Unit II: Amazing Wetlands: Functions and Values

Introduction

So, what's all the fuss about? Why are wetlands critical habitats? In this unit, the many roles that wetlands play will be explored. Wetland functions include many that are of importance to people, including flood control, ground water recharge, water filtration and purification, erosion control, recreation, education and research. They also have many functions that make themimportant to wildlife and the ecosystems connected to them.

The functions that an individual wetland performs depends on its location, surrounding topography, sub-surface geology, hydrology, and the types of plants present. While each wetland may not perform all functions, the cumulative value of all the wetlands in a watershed makes each important.

Topic A: **Why Wetlands Matter**

Activity **1: Wetland Metaphors**

Adapted from: *Project WILD Aquatic,* Western Regional Environmental Education Council, 1989

Grade Level: 3-12
Time Range: 60 minutes
Setting: indoors
Subject Area: Language Arts, Environmental Education, English, Science
Vocabulary: metaphor, simile

Objectives

Students will be introduced to the idea that wetlands are valuable because they serve a number of functions to wildlife and humans.

Students will practice the use of metaphors as a way of representing wetland functions.

Method

Students will view a film and play a game involving wetland metaphors which illustrate the value of wetlands.

Teacher Background

Wetlands perform a number of natural functions of great benefit to people. The functions depend on the wetlands location, surrounding topography, sub-surface geology, hydrology, and the types of plants present. While each wetland may not perform all functions, the cumulative value of all the wetlands in a watershed makes each important. The major functions of wetlands are as follows: (1) flood control; (2) ground water recharge; (3) water filtration and purification; (4) wildlife habitat; (5) shoreline anchoring and erosion control; (6) recreation; and (7) education and research.

(For a more in-depth discussion of functions #l-4, see Unit II, Topic B, Activities l-3, "Water, Water Everywhere.")

Shoreline anchoring: The substrates (sand, rocks and soil) of shorelines and stream banks are subject to erosion. Wetland vegetation reduces erosion primarily by damping and absorbing wave and current energy, and by binding and stabilizing the soil with roots.

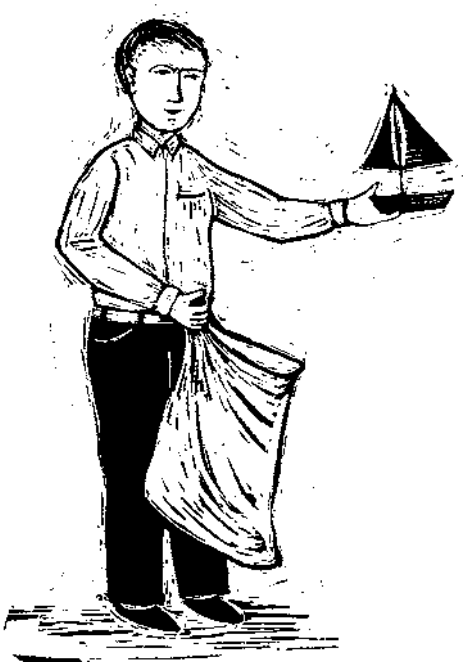
Recreation: Wetlands are of great value for human recreation. They provide opportunities for many activities, including hunting, fishing, bird-watching, photography, and kayaking. With these intrinsic benefits of recreation come economic benefits. In 1980, the U.S. Fish and Wildlife Service estimated that Americans spent nearly $15 billion on observing and photographing fish and wildlife.

Education and Research: Wetlands provide many opportunities for scientific research and serve as "living classrooms," ideal for teaching a range of ecological concepts. With physical, biological, and hydrological cycles constantly in action, wetlands are excellent sites for research and education in ecology, hydrology, botany, ornithology, and other scientific pursuits.

Materials

sponge, pillow, egg beater, cradle, strainer or filter, can of soup, toy boat, shin-guard (or a door-stop or goggles), book; Video: "Fabulous Wetlands"

Procedure



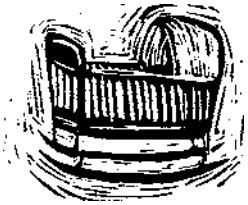
View the video "Fabulous Wetlands." Discuss what information was a review for students and what information was new. You may want to view the film again (it's very fast-paced) and discuss what additional information students gained the second time.

Bring out a bag containing the objects listed under "materials." Explain that a metaphor is a comparison between two things, and give examples:
"The moon is a lantern in the sky." "The flowers are a rainbow." "A tree beside your house is an air conditioner." Take one object at a time out of the bag and have students explain or you make a metaphor statement for each object. Then, have students explain the relationship behind each metaphor statement. Following are some examples and likely explanations:

Metaphor	Explanation
A wetland is a sponge.	Wetlands soak up water and prevent flooding.
A wetland is a pillow.	It's a resting place for migrating birds and salmon.
A wetland is an egg beater.	Salt water and fresh water get "mixed" in some wetlands.
A wetland is a cradle.	Many plants and animals use wetlands for nurseries.
A wetland is a strainer.	Plants filter out sediments and pollution.
A wetland is a can of soup.	Wetlands provides food for wildlife and humans.
A wetland is a boat.	Wetlands provide recreational opportunities.
A wetland is a shin-guard.	Wetlands protect shorelines from erosion.
A wetland is a book.	People can learn a lot from wetlands.

Have students work in groups or pairs to brainstorm more metaphors. Encourage them to look around the room or think of everyday objects. "A wetland is a pair of sunglasses" (both provide shade and cooling). "A wetland is a dollar bill" (both are valuable).
Have groups share their metaphors with the rest of the class. Have the class try to provide an explanation of the relationship.

Note: Be clear in your use of metaphors. Be careful not to confuse metaphors with similes. Similes use the word like; i.e. "A wetland is like a sponge because it stores water."



Extension

Have each student create a page for a class book, with each page illustrating a different wetland metaphor. Share the book with other classes or have students rotate taking the book home to read to parents.

Evaluation

Have students explain wetland metaphors such as: "A wetland is a sponge."

Resources

"Fabulous Wetlands," video tape: Project WILD Aquatic activity guide listed in Appendix A

Topic B: **Water, Water, Everywhere**

Activity 1: **Flooding and The "Giant Sponge" Effect**

Grade Level: 3-12, with variations for K-2
Time Range: 60 minutes
Setting: indoors
Subject Areas: Mathematics, Environmental Education, Science, Earth Science
Vocabulary: sphagnum moss, hydrology, aquifer, evapotranspiration, recharge

Objective

Students will understand that wetlands are valuable because they reduce flooding in a watershed.

Method

Students will conduct an experiment to demonstrate the water retention properties of wetlands.

Teacher Background

Hydrology: Wetlands play an important role in our watersheds by storing water, controlling floods, and recharging and discharging ground water. Wetlands are "giant sponges," collecting, holding, and then gradually releasing water through recharge to the aquifer (ground water); gradual discharge to creeks and rivers, which helps to maintain stream flow; and evapotranspiration (evaporation + water loss by transpiring plants). The "giant sponge" effect of wetlands is most important during floods. The wetlands along a river slow and store flood waters and reduce flooding downstream. In the United States, destruction from floods annually costs $3-4 billion. Loss of wetlands in the flood plain of a river has important economic consequences.

In appendix E there are two articles that explain how wetlands are used to treat water: "The Waste Chase" and "Nothing Goes to Waste in Arcata's Teeming Marshes."

Materials

kitchen sieve or strainer; cheesecloth (or loosely woven material like burlap); large bowl; a scale, to weigh in grams or ounces; sphagnum moss; sod; sand; gravel; data sheet

Procedure

Ask students for their ideas on how wetlands help prevent flooding. Explain that the following experiment will help them understand this phenomenon. Follow these steps:

1) Weigh out an equal sample of each of four materials: sphagnum moss, sod, sand, gravel. Each of the four samples should weigh about the same.

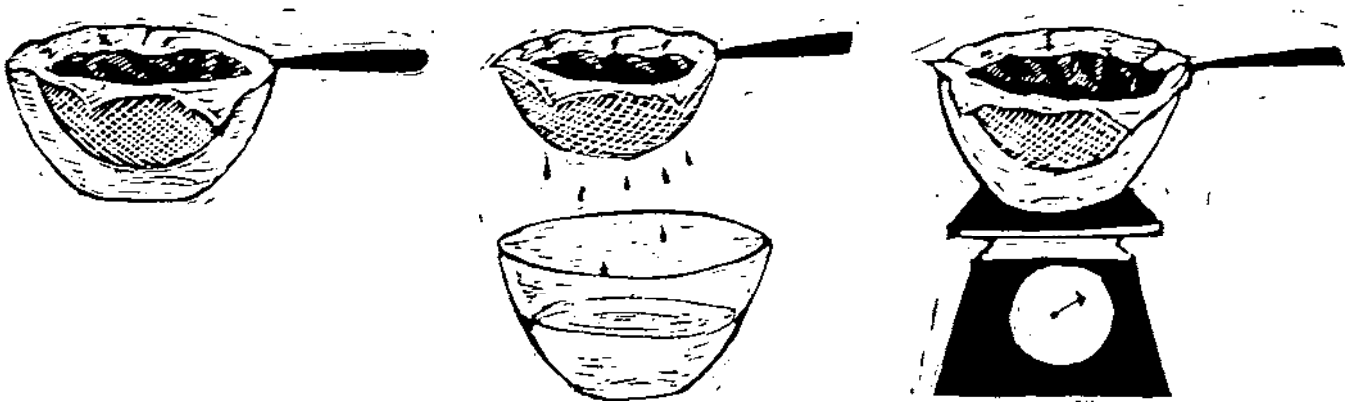
2) Put the cheesecloth (or loosely woven cloth), sieve, and bowl together to make a "Soaker Tester" (see diagram).

3) Weigh it empty and record the weight.

4) Place the sample of sphagnum moss into the soaker tester and weigh the whole thing. Record the weight on the data sheet.

5) Add water to the bowl until it is nearly full. Let the soaker tester and moss sit in the water for five minutes.

6) Take the sieve out of the bowl and allow it to drain until there is only a slow dripping. (Notice and record how long it takes each material to arrive at this stage of slow dripping.) Do not squeeze any water from the moss or sieve.



7) When the sieve has reached a slow drip stage, pour the water out of the bowl.

8) Put the sieve back in the bowl.

9) Weigh the soaker tester and moss again. Record this weight on the data sheet. Subtract the starting weight of the soak tester to get the weight of the soaked sample alone. Record this as wet weight B.

10) Repeat steps 3-6 using each of the other materials (sand, sod, gravel).

11) Find out how much water each material held by subtracting the dry weight "A" from the wet weight "B. " Record the weight of the water in column "C."
(Soaked sample weight - dry sample weight = weight of water.)

12) Have students organize and display results in a way that enhances their understanding (such as a bar graph) comparing dry weight with wet weight for each material.

Ask the following questions:
a. Which materials hold water best?
b. Which material would most likely be found in a wetland? (sphagnum moss & sod)
c. How do wetlands help to prevent flooding?
d. Why do you think having wetlands along a river or stream help to keep that stream flowing in the summer? (The river is constantly "recharged" by water that is slowly released from wetlands, much like the moss kept releasing water slowly for a long time.)

Grade Level Variations

K-2: Older students or parent helpers can assist younger students in the construction of their "Soaker Tester."

Evaluation

Evaluate students' data organization and answers to questions under procedures.

Related Activities

"Wetland Model: Sediment Filtering," Unit II, Topic B, Activity 3

Wet Land in the Wetlands

Data Work Sheet

Material	A. Weight of Soaker Tester (dry)	B. Weight of Soaker Tester (wet)*	C. Weight of Soaker Water (B-A)
Sphagnum Moss			
Peat Moss			
Sod			
Sand			
Rock			

*** Keep Soaker Tester in water for 5 minutes.**

Topic B: **Water, Water, Everywhere**

Activity **2: Treatment Plants**

Grade Level: 3-8, with variations for K-2 and 9-12
Time Range: 15 minutes one day and 15 minutes the following day
Setting: indoors
Subject Areas: Environmental Education, Life Science, Biology
Vocabulary: stomata

Objectives

Students will understand that wetlands are valuable because they filter pollutants in a watershed.

Methods

Students will create a demonstration that illustrates the way plants purify water in wetlands.

Teacher Background

Water Quality: Wetlands help purify the water that flows through them. Sediments suspended in the water are "trapped" while passing through the wetland and settle to the bottom as the flow rate of the water decreases. Generally, the more plants in a wetland, the slower the water flows. Sediments settle to the bottom more readily in slow-flowing water. The settling of sediments is important because excessive sediment in the water can be harmful to many species of animals: smothering bottom-dwellers such as oysters, mussels or aquatic insects; impairing fish spawning by covering sensitive eggs; reducing visibility for sight-feeders; and lowering the level of dissolved oxygen available for aquatic organisms.

Wetland plants also remove pollutants such as excess nutrients, heavy metals, and petroleum-based hydrocarbons from the water. In some areas, artificial wetlands have been created for use in treating waste water.

In Appendix E there are two articles that explain how wetlands are used to treat water: "The Waste Chase" and "Nothing Goes to Waste in Arcata's Teeming Marshes."

Materials

celery stick, jar, food coloring

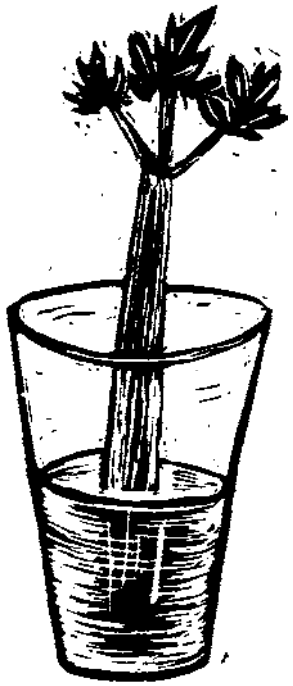
Procedure

This activity is best if spread out over two days. The first day, assemble everything. The second day observe the results and answer questions.

Each group of students prepares a solution in a jar by adding several drops of food coloring to water. Explain that food coloring represents pollution by a toxic substance (for example, a pesticide).

Ask students to imagine water flowing into a wetland with many wetland plants. Tell them that the celery stalks are like the plants of a wetland (cattails, sedges, grasses, etc.).

Cut off the bottom half inch of the celery stalks and place the stalks in the water overnight. Over time, the colored water will visibly travel up the stalks, showing how plants can absorb pollutants when they "drink." If the colored water is not visible on the outside of the stalk, break it open to see the colored water inside the plant tissue.



4. Ask students the following questions:

a. Why is the water remaining in the beaker still polluted?
Plants can only do so much. As new water (hopefully clean) flows into the system, the pollutants will be diluted and the water less polluted.

b. Where does the water go after uptake into the plant?
Transpired out through the pores (stomata) and usually evaporated.

c. What happens to the pollutants?
Stored in the plant tissue and then re-released into the environment when the plant dies.

d. Why can't we dump all of our waste water into wetlands?
Wetlands can only do so much. Too many pollutants will harm or destroy a wetland. The best solution is to reduce pollution.

Grade Level Variations

K-2: You will need to cut celery for younger students. Cut right before being placed into the water, or else the plant will lose its ability to draw water well.

9-12: Older students can research how water is transported up the plant. The plant expends no energy, but simply allows the energy of the sun and the properties of water to move water up its tissues. Imagine, 200-foot tall trees transport water to their upper leaves expending no more energy than a 2-inch blade of grass.

Evaluations

Evaluate the students learning using the questions listed under step 4 in procedures.

Resources

"The Waste Chase" and "Nothing Goes to Waste in Arcata's Teeming Marshes" printed in Appendix E

Topic B: Water, Water, Everywhere

Activity 3: Wetland Model: Sediment Filtering

Grade Level: 3-12, with variations for K-2
Time Range: 60 minutes
Setting: indoors
Subject Areas: Environmental Education, Science, Earth Science, Art
Vocabulary: recharge, impervious

Objectives

Students will understand that wetlands are valuable because they trap sediments in a watershed.

Methods

Students will make a model demonstrating how sediment is trapped in wetlands.

Teacher Background

The fate of pollutants in wetlands is unclear. In some cases, they become trapped in sediments and are either broken down into less harmful forms, taken up by plant roots, or retained in the sediments. These processes remove many pollutants from the water column. However, when plants that absorb pollutants die, or when sediments are disturbed, pollutants may be "re-activated" into the water column.

Some people refer to wetlands as our natural "water treatment facilities." Although wetlands play an important role in purifying water, excessive amounts of pollutants often exceed the wetland's ability to purify water. This overloading can result in degradation not only of the wetland, but other areas downstream in the watershed.

In Appendix E, there are two articles that explain how wetlands are used to treat water: "The Waste Chase" and "Nothing Goes to Waste in Arcata's Teeming Marshes."

Materials

large, shallow pan, modeling clay, large cellulose sponge (not plastic), natural materials (moss, twigs, tree sprigs), muddy water (use multiple numbers of supplies if done in small groups)

Procedure

Explain that students will make a model to demonstrate how wetlands help clean water in a watershed by trapping sediments. Create the model by following these steps:

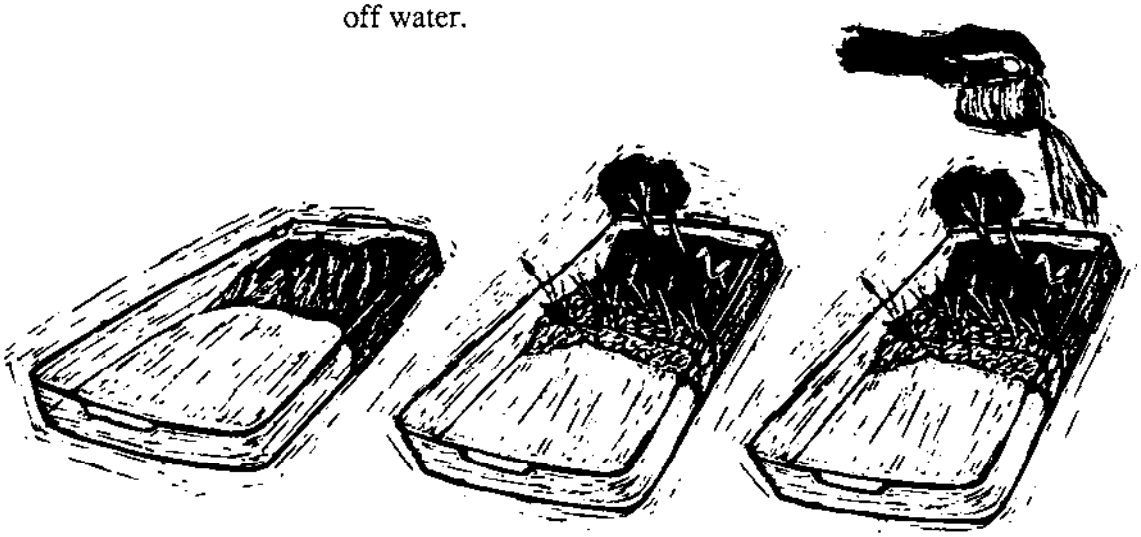
1) Spread a layer of modeling clay in half of the pan to represent land. Leave the other half of the pan empty to represent a lake or stream or ocean.

2) Shape the clay so that it slopes slightly toward the water and smooth the clay along the sides of the pan to seal the edges.

3) Cut the sponge so it will fill half the space at the end of the clay (see diagram). The sponge represents a wetland buffering the open water from pollution.

4) Add decorative touches using natural materials such as toothpicks, twigs and toy animals or cutouts to make the model look like a wetland.

5) Simulate a rain storm which produces dirty run-off water by slowly pouring muddy water onto the highest part of the clay section of the model. Observe how the wetlands trap the sediments and release much cleaner water into the stream or lake. To better simulate rain, sprinkle dirt on the clay uplands, then use spray bottle to create run-off water.



6) After completing the three hands-on activities, have students summarize what they have learned about water in a wetland. How is water retained and released and how is that beneficial? How are pollutants absorbed by plants and how do wetlands act to filter sediments out of water? What difference does this make to wildlife or people?

Grade Level Variations

K-2: Older student or parent helpers can assist groups of younger students in making models, or the whole class can make one large model.

Extensions

1) Replace the "wetlands" in the model with more clay or cover the sponge with plastic or foil to simulate concrete or blacktop, creating an impervious surface. Place houses or a shopping center on this new clay "development" and add more houses along the edge of the original clay bank. (Houses and hotels from the game Monopoly@ work well.) Repeat the simulation of dirty water run-off and observe what happens.

Remove all water from the model (use a sponge, turkey baster, syringe, eye dropper or pour out). Pour on a measured amount of clean water. See how much water it takes to cause flooding in the new development area, including the original clay bank.

Now, remove the water again and remove the impervious surface from the sponge wetland, leaving the houses along the original clay bank. Add the same measured amount of water as applied before. Did the houses get flooded this time?

2) Demonstrate how wetlands can slow the flow of water in a system by simply "being in the way" of the water. Set up an artificial wetland by placing a piece of artificial turf or doormat on a flat piece of wood set at a slight downward angle. This will represent a healthy wetland.

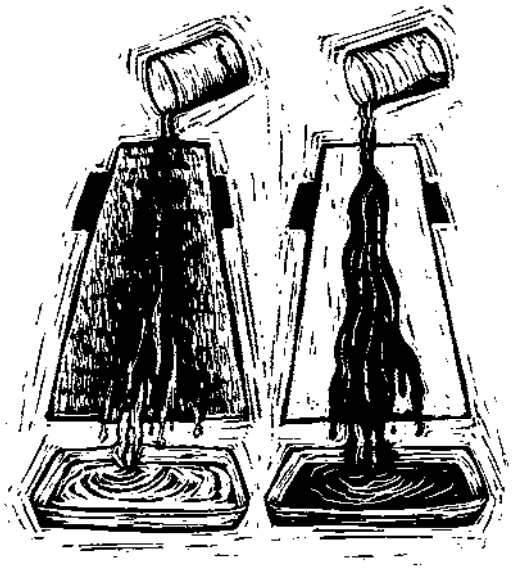
Place another flat piece of wood next to it representing an unhealthy wetland where all the vegetation has been removed. Place a pan to catch water at the bottom of both. Pour water (dirty water illustrates this concept best) simultaneously onto the high end of each. Ask students the following questions:

a. In which "wetland" does the water flow through fastest?
Unhealthy wetland

b. In which "wetland" would more sediment settle out?
Healthy wetland

c. Which "wetland" would have cleaner water flowing from it?
Healthy wetland

d. How would channeling or dredging a ditch through a wetland affect water quality downstream?
Water would flow quickly through the wetland and there would not be time for sediments to settle or be filtered by wetland plants. Water quality downstream would be degraded.



3) Investigate how artificial wetlands are being used to treat sewage and storm water.

Evaluation

Have students write a paragraph starting with this topic sentence: "I learned the following three ways that wetlands help solve water problems."

Resources

Hanging Onto Wetlands, activity guide listed in Appendix A; "The Waste Chase" and "Nothing Goes to Waste in Arcata's Teeming Marsh" printed in Appendix E

Unit II: Amazing Wetlands: Functions and Values

Topic C: Wetland Productivity

Introduction

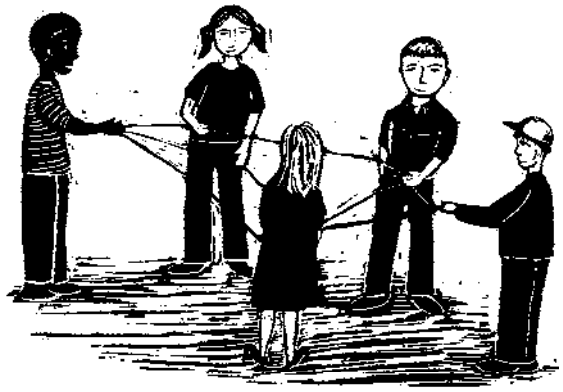
An ecosystem is more than a food web; it encompasses all the relationships between and among living and non-living things. The interactions among plants, animals, and the non-living parts of the environment (sun, air, soil/rocks, water) create an intricate web of interdependencies.

Many relationships in an ecosystem revolve around nutrient and energy cycles: The sun provides energy for green plants to make food from elements in the soil and air; plants provide food for animals; animals leave fecal droppings and eventually die and decay, returning nutrients to the soil, thus completing the cycle.

Native wetland plants provide abundant food for wildlife and humans. Some animals, like deer, elk, snails, and some waterfowl graze directly on the rich vegetation. Often, however, wetlandplants are most useful after they die and decompose. The decaying bits of plant material, called detritus, form the foundation of the food web. Studies show that detritus is the most important food material ingested by invertebrate marine life in coastal marshes.

Because wetlands are shallow, their water warms on sunny days. This warmth, along with the nutrients washed down from streams and the detritus-rich soil forms ideal growing conditions for plants. Ten acres of coastal marshes have been shown to produce ten tons of plant material, more than double the production of a similar area of intensively managed hayfields. The high productivity of plant material provides a large amount of food for animals.

Phytoplankton (microscopic plants) and detritus (resulting from the decay of marsh plants) feed millions of zooplankton (tiny, often microscopic, floating animals). Zooplankton, along with detritus, are consumed by numerous filter feeders in estuaries, including clams, barnacles, shrimps, and worms. Plankton and detritus are also washed out to sea with the tides and help fuel an entire coastal food web. Some common fish and shellfish that depend on wetlands and estuaries are shrimp, salmon, herring, flounder, crab, bass, steelhead, ling cod, red snapper, sole, oysters, and clams. Many people do not understand this connection between wetlands and the seafood we put on our tables.



Topic C: Wetland Productivity

Activity 1: Ecosystems: Discussion & Research

Grade Level : 3- 12, with variation for K-2
Time range: 90 minutes
Setting: indoors
Subject Areas: Life Science, Environmental Education, Art, Language Arts, Biology
Vocabulary: detritus, phytoplankton, zooplankton

Objectives

Students will understand that in an ecosystem there are many relationships between living and non-living things and that some of those relationships are based on **a** cycle of nutrients in the system.

Methods

Students will discuss interactions between living things and non-living things in an environment and be introduced to ecosystem concepts. They will arrange plant and animal cards to show food web relationships.

Teacher Background

Photosynthesis is the process that brings energy from the non-living world to most living things. Plants, which contain chlorophyll, trap light energy and convert it to energy stored in chemical bonds. It is this energy that producers and all consumers depend upon.

Materials

wetland murals (created in Unit I, Topic B, Activity 1: "Venn Diagram and Wall Display") or the Department of Ecology's "Washington Wetlands" poster, large index cards, wetland field guides or other resource materials (plant & animal cards from Appendix G &H)

Procedure

Explain that an ecosystem is a web of interactions between and among living and non-living things. Have students look at a mural or poster of a wetland and list all the non-living components of the environment. (Ecology's "Wetlands" poster would work well, see Appendix A). Discuss how these components interact with the plants and animals in a wetland ecosystem. The following are some interaction ideas:

- The sun provides energy for photosynthesis and warmth for living things.
- Soil provides a place for plants to root.
- Soil provides nutrients for plants. Decayed matter in the soil, "detritus," also provides food for many animals.
- Soil provides a place for animal homes.
- Water is used by all plants and animals to survive.
- Water dissolves minerals to make them available for plant uptake. Minerals are used by plants to build tissues and in body processes.
- Water is home to many fish and aquatic insects.
- Air is needed by all plants and animals.
- Moving air (wind) helps to carry seeds and pollen.
- Moving air directs the water cycle which brings rain to the land.
- Rocks provide minerals for plants.
- Rocks provide homes for animals and plants.

Discuss with students how the great productivity of wetlands causes them to be critical to many life forms.

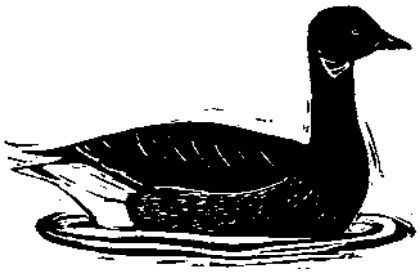
Write each of the words listed under "Living and Non-living Things in a Saltmarsh/Estuary" on large index cards (one word per card) and tape the cards to the board.

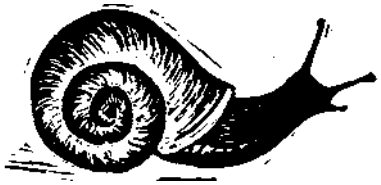
Living and Non-Living Things In a Saltmarsh / Estuary

eel grass, sea lettuce, detritus, saltmarsh grass, phytoplankton

brant goose, snail, crab, clam, mussel, worm, shrimp, mouse, zooplankton, duck, gull, sandpiper, salmon, flounder, heron, osprey, human, water, air, rock, mud, sun

There should be the same number of cards as there are students. You will need to make cards for water, air, soil and detritus and other non-living components in an ecosystem.





Have students use field guides and other resource materials to find out three things about the living organisms that are listed on the cards:

(1) What it eats (or, in the case of plants, what nourishes it);
(2) What eats it;
(3) Other connections it may have besides food web relationships (for example: marsh grass provides nesting grounds for marsh birds).

The plant and animal cards in Appendix G & H will provide much of the information needed. When a student finds a piece of information, he/she should come up to the board and record it on the appropriate index card.

Grade Level Variations

K-2: Simplify the web for younger students by reducing the number of cards. Perhaps students could work in pairs or threes. Assist them with the research needed to complete the cards by providing information or by teaming them with older students.

Extensions

Discuss how saltmarshes are among the most productive ecosystems on earth. Discuss how scientists could measure productivity. *They collect plants from a known area, dry them, and compare the dry weight of plants.*

Invite a speaker from a local planning department, wetlands consultant, or college environmental studies department to talk about wetland productivity.

Evaluation

Have students trace energy from the sun through their food web by writing a paragraph. Consider using "Food Webs and Nutrient Cycles," Unit II, Topic C, Activity 3 as a tool for evaluating this objective.

Related Activities

"Ecosystem Webbing Game," Unit II, Topic C, Activity 2; "Food Webs and Nutrient Cycles," Unit II, Topic C, Activity 3

Resources

Ecology's "Wetlands" poster listed in Appendix A; Plant Cards, Appendix G; Animal Cards, Appendix H

Topic **C: Wetland Productivity**

Activity 2: **Ecosystem Webbing Game**

Grade Level: K-12
Time range: 30 minutes
Setting: indoors
Subject Areas: Life Science, Environmental Education, Biology
Vocabulary: food web, ecosystem

Objectives

Students will understand that in an ecosystem there are many relationships between living and non-living things and that some of those relationships are based on a cycle of nutrients in the system.

Methods

Students will discuss ecological concepts and play a food-webbing game.

Materials

ball of heavy cotton string (or yarn), index cards made in Unit II, Topic C, Activity 1 or plant and animal cards from Appendices G & H

Procedure

Sit in a circle and hand each student an index card made in Activity 1. Each student needs to briefly read over the information on the card. Explain that you are going to build an "ecosystem," (a web of life showing the interconnections between and among components in a saltmarsh/estuary). Give a ball of string to the student who is the "sun." Discuss why the sun should start the web (i.e. the sun is the source of energy for plants to produce chlorophyll for their food).

The "sun" then passes the ball of string to another student, explaining what the eco-connection is between the two. (The sun will hold onto the end of the string.) Each student, in turn, passes the ball of string to another student, each time explaining the connection and holding onto the string so that a web is formed. (Note: An effort should be made to pass the ball

to students who have not yet had a turn. However, if no clear connection can be made between the student holding the ball of string and students who have not yet had a turn, the ball may be passed back to a student who has already had a turn.)

After the web is spun, have everyone take up the slack in the web by pulling tight on their strands. Ask students to tug gently on the strands to allow the community to feel the connections.

Ask what would happen if a poison entered the ecosystem and killed the phytoplankton. Trace the connections linking other strands to the phytoplankton and discuss the impact. Discuss what else might upset the relationships within the web.

Extensions

Ask students to name a specific place in their community that could represent the wetland ecosystem they have created. Have them brainstorm human and natural actions that could affect the ecosystem. Focus on one specific example such as sedimentation from cleared land. Symbolically throw a piece of cloth or a jacket over the web of strings to visually represent that pollution source. Ask which organisms would first be affected by the pollution. This will often be the phyto- and zooplankton. Ask those affected to tug on their strands. Other parts of the ecosystem that feel the tug should tug in return. Eventually everyone in the web will feel the effects of the pollution. Ask students to generate ideas on how they could reduce that specific source of pollution, such as planting vegetation to hold soil in place. Take a field trip to a local wetland. What are the sources of pollution. Have students choose one source and design an action plan to reduce the pollution.

Evaluation

Have students summarize what they have learned orally or in writing. Consider using "Food Webs and Nutrient Cycles," Unit II, Topic C, Activity 3 for evaluating this objective.

Related Activities

"Ecosystems: Discussion and Research," Unit II, Topic C, Activity 1; "Food Webs and Nutrient Cycles," Unit II, Topic C, Activity 3

Resources

"Web of Life Cards" by Fathom That Creations; Environmental Issues Analysis and Investigations by Hungerford and Volk; both listed in Appendix A

Topic C: Wetland Productivity

Activity 3: Food Webs and Nutrient Cycles

Grade Level : 3-8, with variation for K-2 and 9-12
Time range: 90 minutes
Setting: indoors
Subject Areas: Life Science, Environmental Education, Art, Biology, Language Arts
Vocabulary: producer, primary consumer, secondary consumer, tertiary consumer, nutrient cycle, decomposer, omnivore, detritivores

Objectives

Students will understand that in an ecosystem there are many relationships between living and non-living things and that some of those relationships are based on a cycle of nutrients in the system.

Methods

Students will discuss ecological concepts and construct food chain mobiles.

Teacher Background

Living organisms are grouped to reflect their level or role in the food web. The following are some general definitions for these groups.

Producers are green plants able to carry on photosynthesis using the sun's energy to produce sugar and oxygen. *(In deep ocean environments producers use chemical energy from undersea volcanic vents to produce food and oxygen.)*
Primary Consumers use producers for food; therefore they eat only plants.
Secondary Consumers use primary consumers for food. They do not eat green plants.
Omnivores use both plant and animal material for food.
Scavengers eat dead plant and animal material for their energy.
Decomposers (such as bacteria) break dead plant and animal material down into nutrients that can be reused by producers.

Materials

cards made in Activity 1 or plant and animal cards from Appendices G & H, half-gallon milk cartons covered with construction paper (one per student), glue, yam, crayons or markers

Procedure

Discuss the fact that many of the relationships in the webbing game were based on food chain relationships (something eating something else). Point out that food chains are actually part of a cycle that repeats itself over and over. This is referred to as a nutrient cycle. Have students build a saltmarsh nutrient cycle together by following these steps:

1. Using the index cards made in Activity 1, tape the four salt marsh plants in a row near the middle of the board: phytoplankton (microscopic plants), sea lettuce (algae), eelgrass, and saltmarsh grass. Label this row "producers" and explain that only green plants can produce food from inorganic materials and the sun's energy. (Refer to the sample nutrient cycle that follows #9.)

2. In a row above the producers, tape the animals that eat the plants: zooplankton (tiny, often microscopic animals) eat phytoplankton, snails eat seaweed, a brant goose eats eelgrass, and a mouse eats the seeds of marsh grasses. Draw arrows from the plants to the animals to show that the plants provide nutrients for the animals. Label this second row, "consumers." (Advanced students may use the term "primary consumers.")

3. In a third row, tape the animals that eat the animals already listed: salmon and flounder eat zooplankton, scoters eat snails, and harriers eat mice. Draw more arrows to show how the nutrients are passed on. (These animals are also consumers. Advanced students may label them "secondary consumers.")

4. Continue with a fourth row of animals ("tertiary consumers"): the heron eats flounder, the osprey eats salmon, and humans eat both. Draw more arrows.

5. Now discuss the fact that when plants and animals die, they decay, through bacterial action, which results in nutrients being returned to the soil. Point out that this decayed material is called "detritus." You can see detritus by looking closely at a handful of topsoil. Draw arrows from several plants and animals to a soil/bacteria/detritus layer at the very bottom of the board, below everything else. Label this layer "decomposers" to identify the bacteria, fungi, and other living things that help decompose dead plants and animals into soil nutrients.

6. Now discuss where to add the cards of the animals that eat detritus: clams, crabs, shrimp, barnacles, worms, mussels. Point out that most

of the animals in an estuary/salt marsh are "detritivores" (detritus-eaters). Tape up the cards in the place decided upon and draw arrows from the detritus to them (and a few arrows back to the detritus to represent the cycle). Also add an arrow from detritus to zooplankton.

7. Now add the animals that eat detritivores: gulls eat crabs andclams, sandpipers eat worms and shrimp. Add arrows. Also draw arrows from some of the detritivores to humans who eat crabs, clams, shrimp, and mussels.

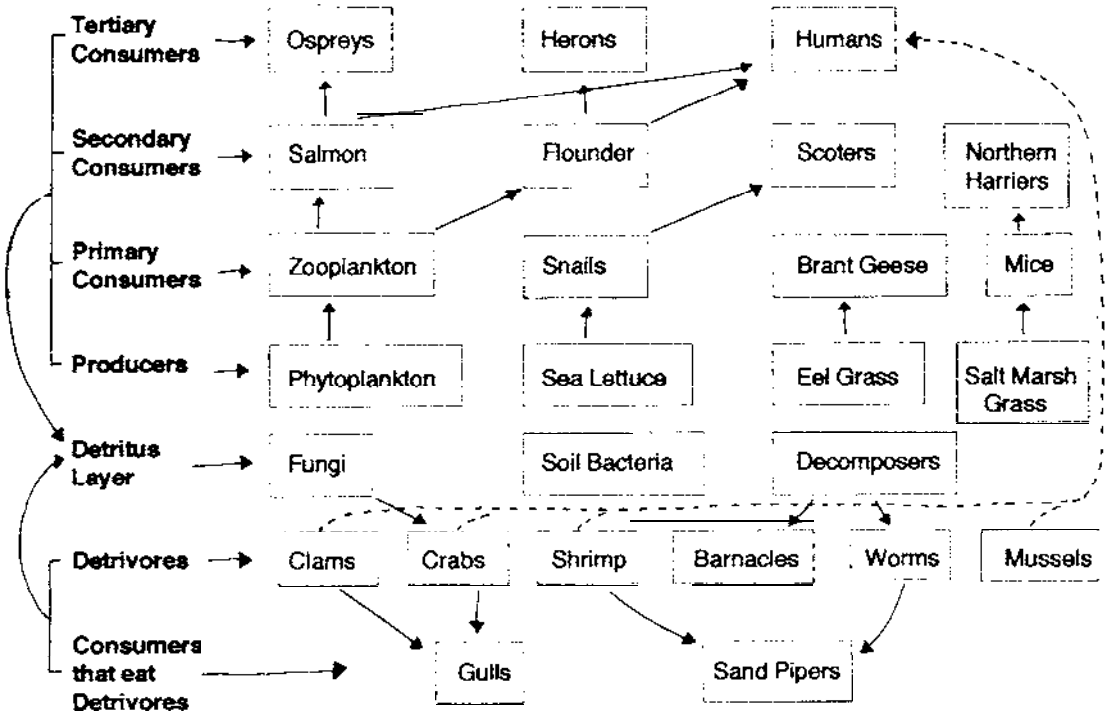
8. Have students summarize in their own words what they have learned about the cycle of nutrients. Have them illustrate the cycle by creating saltmarsh food chain mobiles as follows.

9. Have students draw/color four pictures onto the four sides of a milk carton covered with paper and hang the carton by a string. The carton revolves just as the cycle does in nature. Note: It would be easier to draw the pictures first, before covering the carton.

Suggestion for pictures:

Picture #l: Draw a "high tide" saltmarsh setting with several plants underwater. Draw bits of detritus floating in the water. Include the sun in the picture, and draw an arrow from the sun to the plants and from the plants to the detritus.

Salt Marsh Nutrient Cycle



Picture #2: Draw a picture of zooplankton eating detritus.
Picture #3: Draw a picture of a flounder eating zooplankton.
Picture #4: Draw a picture of a heron eating the flounder.

10. Have students tell the revolving story of their food chain mobiles. They should explain how nutrients cycle in a saltmarsh, with the death and decay of the heron completing the cycle when it becomes detritus.

Grade Level Variation

K-2: Younger students may benefit from visualizing the concept more through physical participation. Give each student a card with a plant or animal on it. Have students move to the front of the room with their cards as they "eat" their prey. The prey then move back to their own seat and so on up the food chain.

9-12: Older students can do advanced research on specific nutrients, such as the nitrogen cycle or the carbon cycle.

Extensions

Use small school milk cartons and create a "mega-mobile" food web from all their food chain mobiles.

Evaluation

Evaluate the students' mobiles and stories. Listen to their presentations in step 10 in the Procedures.

Related Activities

"Ecosystems: Discussion and Research," Unit II, Topic C, Activity 1; "Ecosystem Webbing Game," Unit II, Topic C, Activity 2

Topic C: Wetland Productivity

Activity 4: Water Drop Jungle-

Grade Level: 3-8, with variation for K-2 and 9-12
Time range: two 45 minute periods + field trip setting: indoors and outdoors
Subject Areas: Life Science, Environmental Education, Biology
Vocabulary: zooplankton, phytoplankton, plankter (singular)

Objectives

Students will be able to understand what plankton are and the role they play in an aquatic ecosystem, and identify a few microscopic life forms.

Method

Students will build and use a plankton net, then view live plankton with the aid of a microscope or other tool. Observation skills will be developed through drawing what they see.

Teacher Background

No study of water-be it pond, stream or mud puddle - is complete without a glimpse into the busy, microscopic world contained within a single drop. These tiny plants and animals are collectively known as "plankton." Not only are they the basis of the food web, they are also an infinite source of inspirational art and outrageous designs. Water may never look the same again!

The word "plankton" comes from "planktos," the Greek word for wanderer. Organisms that are carried by the currents in water, unable to move on their own, are called plankton. Not all plankton are microscopic (some jellyfish are quite large), though we usually use the word to refer to microscopic organisms.

Plankton are mostly animals (zooplankton) and plants (phytoplankton). There are other life forms, such as dinoflagellates, that exhibit

characteristics of both plants and animals. Usually animals move and plants do not, though there are exceptions.

Some zooplankton are fully grown, permanently microscopic animals; others are animals that are passing through a stage in their life cycle to adulthood. Most aquatic animals begin life as plankton.

Phytoplankton are the basis of the food web. In addition to photosynthesizing they also produce much-needed oxygen. They, in turn, are eaten by zooplankton... zooplankton are eaten by larger zooplankton or other animals, and so on up the food chain. Nearly every animal in a wetland is dependent on plankton for food by direct or indirect consumption.

Materials

One set for each student:

one knee-high "nylon" stocking
13 oz. plastic container (or can) with both ends cut off
embroidery hoop or bent coat hanger
l/2" dowel approximately 3'long
eye hook screwed into one end of the dowel
plastic film canister
rubber band

Have enough to share:

carpet thread and large-eyed needles
awl (or large nails)
hammer
block of wood that will fit inside the can
microscopes or Discovery Scopes (see Appendix A), or microfiche readers make great viewers
eye droppers
petri dishes
paper
colored pencils
identification pictures of plankton (Pond Life by Golden Guide is good, listed in Appendix A)

Building the Net:

Refer to the diagram as you guide your students through making their plankton net.

1. Punch four equally-spaced holes around one rim of the can or plastic container. Use hammer and awl (or nail), punching through to the block of wood supporting it.

2. Pull the stocking over the can, keeping the holes at the top of the container. Double the finished edge of the stocking over the edge of the container.

3. Cut four, one-foot-long pieces of carpet thread.

4. Thread a needle, and pull each strand through one of the holes in the can and stocking (doubled over for extra strength), then knot it securely.

5. Gather the four loose ends, make sure the can is hanging straight, and knot the threads together.

6. Pull these strands through the eye hook that is screwed into the end of the dowel. Knot the threads together securely.

7. Drop the film canister into the toe of the stocking with lid facing you and use the rubber band to secure it. You are ready. Remember to take the canister lid off while collecting, and to put it back on for transporting to the viewing scope.

To Use the Net:

8. Sweep the net back and forth under the water, taking care not to snag it on rocks or branches, and to keep it out of the mud. The dowel allows you to hold the net away from your body so you don't stir up the sediment or disturb the water.

Viewing the Plankton:

9. Instruct students to closely observe the sizes, shapes and movements of the plankton. Have them draw what they see, perhaps in a large water drop that they have sketched on their paper.

10. Use a reference to identify a few of the organisms (see Appendix A, Resources). Distinguish plants from animals. Ask for words to describe how the zooplankton move: twirl, slither, break-dance, like a floor polisher.

11. Ask if we would notice if something, like a toxic pollutant, got into the water and silently killed off all the plankton. How so?

12. Begin a discussion of the food web in the wetland community. Who is dependent on whom? (See "Ecosystem Webbing Game:" Unit II, Topic C, Activity 2.) Trace a food chain starting with the sun, through plankton, eventually to people.

Grade Level Variations

K-3: Younger students may need your help in screwing the eye hook into the dowel, punching the holes in the container, etc.

For younger students you may wish to use a coat hanger, nylons, duct tape and a dowel. Use a bead of glue to attach the nylon to itself around the hanger.

Plankton viewing would be a good "study-buddy" activity in which high school students team up with elementary students to help make the nets and view plankton.

9-12: Older students are able to do more of the construction themselves. If resources are available, more in-depth observation and identification is possible.

Samples could be taken from a variety of locations, such as creeks, saltwater, and marshes. From these, different plankton could be compared.

Extensions

Consider if there would be more plankton near the surface of the water or deeper *(near surface)*. Why? *(need sunlight or eat phytoplankton that need sunlight)*

Take small samples of mud at different depths to see if the plankton are similar or different.

Look at adaptations of plankton for staying afloat *(many appendages to increase surface area, droplet of oil in their body, ways of moving)*

Look up "diatoms" in an aquatic ecology book. See if you can find any diatoms in your plankton sample. Research how diatoms are used by people. For example, diatomaceous earth is used as a polishing agent in industry and toothpaste.

Make larger-than-life models of plankton and hang them from your classroom ceiling.

Create a matching game to pair up young plankton with their adult forms.

Students make a mobile of plankton drawings and have students tell you orally why they are important.

Have students create a performance in which they act out the movements of the individual zooplankton species. Others can guess the species being simulated.

Evaluation

Have students draw 3 different phytoplankton and 3 different zooplankton and tell what makes some plankton different from others?

Have them write a paragraph on how we would be affected if plankton disappeared.

Have students discuss the impact of lack of plankton on the food chain.

Resources

"Web-of-Life," game cards; "Project Home-Planet," Whole-Language/Environmental Education curriculum; Discovery Scopes from Enviro-Ed; all listed in Appendix A

Unit II: Amazing Wetlands: Functions And Values

Topic D: Wetland Habitats

Introduction

One of the best known functions of wetlands is their importance to wildlife. Serving as feeding, breeding, rearing, resting, or refuge areas, Washington's wetlands are host to numerous permanent and transient inhabitants, including the following:

spiders and insects - beetles and many larval forms;
amphibians - frogs, toads and salamanders;
reptiles - turtles and snakes;
mammals - muskrat, nutria, beaver, moose, deer, and elk;
birds - waterfowl, shorebirds, and wading birds;
fish and shellfish - salmon, crabs, crayfish, oysters, and clams.

The transient or "part-time" inhabitants spend some stage of their lives in wetlands, seeking refuge or feeding on the ample food supply. Estuaries, for example, are critical nurseries for many of the fish and shellfish vital to the U.S. commercial fishing industry, including Dungeness crab and three species of salmon. Other fish and shellfish that depend on wetlands and estuaries include shrimp, herring, flounder, bass, steelhead, ling cod, red snapper, sole, oysters, and clams. In fact, over 50 **percent** of the commercially important fish and shellfish on the West Coast depend on wetlands for all or part of their life requirements.

The permanent residents of wetlands find everything they need there: food, shelter, water, and nesting sites. Muskrat, beaver, and frogs are examples of permanent wetland residents.

Other animal species visit wetlands regularly (daily or annually) to feed and drink. Many species of birds feed in wetlands, then return home to their nests or roosting areas outside the wetland. Deer, coyote, raccoon and other mammals also feed in wetlands. Many wetlands are critical stopover sites for migrating waterfowl. Wetlands along the major flyways swell in population during spring and fall as the birds stop to rest and "refuel" before continuing their long journey.

Wetland plants provide abundant food for wildlife. Some animals, like deer, elk, and some waterfowl graze directly on the rich vegetation. Often, however, wetland plants are most useful after they die and decompose. The decaying bits of plant material, called detritus (dee-try-tus), form the foundation of the food web. Studies show that detritus is the most important food material ingested by fish and invertebrate marine life in coastal marshes.

Because they provide water, a rich and diverse supply of food, and plentiful shelter, wetlands attract a variety of animals. They are essential, irreplaceable habitat.

Topic D: **Wetland Habitats**

Activity **1: Wetlands Poster**

Grade Level: 3-12, with variations for K-2
Time range: 30 minutes
Setting: indoors
Subject Areas: Life Science, Environmental Education, Life Sciences, Language Arts

Objectives

Students will understand how wetlands provide a variety of habitats to meet wildlife needs.

Method

Students will examine the wetland poster to discover the many ways that animals use wetland habitats.

Materials

Department of Ecology's Wetlands Poster

Procedure

Provide the following list of questions along with the poster. Have small groups of students or partners take turns observing the poster and thinking and/or writing the answers to the questions. (This could be an individual center activity, a free-time activity, or a parent-helper-directed activity.) After everyone has had a chance to study the poster, discuss answers to the questions. Summarize by listing all the ways in which the animals are using the wetland in the poster. (Though nests are not seen in the poster, the redwing blackbird and the marsh wren build their nests in the reeds and cattails.)

Note: The wetland shown on the poster is a freshwater marsh; you can tell by the types of plants and animals. Names of mammals, birds, reptiles, and fish are found at the top of the poster.

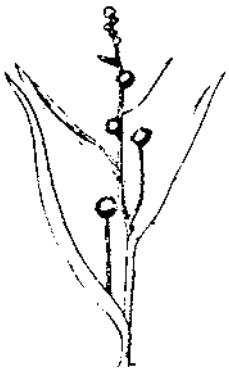
Wetlands Poster Questions

1. What kind of wetland do you think is shown on the poster?

2. What clues led you to your answer in question 1?

3. What mammals (animals with fur) are using this wetland?

4. What birds are using this wetland?



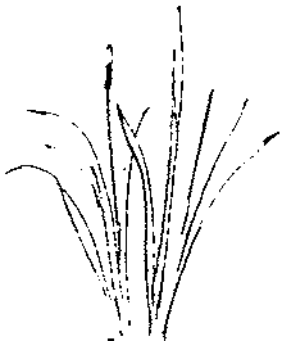
5. What reptiles are using this wetland?

6. What amphibians are using this wetland?

7. Name three kinds of fish in this wetland.

8. How many invertebrates (animals without backbones, like insects and shellfish) can you see?

9. What is the pintail duck doing?



10. What is the bittern doing?

11. What is the beaver doing?

12. Why must a frog lay its eggs in water?

13. Which of these animals might live somewhere else but is visiting the wetland in order to find food?

14. Which of these animals will leave the wetland for a year or two to live in the ocean?

15. Describe one connection you see between a plant and an animal.

16. Describe one connection you see between an animal and an animal.

Grade Level Variations

K-2: Parent helpers or the teacher can help small groups of younger students write their questions for them.

Extensions

Have students make their own wetlands posters.

Evaluation

Evaluate the students answers to questions 1-16.

Resources

Department of Ecology's Wetlands Poster, listed in Appendix A

Topic D: **Wetland Habitats**

Activity 2: **Drama Activity**

Grade Level: 3- 12, with variations for K-2
Time range: 60 minutes
Setting: indoors
Subject Areas: Life Science, Environmental Education, Biology, Drama
Vocabulary: wrack, predator, adaptation, understory, overstory

Objectives

Students will understand how wetlands provide a variety of habitats to meet wildlife needs.

Students will understand that wetland animals have a variety of adaptations which allow them to survive in their particular habitat.

Method

Students will play a charade-type game to discover the many ways that animals use wetland habitats.

Materials

game cards (one per student copied from the ones in this activity)

Procedure

As a class, brainstorm the needs that animals have (e.g.: air, water, food, a place to sleep, a place to be safe from enemies, a protected place to nest and raise their young, a way to protect themselves from severe weather, etc.) Hand out one game card to each student and explain that, in a wetland, there are several different habitats, or places where animals live, which provide for these needs. Those habitats include: the surface of the water, under the water, under the soil or mud, the understory (low-level plants), the overstory (higher shrubs and trees), rocks and piers, and under the wrack (piles of dead plants washed up by the tides).

Have students take turns acting out the animal behavior described on each card. The rest of the class is told only the habitat and must guess which animal it is and what the animal is doing in that wetland habitat.

When everyone has had a turn, have students summarize all the ways that animals depend on wetlands to meet their needs.

Grade Level Variations

K-2: Younger students may need the cards read to them.

Extensions

Research other animal behavior strategies and how they help the species survive.

Have students write and act out a play depicting all sorts of animals in the wetland.

Evaluation

After everyone has had a turn, have students summarize all the ways that animals depend on wetlands to meet their needs.

Related Activities

"Create-A-Critter," Unit II, Topic D, Activity C

Habitat:	under the water
Animal:	sculpin
Behavior:	feeding

Habitat:	underwater
Animal:	beaver
Behavior:	dam-building

Habitat:	under the water
Animal:	salmon
Behavior:	resting from migration

Habitat:	underwater
Animal:	polliwog
Behavior:	hatching

Habitat:	on the estuary floor
Animal:	stickleback
Behavior:	building a nest

Habitat:	water's edge
Animal:	raccoon
Behavior:	feeding on crayfish

Habitat:	in the eelgrass beds
Animal:	pipefish
Behavior:	hiding from predators

Habitat:	water's edge
Animal:	deer
Behavior:	drinking

Habitat:	under the wrack (seaweed)
Animal:	amphipods (sand fleas)
Behavior:	feeding on detritus

Habitat:	underwater plants
Animal:	snails
Behavior:	feeding

Habitat:	on the rocks
Animal:	barnacles
Behavior:	anchoring themselves against the tidal waters

Habitat:	water surface
Animal:	water strider
Behavior:	resting

Habitat:	under a rock
Animal:	crab
Behavior:	hiding during molting

Habitat:	in the air
Animal:	dragonfly
Behavior:	feeding

Habitat:	in the mud
Animal:	clam
Behavior:	filter feeding

Habitat:	in the water
Animal:	swallow
Behavior:	feeding

Habitat:	marsh grass
Animal:	northern harrier
Behavior:	hunting

Habitat:	in the cattails
Animal:	muskrat baby
Behavior:	hiding from predators

Habitat:	cattails
Animal:	redwing blackbird
Behavior:	nesting

Habitat:	in a tree
Animal:	owl
Behavior:	sleeping

Habitat:	water surface
Animal:	ducks
Behavior:	resting from migration

Habitat:	water surface
Animal:	mosquitoes
Behavior:	hatching

Topic D: **Wetland Habitats**

Activity 3: **Create-a-Critter**

Grade Level: 3- 12, with variations for K-2
Time range: 90 minutes
Setting: indoors
Subject Areas: Life Science, Environmental Education, Art, Biology

Objectives

Students will understand that wetland animals have a variety of adaptations which allow them to survive in their particular habitat.

Method

Students will "create a critter" that demonstrates adaptations to a wetland habitat.

Materials

art & recycled materials, habitat cards

Procedure

Discuss some of the adaptations wetland animals have which allow them to survive in a swamp or marsh. Hand out habitat cards, one per student. Have each student create an imaginary wetland creature with adaptations which would allow the creature to survive in the habitat describedon the student's card. Similar to plant-adaptation activity in Unit 1. Provide art and recycled materials for the activity. Have students present their creatures to the class and describe how each adaptation helps the creature survive in its environment. This may also be done in writing.

Grade Level Variations	K-2: Younger students may have to have cards read to them.
Extension	Have students research real animals that live in the habitats described. Describe real-life adaptations to live in that habitat.
Evaluation	Evaluate the students description of how their creatures adaptations help it survive.
Related Activities	"Create-A-Plant," Unit I, Topic B, Activity 3
Resources	Animal Cards in Appendix H

Habitat cards: (Make multiples of 4 or 5 to give to small groups)

Swims in the Water	**Buried in the Mud**
Flies in the Air	**Lives in a Tree**
Crawls on the Pond Bottom	**Skims the Water's Surface**

Lives in the Reeds

Topic D: **Wetland Habitats**

Activity **4: Frogs Leap, Toads Hop**

Grade Level: 3-12, with variations for K-2
Time Range: l-2 class periods
Setting: Indoor discussion; outdoor field study
Subject Areas: Art, Environmental Education, Life Science, Language Arts, Biology
Vocabulary: metamorphosis, habitat, amphibian

Objectives

Students will learn about the life cycle of frogs and toads and the seasonal and yearly changes they experience.

Students will be able to differentiate between frogs and toads in appearance and way of life.

Method

Students will study the life cycle of a frog by forming each stage in clay. Students will discuss the seasonal and yearly changes a frog and toad experience. In the field, students will learn to differentiate between frogs and toads, their eggs, and their behavioral characteristics.

Teacher Background

Both frogs and toads metamorphose, changing dramatically as they develop from plant-eating tadpoles to insect-eating adults. Adults may also eat spiders, bats (eaten by large bullfrogs), and other frogs. Throughout their lives they are choice prey for many animals, including birds (such as kingfishers, owls, and herons), river otters, humans (for frog legs), snakes, bats and other frogs. They can also be "prey" for plants! A Venus Fly Trap can eat a small frog if it falls into its trap. Tadpoles are preyed upon by fish, dragonfly nymphs, water beetles, crayfish and water shrews, as well as other tadpoles.

Female frogs lay their eggs in shallow water, as males spread sperm over them. Frog egg masses are round to oval, and surrounded by a jelly-like covering Toads'eggs are in long strings that are entangled in plants in the bottom of the pond. At low elevations, frogs spawn from late winter to early spring, toads spawn in late spring. In the mountains, the breeding may not occur until June.

After a few days, the eggs hatch into tadpoles. Tadpoles feed mainly on plants, especially algae, and breathe with gills.

After several weeks, the two hind legs develop from the base of their tail. Shortly before metamorphosis, the two front legs emerge from the gill chambers, located under the head. They stop eating as their body goes through dramatic changes. The mouth becomes larger and is now hinged, the tongue gets longer, eyes grow larger and now bulge out the top of the head, gills make way for lungs, and their tail begins to shrink. As it does so, it supplies the rest of their body with nutrients. Their digestive system changes to adjust to eating insects.

Adult frogs have lungs; their gills are gone. The hind legs have become long and powerful. Their long tongue and wide mouth are adept at catching insects. Some species are mostly land animals now, but return to water to mate and lay eggs; others remain in and/or near the pond throughout their lives.

Frogs are "ectothermic" (co1d-blooded), relying on the external environment to regulate their body temperature. For example, on cold days they seek the sun and on warm days they hide in the cooler shade. In winter they burrow down to where the environment is more stable (temperatures are more stable in water and mud than in air). They essentially "shut down" - their temperature lowers, respiration slows down, and they consume less oxygen. Frogs use their own body energy for fuel, and lose weight during the winter months. When ice forms, it insulates the pond from temperature fluctuations. Many amphibians absorb oxygen through their skin and eat nothing all winter.

Frogs are among the oldest vertebrate (animals with backbones) creatures on earth, first appearing about 150 million years ago. There are over 3000 species of frogs, Some kinds of frogs are called "toads." Differences in appearances and behavioral characteristics are summarized on the "Frog and Toad Chart" in this activity.

Materials

life cycle illustration - a copy for all or made into a large poster
clay - a fist-sized clump for each student, "Toad-Frog Chart"

Procedure

Ask your students if they can think of any young animals that don't look anything like their parents. Define metamorphosis (a marked change). Briefly have them describe the changes in the life of a butterfly or other insect.

Hand out copies of a frog's life cycle. Have your students describe the physical changes in a frog's life.

Give each student a ball of clay to shape into a mass of eggs. Take "an egg" and, one stage at a time, form the changes from an egg to a tadpole, froglet and finally an adult frog. Discuss each stage - how it fits into the food web, what habitat it lives in.

Talk about seasonal changes, and what a frog does in the winter.

Read aloud some of the "Fascinating Frog Facts" on page 30.

Do a lesson in the classroom on the differences between frogs and toads before taking students into the field.

If possible, arrange a field trip to a wetland. In the field, look for frogs and toads. Refer to the chart to aid in observation and identification.

Extensions

Students can make leaping origami frogs (see instructions in this activity). They can act out the stages of a frog's life.

They may learn the life cycle by cutting apart the life cycle illustration, and putting it back together in the right order.

Students can design a bulletin board depicting the stages in the life cycle.

If you are able to get out into the field throughout the spring, students can try to find frogs in every life stage, and keep a journal of the observed changes.

Have your students draw a larger-than-life size illustration of a frog and describe how a frog is adapted for survival.

Go on a night-time adventure in early spring to find spring peepers.

Have students draw a frog or toad in its own habitat.

Create a frog or toad costume or puppet with your students and put on a play.

Bring a frog and a toad to class and discuss their differences and similarities.

Have older students make a "frog layer book." Each paper or transparency layer shows different systems of the frog, with labels. As you flip through the layers you see the skin, circulatory system, digestive system, respiratory system, reproductive system and skeleton.

Have your students draw a larger-than-life size illustration of a frog. Identify body parts and how they are adapted for survival.

Raise frogs in your classroom (see Unit I, Topic C, Activity 1, "Classroom Frogs").

Evaluation

Have students outline the life cycle of a frog or toad, including approximate times of metamorphic changes.

Describe the physical changes in each stage.

Explain what frogs do in winter; what can't they do and why.

Write a story about a toad or frog using the information students have learned.

List five differences between frogs and toads.

Related Activities

"Classroom Frogs," Unit I, Topic C, Activity 1; "Frogs in Trouble," Unit III, Topic E, Activity 1.

Resources

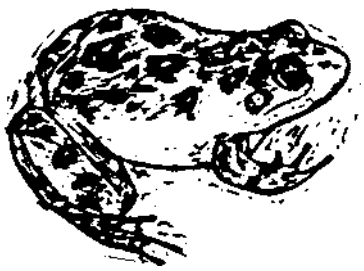
"Everybody Loves Frogs," Ranger Rick Magazine, March 1993; listed in Appendix A

Frog Adaptations

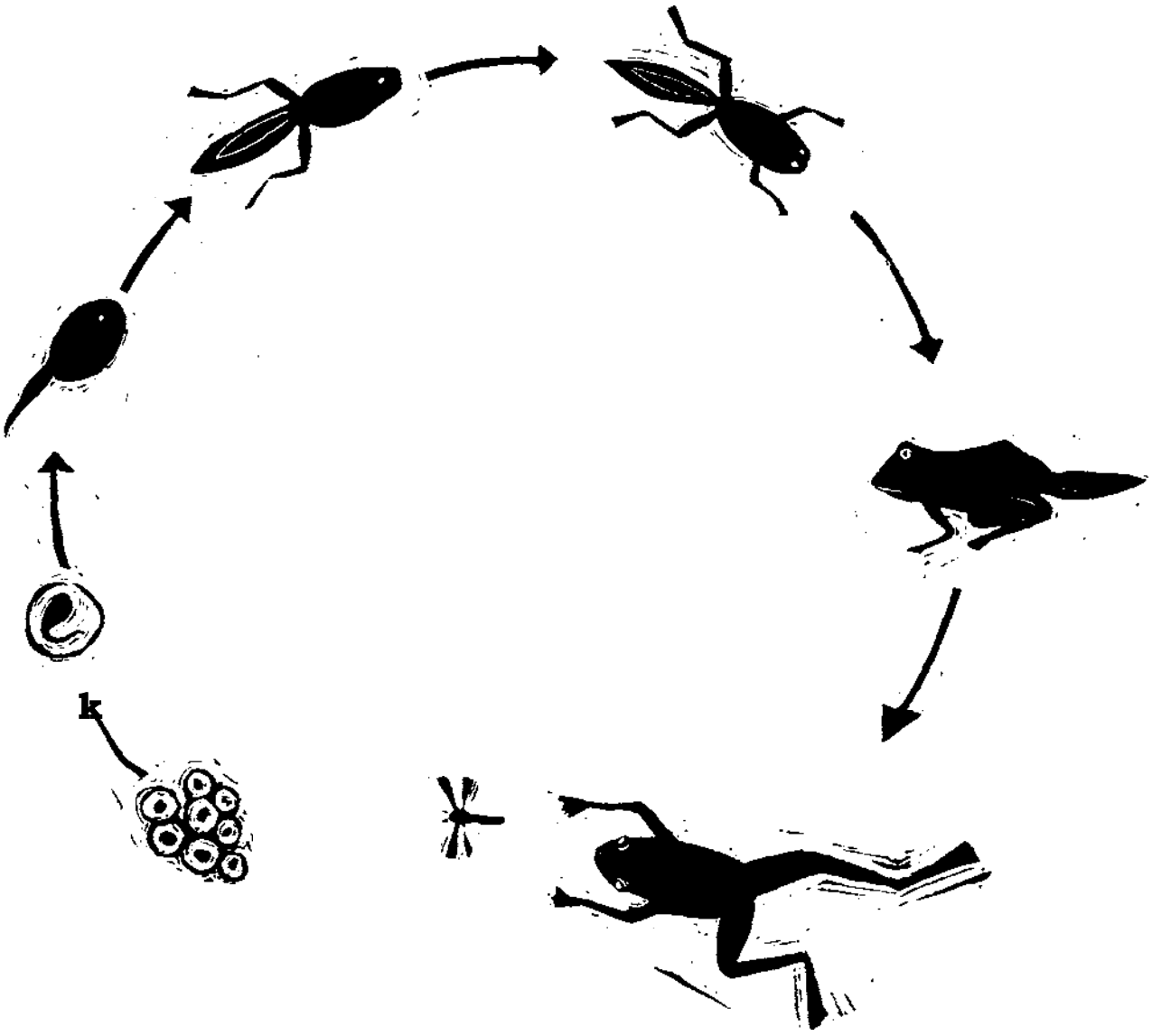
bulging eyes	to be able to see when submerged
special eyelids	like swimming goggles, to see underwater ("nicitating membranes")
hind feet	webbed for swimming, strong for leaping
sight	excellent for seeing something that is moving
touch	can sense vibrations
tongue	sticky, for catching insects attached to front of mouth
tiny teeth	to hold onto slippery prey
eyes	sink down into head when swallowing, to help push food down throat
"toes"	tree frogs have sticky toe pads to grip when climbing
skin	absorbs (and loses) water through skin; skin can "drink," absorbs oxygen
cold blooded	finds shade on hot day, sun on cold day to control body temperature
calls	each kind of frog has its own call; males sing to attract females and to tell others to stay away; sacs under chin puff up with air like blowing bubble gum!

Frog And Toad Chart

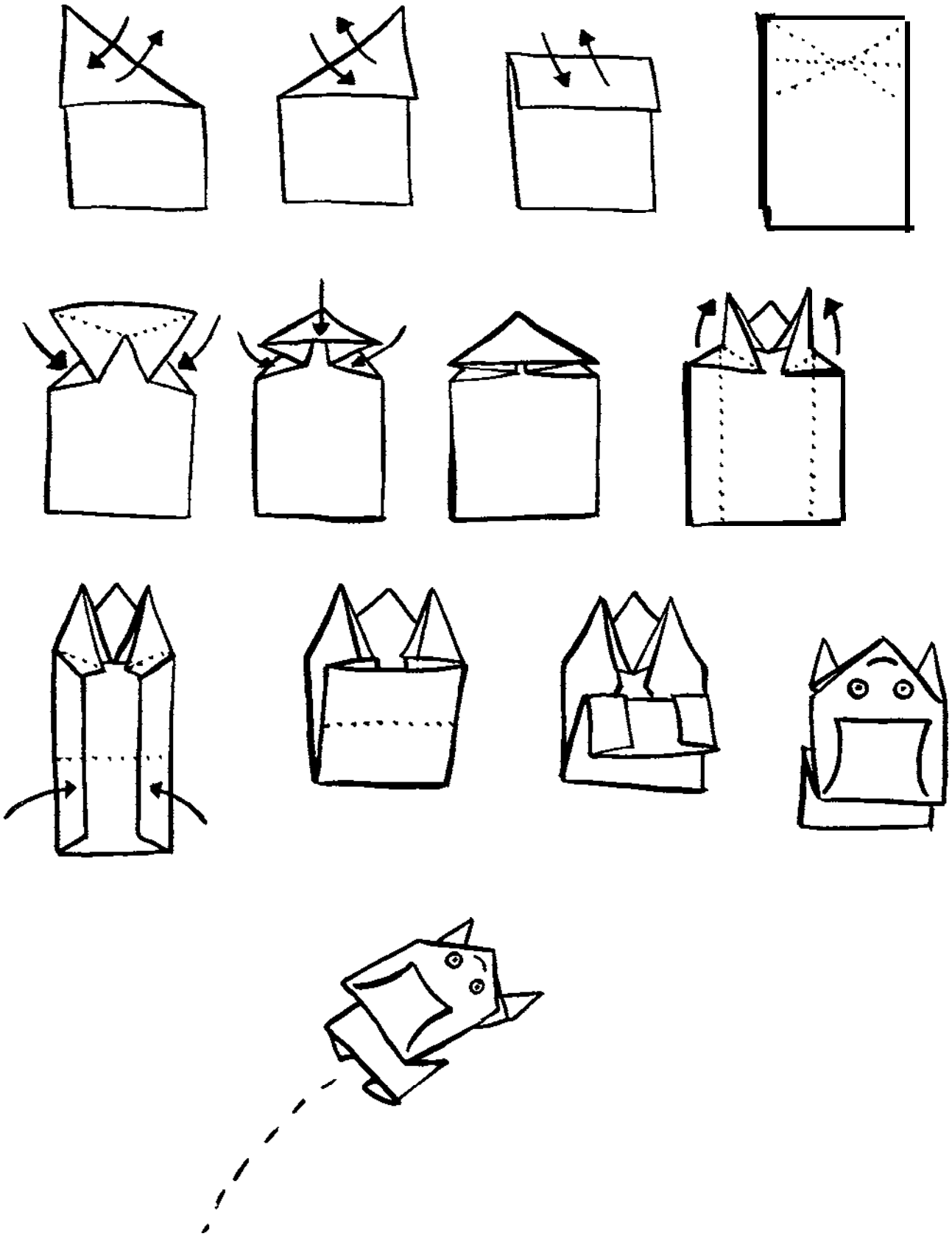
	Frogs	Toads
habitat	move in water	move on land
skin	moist and smooth	dry and bumpy
color	green or light brown for blending in with plants	brown, for blending in with mud & leaves
legs	longer	shorter
movement	leap	hop or walk
spawning	early spring	late spring
eggs	in clusters	in strings
behavior	alert	"sleepy"
prey	insects, small invertebrates, smaller frogs	insects, earthworms, spiders, smaller toads
predators	raccoons, birds, snakes, bullfrogs, river otters	birds, skunks, snakes, larger toads
protection	hops away, camouflage	poison from glands on top of head to deter predators, camouflage



Life Cycle Of A Frog



Origami Frog Instructions



Topic D: **Wetland Habitats**

Activity **5: The Toad is Heaven's Uncle**

Grade Level: 3-8, with variations for K-2 and 9-12
Time range: **2** class periods
Setting: indoors
Subject Areas: Life Science, Environmental Education & Issues, Biology, Language Arts, English, Art

Objectives

Students will become familiar with frog and toad stories from other countries.

Students will learn some natural and human causes of drought and how drought affects wetland habitats.

Method

Students will read a folktale and write their own creative tale.

Teacher Background

Frogs and toads are often seen as diminutive, typically inelegant creatures. However, in many cultures they are viewed as heroes. In this gentle Vietnamese story of strength and wisdom, toad rises to a place of respect.

Toad sees that his pond is drying up, and knows that he must go to the King of Heaven and have a talk with him. Other animals see his wisdom, and join him enroute. When the King of Heaven sees the little toad before him, he is outraged, but the animals soon discover there is strength in numbers. Together they defeat the King of Heaven and all his forces. The great king learns that he must treat the toad with respect, and vows that from that moment on, he will respond to the toad's every request for rain.

In this story, controlling drought is in the hands of the King of Heaven, but here on earth, drought is sometimes accentuated by human activities. Natural fluctuations in weather patterns and unusual climate changes can cause drought. Years of low precipitation can mean little snow and reduced spring runoff.

Development pressures have caused many wetlands to dry up. Habitat has been destroyed for the building of roads or urban areas. Water has been diverted away from natural channels for other uses such as irrigation and industry. In areas where there is an overabundance of deep wells, the combined draw from the aquifer can deplete a wetland's water supply. Diking river channels prevents floods from resupplying water to nearby wetlands. The construction of ditches to drain wetlands removes the much-needed water from these areas. These changes in the water level disrupt the delicate balance of organisms within the wetland community.

Materials

one copy of "The Toad is Heaven's Uncle" for each student
paper and pencils
news articles on drought, local and global, if available

Procedure

1. Briefly introduce the story. Read the story to them or ask students to read the story either quietly to themselves or aloud to each other.

2. Review the story by asking questions such as:

   "Why did toad decide to go to see the King of Heaven?"

   "Who went with him?" "Why did they choose to go along?"

   "How did the King greet the toad?" "Why?"

   "How did the toad respond ?" "How did his friends respond?"

   "What did the King of Heaven eventually do?"
   "What caused him to change his attitude?"

   "What do wetland animals do now when rain is needed?"

   "How would you describe the toad?"

   "What characteristics of the toad attracted other animals to him?"

"What might have happened if the toad had gotten angry at the King?"

"How do you think you would have felt, and reacted, if you were the toad?"

3. Discuss some of the actions, both natural and human, that can affect the impacts of drought. Refer to news articles, if available.

4. Ask students to think about the positive qualities of frogs and toads. Have them create a story where either a toad or frog becomes a hero by helping animals in a wetland.

5. Reread the story and have students write their own story of a related frog, trying to solve the problem of our shrinking wetlands, 5,000 years after the story of "Toad is Heaven's Uncle."

Grade Level Variations

K-2: Have students make stick puppets of wetland animals and hold "interviews" in which the puppets must explain why they like wetlands so much.

9-12: Have students explore some of the economic benefits of wetlands; how flood control, erosion-control, wildlife habitat, food production, etc. provide economic value to humans.

Have students write math story problems based on the information they read about the economic value of wetlands.

Extensions

Play "Migration Headache," a Project Wild Aquatic game (see Appendix A). Afterwards, have students write a first person story, from a duck's point of view, about the yearly migrations experienced during the game.

Read some of the "wetland riddles" (at the end of this activity). Have students write their own riddles (not necessarily rhyming ones) based on their knowledge of wetland animals and their adaptations.

Have students complement their written tales with illustrations.

Research drought and its effect on people and other populations.

Have students interview others, especially elders, to find out how they feel about frogs and toads. Discuss some of the folk tales from around the world listed in "Froggy Folk Tales From Around The World."

Evaluation

Evaluate students understanding from their own stories written 5,000 years after the story of "The Toad Is Heavens Uncle."

Have students write about the effects of drought on living things.

Related Activities

"Skunk Cabbage Story," Unit III, Topic B Activity 3

Resources

Wetland Tales, Washington Department of Ecology; listed in Appendix A

"The Toad is Heavens' Uncle" from *Vietnamese Legends* by Charles F. Schultz. Copyright © by Charles E. Tuttle, Inc., 1965. Reprinted by permission of Charles E. Tuttle.

The Toad Is Heaven's Uncle

Story Overview

This Vietnamese story tells of a lowly toad that dared to go straight to the top when times got tough for inhabitants on the earth. Toad sees that his pond is drying up, and knows he must go to the King of Heaven and have a talk with him. Other animals see his wisdom, and join him en route. When the King of Heaven sees the little toad before him, he is outraged, but the animals soon discover that there is strength in numbers. Together they defeat the King of Heaven and all his forces. The great king learns that he must treat the toad with respect, and vows that from that moment on, he will respond to the toad's every request for rain. In the story, drought imperils toad's wetland, but in reality, human intervention most commonly causes wetlands to dry out.

Story

When Heaven was close to Earth long, long ago, and all the animals spoke with human voices, a terrible drought descended upon the Earth. It lasted many months, and all the rivers, lakes, ponds, streams, and wells went dry.

Among the Earth's diverse inhabitants there was an ugly toad who lived near a pond. He saw the pond shrinking in size from day to day and finally determined to do something about it. He did not relish a slow, lingering death which seemed inevitable. After thinking it over for some time, the toad decided that the only course was to go directly to Heaven and interest the gods in what was happening on Earth. Alone, he set off on the long journey.

The toad had traveled only a few miles when he met a group of honey bees and stopped to chat with them. During the conversation he told them of his resolve to seek the King of Heaven's help. The bees were enthusiastic about his venture, for they too were seeing bad times; without the flowers there was no honey at all. They decided to join the toad and together the party set out.

When the bees and the toad had continued for some distance, they came upon a cock who was in very low spirits. The harvest had been affected by the drought and there was no grain or insects. It was quite easy for the toad and the bees to convince the cock that he would have nothing to lose by joining forces.

The enlarged party had hardly resumed the journey, when they encountered an ill-tempered tiger. He was especially angry because the drought was killing all the game on which he had been accustomed to prey. He too became a member of the party. Soon a fox and a bear joined up. The group journeyed on, inspired by the worthy purpose that had brought them all together.

After many days of jumping from star to star the party arrived at Tiem Dinh, the very Gates of Heaven. The toad asked the others to remain outside until he called them. Then he hopped through the gates and into the palace. He crossed the polished floors of many empty chambers and finally entered the impressive Hall of Audience. Laughter was audible from somewhere inside, and the toad made his way toward the sound.

Finally he came to a room where the King of Heaven was seated at a table playing cards with a number of angels and fairies. The toad was very indignant to see them engaged in this idle pastime. Inhaling deeply, his bulging eyes wide open, he leapt in a great high hop to land plop in the middle of the players. There was a stunned silence as the smile gradually left the King of Heaven's face. He frowned angrily and spoke in a thundering tone.

"Insolent toad," he roared, "how dare you defile our august company?"

Now the toad, who had already faced death on Earth, did not flinch a bit. He had a quiet courage that comes from extreme desperation.

"Your Majesty," he began, but could say no more.

"What?" shouted the King of Heaven. "How dare you speak in my presence?"

At that moment the guards rushed in, intending to throw the toad out. But a toad is not so easily captured. He hopped away from the guards and called aloud for the bees, who swarmed in and attacked the guards, who retreated in panic to avoid being stung.

The King of Heaven watched the proceedings in utter amazement. Then he called on the Thunder God to silence the insolent toad, but the cock was more than a match for that deity. The King of Heaven then called for the Captain of the Hounds, but the tiger took care of him and the bear and the fox ripped the stomachs of the dogs. Slowly, a look of great respect came to the eyes of the King of Heaven and a reasonableness entered his mind.

"Sire," said the toad, "my friends and I came here respectfully, to bring to your celestial attention the sad plight of the inhabitants of the Earth. There has been no rain for many months, the river-beds have dried up and the fields are parched. Animals are dying everywhere and all the plants have wilted. Sire, we must have rain."

"Yes," nodded the King of Heaven, and added Uncle, so overpowered had he been with the toad's personality. And he promised to look into the matter immediately.

The celestial sluices opened and rain came at last to the Earth. But by that time three-fourths of the population were dead. Some animals of each species survived however, and soon new generations began to populate the earth again. Life was reborn in every comer of the earth.

So that a similar expedition of earthly beings would not again appear in his palace, the King of Heaven told the toad: "From now on, it will not be necessary to make such a long trip with your friends. If there is a drought in the future or whenever you need rain, remain there on Earth and simply call me."

Since that time the toad, "Heaven's Uncle," and his progeny have watched over the Earth's supply of water and have never failed to croak loudly and effectively whenever rain is needed.

When the toad died, his sons and the other animals built a fitting memorial to his memory, and they began to commemorate the day on which he made, his heroic journey to Heaven. Thus, the toad's great deed is remembered to this day in Vietnam, and the expression "The Toad is Heaven's Uncle" has entered Vietnamese parlance.

Wetland Riddles

Developed by Jana Dean, WA Department of Ecology, 1991

Everyone loves riddles: they challenge; they call attention to parts of the environment; and they provide a forum for sharing ideas and observations. As shared at a teacher workshop on July 20, 1991, these riddles were part of a presentation that consisted of the riddles themselves, a food web game called "Webbing" that Joseph Cornell outlines in his *Sharing Nature with Children* (Nevada City, California: Dawn Publications, 1979, p. 56) and a Wyandot creation story "Turtle and the Divers," that appears in the WA Department of Ecology publication, *Wetland Tales.*

Riddles work best if the answers are readily observable, in this case, if the lesson is conducted at a wetland with all of its inhabitants in attendance. The teacher-naturalist can guide the participants' attention to the plants and animals that the riddles identify or to observable signs that they could live in that environment if they chose. When a lesson must occur in a classroom or in a city park without a wetland, photographs of the answers, the Plant and Animal Cards from Appendix G and H, or written answers can convert the riddles into a kind of matching game which focuses attention on the community of creatures that make wetlands their home.

I'm well known as a thief of the night
But trust me,
I don't do it out of spite.
Who am I?

Raccoon

My prehistoric cry is a croak,
And I'm painted the color of smoke.
Who am I?

Great Blue Heron

In the shallows we grow
When the vernal wind blows
Our seeds fall like the snow.
Who are we?

Cattails

When you've got us, why ask for more?
Why did you ever invent the Army Corps?
Who are we?

Beaver

Flat-footed, strong-headed
and nearly bald.
Who are we?

Human beings

As nymphs we're voracious,
As adults, our wingspan is spacious.
Who are we?

Dragonflies

As babies we're water dogs,
But my, what a change.
They say we're something like frogs,
And never far from water do we range.
Who are we?

Salamanders

In June we show our bearded faces.
We look like we're native,
But really, we come from far away places.
Who are we?

Wild Iris

In shallows and deep we will play.
We nearly act like humans,
Some people say.
Who are we?

Otters

We feed on detritus,
Under leaves you will sight us.
Who are we?

Water Scavenger Beetle

I travel with my house on my back.
I'm becoming extinct!
Please give me some slack!
Who am I?

Western Pond Turtle

Strong swimmers we are,
And we travel quite far.
Who are we?

Salmon

I stretch my white wings wide
And fly high in the sky
Before I make my great dive.
Who am I?

Osprey

In the fairy tale they say I'm a prince,
But I'm content as I am,
And the thought makes me wince.
Who am I?

Frog

Human beings as the fountain of life?
You bet, just try asking my wife.
Who am I?

(male) Mosquito

Froggy Folk Tales From Around The World

■ "The Frog-Prince" - a fairy tale about a lowly frog who does many favors for a beautiful princess to show her how good he is. When she finally kisses him, he turns into a handsome prince. Moral: the way people act is more important than how they look.

■ Ancient Chinese people believed that the world rested on the back of a huge frog. When the frog moved there were earthquakes.

■ In Southeast Asia, people believed that the moon got smaller each night because it was slowly being eaten by a huge frog.

■ Indians along the Pacific Coast believe that Frog Woman created the earth.

■ In Korea, if you see a frog with red eyes you will have bad luck. In the southern United States, seeing a frog is lucky - you'll have money.

■ Women giving birth in ancient Egypt prayed for help from *Heqit,* the frog goddess of birth.

■ People once believed that spitting into a frog's mouth and asking it to carry away a toothache would relieve the pain; that rubbing a live frog on freckles would make the freckles disappear.

■ At one time, people would tie a box containing a dead frog around a sick person's neck. As the frog rotted they believed the person would slowly get better.

■ Tlingit Indians are exceedingly frightened of frogs and when encountering a frog on a path, will stop until it has hopped into the woods. They believe that frogs exude a slime from their skins that witches use to cause their victims' eyes and mouths to bulge out like those of a frog.

■ A Bible story tells of how God punished the Egyptian people by sending swarms of frogs. The story says frogs covered the land and climbed all over the people. Even their ovens and beds were full of frogs.

■ In Southeast Alaska the frog is a guarding spirit, a bringer of good fortune, the embodiment of wisdom, a guide through treacherous country and the symbol of secret societies. A frog's owner is supposed to be endowed with singing power.