many of the state’s swamps were destroyed by logging in the early part of the century.



Bogs: Bogs are wetlands formed in cool, wet areas where drainage is poor and the soil lacks oxygen. Characterized by strongly acidic water and dense, sometimes floating mats of vegetation, bogs host a variety of plants and animals. They generally support sphagnum and other acid-tolerant mosses. As the bog ages, the mosses accumulate in layers of soft peat (decayed plant material). Bogs are also home to several interesting species of plants, including the sundew, a small plant that lives by trapping and "eating" insects. Because decomposition is slow and somewhat incomplete in bogs, nutrients are not as readily available to plants. Carnivorous bog plants depend on captured insects for their nitrogen and nutrient supply.

Most bogs in Washington were formed by depressions left by the melting of glaciers 10,000 years ago. Many bogs were destroyed when their peat was commercially mined for fuel and for landscaping and nursery uses. Bogs in western Washington are also used to grow acid-loving berry crops, such as blueberries or cranberries. [1]

Materials

drawing paper, butcher paper or flipchart paper,
video: "Washington Wetlands" (see Appendix A)

Procedures

Have students draw a picture of their perception of a wetland. Compare pictures and point out the similarities and differences among them. Introduce the words "swamp", "marsh" (freshwater and saltmarsh), "estuary," and "bog," and define each. (Refer to the background information.)

See if any of the student pictures represent these types of wetlands. Summarize by agreeing on a definition of wetlands similar to the one in the background information. You can group similar wetland types together or have the students name the type of wetland and where they have seen it.

Together, brainstorm questions about wetlands and record them on butcher paper. Encourage questions that start with "How, why, what, when, where, which, and do." View the video, "Washington Wetlands," and discuss how many of the students' questions were answered by the film. Post the butcher paper in the room and refer to it periodically as you progress through the following wetland learning activities to see if questions are answered. If some unanswered ones remain at the end of your wetland studies, discuss ways to research answers.

Grade Level Variations

K-2: Restrict discussion of wetlands to "cattail marshes." After discussing the plants and animals found in cattail marshes, have students each create a colored picture of a cattail marsh. Collect pictures and cut them into "puzzle pieces." Put the pieces from two pictures into a bag and mix them up. (Do the same for the rest of the pictures.) Have students work in pairs to reassemble the two pictures. Then have them describe the reassembled pictures to the class.

4 - 12: To determine the type of wetland located near your area obtain a National Wetland Inventory (NWI) map from your local planning department.

9-12: Teach the Cowardin classification system (Refer to Appendix F). Divide class into five teams and have each team create a collage, mural, or poster of one of the five types of wetlands from the Cowardin system.

Extensions

Have students return to the pictures they drew at the beginning of this activity and add details based on what they learned from the video.

Evaluations

1. Have students write a paragraph starting with this topic sentence: "There are several types of wetlands in Washington State."

or

2. Have students write one sentence defining each of the five vocabulary words introduced in this lesson.

Resources

At Home With Wetlands, Dept. of Ecology publication; Adopting A Wetland: A Northwest Guide; "Washington Wetlands" videotape; all listed in Appendix A

Notes

1. Steve Yates, Adopting A Wetland: A Northwest Guide (Everett, WA: Snohomish County Planning & Community Development, 1989), 25-28.

Topic B: **Wetland Soils and Plants**

Activity 1: **Venn Diagram and Wall Display**

Grade Level : 3- 12, with variations for K-2
Time: 60 minutes
Setting: indoors; can use outdoors
Subject Areas : Biology, Life Science, Environmental Education, English, Language Arts
Vocabulary: obligate, facultative, upland, hydric, anaerobic, detritus, hydrophytes

Objectives

Students will understand that wetlands are characterized by and identified by certain kinds of soil and specially-adapted plants.

Students will understand that some plants can be found in both wetland and upland communities.

Methods

Students will observe and sketch plants, and compare and contrast wetland and upland plants using a Venn diagram.

Teacher Background

Wetlands are characterized by "hydric" soils which means they are saturated with water and thus have a much lower oxygen content than drier soils. Due to the lack of oxygen in hydric soils, decomposition is often accomplished by "anaerobic" bacteria, (bacteria not requiring oxygen), resulting in the characteristic "sulfur" smell associated with wetlands. Wetland soils often contain high amounts of decayed material, "detritus," which gives the soil its blackish color.

Wetlands are identified by "hydrophytes, "plants that have adapted to hydric soils ("hydro"= water and "phyte"= plant). Western red cedar, cattails, sedges, and eelgrass are all examples of hydrophytes, each with its own unique adaptations which allow it to survive in a saturated

environment. Some plants are "obligate wetland, "meaning that more than 99% of the time they are found in wetlands. Others are "facultative," meaning that they are found growing in wetlands 34-66% of the time. "Upland" plants are not wetlands plants; less than 1% of the time will they be found surviving in saturated soils. (A variation of this lesson for advanced students refines these categories further.)

National Range of Indicators (from National List of Plant Species That Occur in Wetlands; 1988 Washington) reflect the frequency of occurrence of a plant species in a wetland versus a non-wetland.

Indicator Categories:

Obligate Wetland (OBL) occur almost always (> 99%) under natural conditions in a wetlands. Examples: cattail, skunk cabbage, slough sedge, spike rush.

Facultative Wetland (FACW) usually occur in wetlands (67-99%), but occasionally found in non-wetlands. Examples: red-osier dog-wood, black cottonwood, hardhack, reed canary grass, Oregon ash.

Facultative (FAC) equally likely to occur in wetlands or non-wetlands (34-66%). Examples: red alder, deer fern, salmonberry.

Facultative Upland (FACU) usually occur in non-wetlands (67-99%), but occasionally found in wetlands (l-33%). Examples: vine maple, salal, western hemlock, red elderberry.

Obligate Upland (UPL) occur almost always (>99%) under natural conditions in non-wetlands in the region specified (though they may occur in wetlands in another region). Example: orchard grass.

A listing of wetland plants and their adaptations which allow them to survive in wetland environments may be found at the end of Unit 1, Topic B, Activity 2: "Wetland Plant Adaptations."

Materials

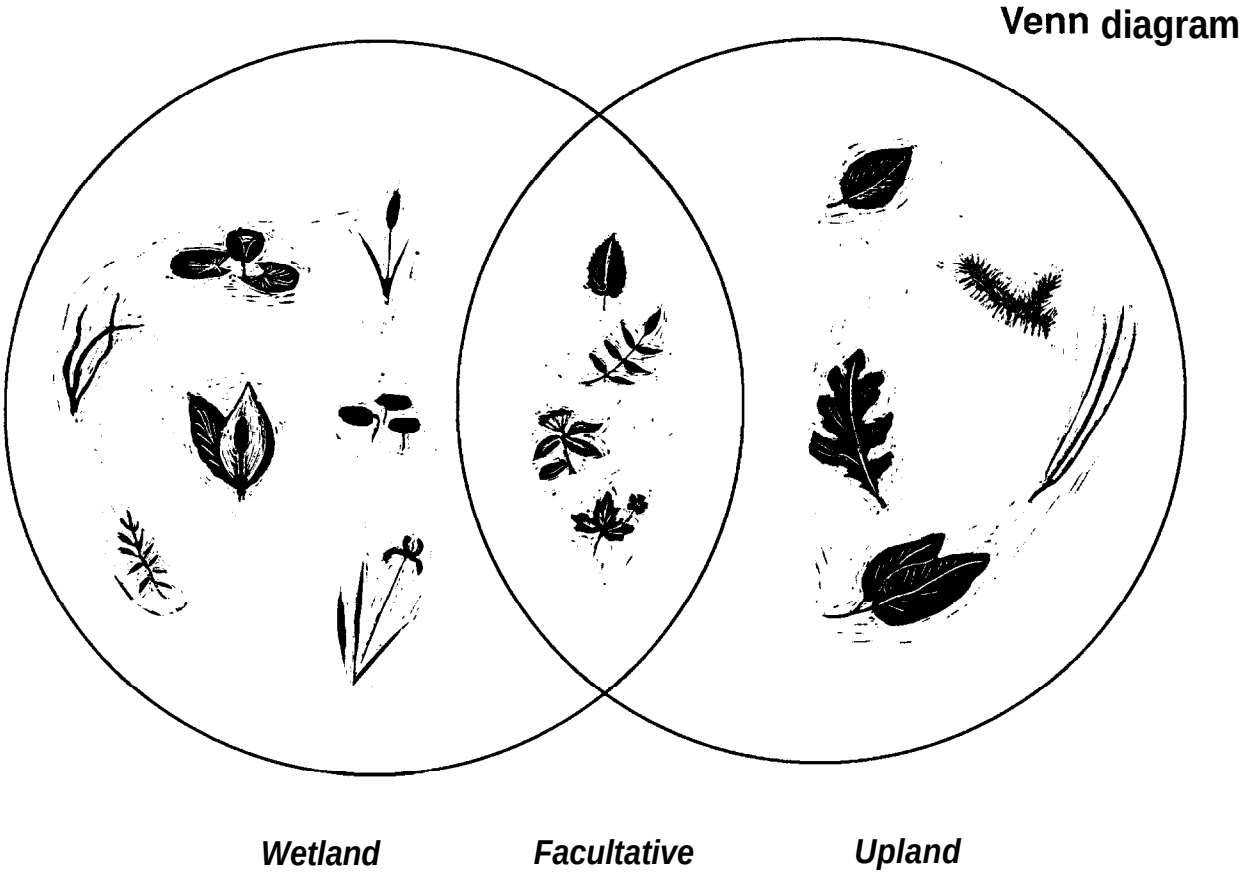
plant specimens, plant cards (Appendix G), brown string, blue yarn, bulletin board, Venn diagram.

Look at the plant cards and identify which plants are "obligate wetland," "facultative" (include "facultative-wet" and "facultative-upland,") and "upland." Provide a few specimens of these plants for students to observe and sketch. Before going out to collect specimens, be sure to read Unit IV's introduction. If sketching will be done in the field, hand out the cards that show obligate, facultative, or upland plants found at the field study site. Students will need to locate the plants and then sketch them. Have students also sketch a cross section of a stem and describe its texture-for example, fuzzy, gummy, hairy, waxy, smooth, etc.

Venn Diagram

In the classroom, draw a large Venn Diagram on the board and label one side "upland' and the other side "wetland' (option: for advanced students, use the word, "obligate wetland" instead of "wetland"). Discuss the characteristics of wetland soils (see background information) and how only certain plants can grow in these saturated soils.

Explain that when we look at a habitat area, one of the ways we know it is a wetlandis by identifying the plants that grow there. The presence



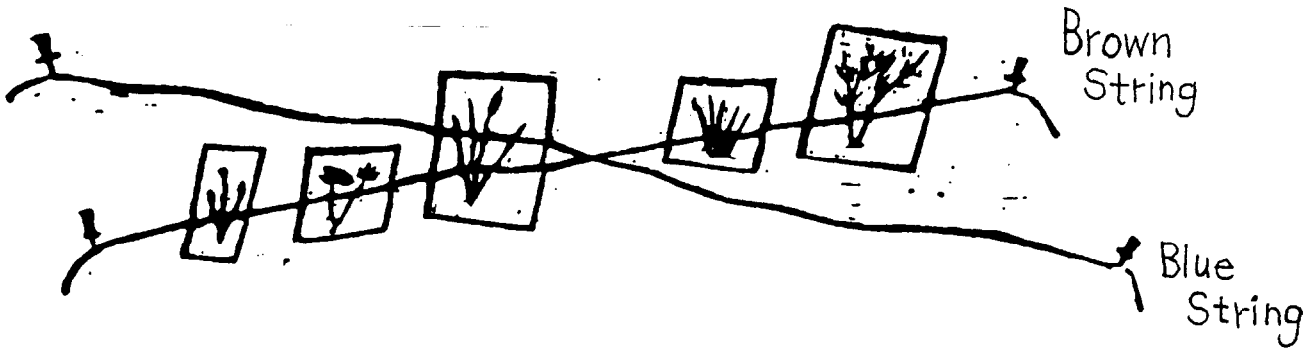
of certain plants (obligates) means the area is definitely a wetland, however, other plants (facultative plants) can grow in uplands as well as in wetlands. Therefore, the presence of facultative plants does not always mean that an area is a wetland.

Have students come up one at a time with their sketches and describe the plant they observed, including the plant's texture. Ask students if they think their plant is a wetland plant or an upland plant, or if it could be found in either environment. Wetland ratings for each plant can be found on each plant card in Appendix G. Have students tape their sketches in the appropriate places on the Venn Diagram. Depending on age-level, the word "facultative" can be used to label the intersection of the Venn diagram. Refer to sample Venn diagram.

Summarize by asking students which plants would indicate the definite presence of a wetland (obligate) and which plants would indicate that an area might be a wetland (facultative).

Wall Display

Attach a brown string or yam at an angle to a wall or bulletin board to indicate land that slopes down to fresh water. Use blue yam to indicate the water level. Have students place either their sketches or the plant cards along the sloping land to indicate where each plant would likely grow in relation to its proximity to water.
(Most of the facultative plants would be placed in the middle, between the upland and wetland plants, but some could appear higher or lower along the sloping line.)



Wetland ***Facultative*** ***Upland***

Grade Level Variations

K-2: Give students a limited amount of plants to examine and only plants from a familiar wetland habitat, such as a cattail marsh.

9-12: Have students research and apply the meaning of wetlands ratings throughout the activity.

Extensions

At a wetland site, use plant cards and their ratings to try to determine the border of the wetland. Invite a wetlands biologist from a local wetland consulting company or agency to assist students and confirm their findings.

Read the story "Why Crayfish has Eyes on Stalks," from Wetland Tales (see Appendix A). Place plants from story on Venn diagram and/or wall display.

Evaluation

Given a list of plants and their wetland ratings, have students arrange the plants along a line similar to that used in the wall display or on the Venn diagram.

Related Activities

"Wetland Plant Adaptations," Unit I, Topic B, Activity 2;
"Create A Plant," Unit I, Topic B, Activity 3

Topic B: **Wetland Soils and Plants**

Activity **2: Wetland Plant Adaptation**

Grade Level: 3-8; with variations for K-2 and 9-12
Time Range: l-2 class periods
Setting: Indoor introduction, outdoor field study
Subject Areas: Life Science, Arts, Environmental Education, Biology
Vocabulary: adaptation, evolve, hydrophyte, hydric soils

Objectives

Students will study the environmental factors unique to wetlands. Students will learn how wetland plants are specially adapted for their habitat.

Method

Out in the field, students will study plants by using hand lenses and referring to information sheets.

Teacher Background

Wetland plants are unusual. These "hydrophytes" (water-loving plants) are uniquely adapted for living in their habitat whether that be freshwater marsh, swamp, stream orestuary. They have evolved ways to obtain oxygen in water-logged soils, to reproduce underwater, to rid themselves of excess salt, or to adapt to changing water levels, thus enabling them to survive in habitats where other plants cannot.

Looking at the form and life cycle of a plant tells us a lot about how it is adapted for survival. Natural selection, or "surviva1 of the fittest," is the theory that those organisms best suited for survival live to reproduce and pass on those genes. Adaptations that enable an organism to survive in its habitat are fascinating to study.

One of the largest challenges to a wetland plant's survival is its ability to get air. Leaves, stems or any other green, photosynthetic organs need to take in carbon dioxide, and release oxygen gas. When light is unavailable or it is too cold to photosynthesize they must also take

in oxygen, since they cannot produce it without light. Roots always need a source of oxygen. Plants that live in well-aerated, upland soils get air directly from the atmosphere and through the soil. Wetland plants must have adaptations to aid in gas exchange, such as air roots, buttress roots, spongy stems, and other air-filled tissues.

Materials

for each team of 2-3 students:
Wetland Plant Activity sheet
Wetland Plant Adaptations sheet
clipboard and pencil
paper for drawing
magnifying glass (for each, if possible)
field guides
Optional: knife for cutting into plant to see internal structures, camera to take photographs

Procedure

Ask students to name the wetland habitats in which they have found plants; list them on the board. (In water, along water's edge, in any of the 5 types of wetlands described in Unit I, Topic A, Activity 1: "Wetland Types.")

Ask students to consider how their house or garden plants would survive in these environments. (poorly) Why? (soil is too wet, too saline, or water levels fluctuate)

Tell them that they will be asking a lot of "why" and "how come" questions to figure out what makes wetland plants able to survive where others cannot.

Out in the Field

Divide your class into teams of 2-3 students. Set a time limit. Pass out Wetland Plant Adaptation sheets and tools listed under materials. Have each team focus on plants in a specific area to work on this activity. (Remind them that they are not to collect anything, and to take care not to trample the wetland!) ALTERNATE: If a field trip is not possible, find a place to collect a few different types of plants and set up this activity in your classroom.

Instruct teams to find as many examples of plant adaptations as they can and make a drawing of each. Use field guides to identify and label plants.

Afterwards, bring the entire class together to share their observations. Discuss different plant adaptations.

Grade Level Variations

K-2: Younger students may need the concepts and vocabulary simplified. They probably will do better at observing the plant structures.
9-12: Older students may want to study plant reproduction strategies, or how people use plants.

Extensions

Put seeds of wetland plants between layers of paper towels or between a wet paper towel and the side of a glass. How long does it take for them to germinate?

Put together information to make a field guide. The use of computers could be integrated by entering information and drawings in HyperCard® stacks.

Cover a bulletin board with a larger-than-life model of a cattail or other plant, labeling the parts and describing how it is adapted for life in a wetland.

Evaluation

Identify three environmental factors to which wetland plants are adapted. Describe how plants are adapted for each factor, and give at least one example.

Consider using the "Create-A-Plant" activity under this topic as an evaluation tool.

Related Activities

"Venn Diagram & Wall Display," Unit I, Topic B, Activity 1; "Create-A-Plant," Unit I, Topic B, Activity 3

Resources

Plant Cards, Appendix G

Name: _____
Date: _____
Period: _____

Wetland Plant Activity Sheet

All plants need sunlight, oxygen and a way to reproduce. Hydrophytes, those plants that live in water-logged soils, have adapted unique ways to survive. Use your eyes and hand lens to observe closely and use the "Wetland Plant Adaptation Sheet" to help you answer these questions.

1. Find a plant living in a wetland. Notice its size and shape. Describe or draw it here.

In what habitat is it living?

How does its size and shape enable it to live in a wetland?

2. Find a plant living in a wetland. Feel its texture. Describe it.

How does its texture help it survive in a wetland?

3. Cut the stem of a plant cross wise. Draw or describe what you see. Use your hand lens to look closely.

How does what's inside help the plant obtain oxygen?

4. Look at the leaves. Describe or draw what they look like.

Does their shape or position help the plant get sunlight or oxygen? How?

5. Can you see flowers (or other reproductive parts)? Describe or draw them here.

How are they adapted for reproduction in a wetland?

6. Dig up one small plant whose species is found in abundance in the wetland and look at its roots. Describe or draw them.

How are these roots suited for living in hydric soils?

7. How is this plant adapted for living with salt water?

Wetland Plant Adaptations

Adaptation	Advantage	Examples
submerged plants:		
thin skin	to absorb nutrients from water	milfoil, pondweed
flexible stems	will bend. not break	most wetland plants
finely cut leaves	to increase surface area for absorbing sunlight to photo-synthesize	milfoil, elodea
floating plants:		
air bladders	for floating (no roots)	bladderwort
digestive juices	to eat insects for nutrients	bladderwort
hanging roots	to absorb nutrients	duckweed
rooted plants:		
large, floating leaves	to reach sunlight to photosynthesize	lilies
stomata on leaf's upper surface	to allow gas exchange	lilies
flowers smell,	to attract insects to pollinate	yellow water lily
emergent plants:		
spongy stem	to transport gases	cattails
large breathing pores	to exchange gases	willows
air filled roots	get gases from upper plant	willows
roots in air	to get oxygen	mangroves[2]
buttress roots	to get oxygen	cypress
gas-transporting tissues	to transport oxygen and carbon dioxide	cordgrass
rot-resistant wood	to prevent decay	cedar, cypress
tall, narrow plants with no branches, long leaves	to reduce resistance to water so leaves won't break in water	cattails, reeds, rushes, bulrushes, sedges
flowers small, up high	keep out of water	sedges, reeds, rushes
long, creeping rhizomes	to anchor plant in soft soil	reeds, rushes, bulrushes
buds on rhizomes,	to reproduce quickly and form dense colonies	reeds, rushes, sedges bulrushes

1. Not necessarily a wetland adaptation
2. Found in subtropical area such as in the Florida Everglades, Belize, and Mexico

Adaptation	Advantage	Examples
salt-tolerant plants:		
gummy, hairy, waxy skin	to prevent salt absorption	gumweed, pickleweed, cinquefoil, sea thrift
holds water in cells	to maintain water supply	pickleweed
oxygen-rich layer around roots	to obtain oxygen	cordgrass (tiny organisms live there!)
exudes salt crystals	to rid of excess salt	saltgrass
salt drops on tips of leaves	to rid of excess salt	pickleweed
large, hardy seeds	to maintain salt balance in cells; to keep salt water from flowing in	pickleweed
low, sprawling form	to reduce water loss from wind exposure	pickleweed, jaumea
small flowers,	uses little energy	sedges, rushes, bulrushes
parasitic,	to obtain nutrients from other plants	salt marsh dodder
bog plants:		
sticky, sweet smelling	to attract insects for nutrients	sundew, pitcher plant
leaves upright,	to reduce surface area for drying out from exposure to the sun	Labrador tea, cranberry
thick, fuzzy, rolled leaves,	to prevent water loss from evapotranspiration	Labrador tea
live symbiotically with fungi,	to obtain nutrients	orchids, heath plants

1. Not necessarily a wetland adaptation

Topic B: **Wetland Soils and Plants**

Activity 3: **Create-A-Plant**

Grade Level: 3-8; with variations for K-2 and 9-12
Time Range: 60-90 minutes
Setting: indoors
Subject Areas: Life Science, Environmental Education, Art, Biology, Language Arts

Objectives

The students will demonstrate their understanding of wetland plant adaptations by "creating" a wetland plant for a specific habitat.

Methods

Students use art and recycled materials to make plants that have adaptations for a certain habitat.

Teacher Background

If this activity is not being used following Activities 1 or 2 under this topic, go back and read the teacher's background for each of these activities.

Materials

a variety of art and recycled materials (Styrofoam, popsicle sticks, toothpicks, pipe cleaners, foil, yarn, toilet paper tubes, egg cartons, paper cups, clay, etc.); Habitat Cards (make as describedin Procedure section)

Procedure

Discuss what kinds of adaptations a plant would need in order to survive in a wetland. How could it manage to stay upright in soggy soil? How could it get oxygen to its roots? If it grows in salty water, how could it get rid of the salt in the water? How could it survive the constant influx and outflow of tidal waters? How could it disperse its seeds? How could it obtain nutrients if the soil is nutrient-poor as in

bogs. Have students refer to their sketches or plant specimens to see if they can answer any of the above questions. Use the information in Activity 1.B .2: "Wetland Plant Adaptations" to further the discussion.

Make the habitat cards from topics below. (Write these descriptions on index cards or scraps of paper).

Habitat Cards: lives submerged in a pond
lives along a swiftly moving stream
lives in an estuary
lives along edge of a freshwater marsh
lives in a bog, must capture insects for nutrients
floats on surface of a pond

Hand out one card per student. Each student must create a plant (real or imaginary) which can survive in a particular habitat. Provide a variety of art and recycled materials for students to use. Have students share their creations and explain, either orally or on paper, how the adaptations enable the plant to survive in the habitat described on the student's card.

Grade Level Variations

K-2: Have students observe and do rubbings/sketches/leaf printings of some freshwater marsh and upland plants. Help them classify the plants into two groups: "Ones that often grow in a cattail marsh," and "ones that usually grow on drier land. "Have each student choose one of the following framed sentences to write and illustrate : "In a cattail marsh, you can often find _____."; or "In a cattail marsh you will seldom find _____." Bind pages into a class book and have students practice reading it.

9-12: Have students make collections of plants found on the plant cards to create a field guide. They may press them and mount them with clear contact paper or laminate them (see Appendix I, Field Study Tools, for how to make a plant press.) Have students learn the scientific names of plants and the five categories ranging from "obligate wetland" to "upland." Refer to Activity I.B.l., "Venn Diagram and Wall Display."

Obligate Wetland: plant occurs over 99% of time in wetlands
Facultative-Wet: plant occurs 67-99% of time in wetlands
Facultative: plant occurs 34-66% of time in wetlands
Facultative-Upland: plant occurs l-33% of time in wetlands
Upland: plant occurs less than 1% of time in wetlands

Extensions

Read the folk tale, "Why Crayfish Has Eyes on Stalks," from Wetland Tales (see Appendix A), and have students write a similar tale which substitutes a different type of wetland with other plants along the slope from wetland to upland. They may also want to change the main character to some other wetland animal.

Perform an experiment in which pairs of small, identical, potted plants are treated exactly the same except that one member of the pair is immersed in water up to the soil line and one member is watered and allowed to drain normally. (Use some native plants like ferns, buttercup, and horsetails, and some ornamentals like pansies and marigolds.) Predict outcomes. Measure and graph growth each week. Compare after one month and draw conclusions about which plants like to live in "water-logged" soil and thus may be hydrophytes.

Evaluation

For a simple evaluation, judge how well the students explained their plants' adaptations for the particular habitat.

For a more comprehensive evaluation, divide the class into groups of four. The task for each group is to create a four-part mural (or four posters) depicting a freshwater marsh, a freshwater swamp, a saltmarsh/ estuary, and a bog. The mural must depict the plants and animals of each habitat, with appropriate labels and "bullets" of information (such as a description of hydric soils). Teams may divide up the work any way they wish and may use the plant and animal cards from Appendix G and H as well as other resource books. Magazines and art supplies should be made available.

Have each team present their project to the rest of the class.

Related Activities

Related Activities: "Plant Press," Field Study Tools, Appendix I; "Venn Diagram & Wall Display," Unit I, Topic B, Activity 1; "Wetland Plant Adaptations," Unit I, Topic B, Activity 2

Resources

Resources: Pond Life, a field guide; Wetland Plant Guide, King County Cooperative Extension Service; Adopting-a-Wetland, Adopt-a-Stream Foundation, University of Washington Press; all listed in Appendix A

Topic C: Frogs in Washington's Wetlands

Activity 1: Classroom Frogs

Grade Level: 3-8; with variations for K-2 and 9- 12
Time range: 3-4 months in the spring
Setting: indoors
Subject Areas: Life Science, Environmental Education, Language Arts, Biology
Vocabulary: habitat, spawn

Objectives

Students will understand how to provide a healthy habitat in an aquarium to meet the food, shelter, and water needs of frogs.

Students will be able to identify some of the frogs that live in Washington wetlands.

Met hods

Students will discuss the needs of frogs, how a wetland habitat provides for those needs, and how to simulate that habitat in a classroom aquarium. The class will set up an aquarium, care for eggs, tadpoles, and frogs, and release grown frogs to their natural home.

Teacher Background

All wildlife need food, shelter, and water. Living things are adapted to habitats which provide for these needs. Frogs and other amphibians are adapted to living both in aquatic and terrestrial environments. They respond to the health of either habitat. In addition, their skin is water and air permeable, making them unusually sensitive to both water and air borne pollutants. (Refer to "Where Have All the Frogs Gone?," Unit III, Topic E, Activity 1.) Raising frogs from eggs is an excellent opportunity to learn, first-hand, about the amazing life cycle of frogs and how a healthy environment is critical to their survival.

"About 360 million years ago, amphibians evolved from fishes, becoming the first group of vertebrates adapted to life on land... Roughly 345 million years ago, reptiles evolved from amphibians, and eventually birds and mammals evolved from reptiles.

The name amphibian, meaning 'double life,' is derived from the habits of some amphibians which spend part of the year on land but return to ponds and lakes each year to breed. The name also reflects the transformation of aquatic larvae into terrestrial salamanders and frogs...Some species (however) spend their entire lives in water and do not metamorphose into a terrestrial form. Others lay their eggs on land and lack a free-living aquatic larval stage." [1]

All frogs in the Pacific Northwest lay their eggs in the water. Red-legged frogs typically lay 750 to 1,300 large eggs in irregular grape-like clusters. Pacific Treefrogs lay about 400 small eggs in small loose clusters. Bullfrogs deposit eggs in a film approximately 2 feet (61 cm) in diameter which attaches to underlying vegetation before hatching.

Bullfrogs, native to eastern and midwestern United States and south eastern Canada, are an introduced species in Washington. Some scientists believe predation by Bullfrogs is largely responsible for the disappearance of the Spotted Frog from the Puget Sound lowlands. They may also be responsible for the decline in population of the Western Pond Turtle, Northern Leopard Frogs and waterfowl. Never release Bullfrogs into the wild! [1]

Resources

1. William P. Leonard, et al., Amphibians of Washington and Oregon 1993 Seattle (Seattle Audubon Society, 8028 35th Ave NE, Seattle, WA 98115; 206-523-4483), 6.

Notes

Before undertaking this activity, submit the "Application for the Release of Wildlife" to the WA Department of Fish & Wildlife. (Application included at the end of this activity.)

Materials

aquarium (or bowl) with a clear cover
pond water, (or rainwater, or tap water that has been allowed to stand, uncovered, for several days, in order to release the chlorine gas)
gravel and stones
food: cooked lettuce or spinach, hard-boiled eggs; later, lean meat
Application for Release of Wildlife
Animal cards of Washington Frogs (See Appendix H)
"Fascinating Frog Facts" (in this activity)
Frog eggs (if ordered from a scientific supplier, specify a species native to your area; do not order Bullfrog eggs!)

Procedure

First, submit the application for the release of wildlife to the WA Department of Fish & Wildlife. Advanced students can assist with filling out the application and discuss reasons for this procedure.

Explain that the students will care for frogs in the classroom so they may make first-hand observations about a wetland animal. The frogs will only be "visiting," since their real home is in the wild, but while they're in the classroom, they need to live in a safe, healthy environment.

Discuss what a frog needs in order to survive. List students' responses on the board. When finished, have them group their responses into three categories: food, water, and shelter. Explain that any habitat must be able to provide these three things. Discuss how a freshwater wetland provides such a good habitat for a frog. Using the animal cards, identify some of Washington's frogs and toads and add their pictures to the wetland murals created in previous activities.

Discuss how you could simulate a wetland habitat in the classroom. What might be some problems? What might be solutions to those problems? Decide what steps to take and who will be responsible for setting up an aquarium and caring for your visiting frogs. Create a schedule and checklist that lists tasks and person responsible.

Carefully collect frog eggs from a nearby wetland in early spring (February-April) as soon as you notice them. Take only six to ten eggs and do not mix them with other kinds of egg masses (which might be toad or salamander spawn). Over-crowding is the principal cause of tadpole mortality. Seattle Audubon Society's book, Amphibians of Washington and Oregon (see Appendix A) can be used toidentify egg mass species.

Thoroughly rinse the aquarium (no soap), and fill it l/3 full with pond water. Gravel and wetland plants may be added for aesthetics. Add the frog eggs and change the water every 2-3 days. When changing water keep 25% of the water in the container and avoid water temperature differences of more than 5° C. Keep the aquarium cool and out of direct sunlight. Keeping the aquarium outside or refrigerated until the tadpoles emerge is preferable. If water becomes cloudy, aerate it with a small aquarium air stone which can be purchased at a pet store or borrowed from a student.

You may also want to add wetland pond soil. This introduces larval forms of insects which prey on frog eggs and tadpoles for a more natural cycle.

Tadpoles should hatch in less than a week. Discard any eggs that did not develop, or turned gray or white. Tadpoles eat mostly plants, so feed them tiny bits of cooked lettuce or spinach and bits of hard-boiled egg. Do not overfeed them. Do not allow food to stay in the aquarium more than 2-3 hours. Once tadpoles have hatched, change the water weekly to avoid a build-up of nitrogen waste.

Once their back legs begin to develop (8 weeks), they need to eat meat. Live water fleas and mosquito larvae are best, but tiny bits of lean meat (or dog or cat food) will do as well. Again, do not allow food to stay in aquarium more than 2-3 hours.

As their tails shrink, they lose their gills and begin to breathe air (14 weeks). Soon, the froglets will want to crawl out of the water. Place small stones or small pieces of wood that float in the aquarium for them to climb on. Cover the aquarium because they will soon be able to leap. To make sure that air flows freely, use mesh or screen as a cover.

At this stage, frogs will be better off in their natural habitat where they can find the live insects they need for survival. Return them to their original home. Try not to handle the frogs, as doing so removes their protective mucous layer. A small group of students could be assigned to each frog. As a group they should decide where in the original pond they will release the frog based on its habitat needs.

Students may keep a daily journal, or "wetland watch," to record observations. Activities related to learning about the frog's life cycle are presented in Unit II, Topic D, Activity 4.

Grade Level Variations

K-3: Write a group story about setting up the aquarium and caring for frogs.

Interpret wordless frog stories by Mercer Mayer and have students practice re-telling them or create class books x-e-telling the stories. A list of book titles follows:

A Boy, a Dog, and a Frog
Frog, Where are You?
A Boy, a Dog, A Frog, and a Friend
Frog on His Own
all by Mercer Mayer, Dial Press, N. Y.

9-12: Carry out one or more of the following experiments.

See if temperature has an effect on developing frogs. Keep one batch of spawn indoors (below 20 °C), and another outside, but protected from wind and predators. (The indoor batch should develop faster.)

Iodine is important for the production of the hormones that stimulate metamorphosis. Add a few drops of iodine to one batch of tadpoles and see what difference it makes. (The batch with the iodine should metamorphose faster.)

Test the quality of the water, what changes occur? (pH should be 7.2 for optimum development; does dissolved oxygen change?)

Extensions

Add photos or illustrations to the daily log of observations. Students could use a "Zapshot" camera to record images on computer disk and create an animated HyperCard ® stack.

Discuss the reason for the "Application for the Release of Wildlife." Why do students think it is necessary to monitor this? What are the dangers of releasing wildlife? Invite a wildlife biologist from the Washington Department of Fish & Wildlife or local county planning department to talk with your students about this and other issues.

Evaluation

Have students write a short description of the aquarium from the frogs' point of view (a first-person account of how the frogs view their temporary home, how the aquarium meets their needs, and what is lacking).

Related Activities

"Where Have All the Frogs Gone," Unit III, Topic E, Activity 1; "Frogs Leap, Toads Hop," Unit II, Topic D, Activity 4

Resources

"Critters in the Classroom," Instructional Fair; listed in Appendix A

Fascinating Frog Facts

. A female bullfrog can lay 50,000 eggs in one season.

. Indians in South America use the poison from the poison dart frogs on the tips of their darts when blowgun hunting.

. Some frogs are camouflaged to look like leaves (Asian homed frog), some to look like bird droppings. Most are camouflaged to look dark from above (to blend in with the dark water), and light from below (to match the sky).

. Flying frogs can glide between trees using their webbed feet as wings.

. Stomach brooding frogs raise tadpoles in their stomach. They are able to stop their stomach from making gastric juices that could digest the tadpoles. Scientists are studying how they do this, because if we could do the same, we might be able to prevent our gastric juices from eating away at stomach sores called ulcers.

. Special chemicals in frog skin help keep away infections; these chemicals may someday be used to heal our sores.

. World War II Navy divers became underwater spies. They wore SCUBA gear and flippers like a frog's webbed feet... and were called "frogmen."

. Frogs can leap forty times their length, can snag their food with a sticky tongue, swim with built-in "goggles," and grip tree trunks with their toes. Imagine!

. Some frogs can jump 20 feet (6 meters) in 3 jumps.

. Frogs don't have ribs or a diaphragm like humans. We breathe by flexing our diaphragm and pulling air in. Frogs "negative-pressure" breathe. They take in a mouthful of air and force the air into their lungs by pushing down with the floor of their mouth (throat). Try it!

. Frogs can "breathe" through their skin. When they are cold or hibernating, they stop using their lungs for breathing and absorb oxygen through their skin.

. Frogs usually don't see something unless it is moving.

. To ward off enemies, some frogs taste bad or have poison skin.

Washington State Department of Fish and Wildlife

Application for Release of Wildlife

Send this form to Department of Fish and Wildlife, Habitat Division, 600 Capitol Way N., Olympia, WA 98501-1091, FAX 902-2946.

Name: _____

Address: _____

Phone Number: _____

Date of Application: _____

Species and Number Requested for Release: _____

_____

County of Release: _____

Local Description of Release Site: _____

_____

The following guidelines will be used for assessing wildlife and habitat impacts. Questions regarding applicability of policy to genetic variations will be under the appropriate Division's preview.

A. Disturbance of the ecosystem
Any animal species, subspecies, or hybrid proposed for first-time release into the wild in Washington must not adversely affect wildlife, classified food fish, shellfish, or their respective habitats.

B. Available habitat
Before the first-time release into the wild of any animal species, subspecies, or hybrid into an area in Washington in which it did not previously exist, an assessment must show that there is suitable habitat available.

C. Reintroduction of native wildlife
If a pre-release assessment of a habitat in Washington prior to first-time release of any animal species, subspecies, or hybrid shows that there is suitable habitat, that habitat must first be considered for reintroduction of native wildlife.

D. Disease or parasites
An assessment must show the steps that have been and/or will be taken to assure that any animal species, subspecies, or hybrid for first-time release into a habitat in Washington is free of pathogens. In addition, the Commission or Director (depending on whether the animal species, subspecies, or hybrid proposed for introduction already exists in Washington State or not) may require the applicant to quarantine the animal for the length of at least one complete life cycle of applicable pathogen(s).

E. Evaluation and monitoring
An assessment must outline a plan for evaluating the impact a first-time release of any animal species, subspecies, or hybrid has upon previously existing wildlife and/or wildlife habitat.

F. Sociological and political considerations
The Wildlife Commission or Department of Wildlife must affirm that a first-time release of any animal species, subspecies, or hybrid into the wild in Washington is in the best interest of Washington residents. A pre-release assessment must include solicitation of input from appropriate public and private entities and the general public.

FOR DEPARTMENT USE

Region: _____

Approved: _____

Denied: _____

Comments: _____

_____

_____

_____

By: _____

Date: _____

Topic D: **Washington's Wetlands: Where are they?**

Activity **1: Watershed Model**

Grade Level: 3-8; with variations for K-2 and 9- 12
Time range: 30 minutes
Setting: indoors
Subject Areas: Earth Science, Environmental Education
Vocabulary: watershed, non-point pollution

Objectives

Students will understand the concept of a watershed.

Methods

Students will observe a watershed model.

Teacher Background

Wetlands are a part of the total picture of water's journey over the surface of the land and throughout the ground, and eventually to the ocean. It is critical that students understand the connection between a wetland and the rest of the watershed. The watershed is the entire land area drained by a stream or river.

Materials

Large, light-colored plastic trash bag; 2' x 3' board; spray bottle; towel; newspaper; colored drink mix crystals

Procedure

Create a simple watershed model by draping a large, plastic trash bag over some crumpled newspaper "mountains" on a slightly slanting board. (The mountains should be at the top of the board and down along the sides, forming a "valley" in the center. Allow the plastic to extend off the lower end of the board where it is flat. Place a rolled-up towel in a U-shape at this end of the model.) Use a spray bottle to make it "rain" in the mountains. Have students observe how precipitation collects in low spots in the mountains, forming lakes when "deep" and swamps or bogs when shallow. Also observe how water eventually flows down into the valley, again collecting in certain areas to form "marshes." You may need to adjust the plastic in places to help make a river channel that eventually flows to the "sea."

Explain that a watershed is all the land that drains to the same place (in thiscase, the “bay” at the end of the board). Discuss wheredifferent types of wetlands would likely be found in a watershed. Where would a saltmarsh/estuary be located? (In this model it would be the “bay” that forms in front of the towel.) Discuss how this model is the same and different from a real watershed. (This model obviously doesn’t show ground water activity.)

Discuss where people would likely live in a watershed and why. What activities would people do to make a living or for recreation? How would these activities impact wetlands? (Would farmers desiring the flat land along the river want to drain the marshes or dike the rivers? Would industries want to dredge the estuary to create deeper ports for commerce?)

Sprinkle some colored drink mix crystals in the mountains or other upper sections of the watershed. Spray water onto the landscape again and watch the crystals dissolve and eventually color the streams and even the bay. Discuss how pollution on the land (pesticides, oil from cars, soaps) washes into streams (sometimes through storm drains) and is carried throughout the watershed. Identify sources of non-point pollution in your watershed. (Examples may include animal waste on farm fields, lawn fertilizers and pesticides, oil and gas leaking from cars, and leaking septic systems.)

Grade Level Variations

K-2: Younger students will need simplified descriptions and less information. They will enjoy making the rain.

9-12: Use topographic maps as a guide to building scale models of the watershed. Students can do reports on non-point pollution in their watershed.

Extensions

1. Use a white plastic bag to form the land surface of the watershed. Before spraying "ram," draw in where your school would be located, along with other land uses in the watershed such as a town, residential development, farm lands, parking lots, malls, etc. When placing colored drink mix crystals, specify what type of non-point source pollutant they represent.

2. Scale models of the watershed can be built using topographic maps as a guide. They can be assembled using cardboard layers, clay or other materials. A video tape of this process called "No Water, No Life" may be borrowed from your E.S.D. library.

Evaluation

Students write aparagraph describing water's journey from the upper regions of the watershed to the receiving water body.

Resources

" No Water, No Life" video tape from Learning to Live with Your Environment series, listed in appendix A

Topic D: **Washington's Wetlands: Where are They?**
Activity 2: **Mapping Washington's Wetlands**

Grade Level: 3-8; with variations for K-2 and 9-12
Time Range: 60 minutes
Setting: indoors
Subject Areas: Geography, Environmental Education, Language Arts, History, Social Studies
Vocabulary: topographic map

Objectives

Students will become familiar with some of Washington's major wetlands and the wetlands found near their own communities.

Methods

Students will use maps of Washington State to locate wetlands.

Teacher Background

Washington is divided into the following five geographical regions. Each of these regions has distinctive wetlands, some large and well-known, and many, smaller ones which may appear on local city and county maps.

The Coastal Region includes low hills which typically experience mild temperatures and plenty of fog and rain (up to 200"/year). This region includes the Olympic Mountains which receive some of the precipitation in the form of snow.

The Puget Sound Lowlands surround the Puget Sound and extend south to Oregon. This region is made up of hills and flat valleys, many of which provide excellent farmland. The Puget Sound Lowlands also have a mild climate and plenty of rain, but not as much as the coast (up to 70" per year).

The Cascade Mountains run north and south, forming a natural barrier which limits the amount of precipitation that reaches the east side of the state. These mountains include a string of active and dormant volcanoes, the highest of which is Mt. Rainier, at 14,411 feet.

The Okanogan Highlands cross the northern end of eastern Washington and are more like the Rocky Mountains, geologically, than the volcanic Cascades. This region experiences greater temperature extremes than the west side and much less precipitation (20" per year).

The Columbia Plateau is a high, dry, basalt basin drained by the Columbia River. The area includes the Grand Coulee and the Channeled Scablands, lands cut by ancient floods. Like the Okanogan Highlands, it has very hot summers and very cold winters, and has the least amount of precipitation of all five regions (10-15" per year).

Materials

Map of Washington State with five regions outlined (transparency + student copies), large sheets of paper, marking pens, maps showing wetland locations and topographical contours, available from local or state government agencies or commercial sources (refer to "Resources" and Appendix A for more information)

Procedure

Explain that there are many watersheds in Washington, some with many wetlands and some with only a few. Using a transparency of the map of Washington provided in this curriculum, discuss the five geographical regions of the state. (See background information.)

Assign students to regional teams (Coastal Region team, Puget Sound Lowland team, etc.). Provide each group with commercial or government maps of their assigned region. Using your transparency to project the Washington State map on the wall, have student teams trace the outline of their region onto large sheets of paper.

Explain various map features and legend symbols that will be useful. For example, maps in the *Washington Atlas and Gazeteer* have symbols denoting marshes, land subject to inundation, and intermittent water. There are also symbols denoting sites for fishing, hunting, boating, canoeing, wildlife, and beaches.

Have students study and read the information on their maps so they become the "experts." Have students transfer wetland information onto their large regional maps. Their task is to find out as much as they can about the wetlands in their region.

Pass out copies of the Washington State map with the five regions outlined. Have students report in teams by regions. Ask the "regional experts" to name the major wetlands in their region and have them share any other information about those wetlands. If someone has visited these wetlands, ask him/her to describe them. Ask all students to record the information presented to them onto their smaller maps of Washington State.

When finished, ask students if they see any patterns. Are there any generalizations you can make about the major wetlands found in each geographical region of Washington? (Possible answers include: they are found in depressions or low-lying area within the watersheds; they are associated with shores of rivers, lakes, and bays.)

Grade Level Variations

K-3: If there is a wetland on or near your school, observe that it is in a low spot. Together, create a map of the school yard or neighborhood, showing key features and the location of the wetland. Find your wetlands on a commercial or government map. Ask your principal or head custodian for a copy of the site map of the school for reference.

9-12: Teach students how to read a topographic map. Have them create 3-dimensional models by layering cardboard cut into shapes according to the lines on a topographic map. Each layer of cardboard represents a different level of elevation. Refer to the videotape "No Water, No Life" (see Appendix A) for a demonstration of making a 3-dimensional watershed model.

Extensions

Use city and county maps to locate wetlands near you. Plan a trip to each of the different types of wetlands.

Study a topographic map of your area. Have students place pins at the highest points on the map and connect the pins with yarn. The yarn configuration will represent the boundary of a watershed. Have them locate wetlands in the watershed. Refer to the "No Water, No Life" videotape to learn how to identify your watershed on a map.

Make a classroom model of your watershed. Ask your county for a map of your watershed and a map showing elevations. Use clay, paper-mâché, or wet sand to build your model. Have students add stores, schools, marinas, farms, etc. and the location of your local wetlands. Refer to the videotape "No Water, No Life" for a demonstration of making a 3-dimensional watershed model.

Evaluations

Evaluate the quality of regional presentations. Collect all students' small Washington State maps, and evaluate learning based on information recorded.

Resources

Wetland Walks, Dept. of Ecology publication;
"No Water, No Life " videotape from Learning to Live With Your Environment series; all listed in Appendix A

Maps can be obtained from a variety of sources. See Appendix A for ordering information for National Wetlands Inventory maps. Your county or city may be able to provide maps for a nominal fee. Or, you may use commercial maps. Maps for outdoor recreation often have information on wetlands. The *Washington Atlas and Gazeteer* by DeLorme has the entire state on 119 pages of easy to read maps. It is available at many local stores or from DeLorme Mapping, PO Box 298, Freeport, Maine, 04032; (207) 865-4171.

Washington State Regions