Unit IV: Field Studies -A Walk On The Wild Side

Topic A: Wetland Habitats

Introduction

One of the most important elements of a unit on wetlands is field study. The experience can be the event that piques the students interest in learning about this fascinating environment. It may be the culminating experience that reinforces topics studied within the classroom. Either way, a visit to a wetlands fosters a deeper understanding and appreciation of a unique part of nature.

Finding a wetland is not as difficult as it sounds. Many public access wetlands are listed in the Washington Department of Ecology booklet *Wetland Walks: A Guide to Washington's Public Access Wetlands* (Pub. #89-30).

Find out as much as possible about the wetlands you will be visiting. A preliminary visit is strongly recommended. Become familiar with the layout and special features to emphasize to your students. Seek out answers to the following questions:

a) Do you need permission to go there? Determine ownership by looking at a county assessor's map or ask the local planning department or a friendly real estate agent. If it is private land, call the land owner to obtain permission.

b) If it is a park, contact the manager for permission to take a group on the site. Are there any interpretive naturalists available to lead your group? Try contacting organizations like Ducks Unlimited or the Audubon Society. Ask your students if any of their parents have expertise.

c) Is there sufficient parking, especially if you take a bus?

d) Are there potential safety problems, like bridges, deep mud, or open water?

e) Where are the boundaries that you want students to stay within? It is wise to provide students with a sketch.

f) What type of wetland is it? Locate it on a National Wetlands Inventory (NWI) map or local wetlands inventory map from the local jurisdiction's planning department. The key on the bottom of a NWI map will indicate if it is marine, estuarine, riverine, palustrine, or lacustrine and further assign subcategories. For example, a wetland designated as "POW" is "palustrine with open water" habitat (see Appendix F).

g) What sorts of plants and animals are found at the site?

h) Is there a meeting area where you can speak to the entire class? (The middle of the wetland is usually not the place to hold a class lecture.)

Before taking students on any field study, teach them proper field behavior and ethics. You may wish to brainstorm a list with the class before going to the site. The following guidelines will give you the basics. You may also want to add others, depending on your site.

1) Be very considerate of wetlands ecosystems. They are sensitive to trampling. Stay on trails, if possible. Avoid destroying vegetation and breaking branches.

2) Minimize your disturbance to wildlife. Avoid nesting areas. If you turn over rocks or logs, replace them in their original position.

3) Do not collect anything, unless directed by the teacher. Check with the owner or manager first. If you want students to create a collection, have them take very small amounts of the commonplace. Carefully weigh the drawbacks of collecting with the benefits to education.

4) Treat all components of a wetland with respect: soil, plants, animals, water, and rocks. Leave their unique web of life intact for others to enjoy.

Encourage students to wear proper clothing on your trip. Give them plenty of notice and suggestions. Proper clothing and footwear will make the trip fun and allow students to dive into the experience, instead of worrying or suffering.

Topic A: **Wetland Habitats**
Activity **1: Observing Wetland Habitats**

Grade Level: 3-12; variations for K-2
Time range: 60 - 90 minutes
Setting: outdoors
Subject Area: Environmental Education, Biology, Life Science
Vocabulary: habitat, detritus, dominant, emergent, plant-herb, fungus

Objectives

Students will be able to collect and record observations about the environment they are exploring.

Students will be able to identify various habitats and describe their components.

Methods

Students spend time observing the habitats of a wetland, and completing a scavenger hunt and habitat survey form.

Teacher Background

A habitat is a place where particular plants and animals are normally found. The habitat is defined by its physical and biological features. Components of wetland habitats include:

- underneath the soil;
- the surface of the soil;
- the water column of open water;
- the surface of the water;
- the air above the wetland;
- a wetland plant community, for example, in the sedges or an Oregon Ash tree.

Materials

copies of the appropriate "Scavenger Hunt" and "Habitat Observation" sheets (included in this activity)
clipboards, pieces of cardboard, file folders, or other rigid surface to write upon
rubber boots or old shoes
small shovels or spoons to dig with
buckets or trays
any of the following: hand lens, binoculars, sampling nets, underwater viewer

Procedures

Identify the habitats you want students to explore.

Divide students into groups of three to four. Give them any equipment you have gathered and a clipboard with study sheets attached. Show them how to use the equipment, if necessary.

Assign habitats for them to study. Remind them of the boundaries and guidelines you expect them to follow. Give them sufficient time to complete the study sheet activities. Set a time to be back at a central meeting place.

When they are back together, discuss what they found in their scavenger hunt and habitats. Discuss the impacts they have had on the environment, both positive and negative. Have them attempt to identify what they've seen. Encourage them to share their feelings about the experience. If it is raining ask them how the land is helping soak up the rain and how the plant life has prepared for the season.

Grade Level Variations

Older students could complete this individually or in smaller groups. They could also repeat their observations at different times of the day or year, This is a good opportunity for middle or high school students to serve as leaders for small groups of elementary students.

Younger students could be divided into groups of four to five students and supervised by adults. They could complete the scavenger hunt or study one habitat. Each group could be assigned one different item, “a hidden agenda. “The leader takes them to it and asks the question (e.g., where does the smell come from; look at rose hips and cut them open; discuss them as a food and vitamin source) then each group shares their item with the entire group when they reassemble.

Extensions

Take back samples of mud and water for later examination under the microscope. Draw pictures and try to identify any plants or animals you find in the samples.

Use water or soil testing equipment to explore the habitats’ temperature, pH, dissolved oxygen, etc.

Sketch, draw, color and/or paint wetland scenes. Visit the scene in different seasons, and have students compare differences and similarities in the habitat.

Make a wetlands photography collection.

Evaluation

In addition to field exercises, you may want students to compare and contrast two habitats in writing or by drawing pictures

Write their own scavenger hunt and answer key.

Related Activities

“Field Study Tools,” Appendix I

Advanced students should be provided with the Plant & Animal Cards in Appendices G and H; and Field Guides listed in Appendix A.

Resources

The Estuary Program, Padilla Bay National Estuarine Research Reserve; Nature, Crafts, Games, and Projects, Hennepin County Parks Reserve District, The Pond Book, Western Education Development Group; listed in Appendix A.

Name ____________________
Date ____________________
Period ____________________

Habitat Observations

1. What is the name of the habitat? (This may be assigned by your teacher)				
2. Describe it using your senses of smell, touch, sight, and hearing.				
3. What evidence of animals do you observe?				
4. What else might live in this habitat?				
5. Why would an animal want to live in this habitat?				
6. Describe the plants you find in the wetland. What special adaptations help them live here?				
7. Draw a plant and an animal that you see.				

Name ____________________
Date ____________________
Period ____________________

Primary Level Scavenger Hunt

In partners, check when you find something that is:

- ❑ blue
- ❑ yellow
- ❑ green
- ❑ red
- ❑ brown
- ❑ black
- ❑ soft
- ❑ smooth
- ❑ good smelling
- ❑ bad smelling
- ❑ slimy
- ❑ hairy

Draw a picture of something interesting to you:

Name ____________
Date ____________
Period ____________

Scavenger Hunt

If you don't know the name, just describe or draw what you find.

Signs of Animals (not human) ____________

Kinds of Bird ____________

Kinds of Plants ____________

Smells ____________

Signs of Human Influence ____________

Rough Things ____________

Smooth Things ____________

Rotting Things ____________

Bird Nest Material ____________

Things That Change ____________

Things That Change Slowly ____________

Name ____________________
Date ____________________
Period ____________________

Scavenger Hunt

Draw pictures and make good observations. Use these pictures to identify these later.

Land Insect	Aquatic Insect
Bird	Mammal Evidence
Fungus	Dominant Plant - Tree or Shrub
Dominant Plant - Herb	Dominant Emergent Plant
Floating or Submerged Plant	Something With A Unique Smell
Seed	Detritus

COPY

Topic B: **Hydric Soils**

Activity **1: Mucking About**

Adapted from Wonders of Wetlands by Brett Eckhardt Slattery, Environmental Concern, Inc.: listed in Appendix A

Grade Level: 3-12 with variations for K-2
Time range: 30 - 60 minutes indoors; 30-60 minutes outdoors
Setting: indoors and outdoors
Subject Area: Environmental Education, Earth Science, Chemistry, Biology
Vocabulary: mottled, gleyed, anaerobic, hydric, organic

Objectives

Students will be able to identify a wetlands soil and describe its physical characteristics.

Methods

Students will create a wetland soil chart for use in the field.
Students will examine wetland soils texture, color and other features.

Teacher Background

Wetland soils, also called hydric soils, are very different from upland soils. They are saturated with water for a long enough period to develop anaerobic conditions. This lack of oxygen leads to the growth of bacteria that carry out anaerobic respiration. Their metabolic processes cause them to release sulfide compounds into the soil. This is the rotten egg smell you encounter when working with wetland soils. These sulfides are also responsible for the very black color of soils containing iron.

Hydric soils can be identified by their color and texture, even if no water is present at the time. The first thing to determine about your soil is its amount of organic matter. Organic soils have lots of dead plant and animal material in it. This is slow to decay because of the lack of oxygen. Organic soil is usually found near the surface and ranges in color from black to dark brown.

Mineral soils have little organic matter present. They may be sandy, clayey, or silty. Sometimes they are gleyed, which means they have a greenish-gray, bluish-gray, or neutral gray cast. They may be mottled with brown, reddish, yellow, or even black spots. These are formed by alternately drying and wetting the soil or by root action. The presence of oxygen at these times allows the spots to oxidize to the lighter color. In soils with lots of iron, the spots are rusty looking. In magnesium laden soils, they are blackish.

Wetland scientists use a Munsell® soil chart to identify soil color, purity and intensity. The color chart in this activity is a very simplified version.

Wetland soil study is as simple as digging a hole and identifying soil color. The hole may have to be only 18 inches deep, or you may have to make it deeper. Don't be surprised if your hole fills with water; that shows the hydrology that makes the wetland and its soil. The presence of water in the soil is how the wetland scientists test for the wetland hydrology characteristic. If water is present in an 18" hole for two weeks of the growing season, it is legal evidence of a wetland.

Materials

copies of the blank color chart and observation chart, scissors, box(es) of 64 Crayola® crayons, shovel or spade, meter/yard stick, pencils
Optional -hand lenses, clear contact paper or laminating materials

Procedures

In the classroom, describe to students the characteristics of wetland soils. Share with them the factors causing these traits.

Hand out the appropriate color chart and crayons. The crayons must be used as directed on the sheets. Then, students must cut out the shaded holes. If you want to keep these charts for future use, they may be laminated or covered with clear contact paper on both sides. Lamination is preferable, since it is more transparent. Show students how to use the charts before you go out into the field.

At the wetland dig a hole about 2 feet deep. It is possible that you may have to dig deeper, if the area has been disturbed or filled with dirt from elsewhere. Examine the inside of the hole at the different depths listed in the soil observation chart. Remove globs of soil to be passed around and examined by students. Look for mottles.

The best way for students to examine texture is to feel the soil. If the soil feels gritty, it has sand in it. To find out if it is clayey, havestudents roll the soil into balls and then try to push a ribbon of soil off the top until it breaks off. The longer the ribbon, the more clay in the soil.

Students should complete the soil observation chart using their color charts to identify soil color.

Back in class, you may wish to discuss the study questions listed in the evaluation portion of this exercise.

Grade Level Variations

For younger students, use the modified chart. For older students, use the evaluation questions for an in-depth analysis of what they observed, either individually or in groups.

Extensions

1) Soil chemistry kits can be used to test soil pH, nitrates, and other factors.

2) If you find clay, make wetland sculptures to take back to class.

3) Take samples of mud back to the classroom to look at under the microscope.

4) Use different types of soils to make paintings. Wet soil can be smeared on the paper. Dry soil can be sorted by particle size, then glued to paper to make dirt art.

Have everyone in the class make a foot or hand mudprint on butcher paper, so you'll have something to remember your trip!

5) Find out how much water is in soil. Weigh out 10 grams of soil. Dry it in an oven for 2 hours at 250 degrees. Weigh the dried sample. To calculate the percentage of water: (10 grams - dry weight)/ 10 grams x lOO= %. Try comparing various samples of soil.

6) To find out how much organic material is in a sample of soil, take the dry soil and cook it in an uncovered crucible until no steam is given off and it is red hot. Reweigh and calculate percentage of organic material: (dry weight - weight after heating)/dry weight x lOO=%.

7) Take mud and water samples back to the classroom and put in different jars. Set up an experiment to test for the effects of sewage and fertilizers on these systems. Leave one or two jars as controls. Put various amounts of fertilizer and/or fresh manure in the other jars. Measure the dissolved oxygen initially and at 24-hour intervals for a few days. Compare the algae blooms. Chart and discuss the results. What are the implications of runoff from farms and lawns?

Take soil samples from other areas, test them in the same way and make comparisons.

Evaluation

Use these questions for discussion and evaluation. Although answers will depend on the local soil, some guidelines are listed.

1. What physical characteristics of the soil did you observe?
   - color observations
   - amount and type of organic matter
   - textural observations
   - mottling color and patterns
   - smell

2. How did the color and texture of the soil change as you went deeper in the hole?
   - more organic material near surface
   - color changes
   - mottling variations

3. Can you find evidence of where your soil particle came from?
   - decaying, organic materials may resemble surrounding plants
   - soil may resemble that of a nearby stream or waterway
   - particles in the mineral soils may be formed from nearby rock

4. Why does the water collect in this area, forming this wetland?
   - bottom of a slope or depression
   - impervious, clayey soil layers

5. Did you find any human-made items or materials? How do you think it got there?
   - litter may or may not decompose and become part of the soil
   - nearby human activities may leave their mark

6. How does wetland soil compare to the upland soil you observe near your home or school?
   - wetness
   - color
   - texture
   - smell

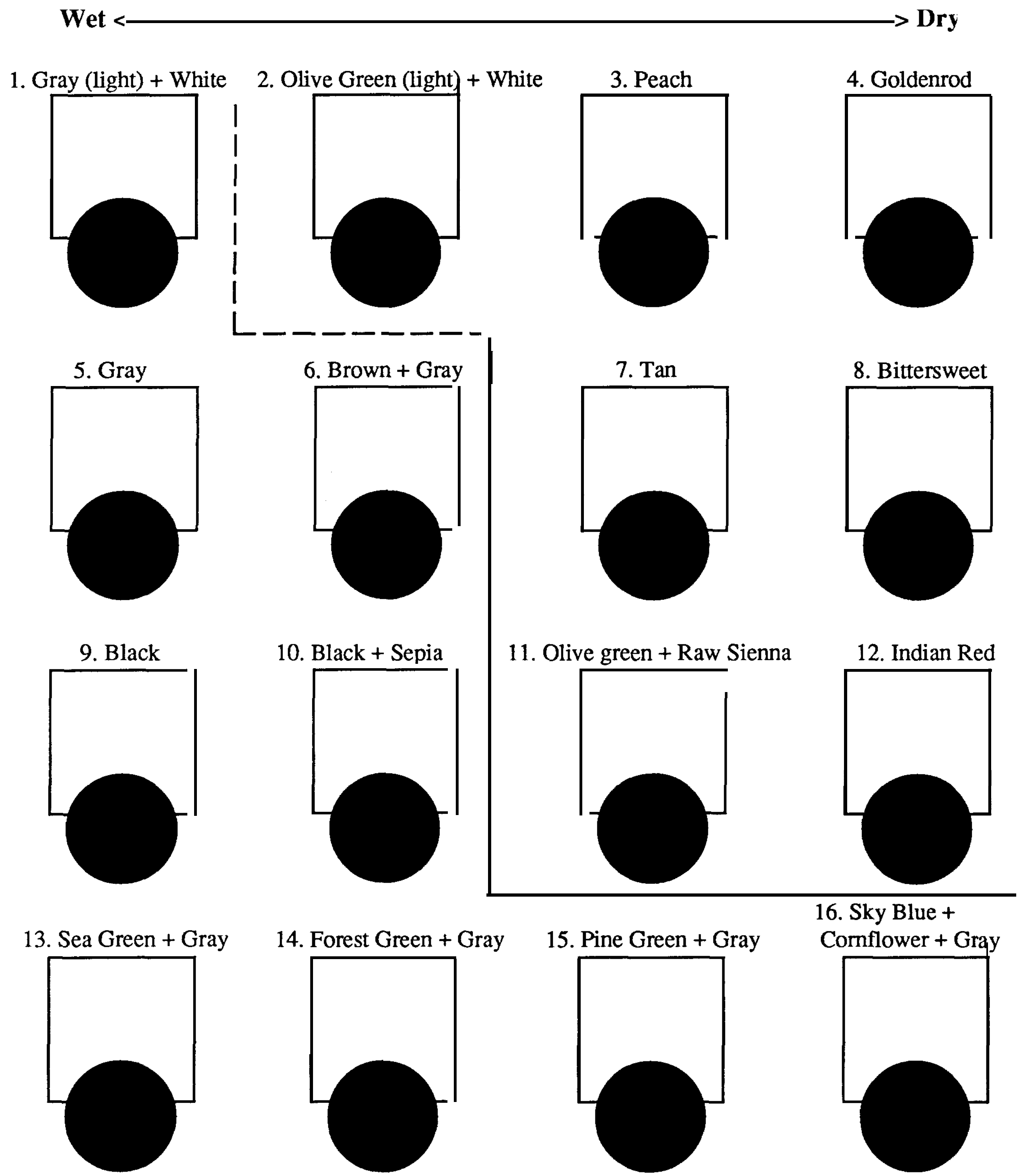
(For more on wetland characteristics, see Unit I.)

Resources

Your local Natural Resource Conservation Service or Conservation District can supply you with soil survey maps for your area.
Water testing kits are available from Hach and LaMotte companies, listed in Appendix A.

Mucking About Wetland Soils Color Chart

Use Crayola® Crayons to color in the squares in the chart below. Press firmly, unless it indicates otherwise. This chart can be laminated after it has been colored. The holes can be cut out before or after laminating. (It will last a little longer if the holes are cut out first, then laminated.)
To use this chart like a wetland professional, hold a handful of wet soil underneath the holes and match the main color of the soil with the box closest in color.
The boxes to the left and below the line are probably wetland soils; the others are not. Colors 14, 15, & 16 are the gleyed wetlands soils. Numbers 4, 8, & 12 can be used to match mottles in the soil.

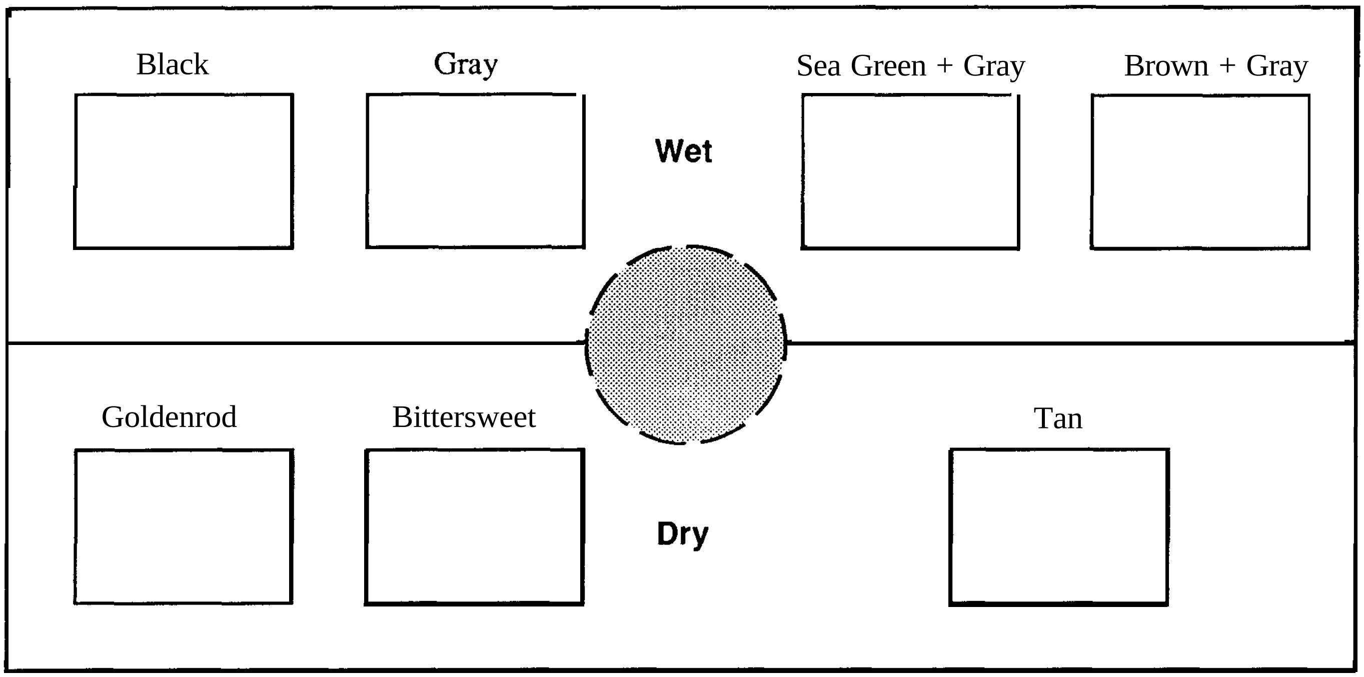


Muckinq About Color Chart
Primary

Use Cravola® Crayons from a box of 64 to color the boxes as directed. Press firmly; when coloring. This chart can be laminated after it has been colored. The holes can be cut out before or after laminating. (It will last a little longer if the holes are cut out first, then laminated.)

Fold the rectangle in half and cut out the circle.

Hold the chart with its hole directly over a sample of soil. If it is a color above the line, it is probably a wetland soil.



Texture / Moisture
Feel the soil. Rub it between your fingers. Is it:
dry, moist, wet, or drippy;
loose or sticky;
slippery?

Soil particles
Draw the size of particles.
Are they:
sand (feels gritty);
clay (feels sticky);
silt (feels slippery);
pebbles;
organic matter?

Other features:
What does it smell like?
Can you identify anything that is living?
Can you identify what the dead, organic material came from?
Do you see any mottles?

Soil Horizon Chart

Depth from Surface	Texture / Moisture	Soil Particles	Color Chart #	Other Features
2” or 5 cm				
4” or 10 cm				
6” or 15 cm				
12” or 30 cm				
18” or 45 cm				

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Topic C: **Who Lives Here?**

Activity **1: Tracking**

This activity was adapted from Wonders of Wetlands by Brett Eckhardt Slattery, Environmental Concern, Inc. listed in Appendix A.

Grade Level:	K-12
Time range:	60 minutes
Setting:	outdoors
Subject Area:	Environmental Education, Biology, Life Science, Art
Vocabulary:	scat

Objectives

Students will learn how and where to look for signs of animals and explore a wetland area to find animals.

Methods

Small groups of students will explore, looking for signs of animals. Then the whole class regroups and relocates the tracks to “read” the clues.

Teacher Background

Animals are hard to see. Some, like birds, are most active in the early morning and evening, taking “siestas” during the heat of the day when we are most likely to be there. Others, in order to survive, protect themselves by being well camouflaged, having the ability to stay motionless, or by burrowing out of sight. Some are “nocturnal,” coming out only at night.

In order to get a glimpse of the inhabitants of a wetland, one must either visit the site at “off’ hours, and/or become adept at “sleuthing.” Learning to read tracks, being alert to browsed tree branch tips, chewed logs, and recognizing sites of predation, can fill in the picture of what happens at a wetland. The following are some animal signs and what they tell us.

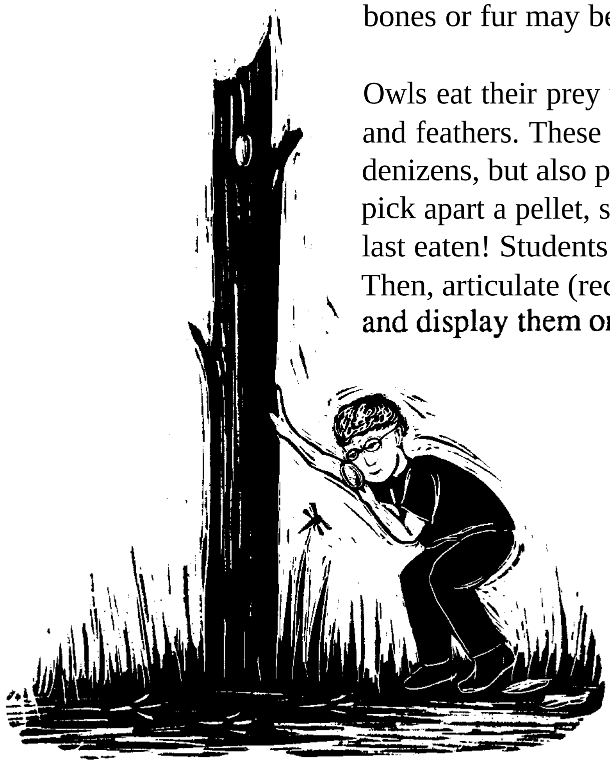
Tracks
Most easily seen in mud or sand. Note the size and arrangement of the track, the number of toes, if claw marks or a tail line is present. Sometimes you can tell which way the animal was moving, and how fast.

Scat
Look for scat (fecal droppings). It is a sure sign of an animal's presence and can tell us what the animal eats. Use a stick or wear gloves to explore in detail.

Trails
Raccoons, squirrels, and opossums may leave claw marks while climbing on smooth bark. Deer, rabbits and field mice create narrow trails and pathways; moles mound up dirt. A muddy slide down a creek bank may be an otter's playground. Muskrats dig tunnels in the mud. Flattened grassy areas may be where a deer bedded down for the night. Wood chips by a tree trunk may indicate a new home for a woodpecker.

Animal Dining Sites
Browsing animals snip off twigs and branches. Beaver leave characteristic chewed branches and small tree trunks. Flat-topped rocks become squirrel "tables" littered with cone and nut shell fragments. Chipmunks and squirrels bury (and later recover) stashes of nuts; look for freshly covered or overturned soil and leaves. Scattered feathers, bones or fur may be the site of a recent killing.

Owls eat their prey whole, then regurgitate the indigestible fur, bones and feathers. These compact "pellets" are not only sure signs of these denizens, but also provide a fascinating study of their diet. Carefully pick apart a pellet, sort out the bones, and try to figure out what it has last eaten! Students can attempt to sort the bones by animal species. Then, articulate (reconstruct) the skeleton, glue it onto an index card and display them on the wall.



Nests

Nests can be found anywhere, though they are usually well hidden. Take extreme care not to disturb active nests. Try to figure out what bird made the nest, looking for clues in the size and materials used, and in its location. A bird field guide often describes its nest.

Using other senses

Most often you will *hear* a snake slither before you see it, or hear a bat's flight overhead. Keep your nose open too, dead remains and skunks have smells you'll never forget!

Materials

field guides to tracks, nests, and scat
magnifying glasses
sticks or sturdy twigs
brightly colored flagging or ribbon
clip boards
journals or paper
pencils/pens

Procedure

Have your group list all of the animals they think might live in your wetland. Asterisk which ones you've already seen, and discuss why you think you haven't seen the others. What clues might they leave behind?

Set boundaries and a time limit. Have students explore in groups of 2 or 3, searching for any clues to an animal's presence. Ask them to place a stick with flagging tied to it where they find a sign, so that it can be easily found later. Remind them to take care not to step on the signs they find.

Regroup at the designated time and place, then travel to all of the clues to ferret out the story written at each scene. Students become interpretors at each field trip stop. What kind of sign is it? What kind of animal made that clue? What was the animal doing? How can you tell?

Grade Level Variations

Younger students can make their own tracks (barefoot or with shoes) in mud or sand. See if others can guess their "story."

Play charades: have students, either individually or in teams, act out the animal that made their track.

Older students can complete the Mammal Study Worksheet in "Taking a Closer Look," Unit IV, Topic D.

Extensions

Make plaster casts of the tracks. Cup a piece of cardboard, make a circle with it around the track, securing it with a paper clip. Pour plaster into the ring and let it harden. Carefully remove the cardboard and turn over your cast.

Compile a book of tracks. Have each child choose one track to draw, including information on the animal, how it lives, what it eats, what preys on it, and any other information deemed valuable.

Have students measure tracks found and categorize them.

Evaluation

List 5 signs of the presence of animals and write a sentence for each describing something that you can learn from each sign.

Keep a journal of the trip findings and write a story about the trip including conclusions about the tracks found.

Write an interpretive brochure describing the various animal signs along the trail.

Related Activities

"Taking a Closer Look," Unit IV, Topic D; "Field Study Tools," Appendix I

Resources

Animal Tracks of the Pacific Northwest, Karen Pandell and Chris Stall; Mammal Finder, Ron Russo and Pam Olhausen; Animal Tracks, Roger Tory Peterson. All are listed in Appendix A.

Topic C: **Who Lives Here?**

Activity 2: **Transect Study**

Grade Level: 6-12
Time range: 60-90 minutes indoors, 60 minutes in field
Setting: indoors and outdoors
Subject Area: Environmental Education, Mathematics, Earth Science
Vocabulary: elevation

Objectives

Students will use qualitative and quantitative methods to observe living organisms.

Students will communicate information they gathered by creating a field guide.

Methods

Students will gather information about organisms in a wetland using a transect study. A field guide will be produced as a demonstration of learning. Advanced students may supplement their transect and guide with a map of the wetland or slope study information; see Activities 3 and 4 in this Topic.

Teacher Background

If at all possible, visit the wetland site ahead of time. This will give you the time to become familiar with safety concerns, the lay of the land, and plants and animals that are likely to be seen. You could also collect representative plants for comparison and to aid in identification. Remember to only collect small amounts of the commonplace. If you want plant specimens to last, consider pressing them. Instructions are included in Field Studies Tools, Appendix I. Plants can also be photocopied and a key made for each group to use.

Do not feel as if you have to be able to identify every plant and animal that students find. Use the plant and animal cards and other field guides as references. Discover along with the students. You'll be a model for lifelong learning.

Materials

clipboards (or other rigid writing surface, like cardboard or manila folder), observation sheet, stakes, ball of heavy twine or string, brightly colored marker or flagging tape, field guides or copies of plant and animal cards

Optional - binoculars, shovels, spoons, buckets, collecting jars, camera

Procedures

Tell your students that the purpose behind their study will be to produce a field guide. Decide the audience for which the field guide is intended. Have them brainstorm what should be in their guide. The guide may include:

- directions to the wetland;
- brief introduction to the wetland including description, type, owner, surrounding uses;
- historical uses and photographs;
- map, from an outside source or from Activity 3;
- list of plant species present;
- list of animal species present;
- transect drawing including plants identified and, for advanced students, information on slope - see Activity 4;
- habitats within the wetland;
- observed animal behaviors;
- sketches of animal signs;
- bird identification information;
- water flow patterns;
- trails in or around wetland;

- a general information section describing characteristics and the importance of wetlands;
- photographs or drawings.

This would be a good time to divide the students into working groups to collect the information and materials they will need.

This is one of the best times to make a trip to a wetland, since the students will have a purpose in being there. They will collect the best information if given a structured study method. The transect study is a good way to have students survey the plant and animal life.

A transect study is a method used to evaluate the landscape of a natural area. It entails recording observations at regular intervals along a straight line and using the information to produce a map of the site.

Run a straight line of string across a wetland area into the upland. Avoid crossing open water. Mark off with flagging tape or brightly colored markers at intervals of 10 to 15 feet. It may be easier to mark the string before you go out into the field.

Give each interval a number and assign a group of students to each interval. Each group marks off a square on one side of the line. Squares may be made by measuring with a meter stick; using a coat hanger bent into the shape of a square; or four, l-meter pieces of PVC pipe assembled in a square with four elbow connectors.

Each group records information about plants and animals. (A sample data sheet follows this activity.)

Plant information should include:
1. kind or description of plants (identification by species is nice but not necessary); especially with younger students, samples of plants can also be taped to a piece of cardboard and taken back to class for identification;
2. numbers of plant types, relative to other plant types - e.g. 90 percent grasses and 10 percent shrubs;
3. approximate height of the plants.

Animal information should include:
1. kind or description;
2. evidence, such as nests, webs, scat, tracks, etc.;
3. numbers;
4. where animals are found in relation to the plants around them.

When this recording is finished, a brief sketch of the composition of the segment can be made on the back of the data sheet. The sketch can be done in two parts; a profile arrangement (side view) or a plan view (top view). When the entire transect has been sampled, return to a central meeting area or the classroom and plan how to combine all this data into one picture of the whole transect.

Draw the transect on a long sheet of shelf or butcher paper. Have each group draw their segment in the proper place on the transect. When it is finished the transect should look similar to the actual line run outside. This is a good way to show the plant community structure of a wetland and how the plants vary according to their elevation.

Using the information gathered from the transect and from other sources, allow the class time to produce the guide. Encourage them to use as many resources as you can offer them: computers, typewriters, drawing materials, etc.

When completed, photocopy the field guide for each student plus extras for distribution. Display their work proudly. Hang the transect drawn on butcher paper to advertise their publication. Have a copy put in the school or community library. Give copies to other classes, the PTA, or the school board.

Take photographs of students collecting data and making the guide, for display on poster board in a prominent place in the school or as a local newspaper feature article.

Grade Level Variations

Advanced students may include photography, slope studies, and mapping.

Younger students may just focus on one plant or animal. For example, have each one color a picture of a plant or bird they've seen.

Younger or special education students may work in groups of four, with an adult, making lists of animals and plants found. They may draw pictures and write descriptive words. Give each group a clip-board where they can list all they find, to be shared with the class later.

Extensions

Students can take slides and produce a slide show about the wetlands. Show the slides to other classes, the PTA, or community groups.

A simple presentation can be developed to go with the field guide. Present it and the guide at Parent's Night or to other classes.

A plant collection could be assembled to accompany the field guide.

Interested students may want to study seasonal changes at the wetlands. Bird identification and counts, plant community changes, and insect surveys are all excellent topics.

Evaluation

Have students develop their own criteria to evaluate their guide.

Related Activities

Plant Cards, Appendix G; Animal Cards, Appendix H; Field Study Tools, Appendix I; "Mapping," Unit IV, Topic C, Activity 3; "Slope Survey," Unit IV, Topic C, Activity 4

Resources

Sight levels available at hardware stores.

Quadrat - Transect Data Sheet

Team members: ____________________________

____

Station #______________

Size of Quadrat_________

Date__________________

Team member tasks:

1) **Recorder:** record information on the data sheet;
2) **Identifiers:** use the guides to identify or write descriptions for later use in identifying plants and animals or animal signs;
3) **Counters:** count the number and note density of populations;
4) **Sketchers:** make a rough sketch of plant shapes, attach to report.

Organism	Description	#Found	Sketch
1.			
2.			
3.			
4.			
5.			
6.			
7.			

Topic C: **Who Lives Here?**
Activity **3: Map Making**

Grade Level: 3-12
Time range: l-2 hours field trip and follow up
Setting: indoors and outdoors
Subject Area: Environmental Education, Mathematics, Earth Science

Objectives

The student will be able to take appropriate measurements and create a map of a wetland.

Methods

Students create a map of their wetland site.

Materials

paper, ruler, colored pencils or crayons, pencils and erasers

Procedure

This is an activity that can vary greatly in sophistication and degree of difficulty. Depending on the age and interests of a group, the map project can range from a general sketch of the wetland to a scale map made using compass techniques. Maps can be made showing different things, for example:

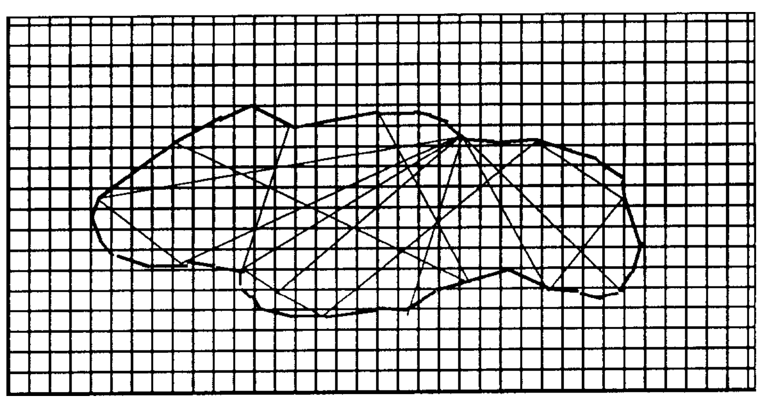
- the entire wetland area, using symbols to represent wetland plants, open water, trees, etc.
- a specific map of the different types of plant and animal communities, drawing in what you found in each place.

If you are going to make a map to scale, you should to determine the length of each student's pace and set up a scale on the map (1" = so many paces or so many feet). The best method, however, is to use a long measuring tape and marking stakes. Put about 10 stakes at selected points around the edge of the wetland. Then measure the distance between each stake and all the others using the tape (and boots if necessary). With these measurements, make a rough sketch of the pond on graph paper. Compare the sketch with the actual pond and draw in the irregularities along the shoreline.

You may want to call a wetland scientist to assist students in determining the edge of the wetland. Remember it is determined by the presence of appropriate hydrology, hydric soils, and hydric plants. Refer to UNIT IV, Topic B: Hydric Soils, Activity 1: "Mucking About" and "National Range of Indicators" from National List of Plant Species That Occur in Wetlands, 1988.

From the completed scale diagram, you can determine the area of the wetland by counting the number of squares and parts of squares that fall within the diagram's outline. Multiply by the scale for one graph paper square. For example, if one square on the map equals 100 square feet then 3 squares = 3 x 100 square feet or 300 square feet.

For greater accuracy, take compass readings from stake to stake as you measure. Transfer the compass directions (as well as distances) to the graph paper using a protractor.



Extensions

Contact your county public works department, a builder, surveyor or road construction company in your community. Ask if they will bring out their survey equipment and show students how the equipment can be used to create very accurate maps.

Evaluation

Use the map produced by the students as their evaluation.

Related Activities

"Slope Survey, "Unit IV, Topic C, Activity 4; and "Wetland Impacts," Unit IV, Topic D, Activity 1.

Resources

Your county planning or public works departments may be able to help you with maps and expertise.

Topic C: **Who Lives Here?**

Activity 4: **Slope Survey**

Grade Level: 6-12
Time range: 60-90 minutes indoors, 60 minutes in field
Setting: indoors and outdoors
Subject Area: Environmental Education, Mathematics, Earth Science
Vocabulary: elevation

Objectives

Students will be able to take measurements and create an elevation profile using homemade range and sighting poles.

Met hods

Students make equipment and use it to measure the elevation changes in a wetland.

Teacher Background

This technique is used to chart elevation changes along a line, such as a transect line. Since higher ground supports very different life than lower and therefore, wetter areas, it is helpful to know the elevation changes along your transect.

Go over the techniques with students. Practice a series of measurements and see if they can do it, before having them strike out on their own.

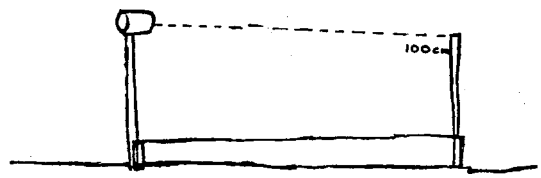
Materials

Teams of three students will each need: a meter stick, a range pole, a sighting pole, two stakes, heavy twine or string, a clipboard, pencil, a copy of "Elevation Worksheet," and a hammer or rock for pounding stakes,

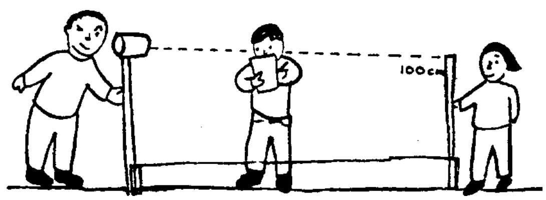
Procedures

This technique involves placing poles at 2-meter intervals along your line and sighting the difference in elevation. The directions must be followedclosely, (it is a good idea to practice in the school yard before going to the wetlands).

Place a straight line across the area you want to measure. Use heavy twine and stakes for accuracy.

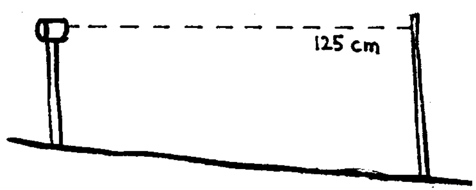


Choose a starting place. This elevation will be O-meters. Pound the sighting pole into the bottom guideline. Hold it exactly vertical (a level should be used for this). One person should be checking for vertical while the other takes a sighting. The third person measures 2-meters down the line and holds the range pole exactly at that point.

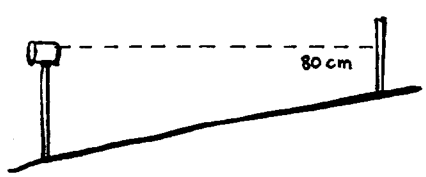


If the reading is exactly 100 centimeters the ground is level.

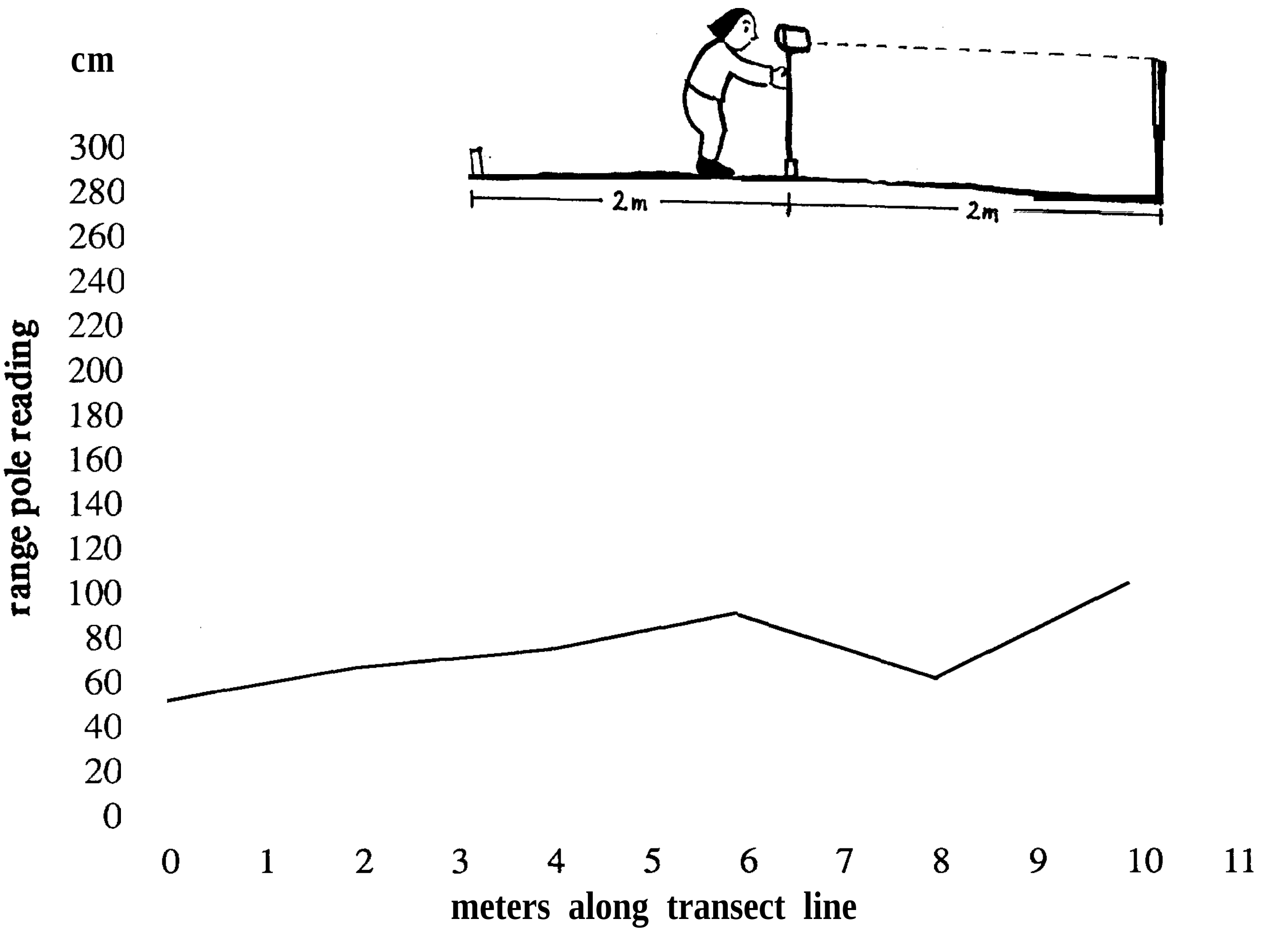
If the reading is higher, say 125 centimeters, the ground slopes down. To calculate the elevation change: 100 cm - 125 cm = -25 cm. This means the ground is 25 centimeters lower than the original point. Negative results mean lower.



If the reading is lower, say 80 centimeters, the ground slopes upward. To calculate the elevation change: 100 cm - 80 cm = 20 cm. This means the ground is 20 cm higher. Positive results mean the ground is higher.



After the first measurement, students move the sighting stake to the point the range pole was at the previous reading. Forget all the other measurements and start over with the sighting stake at 0 elevation. Repeat the process along the entire transect line, charting elevation changes the entire way. An example of this follows.



Grade Level Variation

Younger students could only do this activity in partnership with older students.

Extension

Strike a number of different lines and measure. Use a compass to find their placement and use the profiles to create your own topographic maps of your wetland.

Evaluation

Evaluate the quality of the students' elevation profiles.

Related Activities

"Transect Study," Unit IV, Topic C, Activity 2;
"Map Making," Unit IV, Topic C, Activity 3

Resources

"Marshes, Estuaries, and Wetlands," an *Ocean Related Curriculum Activities* (ORCA) curriculum booklet, listed in Appendix A.

If you don't want to make your own equipment, inexpensive handheld levels are available from Forestry Suppliers, Inc., listed in Appendix A.

Topic D: **Taking a Closer Look**

Activity **I: Wetland Impacts**

Grade Level: 6-12
Time range: 30 minutes before trip; l-3 hours for trip; 30-60 minutes after trip
Setting: indoors and outdoors
Subject Area: Environmental Education and Issues, Biology, Community Service, Earth Science, Life Science, Social Studies
Vocabulary: hydrology, mitigated

Objectives

Students will be able to complete a critical evaluation of a wetland's ability to perform its functions.

Methods

Groups of students will examine the various components of the wetland environment including the hydrology, water quality, wildlife, and plants. They will observe potential influences on the wetland. Worksheets will guide them through each component.

Teacher Background

This activity is designed to help students extend their learning about wetlands. It requires them to apply their previous knowledge of wetland functions and values to make a critical examination of a wetland.

Materials

"Field Study" and "Wetlands Evaluation" worksheets (included in this activity) for each group, (materials are listed on each sheet)

Optional - camera, video camera, maps or aerial photographs

Procedures

Choose your wetland site. It may be a site you visited previously. Before going, review wetlands functions and values with your class. Describe your expectations for the site survey. Divide the class into groups of 2 to 4 students. If you have all day at your site, have every group complete all the worksheets. If time is short, divide up the worksheets among the groups.

Go on your trip and allow adequate time for students to complete their tasks. After the trip, have each group present their findings to the group. After examining all the observations, give groups or individuals time to complete the Wetlands Evaluation Sheet.

Ask the class if they can see ways to improve the wetland. Are there areas that could be cleaned up? Are there areas that could be vegetated? Are there human uses at or near the wetland? Could people relocate or mitigate for these uses?

Encourage students to collect more data and solicit the opinions of experts and the wetlands neighbors. Students may want to choose an issue and research it.

Grade Level Variations

For younger students, consider getting parents involved by having them each lead a group through the activity. Or, contact your local high school and see if you can get high school students to lead the groups. You may even be able to team with a high school teacher and mesh your activities with their study of wetlands.

Extensions

Students can make a plan to improve the quality of the wetland. Get help from local, county, or state agencies. Submit the plan to the property owner and appropriate government groups.

Contact the WA Department of Fish & Wildlife for information and grants for landscaping for wildlife. Use these to complete an enhancement project on your wetland.

If equipment is available, students may perform water quality tests, such as pH, dissolved oxygen, turbidity, etc.

If you have a number of wetlands, have other classes do the same survey at those sites. Develop presentations to share with all the classes. Start a book of local wetland sites with their written observations.

Evaluation

Complete the activities and evaluation sheet.

Related Activities

See Unit II for activities on Wetland Functions and Values.

Resources

WA Department of Fish & Wildlife in Olympia.
This activity is adapted from "Wetlands and Wildlife" - Alaska Wetlands Curriculum; listed in Appendix A.

Name: ________________________________
Date: ________________________________

Wetland Basic Information Worksheet

Materials: calendar, clock/watch, thermometer, pencil, paper, labels
Optional - topographic map, colored pencils

Time Arrive: __________________ **Time Leave:** __________________

Students in Group: ____

____

____

Weather Data:

Cloud Cover (% of sky covered)________________________________

Air Temperature:____

Water Temperature: ____

Type of Wetland:____

Location of Wetland:____

Map / Sketch:

Include dimensions of acreage, areas of open water (ponds, lakes, channels), areas that have plants and types of plants (trees, shrubs, low-growing plants, plants growing in the water), a size scale, a legend, and geographical features.

Name: ______________________________
Date: ______________________________

Wetland Hydrology Worksheet

Materials: topographic map, compass, two stakes, block of wood, stopwatch, meter stick, string, paper

1. **Locate the wetlands on your topographic map.** Draw the wetlands onto a blank sheet of paper, using the topographic map for reference. Don't trace the map - the tracing will be much too small. Draw an enlarged picture on a separate piece of paper.

2. **Where does the water in this wetland come from?** Draw the incoming water source (called an inlet) on your map.

3. **Where does the water in the wetland go?** Draw the outgoing water (called an outlet) on your map.

4. **Show how water flows through the wetland.** Mark the direction of flow with arrows. Are there deep channels in any ponds or lakes? Show the channels on your map.

5. **Measure the water current.**
   - Choose a fairly straight stretch of flowing water.
   - Place one stake in the ground next to the stream.
   - Place a second stake exactly 10 meters downstream.
   - Post one person at each stake.
   - A third person walks about 3 meters upstream, carrying the block of wood and stopwatch. This person gently places the wood in the water.
   - The person at stake #l should yell "start" when the wood reaches stake #l.
   - The third person should start the stopwatch.
   - The person at stake #2 will yell "stop" when the block reaches stake #2 and the stopwatch should be stopped. Record the time.
   - Divide the time in seconds by 10 meters and you will have the current speed (or velocity) in meters per second.
   - Repeat the process two more times. Record the speed each time.
   - Find the average speed.
   - If possible, choose a number of other locations to test the current. Mark all the locations on your map.

6. **Map standing water in pools, ponds, lakes, and wet meadows.** Measure the depth of the water at the edge and middle (if possible) in each different type of wetland.

7. Do you think water would be stored in this wetland if the nearest stream or river flooded? Why or why not?

8. Do you see any indication that the water was higher than it is now? (Look for stains on trees, leaves, and debris deposited on vegetation, and soil that was left as the water went down.)

Name: ______________________________
Date: ______________________________

Wetland Water Quality Worksheet

Materials: topographic map, compass, thermometer, colored pencils, paper

1. Locate the wetlands on your topographic map. Draw the wetlands onto a blank sheet of paper, using the topographic map for reference. (Don't trace the map -the tracing will be much too small.) Draw an enlarged picture on a separate piece of paper.

2. Map the flow of water in the wetland. Show the location of any channels, ponds, lakes, or areas of standing water. Use arrows to show the direction of flow.

3. Observe the water flowing through the wetland. Is it moving fast or slow?

4. On your map, color areas where the water is muddy. Does the water get less muddy as it flows through the wetland?

5. Look for fine particles on the bottom, especially around vegetation. Do you see any sediments that have settled out of the water in the wetlands. Color these areas a different color.

6. Choose five different sites. Record the following information about each site:

- Water Temperature:
- Cloudiness/Turbidity (suspended sediment particles):
- Color:
- Debris or trash seen:
- Observations of plant and animals:
  (What kinds, how many, behavior, etc.)

COPY

Name: ______________________________
Date: ______________________________

Wetland Bird Study / Wildlife Habitat Worksheet

Materials: binoculars or spotting scope, paper, pencils, clipboards, field guide to birds

Take a quick look around the wetland. How many birds do you see? Move a short distance away from the rest of the class and sit where you can see most of the wetland. Sit as quietly as possible. Try not to move a muscle. Listen, and look carefully.

1. Do you hear any sounds? Are any of these bird songs or calls? Try to see the bird(s) making each sound.

2. Use your binoculars or spotting scope to scan the water and edges of the pond carefully. Then walk quietly along the edge of the wetland. Describe any birds you see.

3. Look closely for feathers, tracks, nests, egg shells, and places where birds have probed in the mud. Describe any signs of birds that you find.

4. Find an area with small or large shrubs near the water. Sit down quietly and repeatedly make a quiet “pshhh-pshhh-pshhh” sound, like you were saying “shh” to someone, Make the sound for 15 - 30 seconds, then be perfectly quiet for 1.5 - 30 seconds. Then repeat the sound. What happens?

5. Make a map of the wetland showing where you saw birds or signs of birds. Label the places to show where you saw each kind of bird. Did you see more of one kind of bird in one area than another? If so, why might that be?

6. Try to identify each of the birds you saw with a bird field guide.

7. How many birds did you see in all?

8. How many different kinds of birds did you see?

9. Draw a detailed picture of the one you liked the best.

Name: ______________________________
Date: ______________________________

Wetland Plant Study / Wildlife Habitat Worksheet

Materials: hand lens, paper, pencil, book on wetland plants, vials, meter stick, string, four stakes, crayons, labels

1. What percent of the wetland is covered by plants?
(a) O-5% (b) 5-25% (c) 25-50% (d) 50-75% (e) 75-95% (f) 95-100%

2. How many different types of plants do you see?

3. Are there any plants living in the middle of the wetland?

4. Are there any plants growing along the shores of the wetland? Take a closer look at one of these plants. Does it have roots? stems? leaves?

5. Are there any plants that seem to be growing out of the water? What parts of these plants are above water - roots, stems, leaves or flowers? What parts are underwater?

6. Are there any plants living completely underwater? Do they have roots? stems? leaves?

7. Use your hand lens to look very carefully at some wetland plants. Draw a detailed picture of a single leaf from five different plants. What pattern is formed by the veins? Are the edges of the leaf smooth? Does the stem or leaf have hairs on it? Does the leaf have a stem?

8. Place one of the leaves underneath a sheet of paper and rub crayon lightly over the paper. How does this crayon print compare to your drawing?

9. Look at the underwater stems and leaves of plants. Can you see any insects or other animals on the stems and leaves? Describe them.

10. Mark out a one meter square along the shore with strings and stakes. Count how many kinds of plants are in that area. Estimate percent of coverage of each kind of plant. Estimate percentage of bare ground.

11. Do you think there are any plants you can't see with the naked eye? Collect one vial of water from still water and one vial from flowing water. Take them back to class to view under a microscope to find out if there are any plants that you cannot see with the naked eye.

12. Draw a vegetation map of the wetland that shows which plants are most abundant in different parts of the wetland. When you return to class, try to identify the different kinds of plants you found.

13. Take one last look at the wetland. How many different kinds of plants do you see now?

Name: ______________________________
Date: ______________________________

Wetland Mammal Study Worksheet

Materials: paper, pencil, book on animal tracks
Optional - plaster of Paris, mixing dish & spoon, strip of cardboard and paper clip

1. You are looking for mammals or signs of mammals. Do you see anything moving? Any eyes looking at you from amidst the grasses? Describe what you observe.

2. Do any plants look like they have been dug up or bitten off? How about the herbs? grasses? shrubs? Look at the underwater plants.

3. Do you see any holes on the bank near the wetland? If so, how big are the holes (diameter)? What could be inside?

4. Do you see any piles of sticks, grasses, or branches? If so, what might have made these?

5. Walk carefully along the edge of the wetland. Can you find any tracks in the mud or sand, If so, how many different kinds do you see?

6. What kind of animal might have made the tracks?

7. Pick the clearest, best track to study further.

- How long is the animal's foot?
- How wide?
- How far is it between its front and hind feet?
- Does the animal have claws? hooves?
- How many toes are on its front feet?
- How many toes are on its back feet?
- How deep is the track?
- Does the animal weigh very much?
- Does it weigh more or less than you?
- Can you figure this out by measuring how deep the track is? Why or why not?
- Optional - Make a plaster cast of the track to take back to class!

8. On a separate piece of paper draw a map of the wetland showing where you found the different signs of animals. Are there more signs of animals in one area than another? If so, why might this be?

9. How could you see more of the mammals that live in this wetland?

10. How many different types of mammals did you see?

11. How many mammals did you see signs of?

Name: ______________________________
Date: ______________________________

Wetland Evaluation Sheet

I. Checklist of Wetland Functions

________	Fish Habitat	________	Flood Water Storage
________	Bird Habitat	________	Filter Sediment/Improve Water Quality
________	Mammal Habitat	________	other ( )

II. Human Uses

Type of use For which you found evidence	Potential use: be specific	How could use affect wetland functions?
Education		
Recreation		
Aesthetics		
Food		
Transportation		
Waste Dumping		
Pollution		
Filling		
Draining		
Other:		
Ideas for Improving Wetland:		

Topic E: **Stream Quality Survey**
Activity **I: Stream Insects & Crustaceans**

Grade Level : 3- 12, K-2 with variations
Time Range: 60 - 90 minutes
Setting: outdoors
Subject Areas: Environmental Education & Issues, Biology, LifeScience, Community Service, Earth Science
Vocabulary: macroinvertebrate

Objectives

Students will be able to judge the health of a stream corridor using a macroinvertebrate survey and various qualitative factors.

Methods

Students will sample a stream bed for macroinvertebrates using a kick net. They will also evaluate the stream corridor for activities and factors related to the health of a stream.

Materials

kick net (see Appendix I), small containers (ice cube trays work well), spoons, eye droppers, hand lenses, copies of “Stream Quality Survey” & “Stream Insects & Crustaceans,” clipboards or cardboard for a writing surface (optional)

Teacher Background

Macroinvertebrates, meaning “large animals without a backbone,” make up the majority of animal life in a stream. These critters are usually insects and crustaceans. (In this case “large” means they can be seen without a microscope.) Many spend most or all of their life in the stream bed. Because they live in the stream, they also are an indicator of the water quality of the stream.

An inventory of aquatic life serves as a better water quality indicator over time than a "one moment in time" chemical test. The chemistry may change from day to day, while the life in the stream is an indicator of the longer term water quality.

You can think of an aquatic macroinvertebrate survey as a "movie" of a stream, whereas a chemical test is simply a "snapshot photograph." However, the more frequently chemical tests are conducted, the better the picture is developed of stream quality.

Additional information on aquatic insects can be found in Animal Cards, Appendix H.

Procedures

At the stream site, place the kick screen flush with the stream bed in 3 - 12 inches of water. It is best if the water isn't moving too fast and the bed consists of cobble-sized stones or larger. Gently shuffle your feet through the rocks, kicking up any loose material. This is sometimes called the "bug dance." You can also wash off the rocks by rubbing them in the water with your hands. Do this in a l-meter square area directly upstream from the net.
Remove the net and collect all the organisms trapped in it. Place them in containers with stream water for students to count and identify. They should use the "Stream Quality Survey" form to record their data. Have studentsexamine the stream for the other parameters listed on the back of the form.

When finished, make sure students come up with a water quality rating as directed on the front of the survey sheet.

Grade Level Variations

Younger students can work in groups led by adults. Insects can be collected for them and if a field trip is prohibitive, can even be caught and brought back to the classroom. If you do this, be sure to keep organisms separated or they may eat each other. Also, return them to the stream after your survey, modeling the importance of all levels of life in an ecosystem.

Older students should be able to make their own kick nets and perform the sampling with little direction (see Appendix I).

Extensions

1. Observe the moving gills of some insects along the sides of their body. A DiscoveryScope@, magnifying glass or disecting microscope will help see this process. Count the respiration beats in cold

water vs. warmer water. Note how it changes in response to temperature and changes in the dissolved oxygen content of the water. *(Faster breathing is necessary in warmer water and water with low dissolved oxygen.)*

2. Consider monitoring a stream monthly or over many years. Students can assemble the data into an ongoing database or report. Have them analyze data for changes in the stream's water quality. Contact your local public works department to see if they have a standardized reporting format or use for such data.

3. Take plastic bags and gloves on the field trip and pick up trash and litter when at the stream. Have students analyze what kind of trash is being found and what are its possible sources.

4. Brainstorm what could be done to improve this stream's health. Develop action projects using <u>Environmental Issues Analysis & Investigations</u> by Hungerford & Volk, as a guide (Appendix A). Organize stream restoration projects, such as cleanups, bank stabilization and revegetation, or salmon enhancements. Learn about good home conservation practices to protect streams. Have students help educate their community about how to care for streams.

5. Research the effects of various pollutants on stream health. Phosphates, nitrates, and sewage are all common pollutants. Thermal pollution, acid rain, siltation and toxic contamination may also be affecting your stream.

6. Test various places along the stream. Sites might include above and below wetlands, storm sewers, dams, construction or logging sites, and other areas of human activity. If testing near city or farm waste sources be extra careful to wear gloves and to wash hands after touching stream water.

7. Write a history of your stream. Imagine how the surrounding land uses have changed over the last 100 years.

8. Map the watershed of your stream. Use topographic maps to assist you. Identify drainage patterns, land uses and possible trouble spots.

9. Research the erosion control regulations regarding construction and logging practices, and the Best Management Practices (BMP's) for agriculture. How are these activities supposed to protect streams?

10. Create a specimen set of insects for your school. To preserve organisms place each in small clear vials with a mixture of rubbing alcohol and water at a 1: 1 ratio (1 part alcohol to 1 part water).

Evaluation

Evaluate the quality of students' survey sheets. Ask them to describe the many factors that can tell us about the health of a stream.

Related Activities

Making a kick net is described in Appendix I. Unit IV, Topic D, Activity 1, "Wetland Impacts" also involves evaluating an area's health.

Resources

Izaak Walton League of America, Project G.R.E.E.N., DiscoveryScope®, "Save Our Streams Program;" Environmental Issues Analysis & Investigations, by Hungerford & Volk; all listed in Appendix A; Animal Cards, Appendix H

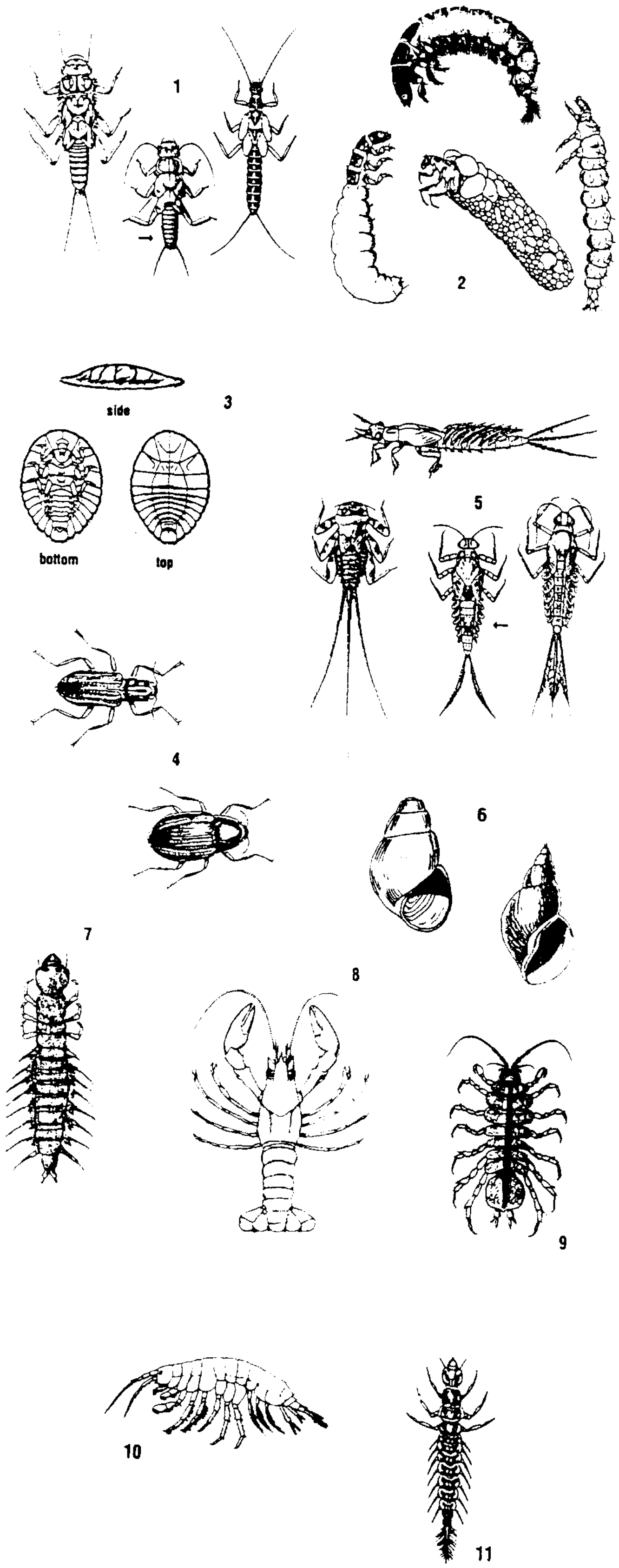
Thanks to the Izaak Walton League of Americafor allowing use of this activity and for their ongoing leadership in protecting streams.

Stream Insects and Crustaceans

From the Izaak Walton League of America

Group One Taxa

Pollution sensitive organisms found in good quality water.



1. Stonefly: *Order Plecoptera.*
   l/2”-1 l/2”, 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)

2. Caddisfly: *Order Trichoptera.*
   Up to 1”, 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on lower half.

3. Water Penny: *Order Coleoptera.*
   1/4”, flat saucer-shaped body with a raised bump on one side and 6 tiny legs on the other side. Immature beetle.

4. Rifle Beetle: *Order Coleoptera.*
   l/4”, oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5. Mayfly: *Order Ephemeroptera.*
   l/4”- l”, brown, moving, plate-like or feathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.

6. Gilled Snail: *C/ass Gastropoda.*
   Shell opening covered by thin plate called operculum. Shell usually opens on right.

7. Dobsonfly (Hellgrammite):Family *Corydalidae.*
   3/4” - 4”, dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

Group Two Taxa

Somewhat pollution tolerant organisms can be in good or fair quality water.

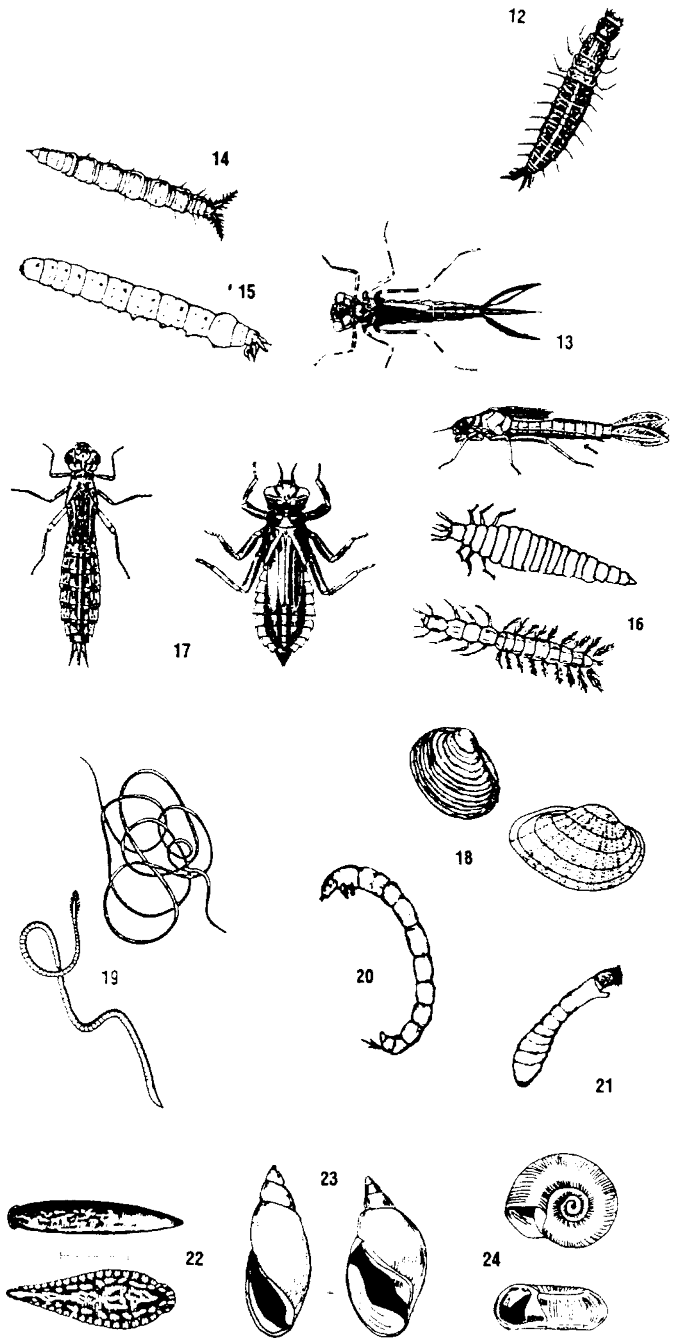
8. Crayfish: *Order Decapoda.*
   Up to 6”, 2 large claws, 8 legs, resembles small lobster.

9. Sowbug: *Order Isopoda.*
   l/4”- 3/4”, gray oblong body wider than it is high, more than 6 legs, long antennae.

10. Scud: *Order Amphipoda..*
   l/4”, white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

II. Alderfly larva: *Family Sialidae.*
   1” long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks.) No gill1 tufts underneath.

Group Two Taxa continued



12. Fishfly larva: Family Corydalidae.
Up to 1-l/2 " long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13. Damselfly: Suborder Zygoptera.
l/2" - 1" 1, 6 thin, hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body.

14. Watersnipe Fly Larva: family *Athericidae (Atherix).*
1/4"- 1 ", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns " at back end.

15. Crane Fly: Suborder Nematocera.
l/3"-2 ", milky, green, or light brown, plump caterpillar-like segmented body, 4-finger like lobes at back end.

16. Beetle Larva: Order Coleopfera.
1/4 "-1 ", light-colored, 6 legs on upper half of body, feelers, antennae.

17. Dragon Fly: *Suborder Anisoptera.*
1/2 "-2 ", large eyes, 6 hooked legs. Wide oval to round abdomen.

18. Clam : *C/ass Bivalvia.*

Group Three Taxa

Pollution tolerant organisms can be in any quality of water.

19. Aquatic Worm: *C/ass Oligochaeta.*
1/4"-2 ", can be very thin; thin worm-like body.

20. Midge Fly Larva: *Suborder Nematocera.*
Up to 1/4 ", dark head, worm-like segmented body, 2 tiny legs on each side.

21. Blackfly Larva: *Family Simulidae.*
Up to 1/4 ", one end of body wider. Black head, suction pad on end.

22. Leech: *Order Hirudinea.*
1/4" - 2", brown, slimy body, ends with suction pads.

23. Pouch Snail and Pond Snails: *Class Gastropoda.*
No operculum. Breathe air. Shell usually opens on left.

24. Other snails: *C/ass Gastropoda.*
No operculum. Breathe air. Snail shell coils in one plane.

Save Our Streams

Stream Quality Survey

October 1994

Name of reviewer: ______________________

Date reviewed: ______________________

Data sent to: ______________________

The purpose of this form is to aid you in gathering and recording important data about the health of your stream. By keeping accurate and consistent records of your observations and data from your macroinvertebrate count, you can document changes in water quality. Refer to the SOS insect card and monitoring instructions to learn how to trap and identify stream macroinvertebrates and how to complete this form.

Stream ______________________ Station # __________ # of participants __________

County ______________________ State ________ Group or individual ______________________

Location ______________________

Weather conditions (last 72 hours) ______________________

Date ______________ Average stream width ______________ ft. Average stream depth ______________ ft.

Start Time ________ End Time ________ Flow rate: High ________ Normal ________ Low ________ Negligible ________

If conducting rocky bottom sampling, select a riffle where the water is not running too fast, the water depth is between 3-12 inches and the bed consists of cobble-sized stones or larger. Monitored riffle area (3' x 3' square) ________ Water depth ______ in., in riffle Water temperature ________ F° ? C° ? Take 3 samples in the same general area. Count each separately and report the highest-scoring sample below. Sample ________ reported of 3.

If conducting muddy bottom sampling, take the required number of scoops from each habitat type: steep banks/vegetated margin (10 scoops), woody debris with organic matter (4 scoops), rock/gravel/sand substrates (3 scoops), and silty bottom with organic matter (3 scoops).

MACROINVERTEBRATE COUNT

Use the stream monitoring instructions to conduct a macroinvertebrate count. Use letter codes (A = 1-9, B = 10-99, C = 100 or more) to record the numbers of organisms found in a 3 foot by 3 foot area. Add up the number of letters in each column and multiply by the indicated index value. The following columns are divided based on the organism's sensitivity to pollution.

SENSITIVE	SOMEWHAT SENSITIVE	TOLERANT
______ caddisfly larvae	______ beetle larvae	______ aquatic worms
______ hellgrammite	______ clams	______ blackfly larvae
______ mayfly nymphs	______ crane fly larvae	______ leeches
______ gilled snails	______ crayfish	______ midge larvae
______ riffle beetle adult	______ damselfly nymphs	______ pouch (and other) snails
______ stonefly nymphs	______ dragonfly nymphs	
______ water penny larvae	______ scuds	
	______ sowbugs	
	______ fishfly larvae	
	______ alderfly larvae	
	______ atherix	
______ # letters times 3 =	______ # letters times 2 =	______ # letters times 1 =
______ index value	______ index value	______ index value

Now add together the three index values from each column for your total index value. Total index value = ______________

Compare this total index value to the following ranges of numbers to determine the water quality of your stream. Good water quality is indicated by a variety of different kinds of organisms, with no one kind making up the majority of the sample. Although the A, B, and C ratings do not contribute to the water quality rating, keep track of them to see how your macroinvertebrate populations change over time.

3-1

WATER QUALITY RATING

______ Excellent (>22) ______ Good (17-22) ______ Fair (11-16) ______ Poor (<11)

Fish water quality indicators:
- ☐ scattered individuals
- ☐ scattered schools
- ☐ trout (pollution sensitive)
- ☐ bass (somewhat sensitive)
- ☐ catfish (pollution tolerant)
- ☐ carp (pollution tolerant)

Barriers to fish movement:
- ☐ beaver dams
- ☐ man-made dams
- ☐ waterfalls (>1 ft.)
- ☐ other
- ☐ none

Stream: ____________________

Station #: ____________________

Date: ____________________

Surface water appearance:
- ☐ clear
- ☐ clear, but tea-colored
- ☐ colored sheen (oily)
- ☐ foamy
- ☐ milky
- ☐ muddy
- ☐ black
- ☐ grey
- ☐ other ____________

Stream bed deposit (bottom):
- ☐ grey
- ☐ orange/red
- ☐ yellow
- ☐ black
- ☐ brown
- ☐ silt
- ☐ sand
- ☐ other ____________

Odor:
- ☐ rotten eggs
- ☐ musky
- ☐ oil
- ☐ sewage
- ☐ other ____________
- ☐ none

Stability of stream bed:
Bed sinks beneath your feet in:
- ☐ no spots
- ☐ a few spots
- ☐ many spots

% bank covered by plants, rocks and logs (no exposed soil) is:	**Good** >70%	**Fair** 30%-70%	**Poor** <30%
Stream banks (sides)	_____	_____	_____
Top bank (slope and floodplain)	_____	_____	_____

Algae color:
- ☐ light green
- ☐ dark green
- ☐ brown coated
- ☐ matted on stream bed
- ☐ hairy

Algae located:
- ☐ everywhere
- ☐ in spots
- _____ % of bed covered

Stream channel shade:
- ☐ >80% excellent
- ☐ 50%-80% high
- ☐ 20%-49% moderate
- ☐ <20% almost none

Stream bank composition (=100%):
- _____ % trees
- _____ % shrubs
- _____ % grass
- _____ % bare soil
- _____ % rocks
- _____ % other ____________

Stream bank erosion:
- ☐ >80% severe
- ☐ 50%-80% high
- ☐ 20%-49% moderate
- ☐ <20% slight

Riffle composition (=100%):
- _____ % silt (mud)
- _____ % sand (1/16"-1/4"grains)
- _____ % gravel (1/4"-2" stones)
- _____ % cobbles (2"-10" stones)
- _____ % boulders (>10" stones)

MUDDY BOTTOM ONLY: Record the number of scoops taken from each habitat type. Provide any details (mostly sand, little silt, etc.) to best describe the habitat.
- ☐ Steep bank/vegetated margin ____________________
- ☐ Woody debris with organic matter ____________________
- ☐ Rock/gravel/sand substrates ____________________
- ☐ Silty bottom with organic matter ____________________

Land uses in the watershed: Record all land uses observed in the watershed area upstream and surrounding your sampling site. Indicate whether the following land uses have a high **(H)**, moderate **(M)**, slight **(S)**, or none **(N)** potential to impact the quality of your stream. Refer to the SOS stream survey instructions to determine how to assess H, M, S, or N. If the land use is not present in your watershed, leave the space blank.
- ☐ Oil & gas drilling
- ☐ Housing developments
- ☐ Forest
- ☐ Logging
- ☐ Urban uses (parking lots, highways, etc.)
- ☐ Sanitary landfill
- ☐ Active construction
- ☐ Mining (types) ____________
- ☐ Cropland (types) ____________
- ☐ Trash dump
- ☐ Fields
- ☐ Livestock pasture
- ☐ Other ____________ ____________ ____________

Are there any discharging pipes? ☐ no ☐ yes If yes, how many? ____________

What types of pipes are they? ☐ runoff (field or stormwater) describe: ____________________

☐ sewage treatment ____________ ☐ industrial: type of industry ____________________

Did you test above and below the pipes to determine any change in water quality? Were changes noticed? NOTE: If you answer *Yes*, you must submit two different survey forms, one for above the pipe and one for below the pipe, to document your claim.

____

Describe amount of litter in and around the stream as % of ground cover. Also describe the type of litter in and around the stream.

____

Comments Indicate what you think are the current and potential future threats to your stream's health. Feel free to attach additional pages or photographs to better describe the condition of your stream. ____________________

3-2

The Izaak Walton League of America • 707 Conservation Lane • Gaithersburg, MD 20878 • 301-548-0150

Glossary

adaptation: the changing of structure or form or habitats of a plant or an animal to improve its chances of survival in a particular place.

anaerobe: an organism, such as a bacterium, capable of living in the absence of free oxygen.

aquifer: a water-bearing rock formation.

biomonitors: organisms that are used as health indicators of a habitat.

bog: wetlands formed in cool, wet areas where oxygen levels and soil temperature cause incomplete decomposition and poor drainage. Bogs are characterized by acidic waters and the presence of organic soils and sphagnum moss.

brackish: refers to the mixing of fresh and salt water, as in an estuary.

bulkhead: A protective wall or embankment along a waterfront.

canneries: factories where food products such as meat, fish or fruit are canned.

Cascade Mountains: mountain range extending from northern California to western Canada. These mountains include active and dormant volcanoes, the highest of which is Mount Rainier (14,411 ft.).

coastal region: area relating to, bordering on or located near the coast. In Washington State, this region includes low hills which typically experience mild temperature and plenty of rain.

Columbia Plateau: high, dry basalt basin, cut by ancient floods in some areas. The soil is fertile but the region experiences very hot summers and very cold winters. Of all the regions in Washington, the Columbia Plateau reports the least amount of precipitation annually.

community: a group of plants and animals living in a given area.

consensus: to come to a general agreement by all or most.

consumer: an organism that eats or uses other organisms or organic matter for its own needs, as opposed to producers, which manufacture their own food.

Cowardin's classification: a wetland classification system adopted by the U.S. Fish and Wildlife Service for use in its National Wetlands Inventory. The actual title is *Classification of Wetlands and Deep Water Habitats of the United States* (Cowardin, et al. 1979). See Appendix F.

decomposer: a group of organisms (usually bacteria and fungi) that break down dead organic material into inorganic material in an ecosystem.

detritus: dead and decaying plant, animal and organic material. An important food source and an important part of the food web.

diatom: a group of single-celled or colonial algae.

dike: an embankment made to prevent flooding by the sea.

diversity: presenting a wide variety or differences in a community.

dredge: a device used to remove underwater material (sediment).

dredging: the process of removing sediment from canals, rivers, and harbors.

drought: prolonged period of dry weather.

ecosystem: a community of living things interacting with one another and their physical environment such as a pond, wetland or a forest.

erosion: the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface.

ethnobotany: the study of how people use plants.

estuarine: wetland type consisting of deep water tidal habitats and surrounding tidal wetlands that are usually semi-enclosed by land but have some kind of opening to the ocean. Saltwater in estuarine wetlands is diluted by freshwater runoff from the land.

estuary: the place where a river meets the ocean. Water in an estuary is brackish.

evolve: to develop by evolutionary processes from one form to another.

extirpated: to uproot or eradicate.

faculative: plants growing in wetlands 34 - 66% of the time.

food web: interconnected series of food chains.

habitat: the specific area or environment in which a particular type of plant or animal lives.

hydric: having to do with water.

hydric soil: soil that are saturated with water for a certain period of the year and have a much lower oxygen content than drier soils.

hydrology: the science dealing with the quality, movement and distribution of water.

hydrophyte: plants that have adapted to living in the water.

interdependency: the reliance for support between wildlife with one another and with various elements of their environments.

interrelationship: connected relationships between organisms, not always dependent relationships.

lacustrine: wetlands existing in or around lakes.

levee: an embankment made to prevent flooding by a river.

lowlands: land below the level of the surrounding land.

marina: small harbor with docks and services for pleasure crafts.

marine: of or found in the sea.

marsh: wetlands that are dominated by grasses and herbs (plants with fleshy stems, not woody, that usually die back at the end of the growing season).

metamorphosis: transformation of one form to another.

mottled: marked with blotches of different colors.

natural selection: a process in nature resulting in the survival and perpetuation of those forms of plant and animal life having certain favorable characteristics that enable them to adapt best to specific environments.

nutrient: nourishing substances necessary to life and growth.

obligate: plant found in wetlands 99% of the time.

Okanogan Highlands: More like the Rocky Mountains than the volcanic Cascades, this region in northeastern Washington experiences greater temperature extremes and much less precipitation than the western part of the state.

organic: material derived from a living organism.

organism: a single plant or animal.

palustrine: nontidal marshes, swamps, bogs and wet meadows.

phytoplankton: microscopic plants that live drifting in water. They are the base of almost all aquatic food chains.

plankton: microscopic plants and animals that live drifting in water.

plankter: singular of plankton.

predator: an animal that survives by eating other animals.

primary producer: green plants that are able to manufacture food on their own.

Puget Sound Lowlands: land that surrounds the Puget Sound between the Cascade and Olympic mountains. This region consists of hills and valleys, many of which have become excellent farmland. The Puget Sound Lowlands also have a mild climate and plenty of rain (35” - 70” per year).

recharge: water that seeps through the soil to replenish an aquifer.

revenue: all the income produced by a particular source.

riverine: wetlands and deep water habitats contained within a channel.

scat: animal feces or waste products.

spawn: verb: to deposit or produce eggs or sperm, usually in great numbers.
noun: the eggs of aquatic animals such as bivalves, fish and amphibians.

swamp: wetland dominated by trees and shrubs. Also called forested wetland.

topographic map: map representing the physical surface features of an area.

transect: method of study to determine the distribution of organisms in comparison to the environmental factors. Usually a line is made with string and marked off in meters; plants or animals are then counted within the meters.

upland: any land at a slightly higher elevation than other land. Upland plants are not wetland plants. Only 1% of the time will they be found surviving in saturated soils.

watershed: all land from which precipitation collects and drains to a common point, also know as a drainage basin.

wetland: a habitat that is characterized by soils that are saturated with water, or has shallow standing water, for part of the growing season.

wrack: collection of seaweeds that washes up on the beach.

yield: the amount or supply of a product.

zooplankton: microscopic animals that live floating in water.

Appendix A
Wetlands Education Resources

Washington Department of Ecology Publications

The Department of Ecology provides the following documents free of charge to Washington State teachers. *(Teachers from outside Washington State may purchase most materials for a modest charge; contact Ecology's Publication Office at the address below and ask for Publication 94-BR-II, "Shore-lands Education Materials for Out-of-State Orders.")*

At Home With Wetlands: A Landowner's Guide (#9O-31, 1990, 42 pp)
Includes information on wetlands values, wetlands protection techniques, ideas for wetlands enhancement, wetlands preservation and regulations, and ways to explore wetlands.

*Wetland Tales - A Collection **of** Stories **for** Wetland Education* (92-17, 1992, 51 pp)
A selection of folktales that portray wetland plants and animals. Essays that accompany the stories provide a backdrop of wetland natural history. For Washington state teachers only.

Wetland Walks (#89-30, 1989, 94 pp)
A guide to over 200 public access wetlands in the State of Washington. The site listings, grouped by county, each contain a description of the location, level of access, ecological features, and a contact phone number.

Wetlands (#92-49, 1992, 18 pp)
Illustrated pamphlet about wetlands for children. Grasses, plants, insects, birds, mammals, amphibians, reptiles, mud and water are introduced one by one as you journey through a wetland. A Spanish version, *Los Humedales* (#93-26), is also available.

Washington's Wetlands (#92-105, 1992, 12 pp)
Illustrated booklet briefly describing wetlands functions and values.

Wetlands, Streams and Estuaries posters
Beautiful four-color illustrated posters free only to Washington State teachers for classroom use. Available from the State Office of Environmental Education, 2800 NE 200th, Seattle, WA *98155, 206/365-3893.*

The Heron Tribune
A wetlands newsletter by and for kids. Contact Ecology's Publication Office for information on available issues. Distributed in classroom sets of 30.

Department of Ecology resources (except full color posters) are available from:

Washington State Department of Ecology
Publications Office
P.O. Box 47600
Olympia, WA 98504-7600
(360) 407-7472

Videotapes (VHS)

Estuary (12 min)

Award winning 16mm film in video format about life in the most productive environment on earth, the estuary. Dazzling underwater photography filmed at Washington's Padilla Bay. Grade Levels: 7th grade to adult. Available through: Washington State Office of Environmental Education, 2800 NE 200th Seattle, WA 98155 (206) 365-3893.

Fabulous *Wetlands* (1989, 8 min)

Three videos on one cassette. Includes: *Fabulous Wetlands* (1989, 8 min), a wacky and entertaining short featuring Bill Nye the Science Guy talking about the importance of wetlands; *Washington's Wetlands* (1986, 15 min), an overview of fresh and salt water wetlands in Washington; and *Yellowlegs, Eelgrass and Tideflats* (1987, 28 min), a documentary on Washington estuaries.

Available through: Washington State Educational Service District media centers, the Washington State Office of Environmental Education (206) 365-3893 and various community libraries. To purchase a copy send a $10 check, money order, *(or purchase order from government agencies only)* to: Washington State Department of Ecology, Cashiering Section, PO BOX 5128, Lacey, WA 98503-0210

Conserving America: Wetlands

Contact the National Wildlife Federation, 1400 16th Street N.W., Washington, D.C., 20036-2266.

No Water, No Life

Describes watersheds; demonstrates how to build a 3-dimensional watershed model; shows students playing the "Puget Sound Game;" facilitated by Laurie Usher. A videotape in the *Learning to Live With Your Environment* series available at your Educational Service District or from the Puget Sound Educational Service District at (206) 439-3936.

A Swamp Ecosystem

Contact the National Geographic Society, Educational Services, Dept. 88, Washington, D.C. 20036-2266.

Videodiscs

Interactive Wetlands

This videodisc, filmed in Washington, highlights the importance of wetlands, their history, and preservation efforts from around Washington. It also includes a slide set of wetlands flora and fauna. Available through Washington State Educational Service Districts media centers and many local school districts.

Wetlands

Side one of this videodisc contains a comprehensive overview of wetlands. Side two takes students on field trips through wetland areas around the United States. Available from Optical Data, 30 Technology Drive, Warren, NJ, 07059; l-800-524-248 1.

Wetland and Aquatic Curricula

A World in Our Backyard - A Wetlands Education and Stewardship Program

A curriculum and videocassette produced in New England. Suggests ways of studying wetland characters, why wetlands are important and how students and teachers can help protect a local wetland resource. Available from Environmental Media Center, Post Office Box 1016, Chapel Hill, NC 275 14; (800) ENV-EDUC

Animals of the Seas and Wetlands, Grade I. Alaska Sea Week Curriculum Series

Hands-on and classroom activities on wetlands and aquatic animals; designed for the 1st grade curriculum but adaptable to a variety of age levels. Available from Alaska Sea Grant College Program, University of Alaska - Fairbanks, Fairbanks, AK 99775-5040

Bellevueś Backyard Wilderness

Activity Packets (K-2 and 3-5) on wetland ecology, habitats, forest ecology, and wildlife of Bellevue. Designed to augment Environmental Science Curricula of the Bellevue School District, and emphasizes flora and fauna of the Lake Hills Greenbelt. Available from Bellevue Parks and Recreation Department, Post Office Box 90012, Bellevue, WA 98009-9012 (206) 455-*6855*

Clean Water Streams and Fish - Elementary and *Secondary* editions

An elementary edition for upper elementary grades and middle schools is an interdisciplinary curriculum on watersheds, water quality, salmonids, habitat, and other concepts in ecology. A secondary edition includes units on salmonids, watersheds, and the many social issues relating to these subjects. Available from Washington State Office of Environmental Education, 2800 NE 200th, Seattle, WA 98155, telephone (206) 365-3893

Coastal Zone Studies - Junior High and *Senior High* editions

Activities to acquaint students with the coastal zone. Includes information on physical and biological processes; estuaries; shoreline issues; and case studies. Available from Washington State Office of Environmental Education, 2800 NE 2OOth, Seattle, WA 98155, telephone (206) 365-3893

Estuary: an Ecosystem and a Resource

A Reading Guide and a Teacher's Manual for grades 9- 12 with units on how estuaries fit into the water cycle; physical factors in estuaries; estuarine habitats; and how estuaries are used by people. Available from: South Slough National Estuarine Reserve, Post Office Box 5417, Charleston, OR 97420.

Also available from the South Slough Reserve:

The Lore of the South Slough

Teacher's guide for middle school that focuses on variety of human uses of estuary.

The Secret of the Medallion

Teacher's guide for grades 5 & 6 that uses scientific principles to examine an estuary.

The Treasure of South Slough

Teacher's guide for grades 3 - 5 that uses natural science activities in a treasure hunt format to discover estuaries.

The Estuary Book

An introduction to estuaries with activities on the social, physical, and biological aspects of estuaries. Available from Pacific Educational Press, University of British Columbia, Vancouver, B.C. V6T lW5.

The Estuary Program

Three estuary curriculum guides are available from the Padilla Bay National Estuarine Research Reserve, 1043 Bay View-Edison Road, Mt. Vernon, WA 98273; (360) 428-1558.

The Estuary Guide - Level I

A curriculum guide designed for use by teachers of primary grades to complement a visit to the Padilla Bay National Estuarine Reserve. Includes pre-trip, on-site, and activities.

The Estuary Program - Level 2

A curriculum guide designed for use with the on-site, all day program at the Padilla Bay Reserve (upper elementary and middle school). Includes pre-trip, on-site, and post-trip information, ideas and activities.

The Estuary Guide - Level 3

A curriculum guide that describes what estuaries are, what lives there, how they function and how we depend on them; provides opportunities to practice making decisions affecting estuaries; and encourages students to examine their daily behaviors that affect their estuary.

Field Manualfor Water Quality Monitoring: An Environmental Education Programfor Schools. 8th Edition.

William B. Stapp, 2050 Delaware Avenue, Ann Arbor, MI 48103.

For Sea

Comprehensive marine science curriculum for grades 1-12 with activities in marine biology, oceanography, career awareness, environmental concerns, etc. Available from: FOR SEA Project, James A. Kolb, Post Office Box 2079, Poulsbo, WA 98370.

Hanging on to the Wetlands

Interdisciplinary classroom and field activities for studying wetlands. Available from: Irwin Slesnick, Biology Department, Western Washington University, Bellingham, WA 98225.

Naturescope: Wading Into Wetlands

One in a series on Naturescope publications, *Wading Into Wetlands* is composed of background information, activities, and "copy cat" pages on a variety of wetland concepts. Designed for kindergarten through grade eight. Available from: National Wildlife Federation, 1400 Sixteenth Street NW, Washington, D.C. 20036-2266; order toll free at 1-800-432-6564.

Ocean Related Curriculum Activities (ORCA)

Curriculum booklets on a variety of topics in aquatic education for grades 4- 12. Examples: "Marshes, Estuaries and Wetlands" (Senior High) and "Beaches" (Junior High). Available from: Pacific Science Center, The Explore More Store, 200 Second Avenue N, Seattle, WA 98109; (206) 443-2870.

Global Rivers Environmental Education Network (GREEN)

National and International Watershed Monitoring Programs are linked through this network. *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools,* listed above, is used as the manual for GREEN projects. Contact Project GREEN, 721 E. Huron Street, Ann Arbor, Michigan 48104, Telephone: 313-761-8142, FAX: 313-761-4951. In the Pacific Northwest, contact GREEN Northwest, 119 North Comercial St. Suite 1110, Bellingham, WA 98225; (360) 676-8255, FAX 676-8399.

Project WET

Collection of innovative, water-related activities that are hands-on, easy to use, and fun. Available to educators through workshops. In Washington State, contact Rhonda Hunter at (360)407-6147; e-mail:rhhu461@ecy.wa.gov. National contact: ProjectWET, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0057, phone: (406) 994-5392, e-mail: rwwet@msu.ocs.montana.edu

Project Wild Aquatic

A collection of 4- 12 grade interdisciplinary activities relating to aquatic environments. Available from: Project WILD, 5430 Grosvenor Lane, Bethesda, MD 20814, or call WA Department of Fish and Wildlife, Watershed and Wildlife Education, (360) 902-2808.

Puget Sound Project

Multi-disciplinary Puget Sound curricula available at the elementary, middle school/junior high and senior high school levels. Stressing the relationships between the ecology, economy, and society of Puget Sound, materials provide teachers with readily usable, activity-oriented approach to teaching about the Sound. Available from: Marine Science Society of the Pacific Northwest, Post Office Box 10512, Bainbridge Island, WA 98110.

Puget Sound Habitats

A handbook on Puget Sound habitats with information on geological origin of the Sound. Available from Washington State Office of Environmental Education, 2800 NE 200th, Seattle, WA 98155, telephone (206) 365-3893.

Save Our Streams

A source of information on stream health & monitoring, much of it free. Contact: Izaak Walton League of America, 1800 North Kent Street, Suite 806, Arlington, VA 22209.

U.S. Fish and Wildlife Service - Habitat and Issue Packets

Activity packets on "Wetlands Conservation and Use," "Freshwater Marshes," "Migratory Birds" and "Beaches, Dunes, and Barrier Islands."
Contact: U.S. Fish and Wildlife Service, 911 NE 11th Avenue, Portland, OR 97232.

Wetlands and Wildlife: Alaska Wildlife Curriculum

Large curriculum set includes activities and games for all grade levels. Available from: Alaska Department of Fish and Wildlife, Division of Wildlife Conservation, P.O. Box 3-2000, Juneau, AK 99802-2000; (907) 465-4170.

Wow! The Wonders of Wetlands

An interdisciplinary curriculum guide for grades K-12. Available from: Environmental Concern, Inc. Education Department, Post Office Box P, St. Michaels, MD 21663; (410) 754-9620.

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Maps

National Wetland Inventory Maps (Scale 1:24,000)

National Wetland Inventory (NWI) maps graphically represent the location, shape, and classification of wetlands and deepwater habitats on USGS base maps. NW1 codes identify the type of each wetland inventoried. Maps may be purchased from U.S.G.S., at l-800-USA-MAPS. (The cost is $3.60 for paper and $5.50 for mylar.) You may be able to obtain copies from the Department of Natural Resources Photo and Map Sales office in Olympia (address below). Your local county planning office may also have mylar copies of the maps.

Topographic Maps

U.S. Geological Survey topographic maps, which show elevation contours as well as natural and human-made features are available in two scales: 1:24,000 (1”= 2,000 ft) and 1: 12,000 (1”= 1,000 ft). The maps may be purchased at:

Photo and Map Sales Unit
111 Washington Street S.E.
P.O. Box 47031
Olympia WA 98504-7030
(360) 902- 1234

Maps may also be purchased at several commercial dealers (sporting good, bookstores, etc.) throughout the state.

Other Resources

Discovery Scopes

ENVIRO-ED, 9730 Manitou Place NE
Bainbridge Island, Washington 98110
(206) 842-2229

These inexpensive field microscopes are durable and fun.

Web of Life Cards

Fathom That! Creations, P.O. Box 964
Port Townsend, Washington 98368

These cards can be used for wetland food web games.

Sight Levels

Forestry Suppliers, Inc. 205 W. Rankin Street
P.O. Box 8397, Jackson, MS 39284-8397
1-800-360-7788 to request a catalog
1-800-647-5368 to order

An excellent source of professional outdoor tools.

Appendix B
Index Of Learning Outcomes

Introduction

This appendix shows the coordination of the activities in this guide to the state learner outcomes in Appendix C.

Index of Learning Outcomes	Science				L.A.	S.S.	E.E.
	K-3	4-6	6-9	9-12			
Unit I: Washington Wetlands							
Topic A: WA Wetlands: What Are They?							
Activity 1: Wetland Types	4B1	4B1	4B1	4B1 3.5	3.3		
Topic B: Wetland Soils & Plants							
Activity 1: Venn Diagrams	1A1-2	2C1	2C1	1C3	3.3		1A5
Activity 2: Create-a-Plant	1A2 1B1	1A1	1B1 3A1 3A2	1B1 1BBio8 4B4	1B4 1.2	3.3	
Topic C: Frogs in WA Wetlands							
Activity 1: Classroom Frogs	1A1,5 1C1 2B1 4B1 4B2	1A1 2A2 2B1 3A1 4B1-2	1A1 2A1 3A1-2 4B1-2 4B4	1A1-5 1BBio5 2A4-5 2C1 3A1-3 4B1-3	1.5 3.1		1A2 2D5
Topic D: Wetlands: Where Are They?							
Activity 1: Watershed Model	1C1	1C1	1C1	1C1 3B1		10	
Activity 2: Mapping WA Wetlands						3.3 3.4	

INDEX OF LEARNING OUTCOMES	SCIENCE				L.A.	S.S.	E.E.
	K-3	4-6	6-9	9-12			
Unit II: Amazing Wetlands: Functions and Values							
Topic A: Why Wetlands Matter							
Activity 1: Wetland Metaphors	1A1 1C1	1A1 1C1 3B1	1A1 3B1 3B1	3B1	3.5 3.6	3 11	2A1 2A2
Topic B: Water, Water Everywhere							
Activity 1: Flooding and the Giant Sponge Effect	1A1-10 2A2 2B1 2C1 2D1 2E1 3A1 3B1	1A1 2A1 2B1 2C1 2D1 3A1 3B1	1A1 2A1 2B1 2C1 2D2 3D1	1A1 2A1 2B1 2C1 2D2 3D1	3.3	10	
Activity 2: Treatment Plants	1A1-10 3B1 4B1 4B2	1A1 3B1 4B1 4B2	1A1 3B1 3D1 4B1-2	1A1 3B1 3D1 4B1-2	3.3	10	1A5
Activity 3: Wetland Model: Sediment Filtering	1A1-10 1B1 3B1 3E1 4B3	1A1 1B1 3B1 3E1 4B3	1A1 1B1 1D1 3B1 3D1 4B2	1A1 3B1 3D1 4B2	3.3	10	
Topic C: Wetland Productivity							
Activity 1: Ecosystems Discussion & Research	1B1	1B1 1C1	1B1 3A1	1BBio6 2E1 3A1-3	3.3	10	1A1-6
Activity 2: Ecosystem Webbing Game	1B1 C1-2 3C1	1B1 1C1 3B1	1B1 3A1 3B1	1BBio6 3A1-3 4B7		10	1A1-6
Activity 3: Food Webs & Nutrient Cycles	1B1 1C1 1C2	1B1 1C1	1B1 3A1	1BBio6 1BBio8 4B7		10	1A1-5
Activity 4: Water Drop Jungle	1A1 2A2 2B1 4B1 4B2	1A1 2A1-2 2B1 3A1 4B1-2	1A1 2A1 2B1 3A1	1A1 2A1-2 2A4-5 3A1 4B1-3		10	2C1

INDEX OF LEARNING OUTCOMES	**SCIENCE**				**L.A.**	**S.S.**	**E.E.**
	K-3	**4-6**	**6-9**	**9-12**			
Topic D: Wetland Habitats							
Activity 1: Wetland Poster	1A1 1A5 1C1 4B1-2	1A1 3B1 4B1 4B2	1A1 3B1 4B1-2 4B4	1BBio6 3B1 4B1-2 4B4	3.4	10	1A1-5
Activity 2: Drama Activity	3B1 4B1 4B2 4B4	3B1 4B1 4B2 4B4	3B1 4B1 4B2	1BBio4 3B1 4B1-2	1.2	10	1A5
Activity 3: Create-A-Critter	1B1 3B1 3C1 4B1	1B1 3B1 3C1 4B1	1B1 3B1 4B1 4B4	1BBio4 4B1 4B4 4B7		10	1A5
Activity 4: Frogs Leap, Toads Hop	1B1 3A1	1B1 3B1	1B1 3B1	1BBio8 3A2-3	3.3	10	1A5
Activity 5: The Toad is Heavens Uncle					1.4	6 10	1A5 1B1

Unit III: People and Wetlands

Topic A: Communicating Our Perceptions							
Activity 1: Down By The Bay		4B3 4C1	4B3	4B5 4C2	1.1 2.2	3 3C1	1C1-2 2D2
Activity 2: Wetlands Gazette	4C1 4C2	1D1 4C1 4A2 4D3	1D1 3A1 4A2 4C1 4C2 4D3	1D1 3A1 2.1 4C1 4C2 4D3 4.4 4.5 5.3 5.7	1.1 1.5 11 2.2 3.4 4.2	3 10 3A1 12	1A6 2D3 3A2 3C1
Topic B: Pacific NW Native Americans & Wetlands							
Activity 1: Plant Posters				2.5	1.2	6	1A5-6 2D2
Activity 2: Arts & Crafts					6	3	1A5-6 2C2 2D2

Index of Learning Outcomes	Science				L.A.	S.S.	E.E.
	K-3	4-6	6-9	9-12			
Activity 3: Skunk Cabbage Story				1.4 2.5	1.2 10	6	1A5-6 2C2 2D2
Topic C: Personal Values							
Activity 1: Draw the Line	4A2	4C1	4A2 4C2	4A2 4C2	4.1 4.2	10	3A2 3C1 4C1
Topic D: Land Use Planning							
Activity 1: Dragonfly Pond	3B1 3C1 4C1 4C1 4C2	1A1 1D1 3B1 3C1 4C1 4C2	1A1 1D1 3B1 3B1 3C1-2 4C1-2	1A1 1D1 1D3-4 2.3 4.2	1.5 2.1 2.2	3 8 11	1A6 1B2 1C1 2E2 3A1 3A2
Activity 2: Wetlands controversy		4C1-2	4C1-2 4C1-3	4C1-4 4D1-6	2.1-3 4.1-5 5.3	3 11 12	3A1-2 3B1-4 3C1-2 4A1 4B1 4C
Activity 3: Wetland decisions	4C1 4D1-3	4C1-2 4D1-3	4C1-2 4D1-3	4C1-4 4D1-6	5.3	3 11 12	3A1-2 3B1-4 3C1-2 4A1 4B1 4C
Activity 4: Loon Lake Dilemma		1D1 3E1	1D1 3A1 3E1 4C1 4C2	1D1-4 3C1-2 3E1-2 4A2 4C1-4	1.5 2.2 2.3 3.4 4.2	3 10 11 12	1A6 1C1-2 2A2-3 2B1-2 2D4 4A1 4B1 4C1
Topic E: Where Have All The Frogs Gone							
Activity 1: Frogs in Trouble	1A4 1A6 3B1 3C1	1D1 3B1 3C1	1D1 3C1-2 3E1 4B4 4C2	1D1-4 3B3 3C1-2 3D4 3E1-2 4B3 4C4	1.5 2.1 2.2 3.3 3.4 5.6	3 10 11 12	1B1-2 3B3 3C1-2

INDEX OF LEARNING OUTCOMES	SCIENCE				L.A.	S.S.	E.E.
	K-3	4-6	6-9	9-12			
Unit IV: Field Studies: A Walk on the Wild Side							
Topic A: Wetland Habitats							
Activity 1: Observing Wetland Habitats	1A1 1A4 1C1 2B1 4B1-2 4C1	1A1 2B1 4B1 4B2 4C2	1A1 2A1 2B1 3A2 4B1-4 4C1	1A1 1BBio6 2A5 2C1 4B1-7 4C1	3.3	3	1A1 1A5 2C1
Topic B: Hydric Soil							
Activity 1: Mucking About	1A1 2B1 3A1 4B1-2 4C1	1A1 2B2 3A1 4B1-2 4C2	1A1 2B1 4B1-2 4C1 4B1-2	1A1 1BE/S2 2B1 3A1 4B4-7 4C1	3.1 3.3	3	1A1 1A5 2C1
Topic C: Who Lives Here?							
Activity 1: Tracking	1A1 1A5 3A1 2B1 4B1-2 4C1	1A1 2B1 3A1 4B1-2 4C2	1A1 2B1 3A1 3B1 4B1-2 4B4 4C1	1A1 2B1 3A1 4B1-2 4B4 4B7 4C1	3.1		2C1
Activity 2: Transect Study	1A1 1A4 1C3 2B1 2C1 3A1 4C1 4B1-2	1A1 2A1 2B1 3A1 4B1 4B2 4C2	1A1 2A1 2B1 3A1 4B1-2 4B4 4C2	1BBio6 2A5 2C1 3A1-3 4B1-4 4B7 4C1	3.1 3.3	10 11	1A2 1A4 1A5 2C1
Activity 3: Map Making	2A1 2A2 2D1 4B1 4C1	1A1 2A1 2B1 2C1 2D1 3A1 4B1 4B2 4C2	1A1 2A1 2B1 2D2 3A1 4B1 4B2 4C2	1A1 2A1 2B1 2B2 2C1 2D3 3A1 4B1 4B2	3.1	3	2C1

Index of Learning Outcomes	Science				L.A.	S.S.	E.E.
	K-3	4-6	6-9	9-12			
Activity 4: Slope Survey			1A1 2A1 2B1 2C1 2D2 3A2 4B1	1A1 2A1-2 2B2 2C1-2 2D3 2F2 3A1-2 4B1	3.1		
Topic D: Taking a Closer Look							
Activity 1: Wetland Impacts	1A1-7 1B1 1C1 1C3 2A1-2 2B1 2C1 2D1 2E1 3A1 3C1 4A1-3 4B1-2 4C1	1A1 1B1 1D1 2A1 2B1 2C1 2D1 2E1 3A1 3B1 3C1 3E1 4A1 4B1-3 4C1-2	1A1 1B1 1C1 1D1 2A1 2B1 2C1 2D1 2E1 3A1-2 3B1 3C1-2 3E1 4A1 4B1-4 4C1	1A1-2 1BBio1 1BBio5 2A1-2 2A5 2B1-2 2C1-2 2D3 2E1-2 3A1-3 3B1-3 3D4 3E1-2 4A1 4B1-7 4C1	3.1 3.3 3.5 4.2	3 10 11	1A5-6 1C1 2A2 3A2
Topic E: Stream Quality Survey							
Activity 1: Stream Insects & Crustaceans	2A1-2	2A1	2A1	2A1-2			

Appendix C
Curriculum Guidelines

Science Learner Outcomes (Grades K-3)

GOAL I: DEVELOP AND APPLY KNOWLEDGE OF OBSERVATIONAL FACTS, CONCEPTS, PRINCIPLES, THEORIES AND PROCESSES OF SCIENCE.

A. Acquire the techniques of using the processes of scientific theory.
1. Students learn to make observations using all their senses.
2. Students learn to classify data on the basis of their observations.
3. Students learn to use numbers to order data in a logical, meaningful, and sequential manner.
4. Students learn to communicate in written and oral form.
5. Students learn to discuss their observations.
6. Students learn to formulate explanations for observed events.
7. Students learn to interpret data based on new information.
8. Students learn to predict a result based on known data.
9. Students learn to modify a prediction based on new data.
10. Students learn to test predictions through experimentation.

B. Practice applying the knowledge of the content of the major scientific disciplines in areas of life, physical, chemical, and earth/space sciences.
1. Students gain knowledge in the areas of physical science, life science, and earth/space science.

C. Demonstrates understanding of some basic generalizations, relationships, and principles applied to all sciences.
1. Students gain knowledge that will lead to an understanding of basic natural cycles and systems.
2. Students learn concepts of form and patterns such as; circles, polygons, chains, grids, spirals, etc.
3. Students understand the basic concepts of communities (integrate with social studies

GOAL II: DEVELOP SKILLS IN MANIPULATING MATERIALS AND EQUIPMENT, AND IN GATHERING AND COMMUNICATING SCIENTIFIC INFORMATION.

A. Assemble and handle laboratory apparatus, tools, materials, and living organisms.
1. Student learns to use measuring tools calibrated in standard U.S. and in metric systems to collect data in a skilled manner.
2. Student learns to operate and use equipment in a safe manner when doing science.

B. Gather qualitative and quantitative information.
   1. Students learn to use observation skills for data collection and organizational skills to order qualitative and quantitative information from a variety of sources.

C. Record observations accurately and organize data and ideas in ways that enhance their usefulness.
   1. Students learn to record and organize data and ideas in a useful manner.

D. Apply appropriate mathematical concepts and skills in interpreting data and solving problems.
   1. Students learn to apply mathematical skills and concepts to interpret data and solve problems.

E. Communicate with others in a manner that is consistent with scientific reporting.
   1. Students will learn to communicate data in written forms (graphs, diagrams, equations, words) and through oral discussion.

GOAL III: DEVELOP AND APPLY RATIONAL, CREATIVE AND CRITICALTHINKING SKILLS.

A. Acquire the ability to collect and process data.
   1. Students will understand how data collecting and organization skills are used to obtain and order information.

B. Acquire the ability to generate ideas.
   1. Students will understand how creative thinking processes are used to generate ideas.

C. Apply ideas and/or data to situations and problems.
   1. Students will understand how data and rational thinking processes are applied to solving a variety of situations or problems.

D. Use procedures for checking generated ideas and solutions.
   1. Students will recognize the value of subjecting data and ideas to others for testing and review.

E. Anticipate future situations and problems.
   1. Students will understand how questioning and creative thinking strategies are used to predict possible future situations and problems.

GOAL IV: TO DEVELOP VALUES, ASPIRATIONS, AND ATTITUDES THAT PROMOTE PERSONAL INVOLVEMENT OF THE INDIVIDUAL WITH THE ENVIRONMENT AND SOCIETY.

A. Acquire a positive realistic self-concept.
   1. Achieve attitudes and behaviors of a self-directed learner.

2. Demonstrates and values personal decision making.
3. Relate concepts of science to their own world.

B. Acquire an awareness and appreciation of beauty and orderliness in nature.
1. Enhance the desire to question, know and understand the natural world.
2. Encourages a sense of wonder about the environment.

C. Participate actively in identifying and solving societal problems dependent on science and technology.
1. Develop cooperative skills in working within a group.

D. Acquire knowledge of the interrelationships between science, politics, economics, religion, and other aspects of culture.
1. An awareness of science as an activity of humans from all racial, ethnic and cultural backgrounds.
2. Recognition that scientific inferences are affected by the value system of the observer.
3. Value science as a participant in the potential improvement of the culture.

E. Acquire an appreciation for science related careers and science learning throughout ones life.
1. Consideration of science as future oriented, preparing individuals for a fuller, richer and more effective life.

Science Learner Outcomes (Grades 4-6)

GOAL I: DEVELOP AND APPLY KNOWLEDGE OF OBSERVATIONAL FACTS, CONCEPTS, PRINCIPLES, THEORIES AND PROCESSES OF SCIENCE.

A. Acquire the technique of applying knowledge of the processes of scientific inquiry.
1. Ability to use basic investigative techniques and processes when conducting a scientific investigation.

B. Practice applying the knowledge of the content of the major scientific disciplines in the areas of Life, Physical, Chemical, and Earth/Space Sciences.
1. The student matches activities and subject areas to their representative scientific disciplines.

C. To produce an understanding of some basic generalizations, relationships, and principles applied to all sciences.
1. The student will be able to identify systems in nature that involve principles common to all science.

D. Enhance problem solving skills by analyzing social-environmental and technological problems.

1. Acquire an ability to apply rational and creative thinking processes to individual problems, and to general technological and environmental problems.

GOAL II: DEVELOP SKILLS IN MANIPULATING MATERIALS AND EQUIPMENT, AND IN GATHERING AND COMMUNICATING SCIENTIFIC INFORMATION.

A. Assemble and handle laboratory apparatus, tools materials, and living organisms in a skilled and responsible manner giving due attention to accident prevention.

1. Recognition of the proper and safe use of equipment.
2. Students will learn to maintain a proper environment for the healthy maintenance of all living organisms.

B. Gather qualitative and quantitative information.

1. Students will make measurements and produce a written record of their data, such as: size, number, and type of observations.

C. Record observations accurately and organize data and ideas in ways that enhance their usefulness.

1. Develop an ability to organize information in various graphic and tabular forms.

D. Apply appropriate mathematical concepts and skills interpreting data and solving problems.

1. Acquire an ability to apply the four arithmetic operations to physical events; to calculate rates, and to find arithmetic means of measurement.

E. Communicate with others in a manner that is consistent with scientific reporting.

1. Ability to explain both orally and in writing the methods and procedures involved in carrying out an investigation.

F. Identify sources of error, inconsistencies in measurements, and other threats to the validity of findings.

1. Ability to identify sources of error in the experimental process.

GOAL III: DEVELOP AND APPLY RATIONAL, CREATIVE AND CRITICAL THINKING SKILLS.

A. Acquire the ability to collect and process data.

1. The student will be able to generate data by observing, identifying, measuring and recording.

B. Acquire the ability to generate ideas.

1. Students will be able to put observations together through the use of analogy, correlation between patterns, discrepancies, synthesis, logic and mathematical relations.

C. Apply ideas and data to situations and problems.
   1. Ability to use patterns and trends derived from experimental data as a basis for examining related problems.

D. Use procedures for checking generated ideas and solutions.
   1. Student will be able to check assumptions and consider the reasonableness of solutions to problems.

E. Anticipate future situations and problems.
   1. Students gain the ability to organize, interpret, and predict future outcomes based on observation and from available data.

GOAL IV: TO DEVELOP VALUES, ASPIRATIONS, AND ATTITUDES THAT PROMOTE PERSONAL INVOLVEMENT OF THE INDIVIDUAL WITH THE ENVIRONMENT AND SOCIETY.

A. Acquire a positive, realistic self-concept.
   1. Achieve attitudes and behaviors of a self-directed learner.
   2. Completes, successfully, a self-initiated classroom investigation.
   3. Completes, successfully, an individual science project.

B. Acquire awareness and appreciation of beauty and orderliness in nature.
   1. Creates a desire to question, know, and understand the natural world.
   2. Develop a sense of wonder about the environment.
   3. Express feelings about the aesthetic aspects of the natural and technological environment.

C. Participate actively in identifying and solving societal problems related to science and technology.
   1. Student will be able to identify problems in their immediate environment that result from the impact of science and technology.
   2. Students will participate constructively in a group science activity.

D. Acquire the knowledge of the interrelationships between science, politics, economics, religion, and other aspects of culture.
   1. The student will value science as an activity of humans from all racial, ethnic, and cultural backgrounds.
   2. Students will recognize that scientists may make the initial observations but interpret them differently according to their value system.

3. Students will be able to give examples of how science has contributed to the mental and physical well being of people and society.

E. Acquire an appreciation for science related careers and science learning throughout one's life.

1. Students will consider science and technology as a career choice.

Science Learner Outcomes (Grades 6-9)

GOAL I: DEVELOP AND APPLY KNOWLEDGE OF OBSERVATIONAL FACTS, CONCEPTS, PRINCIPLES, THEORIES AND PROCESSES OF SCIENCE.

A. Acquire the technique of applying knowledge of the processes of scientific inquiry.

1. The student will use the following processes when conducting a scientific investigation:
    - a. observation
    - b. organization
    - c. communication
    - d. inference
    - e. prediction
    - f. application

B. Practice applying the knowledge of the content of the major scientific disciplines in the areas of Life, Physical, Chemical, and Earth/Space Sciences.

1. For each content area, the student will be able to use appropriate facts, concepts, and vocabulary.

C. To produce an understanding of some basic generalizations, relationships, and principles applied to all sciences.

1. The student will be able to:
    - a. use inferences to make generalizations
    - b. recognize and predict patterns
    - c. state laws
    - d. formulate explanatory models
    - e. develop theories

D. Enhance problem solving skills by analyzing social, environmental and technological problems.

1. Students will recognize the relevancy of science by using the scientific knowledge, processes and methods to:
    - a. clarify values
    - b. examine issues
    - c. solve scientific, personal, and societal problems

GOAL II: DEVELOP SKILLS IN MANIPULATING MATERIALS AND EQUIPMENT, AND IN GATHERING AND COMMUNICATING SCIENTIFIC INFORMATION.

A. Assemble and handle laboratory apparatus, tools materials, and living organisms in a skilled and responsible manner giving due attention to accident prevention.
   1. The student will develop fundamental skills in:
      a. orderliness
      b. safe manipulation of materials and equipment
      c. caring and handling of living things

B. Gather qualitative and quantitative information.
   1. The student will develop measurement skills that allow for comparisons using:
      a. sensory
      b. relative position
      c. inner
      d. weight
      e. capacity
      f. quantity

C. Record observations accurately and organize data and ideas in ways that enhance their usefulness.
   1. The student will develop organizational skills in:
      a. gathering
      b. sequencing
      c. grouping
      d. classifying data
      e. graphing
      f. charting

D. Apply appropriate mathematical concepts and skills interpreting data and solving problems.
   1. Use measured data and/or mathematical model to describe observed phenomena.
   2. Use basic math skills to solve scientific problems.

E. Communicate with others in a manner that is consistent with scientific reporting.
   1. Students achieve communication skills which will enable them to express themselves.

F. Identify sources of error, inconsistencies in measurements, and other threats to the validity of findings.
   1. Ability to find sources of variation in the results of experimentation that occur from human error, instrument error, and experimental error.

GOAL III: DEVELOP AND APPLY RATIONAL, CREATIVE AND CRITICAL THINKING SKILLS.

A. Acquire the ability to collect and process data.
   1. Communication skills which will enable them to express themselves orally.
   2. Develop organizational skills in gathering, sequencing, grouping, and classifying data.

B. Acquire the ability to generate ideas.
   1. Students will be able to put observations together through the use of:
      a. analogy
      b. correlation between patterns
      c. discrepancies
      d. synthesis
      e. logic
      f. mathematical relationships

C. Apply ideas and data to situations and problems.
   1. Recognition of the relevancy of science by using scientific knowledge processes and methods to clarify values, examine issues, and solve scientific, personal, and social problems.
   2. Application of scientific knowledge (technology) to satisfy personal curiosity or solve a problem.

D. Use procedures for checking generated ideas and solutions.
   1. Ability to design and conduct experiments, construct classification schemes and identify factors that might have influenced conclusions.

E. Anticipate future situations and problems.
   1. Anticipates future consequences of present actions by applying cause and effect relationships.

GOAL IV: TO DEVELOP VALUES, ASPIRATIONS, AND ATTITUDES THAT PROMOTE PERSONAL INVOLVEMENT OF THE INDIVIDUAL WITH THE ENVIRONMENT AND SOCIETY.

A. Acquire a positive, realistic self-concept.
   1. Achieve attitudes and behaviors of a self-directed learner.
   2. Demonstrates and values personal decision making.

B. Acquire awareness and appreciation of beauty and orderliness in nature.
   1. Enhance the desire to question, know and understand the natural world.
   2. Encourage a sense of wonder about the environment.

3. Help focus feelings about the aesthetic aspects of the natural and technological world.
4. Gain an appreciation for the interdependence of living organisms as necessary for their continued survival in the natural environments.

C. Participate actively in identifying and solving societal problems related to science and technology .
1. Develop cooperative skills in working within a group.
2. Ability to express an opinion on societal issues using knowledge of science and technology to support that opinion.

D. Acquire the knowledge of the interrelationships between science, politics, economics, religion, and other aspects of culture.
1. Students will understand by examples how science has contributed to the mental and physical health and well being of people.
2. Value science as an activity available to males and females from all racial, ethnic, and cultural backgrounds.
3. Recognize that scientific influences are affected by the value system of the observer.

E. Acquire an appreciation for science related careers, and science learning throughout one's life.
1. Consideration of science as future oriented, preparing individuals for a fuller, richer, and more effective life.
2. Students will consider science and technology as a career choice.

Science Learner Outcomes (Grades 9-12)

GOAL I: DEVELOP AND APPLY KNOWLEDGE OF OBSERVATIONAL FACTS, CONCEPTS, PRINCIPLES, THEORIES, AND PROCESSES OF SCIENCE.

A. Acquire the technique of applying knowledge of the processes of scientific inquiry.
1. Make accurate measurements and observations.
2. Form hypotheses from both quantitative and qualitative observations.
3. Use experimental procedures to confirm or reject hypotheses.
4. Integrate observations and experimental results with scientific ideas.
5. Subject results and conclusions to critical evaluation by self and others.

B. Practice applying the knowledge of the content of the major scientific disciplines in the area of Life, Physical, Chemical, and Earth/Space Sciences.

PHYSICS

1. Accurately predict what will happen during physical events.
2. Accurately describe physical phenomena in terms of materials and wave properties.
3. Explain phenomena, appropriately applying ideas of interaction and conservation.
4. Develop and use an appropriate scientific vocabulary.
5. Develop a set of meaningful ideas of the natural world which are more convincing and more powerful than the ideas held before instruction.

BIOLOGY

1. Develop and use appropriate biological facts, concepts, and vocabulary.
2. Understand the molecular and cellular aspects of living things.
3. Demonstrate knowledge of the systems of living things.
4. Demonstrate knowledge of the relationship between structure and function of living organisms.
5. Understand species continuation.
6. Recognize interrelationships between living and non-living systems.
7. Understand that diversity and adaptation allow for change through time.
8. Understand the systematic grouping of organisms.
9. Understand the factors influencing behavior of organisms.

CHEMISTRY

1. Accurately predict what will happen during chemical events.
2. Accurately describe chemical phenomena and changes in physical and chemical properties of matter.
3. Understand elementary atomic structures and regularities in the Periodic Table.
4. Develop and use an appropriate scientific vocabulary.

EARTH / SPACE SCIENCE

1. Develop and use an appropriate scientific vocabulary.
2. Understand the interactions of matter and energy in processes within meteorology, astronomy, geology and oceanography in describing and explaining natural phenomena occurring in earth and space.

C. To produce an understanding of some basic generalizations, relationships, and principles applied to all sciences.

1. Recognize that most events in nature occur in a predictable way and are understandable in terms of cause-and-effect relationships.
2. Understand that natural laws are universal and are demonstrated throughout time and space.
3. Recognize that through classification systems, scientists bring order and unity to apparently dissimilar and diverse natural phenomena.
4. Understand the tentative nature of science.

D. Apply the content and processes of science to the understanding of social, environmental and technological problems.
   1. Identify existing and potential problems.
   2. Gather data relevant to the problem.
   3. Evaluate opinions and proposed solutions.
   4. Analyze data to better understand the problem, to form an opinion, or to propose solutions.

GOAL II: DEVELOP SKILLS IN MANIPULATING MATERIALS AND EQUIPMENT, AND IN GATHERING AND COMMUNICATING SCIENTIFIC INFORMATION.

A. Assemble and handle lab apparatus, tools, materials, and living organisms in a skilled and responsible manner, giving due attention to accident prevention.
   1. Manipulate in a safe manner appropriate materials, apparatus and equipment.
   2. Acquires and assembles appropriate science apparatus, materials, and equipment in order to obtain designated data.
   3. Proper and safe disposal of all laboratory waste.
   4. Maintain appropriate life supporting equipment for laboratory organisms.
   5. Cares for and uses organisms in a responsible and legal manner.

B. Gather qualitative and quantitative information.
   1. Gather information that has been generated from a variety of sources.
   2. Measure accurately using standard metric and the English systems of measurement.

C. Record observations accurately and organize data and ideas in ways that enhance their usefulness.
   1. Maintain an accurate record of primary data, recorded at the time of observation.
   2. Construct appropriate charts and tables to clearly illustrate the data in a systematic manner.
   3. Use a computer to record, manipulate, and display data.

D. Apply appropriate mathematical concepts and skills in interpreting data and solving problems.
   1. Apply appropriate algebraic, geometric, and statistical techniques to manipulate data.
   2. Use measured data to derive mathematical expressions to describe phenomenon.
   3. Manipulate appropriate mathematical relationships to solve problems.

E. Communicate with others in a manner that is consistent with scientific reporting.
   1. Appropriately represent phenomena, relationships and explanations with words, equations, numbers, and diagrams.
   2. Use the appropriate level of written and oral skills to transmit self-generated and acquired knowledge to others.

F. Identify sources of error, inconsistencies in measurements and other threats to the validity of findings.
   1. Evaluate the methodology of the experiment, in problem-solving, etc. as to its appropriateness.
   2. Ability to calibrate instruments.
   3. Ability to apply appropriate statistical methods to determine fitness of data.

GOAL III: DEVELOP AND APPLY RATIONAL, CREATIVE, AND CRITICAL THINKING SKILLS.

A. Acquire the ability to collect and process data.
   1. Skill development in gathering data.
   2. Skill development in organizing and describing data.
   3. Skill development in comparing and evaluating data.

B. Acquire the ability to generate ideas.
   1. Students will learn to generalize ideas:
      a. infer visual, attributable, qualitative, or numerical patterns,
      b. synthesize observations into a new concept,
      c. synthesize new observations with an existing idea,
      d. invents the operations that define an idea (create an operational definition),
      e. generalize a conclusion from observations, and
      f. search for similar patterns in similar situations.
   2. Students will learn to infer relationships:
      a. hypothesize a relationship between variables,
      b. infer a mathematically functional relationship, and
      c. infer a correlation of variables.
   3. Students will learn to reason hypothetically:
      a. invent and/or use an analogy to bridge understanding,
      b. use inductive arguments to infer a conclusion,
      c. use deductive reasoning to infer a conclusion, and
      d. use indirect rational argument to infer a conclusion.

C. Apply ideas and/or data to situations and problems.
   1. Apply learned ideas:
      a. seeks opportunities to apply learned ideas,
      b. applies learned ideas to given situations or problems, and
      c. identify problems and situations for which it would be appropriate to apply the learned idea.
   2. Apply problem solving skills:
      a. fully describe the problem,
      b. identify which principles are relevant to a particular problem or situation,
      c. make an educated guess at solutions to problems,
      d. attempts a qualitative approach to the problem before using formulas and specific numbers,

e. chooses an appropriate equation or set of equations for the particular problem,
f. acts out conditions of the situation to seek a possible solution, and
g. identify relevant and irrelevant variables in a problem/situation.

D. Use procedures for checking ideas and solutions.
1. Check experimental results by:
a. suggesting or conducting a replication experiment,
b. checking actual, experimental results against predicted results,
c. revising a hypothesis on the basis of experiment results,
d. suggesting a modeling situation to test results,
e. revising experimental design to more accurately answer the question or test the hypothesis, and
f. attempting to extrapolate the results of other situations to check their validity.
2. Check logical arguments by:
a. considering assumptions, premises, and conclusions made in arguments,
b. retracing steps followed to generate a conclusion or solution,
c. working backwards through steps in an argument, and
d. checking the validity of each "if, then" link in a chain of implications.
3. Check the solution to problems by:
a. checking the reasonableness of the solution,
b. making an estimated or approximated solution to check the actual full solution,
c. solving problems using more than one method,
d. seeking multiple solutions in situations where they might exist,
e. evaluating solutions to
(i) determine if the solution is of value, and
(ii) determine if the solution is the best one available, and
f. checking dimensional units to see if the answer is consistent.
4. Reflect on their own learning
a. identifying when they understand and when they do not, and
b. identifying what they understand and what parts they do not.

E. Anticipate future situations and problems.
1. Predict future consequences of present actions by:
a. applying cause and effect relationships,
b. extrapolating present trends into the future,
c. envisioning conditions in the future, and
d. identifying critical factors affecting conditions in the future.

2. Develops possible alternatives to solve anticipated problems:
a. considers or invents possible future breakthrough in ideas on technology,
b. consider possible impediments to proposed alternatives, and
c. consider possible consequences of proposed solutions.

GOAL IV: TO DEVELOP VALUES, ASPIRATIONS, AND ATTITUDES THAT PROMOTE PERSONAL INVOLVEMENT OF THE INDIVIDUAL WITH THE ENVIRONMENT AND SOCIETY.

A. Acquire a positive realistic self-concept.
   1. Achieve attitudes and behaviors of a self-directed learner.
   2. Demonstrates and values personal decision making.

B. Acquire awareness and appreciation of the beauty and orderliness in nature.
   1. Encourage the desire to question, know and understand the natural world.
   2. Encourages a sense of wonder about the environment.
   3. Gains an appreciation and respect of living organisms and accepts responsibility for their care in natural and artificial environments.
   4. Identifies patterns in color, form, texture, and arrangement to the design of object in the environment in an attempt to understand order in nature.
   5. Helps focus feelings about aesthetic aspects of the natural and technological world.
   6. Enjoyment of participating in scientific activities.
   7. Respect for the process of that interdependence of living organisms that is necessary for their continued survival in the natural environment.

C. Participate actively in identifying and solving societal problems related to science and technology.
   1. Develops cooperative skills in working within a group.
   2. Strengthen attitudes towards conservation, preservation, and wise use of natural resources.
   3. Helps people meet their responsibility in valuing environmental quality.
   4. Ability to express an opinion on societal issues using knowledge of science and technology to support that opinion.

D. Acquire knowledge of the interrelationships between science, politics, economics, religion, and other aspects of culture.
   1. Value science as an activity of males and females from all racial, ethnic, and cultural backgrounds.
   2. Recognition that scientific investigations are affected by the value system of the observer.
   3. Value science as a participant in the potential improvement of the human condition.
   4. Understand how politics, economics, and value systems influence what science investigation and technology develops.
   5. Realize that scientific truths must be pursued through research even if unpopular or not immediately applicable.
   6. Recognition that historical advances in science have been influenced by the cultural conditions of the time period.

E. Acquire appreciation for science related careers and science learning throughout ones life.
   1. Knowledge about the qualities of science related careers that satisfy human needs for creativity, high credibility, relevance, active participation and rewards.
   2. Consideration of science as future oriented, preparing individuals for a more continuously relevant, effective, richer life.
   3. Assume responsibility for making a realistic decision about the pursuit of a science related career by considering personal interests, attitudes, aptitudes, and career trends.

Environmental Education Learner Outcomes

GOAL I: THE STUDENT WILL DEVELOP KNOWLEDGE OF THE COMPONENTS OF THE ENVIRONMENT AND THEIR INTERACTIONS.

A. The teacher will help students to recognize that the earth's living and non-living components are interrelated.
   1. The student will distinguish the difference between living and non-living things.
   2. The student will identify the components essential for life.
   3. The student will recognize that the sun is the primary source of energy.
   4. The student will identify systems and cycles within the environment.
   5. The student will describe ways in which living organisms and components of the environment are interrelated.
   6. The student will understand that humans are a part of nature, not separate from it.

B. The teacher will show students that populations respond to the limiting factors of the environment.
   1. The student will identify factors that limit populations.
   2. The student will describe the effects of limiting factors on a population.
   3. The student will demonstrate the effects of limiting factors on a population.

C. The teacher will show that as the human population increases, our impact on the environment becomes more pronounced.
   1. The student will identify examples of human impact on the environment.
   2. The student will demonstrate how increasing populations impact the environment.
   3. The student will recognize that technological growth is exceeding our understanding of its impact on the environment.

D. The teacher will help students to understand that people need to conserve the earth's natural resources.
   1. The student will identify renewable and non-renewable natural resources.
   2. The student will describe how conservation practices affect natural resources.
   3. The student(s) will plan and implement a conservation project for a local area (e.g. classroom, school ground, home, neighborhood park).

GOAL II: THE STUDENT WILL VALUE THE ENVIRONMENT AS THE BASIS OF OUR PHYSICAL LIVES, ECONOMY, AND EMOTIONAL WELL-BEING.

A. The teacher will demonstrate that human health responds to the quality of our environment.
   1. The student will describe the elements of a quality environment.
   2. The student will compare and contrast natural and man-made environmental hazards.
   3. The student will evaluate alternative methods of dealing with potential hazards.
   4. The student will determine how cultural attitudes affect definitions of a healthy environment.

B. The teacher will show that a viable economy is dependent upon the responsible use of our natural resources.
   1. The student will understand the environment impacts of supply and demand components of the economy.
   2. The student will compare, contrast, and evaluate responsible and irresponsible use of our natural resources.

C. The teacher will foster the concept that appreciation of nature's intricacy and beauty promotes tranquility and creative expression.
   1. The student will experience the aesthetic value of nature.
   2. The student will compare various art forms and how they reflect cultural response to nature.

D. The teacher will communicate that respect for the earth and all its living things encourages people to maintain a quality environment.
   1. The student will describe ways in which people show a respect for a quality environment.
   2. The student will understand how a given culture interrelates with its environment.
   3. The student will understand the intent of an environmental law and the resultant public policies.
   4. The student will identify and understand the functions of resource, corporate, public, and governmental agencies that work directly with the environment.
   5. The student will demonstrate practices that show respect for the earth and its living things.

E. The teacher will discuss how technology can modify the environment.
   1. The student will identify change brought about by technology.
   2. The student will evaluate ways that technology has affected the environment.

GOAL III: THE STUDENT WILL APPLY PERSONAL DECISION-MAKING SKILLS TO ENHANCE ENVIRONMENTAL QUALITY.

A. The teacher will discuss how individual decisions and individual actions impact the environment.
   1. The student will identify methods of making effective decisions.
   2. The student will learn to:
      a. identify positive and negative personal decisions that impact the environment;
      b. analyze how past individual actions have impacted the environment; and
      c. take and defend a position on an environmental concern.

B. The teacher will help students to understand that role models encourage the positive participation of others.
   1. The student will recognize those qualities which make a person environmentally responsible.
   2. The student will:
      a. identify positive and negative role models, and
      b. compare and contrast role models.

   3. The student will participate in an activity that enhances environmental quality.
   4. The student will evaluate herself or himself as a role model.

C. The teacher will lead a discussion on how personal decisions and actions alter the outcomes of environmental issues.
   1. The student will:
      a. understand that both action and inaction affect the outcome of environmental issues;
      b. review past decisions and actions that have impacted the environment;
      c. debate the impact of an individual's decision or action on an environmental issue.

   2. The student will predict the consequences of different decisions related to environmental issues.

GOAL IV: THE STUDENT WILL DEVELOP AND UTILIZE THE KNOWLEDGE AND SKILLS NECESSARY FOR COOPERATIVE ACTION ON BEHALF OF THE ENVIRONMENT.

A. The teacher will discuss how cooperation among communities (including individual citizens, interest groups, businesses, governmental agencies and others) is essential to improve, maintain, and enhance environmental quality.

1. The student will:
    a. understand the significance of the interactions and interrelationships of these groups and how they affect environmental quality;
    b. identify the role of resource agencies in enhancing the environment;
    c. examine the positive and negative impact of the economic community on environmental quality; and
    d. recognize the diversity of cultural attitudes and practices, and the ways in which these cultures enhance and/or detract from environmental quality.

B. The teacher will show how interest groups stimulate public awareness and effect change.

1. The student will:
    a. understand the nature and purpose of environmental interest groups;
    b. describe how economic values of individuals, companies, etc., influence final decisions; and
    c. identify several methods used by interest groups to influence change.

C. The teacher will foster the idea that involvement in the political and legal process is paramount to resolving environmental issues.

1. The student will:
    a. identify the structure of the political and legal processes;
    b. describe the relationship between the legal and political processes that are important in solving environmental issues;
    c. recognize that change is normal, and that the direction and impact of change depend on both individual and collective efforts; and
    d. participate as an active citizen in the legal/political system to achieve a change in environmental quality.

English / Language Arts Learner Outcome

1. IMAGINING
   - 1.1 Student appreciates the power of language.
   - 1.2 Student uses a variety of prompts to generate, produce, and present a work.
   - 1.3 Student enjoys and values the literary arts.
   - 1.4 Student understands and uses literary devices such as elements of fiction and figurative language.
   - 1.5 Student respects and describes different points of view.

2. FEELING
   - 2.1 Student expresses feelings, attitudes, and values effectively to others.
   - 2.2 Student interprets and responds respectfully to another's feelings, attitudes and values.
   - 2.3 Student gives and accepts complaints and criticisms.
   - 2.4 Student interprets and portrays different moods.
   - 2.5 Student know and respects cultural differences.

3. INFORMING
   - 3.1 Student follows and gives directions accurately.
   - 3.2 Student accurately paraphrases a message or main idea.
   - 3.3 Student seeks, organizes, and uses information from a variety of sources.
   - 3.4 Student develops skill and confidence in discussions, conversations, and presentations.
   - 3.5 Student increases vocabulary according to developmental level and subject matter.
   - 3.6 Student recognizes and uses common literary forms and terms.
   - 3.7 Student selects reading materials appropriate to task, reading level, and audience.
   - 3.8 Student becomes familiar with important writers and their words.

4. CONTROLLING
   - 4.1 Student distinguishes fact from opinion.
   - 4.2 Student states an opinion and defends it with relevant evidence and examples.
   - 4.3 Student determines the intent of a message.
   - 4.4 Student identifies and uses techniques of persuasion.
   - 4.5 Student understands how biases influence a response to a message.

5. RITUALIZING
   - 5.1 Student recognizes and responds to the rituals of communication (e.g. greetings, introductions, interruptions).
   - 5.2 Student interprets and responds to nonverbal language.
   - 5.3 Student delivers a message in a manner appropriate to situation, purpose, and audience.
   - 5.4 Student selects standards appropriate to audience and purpose.
   - 5.5 Student understands and respects the varieties of dialects, idioms, and usages.
   - 5.6 Student understands and uses standard media forms (e.g. textbooks, newspapers, newscast, theater).
   - 5.7 Student understands the American tradition of the free expression of ideas.

Social Studies Learner Outcome

1. Learn about the past to better understand the present, in order to anticipate and prepare for the future.

2. Develop an understanding of and an appreciation of our American Heritage.

3. Understand the relationship between human societies and their physical world.

4. Understand how the economy and a changing workplace affect their lives now and in the future.

5. Increase their understanding of and appreciation for systems of law.

6. Accept the integrity and importance of the individual in the context of his/her culture and appreciate the multicultural nature of our society (United States) and the world.

7. Understand the interdependence of their own community and the world.

8. Recognize change as a natural part of life and learn to deal with it effectively.

9. Appreciate self and demonstrate respect for every human being.

10. Develop critical thinking skills.

11. Improve their individual and group communication skills.

12. Demonstrate responsible citizenship through active participation.

Appendix D
Sequencing Options for Wetlands Education Units

Three Week Units

General Sequence

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They?
Unit IV:	Topic A: Activity 1	Scavenger Hunt
Unit I:	Topic D: Activity l-2	Watershed Model & Mapping
Unit II:	Topic A: Activity 1	Wetland Metaphors
Unit II:	Topic B: Activity 1-3	Flooding & Treatment Plants & Filtering
Unit I:	Topic B: Activity l-2	Venn Diagrams & Create-A-Plant
Unit II:	Topic C: Activity l-4	Research Cards, Food Webs &Water Drop Jungle
Unit II:	Topic D: Activity 3-4	Create-A-Critter & Frogs Leap, Toads Hop
Unit III:	Topic A: Activity 1	Down By The Bay
Unit III:	Topic B: Activity l-3	Pacific NW Native American Activities
Unit III:	Topic C: Activity 1	Personal Values
Unit III:	Topic D: Activity l-2	Dragonfly Pond & Loon Lake Dilemma
Unit IV:	Topic D: Activity 1	Habitat & Wetland Impacts

Focus On Frogs

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They?
Unit IV:	Topic C: Activity 2	Transect
Unit II:	Topic A: Activity 1	Wetland Metaphors
Unit I:	Topic C: Activity 1	Frogs in WA Wetlands
Unit I:	Topic B: Activity 2	Create-A-Plant
Unit II:	Topic D: Activity 3	Create-A-Critter
Unit II:	Topic D: Activity 4	Frogs Leap, Toads Hop
Unit II:	Topic C: Activity 3	Construct Food Web
Unit II:	Topic D: Activity 5	Toad is Heaven's Uncle
Unit III:	Topic B: Activity l-3	Pacific NW Native American Activities
Unit III:	Topic E: Activity 1	Frogs in Trouble

One Week Unit

Sequence I

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They?
Unit I:	Topic D: Activity 1-2	WA Wetlands: Where Are They?
Unit II:	Topic A: Activity 1	Wetland Metaphors
Unit III:	Topic D: Activity 1	Dragonfly Pond
Unit III:	Topic A: Activity 2	Wetlands Gazette

Sequence II

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They?
Unit IV:	Topic A: Activity 1	Scavenger Hunt
Unit II:	Topic C: Activity 2-3	Food Webbing
Unit I:	Topic B: Activity 2	Create-A-Plant
Unit III:	Topic D: Activity 1 or 2	Dragonfly Pond or Loon Lake Dilemma

Three Day Wetland Units

Sequence I

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They?
Unit II:	Topic A: Activity 1	Wetland Metaphors
Unit IV:	Topic A: Activity 1	Scavenger Hunt

Sequence II

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They? & Wetlands Poster
Unit II:	Topic D: Activity 1	
Unit I:	Topic D: Activity 1	Watershed Model & Food Webbing
Unit II:	Topic C: Activity 2	Ecosystem Webbing Game
Unit III:	Topic D: Activity 1	Dragonfly Pond

Sequence III

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They? & Wetland Metaphors
Unit II:	Topic A: Activity 1	

Unit II:	Topic D: Activity 1	Wetlands Poster & PNW Native American Activities
Unit III:	Topic B: Activity 1	Plant Posters
Unit III:	Topic B: Activity 2	Arts & Crafts
Unit III:	Topic B: Activity 3	Skunk Cabbage Story
Unit III:	Topic D: Activity 1	Dragonfly Pond

One Day Unit

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They?
Unit II:	Topic A: Activity 1	Wetland Metaphors
Unit II:	Topic D: Activity 1	Wetlands Poster

Ongoing Study of a Wetlands

Unit I:	Topic A: Activity 1	WA Wetlands: What Are They?
Unit IV:	Topic A: Activity 1	Scavenger Hunt
Unit IV:	Topic F: Activity 1	Field Study Tools
Unit I:	Topic B: Activity l-2	Venn Diagrams & Create-A-Plant
Unit IV:	Topic B: Activity 1	Mucking About
Unit IV:	Topic C: Activity l-2	Tracking & Transect
Unit I:	Topic D: Activity 1-2	Watershed Model & Mapping
Unit IV:	Topic C: Activity 3-4	Mapping & Profile/Slope
Unit II:	Topic A: Activity 1	Wetland Metaphors
Unit II:	Topic B: Activity l-3	Flooding, Treatment Plants & Filtering
Unit I:	Topic C: Activity 1	Frogs in WA Wetlands
Unit II:	Topic C: Activity l-4	Wetland Productivity
Unit II:	Topic D: Activity l-4	Habitats
Unit IV:	Topic D: Activity 1	Habitat & Impacts
Unit III:	Topic A: Activity 1	Down By The Bay
Unit III:	Topic B: Activity l-3	PNW Native Americans
Unit III:	Topic A: Activity 2	Wetlands Gazette
Unit III:	Topic C: Activity 1	Values Continuum
Unit III:	Topic D: Activity l-2	Land Use Planning
Unit III:	Topic E: Activity 1	Frogs in Trouble

Appendix E
Wetlands articles

Where have all the amphibians gone?

by Greg Pope, *Science World,* March 20, 1992, Vol. 48, No. 13

Scientists who listen for the croak ***of*** *frogs are instead hearing . . . silence. It's the awful sound of amphibians disappearing form this earth, and it may be sound that warns us we're in danger too.*

David Wake was frustrated. The University of California biologist was helping a colleague set up a research project to study toads in the Sierra Nevada mountains of California. Trouble was, the toads didn't show up...

That was the early 1980s. Soon afterward, Wake traveled to Central America to study his favorite amphibians, salamanders. But now the salamanders were nowhere to be found. And Wake noticed another spooky thing. He didn't hear the usual symphony of frog calls. "The forest was silent at night," he recalls.

"I just knew something wasn't right," Wake says. And it turns out his instincts were correct. Last September, when he attended a convention of herpetologists (scientists who study reptiles and amphibians), Wake discovered that everyone was complaining about the same thing: Amphibians-the water-loving, landlubbing class of animals that includes frogs, toads, and salamanders-are getting harder and harder to find.

It seems that, in places on every continent, amphibians are vanishing. Researchers don't have enough data yet to say for sure what's behind the disappearance. But most scientists believe that we humans are probably the cause. "The problem is in our backyard," says Wake, "and we have no one to blame but ourselves."

One way or another, he says, we are changing the environment in ways that amphibians can't handle. Poisonous chemicals are draining from our homes, farms, and factories, winding up in and around the ponds, rivers, and lakes where amphibians live. Pollutants from cars and smokestacks are mixing with water vapor and turning into acid rain and snow, which cascades into the mountain pools where some amphibians lay their eggs. We are destroying wilderness areas to build homes for ourselves. For all these reasons, amphibians are running out of healthy habitats-areas that contain the food and breedingplaces that the creatures need to live.

Wet and Slimy Lifestyles

To understand their woes, let's look at what makes amphibians amphibians. These cousins to reptiles have three distinguishing features.

- they live in water *and* on land;
- they have moist skin without scales, fur, or feathers;
- they lay eggs without protective hard shells.

All three traits make amphibians very sensitive to environmental damage.

Take your friendly neighborhood bullfrog, for example. Like all amphibians, it starts its life in the water, as one of hundreds of eggs its mother lays. Then it hatches into a larval, or immature form. In frogs and toads, the larval form is called a tadpole. The tadpole propels itself through water with a tail, absorbing oxygen through its gills, and chomping on algae and pond weeds.

Then comes metamorphosis, a dramatic changes in anatomy common to all amphibians. For a tadpole, that means that, within a few weeks, it loses it gills and tail, develops lungs, grows legs, and crawls out onto land. Now it's an adult amphibian. But it still needs to be near water, as you'll see below.

Scrambled Eggs

At each stage in its life cycle an amphibian is vulnerable to contamination of its habitat.

Start with those eggs. Amphibians lay their eggs in water, because the eggs lack hard shells to lock in moisture. Sitting around in a polluted pond, amphibian eggs can soak up a lot of poisonous chemicals, which lay waste to the developing embryos.

But water pollution is not the only threat to amphibian eggs. Another is acid precipitation. In Colorado's Rocky Mountains, for example, tiger salamanders are disappearing because of acid snow, says John Harte, an atmospheric physicist with the University of California at Berkeley. In spring, when the snow melts, acid water cascades into mountain pools, just after salamanders lay their eggs. The jolt of acidity wipes out the baby salamanders developing inside the eggs.

Things don't get much better for eggs that manage to hatch into larvae, says biologist Richard Wassersug, a tadpole expert at Canada's Dalhousie University.

Tadpoles are especially prone to damage from water pollution, more so even than fish. Why? Because unlike a fish, a tadpole isn't completely adapted to a watery environment.

A fish can control the amount of water in its body; a tadpole can't. The result: tadpole bodies contain a lot more water (and a lot more harmful water pollution) than fish bodies. It isn't worthwhile for a tadpole to spend energy pumping water out of its body like fish do, because in a few weeks it will undergo metamorphosis and be out of the water anyway. "But if your pond's not healthy," says Wassersug, "you won't even make it to metamorphosis."

Sensitive Skin

The lucky amphibians that manage to complete metamorphosis still face many dangers. Just as a baby amphibian isn't completely suited to a watery habitat, an adult amphibian isn't completely suited to dry land.

The problem lies in amphibian skin. Amphibians depend on their skill to obtain what every animal needs-oxygen and water. Amphibian lungs aren't as effective as those of full-time land-dwellers, such as reptiles, birds, and mammals. So amphibians absorb a lot of oxygen (and a lot of damaging air pollution) directly through their skin. In addition, amphibians have to constantly soak up water (and harmful water pollution) through their skin, because they can't store moisture like land animals do.

So amphibians have to stay near water, to keep from drying up as well as to lay their eggs safely. But as we've seen, a lot of water habitats are polluted. And a lot are just plain disappearing, taken over by humans for their homes.

Triple Whammy

So amphibians are getting socked in all three stages of their life cycles-as eggs, as larvae, and as adults. No wonder they're disappearing. Should we care? Scientists say we should more than care-we should be alarmed.

First of all, amphibians are important players in the environment. In the U.S., they're the number-one land vertebrates (animals with backbones) in terms of biomass-a measurement of the amount of living matter in an area. In other words, if you put all the amphibians in a forest on a scale, they'd outweigh all the reptiles, or all the birds, or mammals.

Through sheer numbers, amphibians keep bug populations under control. "They play major roles as consumers of insects," says Wake.

But if insects are celebrating the demise of amphibians, humans should be worrying. By dying out, amphibians are alerting us that something is terribly wrong with the way we treat the environment. It's one thing to have amphibians disappearing from places where homes are being built. But what about all the undisturbed ponds-the ponds in protected areas-where frogs are disappearing? "That's scary," says tadpole expert Wassersug, because it means we're hurting the environment in ways we aren't aware of, in ways that soon may threaten us.

Wake agrees. "Amphibians survived whatever wiped out the dinosaurs," he says. "If they're suddenly dying out now, we ought to take it seriously."

Can we do anything to save these animals? Scientists are now organizing massive frog censuses, to see how bad the problem is. But beyond that, says Wake, we must heed the warning and change our careless attitudes toward the environment. After all, as Kermit would say, "When the frogs are happy, everybody's happy."

Amphibians: biomonitors of environmental health

by Klaus 0. Richter, Coastal Currents, March 1991, Vol. 15, No. 9

As children, many of us became familiar with The Frog Prince, the fairy tale in which a beautiful princess promises to let a loathsome frog sit, eat and sleep with her if he retrieves her golden ball from the bottom of a deep pool. The frog recovers the ball, the princess reluctantly shares her life with the frog and lo-and-behold, the frog turns into a handsome prince. One moral from this fairy tale is "never judge a book by its cover" even if it is a frog.

To most of us, frogs and other amphibians remain the bug-eyed, slimy skinned, swamp dwellers we knew as children. To herpetologists, the attributes that may at first seem abhorrent account for an upsurge of Northwest and global interest in using amphibians as biomonitors of environmental health.

Amphibians combine three traits that promise to make them ideally suited to warn people of environmental hazards stemming from human activities. Practically all amphibians: 1) are animals whose well-being, distribution and abundance can readily be determined, 2) exhibit an aquatic and terrestrial life history, and 3) are restricted to environments that are already heavily stressed by humans.

Amphibians, a word derived from combining two Greek words, amphi=both, and bios=life, are befittingly named to describe their life at the transition between land and water. The red-legged frog (Rana aurora) western toad (Bufo boreas), pacific treefrog (Pseudacris regilla), long-toed salamander (Ambystoma macrodactylum), northwestern salamander (A. gracile), and many other local species, for example, must return to open water to breed. Both eggs and tadpoles are under the constant influences of hydrologic and water quality changes to their aquatic environment. Most Northwest amphibians also breathe through their skin.

To absorb oxygen and remove carbon dioxide effectively, these amphibians must keep their skin constantly moist and thereby live in wetlands, along streams and in other damp places. It is these behavioral and physiological ties to water that scientists believe make amphibians perfect candidates as biomonitors.

Unfortunately, wetlands, lakes, streams and their associated transition zones are also disproportionate recipients andconduits of human activity. These habitats are being eliminated or undergoing dramatic changes in water flows and water quality associated with urbanization. They receive sediments from land clearing and construction, runoff from roofs, parking lots and highways, and animal and human pathogens. Specifically found in wetlands today are heavy metals such as lead and zinc, organics including oil and grease, the breakdown products of herbicides, pesticides and other landscape chemicals and several kinds of colon bacteria and human viruses.

The Puget Sound Wetlands and Stormwater Management Research Program, a comprehensive scientific study of stormwater impacts on wetland water flow, water quality, aquatic invertebrates and wildlife, is focusing on amphibian studies to guide human stewardship of the environment. By documenting the distribution and abundance of amphibians in wetlands affected and unaffected by urbanization, program scientists hope to show a correlation between land use, water characteristics, and species composition.

Biologists have singled out the northwestern salamander, red-legged frog, and pacific treefrog for intensive studies. These aquatic-breeding amphibians deposit large, readily identifiable egg clutches that can be easily monitored for health and survival.

Each species prefers a distinct breeding habitat. Research shows that when a habitat is altered by fluctuating water levels and sediment, egg desiccation and suffocation rates are higher than when clutches are unaffected by fluctuations. Embryonic mortality leads to fewer tadpoles and adults the following years, leading to local extinctions.

This is what may have happened to the spotted frog, (Rana pretiosa), which has experienced a dramatic reduction in its historical range and is now almost totally extirpated in Western Washington. It seems reasonable to assume that if declining numbers of amphibians are the result of deteriorating water flow and quality, humans may also be at risk.

Early detection of detrimental impacts to the environment is an important and difficult challenge to scientists. By monitoring amphibians, which are readily affected by habitat disturbance and which accumulate environmental pollutants, damage can be assessed before such harm can have serious consequences for humans.

Rather than frogs being turned into handsome princes by unwilling princesses, hopeful scientists are turning frogs into biomonitors of environmental health, implying there is more to amphibians than meets the eye.

The Waste Chase

by Karolyn Kendrick, *Science World,* March 20, 1992, Vol. 48, No. 13

Like it or not, down the drain isn't the end of the line for our waste. If you've ever been within sniffing distance of a sewage treatment plan, you already know that. Almost everyone's wastewater-the liquid and solid waste that drains from bathrooms and street sewers-eventually makes it way to one of these plants.

Red Hook, just one of New York City's 14 sewage treatment facilities, handles 40 millions gallons each day. (That's enough to fill 72 Olympic-size swimming pools, or nearly four times the volume of oil spilled from the Exxon Valdez.) At the plant, the waste is broken down by bacteria, chemicals, and a variety of energy-guzzling machines.

The process is expensive, and it doesn't exactly get rid of the stuff. For one thing, the liquid portion of the waste, once "treated," still contains billions of floating solid particles and chemical pollutants such as pesticides and heavy metals.

Typically this effluent is poured into the nearest waterway. (Watch out for the drinking water downstream!) And the smelly, solid leftovers, called sludge, must still be dumped somewhere-usually in a landfill-or burned. To make matters worst, most of us don't want any of this going on in our neighborhood.

So what would you say if we asked you to take a stroll through the sewage treatment "plant" in Arcata, California? Yuck? Fear not: There's no sludge monster here. But you might run into some birdwatchers, joggers, and even baby strollers. Arcata's sewage treatment facility is a 154-acre human-made freshwater marsh and wildlife sanctuary where people come to relax.

Wet and Wild

Communities across the country are building wetland systems-both outside and in large greenhouses-to deal with their wastes the natural way. Some systems, like the marsh at Arcata, simply purify the effluent that comes out of a traditional sewage treatment plant. Others do the job of sewage treatment from flush to finish.

In all cases, the principle is the same: The bacteria that live in the water-soaked environment break down and recycle the wastes. They turn most sewage and many pollutants into nutrients that marsh plants and critters need to grow.

"What comes in as your partially digested hamburger goes out as new tissue for a plant or fish," says Scott Sargent, who runs a natural treatment project in Providence, Rhode Island. The wastes, in effect, become the living things that inhabit the system.

There's not sludge, just purified water. And if your "wetland" is outdoors, you get a great wildlife habitat bonus.

Why Fake It?

So why doesn't every city start dumping its sewage into the nearest marsh?

Well, *volume* is a problem. One of the great things about wetlands is that water tends to hang around in them for a long time-long enough for the bacteria to do their complex digesting. But if the volume of wastewater running through were suddenly to increase, say, as it does after a storm, wastes might pass on through without so much as a nibble from the microbes.

In artificial systems, engineers can monitor the quality of wastewater-and keep it in the system for a longer or shorter period of time, depending on the level of pollutants to be purified.

Artificial systems have another advantage over natural marshes: They can be designed on a small scale to treat waste inside your house. Interested? Talk to Bill Wolverton. He constructed the first wetland-modeled sewage treatment facility in the U.S. (for a NASA lab in Bay St. Louis, Mississippi, back in the late 1970s). Now he has one in his home.

Wolverton's wastewater runs through a series of planters filled with lush houseplants. The clean, clear water that emerges fills an aquarium of fish before running into a backyard pond. And it doesn't even smell like sewage.

Why not? The smell usually comes from the byproducts of bacterial digestion-chemicals like hydrogen sulfide, which smells like rotten eggs. In a wetland system, the plants eat this smell stuff up. They may even use the odoriferous substances to make sweet-smelling flowers!

Nothing's Perfect

But the story of artificial wetland treatment systems isn't all rosy. Outdoors projects, for example, take up a lot of land, so they're best suited for communities with small populations and room to sprawl. Even then, growth can be a problem. If a community "doubles its population, but doesn't increase the area of its wetland treatment system," says Bob Bastian of the U.S. Environmental Protection Agency, "the wetland will not be able to handle the pollution load. "Pollutants would run through the system untreated, possibly killing the complex web of marsh life as they go.

Another problem is climate. So far, most wetland projects have been constructed in areas with mild climates, where plants have long growing seasons. But even there, "the system changes seasonally as plants go through growth cycles," says Stephen Tyler, who runs Arcata's Marsh. "No month is the same. You have to be flexible." For example, when plants are taking up fewer nutrients during low growth periods, you have to slow down the flow of waste.

But the wastewater-battling scientists aren't giving up. Some are seeking out specific combinations of bacteria and plants that will use up industrial wastes, the kind you can get a lot of in the sewage of big cities. And Wolverton is taking on the "not-enough-space" problem. "Why not build these systems up or down," he suggests, "instead of out, as we do in rural areas?" We do it with parking garages, offices, and health clubs, he points out. Why not do it with wetlands?

Nothing Goes To Waste In Arcata's Teeming Marshes

Doug Stewart, *Smithsonian,* Vol. 21, No. 1, April 1990

A California town proves that ingenuity is a match for high-tech engineering in turning sewage into a natural resource.

Crouching by the edge of the marsh, workbooks and pencils in hand, the three third-grade girls peer into the water. On a field trip from a nearby city, they're searching for minnows. A passer-by, strolling along the trail of redwood chips that skirts the marsh, asks the girls if they realize that the water they're hovering over all came from the drains and toilets of the town just across the railroad tracks.

"No way. " "Eeeeeeooooo!" "Sick-o!"

If the girls were townies, chances they'd know about-in fact, take pride in-the civic duty this little lagoon is so tirelessly performing. The body of water is part of the Arcata Marsh and Wildlife Sanctuary, a 154-acre wetlands park wedged between the foggy shore of Northern California's Humboldt Bay and the small city of Arcata (pop. 15,000).

The quiet and perfectly pleasant-smelling park has turned Arcata, 280 miles up the Pacific coast from San Francisco, into a tourist stop and bird-watching Mecca. It also enables the town to meet the state's strict sewage-discharge standards. Since 1986, partially treated sewage from the town's conventional primary-treatment plant has been meandering through the park's chain of man-made marshes. After a two-month odyssey, it's piped into Humboldt Bay. The discharged marsh water is generally clearer and cleaner than the water already in the bay.

"Traditionally, people think of wastewater as something to get rid of," says Dave Hull, the Public Works Department's bearded young aquatic-resources specialist. Here, we think of wastewater as a natural resource." The system's low-key simplicity won the city a $100,000 grant from the Ford Foundation's Innovations in Government program, and has set off a flood of inquiries from mayors and town engineers around the country.

Contrary to popular belief, raw sewage (or wastewater, as engineers prefer to call it) is 99.9 percent pure H2O. "Every time you flush the toilet, that's another five gallons of water down the drain," Hull explains as he stands over a metal grate set into a concrete slab at the town's headworks. Below his feet, fresh sewage arriving straight from town gushes from a large pipe into a holding tank. Nearly half of the outpouring is from toilets; most of the rest is from kitchen sinks, showers, bathtubs, and washing machines.

The sewage flows to an enormous, open-air concrete tub a few yards away, where coarse solids-fecal and food wastes-settle to the bottom. The town used to spread the dried sediment, or sludge, around the city parks as mulch, but state health codes put an end to that: disease-causing parasites could lurk in the untreated residue. The town is now considering treating the sludge by simply cornposting it, then spreading it around Arcata's 1,200 acres of upland redwood forests.

As for the wastewater that's drained off from the tub, it's channeled to a pair of large oxidation ponds near the headworks. There and in the marshes farther along the chain, Arcata does the same thing with its sewage that other towns do: It lets the appetites of various one-celled microbes go to work on the organic ingredients. The alleged state of the art in sewage treatment employs huge concrete vats that break down the "mixed liquor" (sanitary engineers love euphemisms) with the aid of compressors, mixers, aerators and diffusers. Arcata, in contrast, abets the biological process in a far more leisurely fashion.

Dave Hull's former teacher Bob Gearheart helped design Arcata's waste-fed string of lagoons. A professor of environmental engineering at the local college, Humboldt State University, Gear-heart has a penchant for low-cost, low-energy technologies. Among other projects, he has helped set up crop-irrigation systems using wastewater in several Third World communities. In a developing country, he found, high-quality fresh water was often unavailable and chlorine unaffordable.

In Arcata one recent morning, Gearheart stands at the edge of Gearheart Marsh (a name for which he disavows responsibility) and riffles one hand through a dense thicket of cattails growing in the shallow water. "What really does the work here are the microorganisms that grow around the roots and stems of these plant," he says. Gearheart Marsh is the second of three so-called enhancement marshes that are fed by smaller marshes farther upstream. Each enhancement marsh has a balance of open water and marsh plants. The shapes of the marshes are pleasantly irregular, and small man-made islands punctuate their surfaces. Gearheart, a solidly built Texan who's wearing a scuffed leather bomber jacket and sneakers, grabs a cattail and yanks it out of the mud, roots and all. "Smell the hydrogen sulfide? That's anaerobic bacteria at work," he says. The stem is slippery, evidence of underwater bacteria and fungi that have latched onto it to feed on the organic nutrients in the water flowing past-tiny biological filters, in effect.

Earlier, air-breathing bacteria have already taken a shot at breaking down the sewage into less-noxious components. This happened in the unvegetated oxidation ponds that are at the head of the chain of lagoons. Oxidation ponds were once a standard feature of sewage treatment plants, and they're still used in thousands of small towns with plenty of land and not too many toilets. Unfortunately, they're prone to algae blooms, which worsen water quality instead of helping it. Oxygen and nitrogen levels, in particular, can swing wildly as the algae alternately prosper or die off. Adding the string of plant-filled marshes, Gearheart says, has put a stabilizing buffer between the oxidation ponds and the bay ("polishing the effluent" is the phraseology that engineers have come up with). As a precaution, wastewater is chlorinated soon after it leaves the oxidation ponds; this kills any disease-spreading germs, but the chlorine dissipates quickly, so it does no harm to plant and animal life.

An eye on recycling opportunities

All this nutrient-rich swamp water does for plant life what spinach does for Popeye. Duckweed, cattails, pennywort and hard-stem bulrushes flourish in the enhancement marshes. Breaking open a cattail, Gearheart reveals its mealy, white interior. "This is just starch, like a potato," he says. To keep the marsh plants from crowding out the open water, the city plans to drain the marshes every few years, and harvest the rushes and cattails with farm equipment. Always on the lookout for recycling opportunities, Gearheart hopes the city will let the starch ferment into ethanol, useful as a fuel. "Cattails are one of the most efficient ways you can get biomass per acre," he notes.

The wetlands flora, in turn, attract astounding numbers of waterfowl: ducks, coots, egrets, herons, hawks, avocets, pelicans. Altogether, naturalists have tallied close to 200 bird species in the sanctuary, double the number of just a few years ago. Otters, voles, mice and muskrats rummage in the thickets onshore. On a recent afternoon, a man-made lake was ringed by telescopes on tripods, all focused on a peregrine falcon single-handedly giving the heebie-jeebies to several thousand marbled godwits. Nearby, a brown pelican crash-dived into the lake for trout. Onshore, a great egret struggled to swallow a field mouse, finally washing it down with a gulp of lake water. Joggers huffed down the redwood-chip trails, and office workers on their lunch breaks sat reading in parked cars. Directly and indirectly, sewage made it all happen.

The outpourings of Arcata's toilets have become a source of civic pride-and humor. The town inaugurated its new sewage system by holding a "Flush the Pride" festival. Citizens wore T-shirts emblazoned with the festival's logo, a salmon leaping out of a toilet as a great blue heron perched on the seat. A visitors' center is being planned for the park, and there's talk of posting signs inside its toilet stalls that will read: Thank You For Your Contribution. "We're using a product that almost everybody wants to get out of their minds," says Frank Klopp, Arcata's public works director, "and we're having fun with it." Klopp is a raspy-voiced, wise-cracking former forester who's listed as "Klippity" on the magnetic In-Out board outside his office.

Klopp says, "You wouldn't believe how many public works directors call me up and say, 'My mayor asked me to call you and ask about your system. It really won't work for our town, will it?'" Klopp shakes his head. Politicians are intrigued by what Arcata is doing, he says, but engineers tend to be dubious. "A consulting engineer from another town called me the other day and hit me with a classic. He said, 'We can't have people walking around our waste treatment plant! '"

Klopp tells whoever asks him that any town with both oxidation ponds and ample public, low-lying wetlands can use its sewage to build a marshland park. A seacoast isn't necessary, he says, nor is a tiny population. Arcata is the first American city to build a public park and wildlife sanctuary with its sewage, Klopp believes, but now larger cities are borrowing some of its ideas. Hillsboro, Oregon, with twice Arcata's population, is contemplating a system of more than 1,000 acres of waste-fed wetlands. The wetlands would clean up Hillsboro's sewage enough for it to be dumped harmlessly into a local river. Landlocked Santa Rosa, California, with more than 100,000 inhabitants, plans to run a portion of its sewage through several hundred acres of ribbon-shaped wetlands, hoping to re-establish trout and salmon in nearby streams in the process. A key constraint for any town contemplating wetlands treatment, Klopp says, is that household sewage not be overwhelmed by either untreated industrial waste or storm-drain runoff. Each of these can upset a wetland's fragile ecology by sweeping too many microbe-killing pollutants into the mix.

Arcata's unusual toilet-to-marsh-to-sea operation would probably never have gotten started were it not for George Allen, a fisheries professor at Humboldt State. In the late 196Os, Allen was looking for a freshwater creek where he could study salmon with his students. Most of the local creeks had either been buried, diverted or otherwise rendered inhospitable to fish. Filling ponds with tap water was too expensive. In need of an alternative, Allen began siphoning off wastewater from Arcata's oxidation ponds.

Allen, now semi-retired, is hoping to get salmon to imprint on the unique flavor of Arcata's sewage. Long after they've headed downstream and out to sea, salmon can recognize the exact mix of ingredients in the freshwater streams and ponds they grew up on. After months or even years as oceangoing adults, they try to return there to spawn. If Allen's pilot project works, the city of Arcata may take up fish farming for fun and profit. In a reversal of the NIMBY (Not In My Backyard) syndrome, Arcata would take what other towns banish, and grow protein in it.

It was Allen's incorporation of sewage into the food chain that first got others in town to thinking. By the mid-'70s stringent state sewage-discharge rules had caught up with Arcata and its neighbors. For years, Arcata had simply dumped treated wastewater from its oxidation ponds directly into Humboldt Bay. An expensive new regional sewage plant was being planned, and the state was pressuring Arcata to pay up and tie in. The plant was to be the latest thing in high-tech sanitary engineering. One design option called for revolving drums, close to ten feet in diameter, that would agitate a tankful of sewage in the way a paddle wheeler chums upstream. A slimy coating of bacteria on the drums would gulp air on the upswing, force-feed on the down. In five or six hours, the job would be done. The plant, whatever design was used, would be big-big enough to handle a flow of 40 million gallons a day without choking. And expensive: by 1976, the estimated cost of building it had passed $50 million.

Arcata's self-image was on the line

Klopp, Gearheart, Allen and others, meanwhile, had begun exploring the idea of running Arcata's sewage through marshes instead. They drew up plans for ponds that would be dug out of 32 acres of desolate waterfront land where a series of abandoned and decrepit lumber mills stood. Dominating the debris-covered site was the old county dump. When Gearheart et al. pitched their better idea, the city counselors and a majority of its voters were won over. Homeowners dreaded the prospect of soaring sewage-treatment costs if the new regional plant were to be built. Moreover, Arcata's civic self-image was on the line. The town had long prided itself on being something of a counterculture bastion, even by Northern California standards. Arcata is the sort of community where men still wear ponytails, VW buses are common and the town library, as part of its Hassle Reduction Program, no longer fines delinquent borrowers.

Arcata's marsh-building plan touched off a bureaucratic squabble. The town fought stubbornly to extricate itself from the regional plant tie-in while battling a phalanx of skeptical state and regional agencies. Says Gearheart, "The perspective of the agencies has always been: contain, treat, discharge, with no other uses." Arcata eventually prevailed. The regional plant was scrapped, and Arcata began building marshes, but with two conditions. It had to monitor water quality strenuously throughout the marshes (a requirement that has driven up the cost of the system) and, just to be safe, it had to chlorinate the effluent a second time, after the trip through the marshes ("which is ridiculous," Frank Klopp grumps).

Leaning back in his office chair after an extended lunch hour spent at Klopp Lake with his daughter and a bag of popcorn, Klopp expounds on the virtues of sewage marshes. The system is cheaper than a conventional plant would be, though not dramatically so. Besides that, "It's fun." Had it not been for the park's vital public works function, the town could never have afforded such a sprawling recreation area, which is complete with landscaping, park benches, bird blinds and groomed trails.

Klopp, at 55, is a keen outdoorsman who hunts deer and pheasant and dives for abalone. The walls of his small office bristle with no fewer than eight sets of deer antlers. That his department built and manages a public-works facility that doubles as a teeming wildlife sanctuary is a source of great pride, with or without the lake named after him. And though he's an engineer, the unmechanized simplicity of the marshes pleases him. "Managing the marshes is absolutely no problem," Klopp says. "It's not like you go out there and turn the wrong valve and everything blows up. The biggest problem we have is how to raise enough ducks." Asked why the town needs ducks, Klopp stares at his questioner in amazement. "Why else would we want to grow a marsh?" he says. "You think we did all this just for water quality?"

Swamp Samaritans

by Ben Fischman, *Science World,* March 20, 1992, Vol. 48, No. 13

Earlier this century, Florida made room for farms and towns by draining half its wetlands. But many Floridians now see wetlands as places to preserve. Here are three stories of people-from savvy seventh graders to an old woman in a big hat-who are helping save the Sunshine state's precious swamps and marshes.

Lady of the Everglades

Back in 1920, Marjory Stoneman Douglas was writing for a newspaper. One story she wrote was about the effort to preserve the Everglades-vast marshlands that filter water for millions of Floridians-by making them a national park. That story landed her on the park committee, and ever since, Douglas's name has been linked with this unique wetland ecosystem. Even today, she's fighting to protect the park from pollution and other dangers.

Water in the Everglades is just inches deep in most parts. Yet it flows through in a sheet like a slow river 40 miles wide. Before Floridians dug drainage canals through the Everglades to make farmland, the water flowed all the way down what Douglas calls "the great pointed paw of the state of Florida." Even now, the fields of waving green sawgrass seem infinite. But the fact is, they are in peril.

One threat is to the natural mix of plant life. Sawgrass and cattails have always co-existed in the Everglades. But the sawgrass, because it needs fewer nutrients, has traditionally been more abundant. Today, however, much of the Everglades' water seeps in from farms to the north, carrying fertilizers that permit legions of cattails to grow. Result: The cattails' IO-foot height blocks sunlight from the sawgrass and resident algae, and the sawgrass vanishes, along with the algae that support the Everglades' food web.

Today, Douglas is pushing for solutions to the fertilizer problem, and for ways to restore the natural water flow upstream to "maintain the sheet flow of the Everglades."

Her message is getting through. The state and federal governments are planning to break open some canals, and are looking for ways to keep the Everglades from turning into cattail farms.

Swamp Saviors

It's amazing what one group of kids can accomplish. In fast-growing southwestern Florida, some students are saving a pristine cypress swamp from development-and in the process, they're turning their whole county on to ecology.

The students have formed a group, Save Our Swamp (S.O.S.), to keep out roads that would damage the swamp. S.O.S. gets Lee County officials to take them seriously by wading through the mire, learning and teaching others about the unique habitat. That's the way their predecessors first persuaded thecounty to buy up the swamp in the 1970s.

Cypress swamps are dark, eerie places. Curtains of Spanish moss hang from tree limbs overhead. The cypress trees have knees, gnarled root extensions above the water. (Scientists think the knees may be an adaptation to the oxygen-poor swamp soil, helping trees absorb oxygen from the air.) The dark acidic water breeds carnivorous plants.

"It's like a different world. Not yours, but nature's," says Lorri Taylor, an 18-year-old in this year's program. She has sent flyers to swamp residents to stop road development. "To keep just a little makes a big difference in the long run."

Dust into wetlands

Alchemists were people who sought to turn less-valuable metals into shining gold. Today, Hamilton Middle School students are following in their footsteps, trying to turn an old phosphate mine into a cypress swamp.

The seventh graders are planting 12 samplings each, at the invitation of Occidental Chemical Corporation (OxyChem). As OxyChem tears up wetlands to mine phosphate (a fertilizer), state law says they must restore wetlands as well.

The future swamp: two acres of dust, dirt, and puddles. OxyChem has already dug the area into a slight bowl shape to retain rain runoff. Now the kids are busy planting the trees-such as baldcypress, tupelos, and black gum-that they hope will someday turn the site into a genuine cypress swamp.

"We're going to be making a habitat for animals-like herons, frogs, snakes, and alligators," says 12-year-old Nedra Bennett. But it won't be all work. "We'll be splashing in the water as we plant."

Appendix F
Cowardin U.S.F.W.S. Wetland Classification System

Since 1906, wetlands have been inventoried andplaced into a number of different classification systems. In the 1960's, concern over the destruction of the nation's wetlands blossomed and the need for a comprehensive classification system became apparent. The US Fish and Wildlife Service adopted a new classification system for use in its National Wetland Survey, begun in the early 1970's. The *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin, et al. 1979) includes both wetlands and other aquatic systems, such as lakes and streams. This system allows a convenient way for scientists and government agencies to look at all water-related areas within one system.

The Cowardin System divides water-influenced habitats into **five** main systems: **Marine, Estuarine, Riverine, Lacustrine,** and **Palustrine.**

Marine systems include all unsheltered intertidal areas that are covered by undiluted saltwater. Examples include most beaches and tide flats.

Estuarine systems include all sheltered intertidal areas where incoming fresh water mixes with salt water at least part of the time. These areas include beaches, semi-enclosed bays, salt marshes and swamps that lie near the mouths of rivers.

Riverine systems include all fresh water flowing in channels, such as rivers and streams. Streams are further subdivided based upon their velocity and whether they flow year round.

Lacustrine systems include reservoirs or lakes larger than 20 acres with less than 30 percent of their surface covered by emergent vegetation.

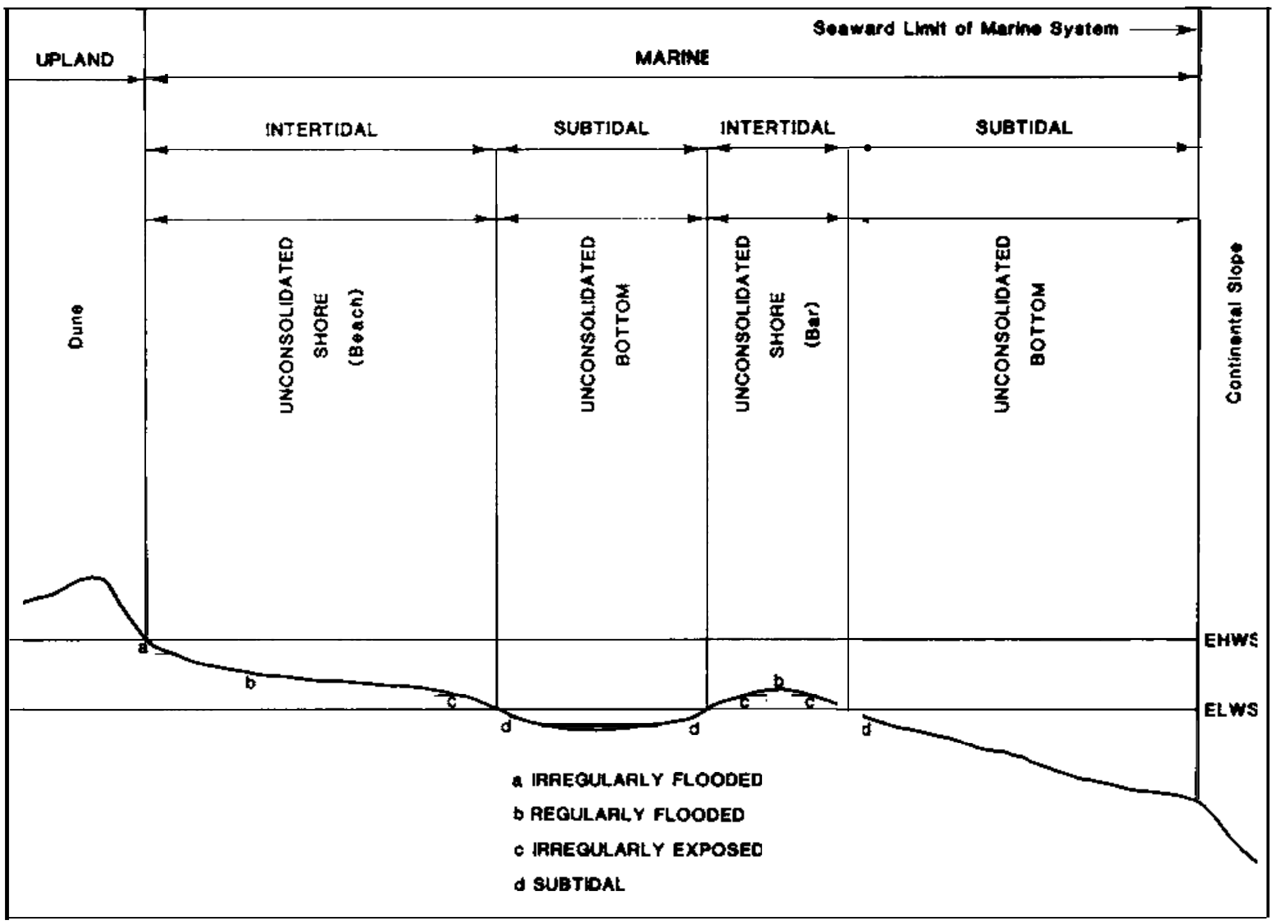
Palustrine systems include all other freshwater wetlands. Many familiar wetlands are classified here. Marshes, ponds (covering less than 20 acres or six feet deep), scrub-shrub wetlands, wooded wetlands (swamps), wet meadows, bogs, potholes and desert playas are all palustrine systems. These are further divided based upon other characteristics such as vegetation, flooding patterns and soil type.

National Wetlands Inventory (NWI) maps show not only these major systems, but also subsystems and other divisions within the "Cowardin" classification. These maps are available from the US Fish and Wildlife Service (see resources listed in Appendix A).

Marine wetlands

From *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin, et al. 1979)

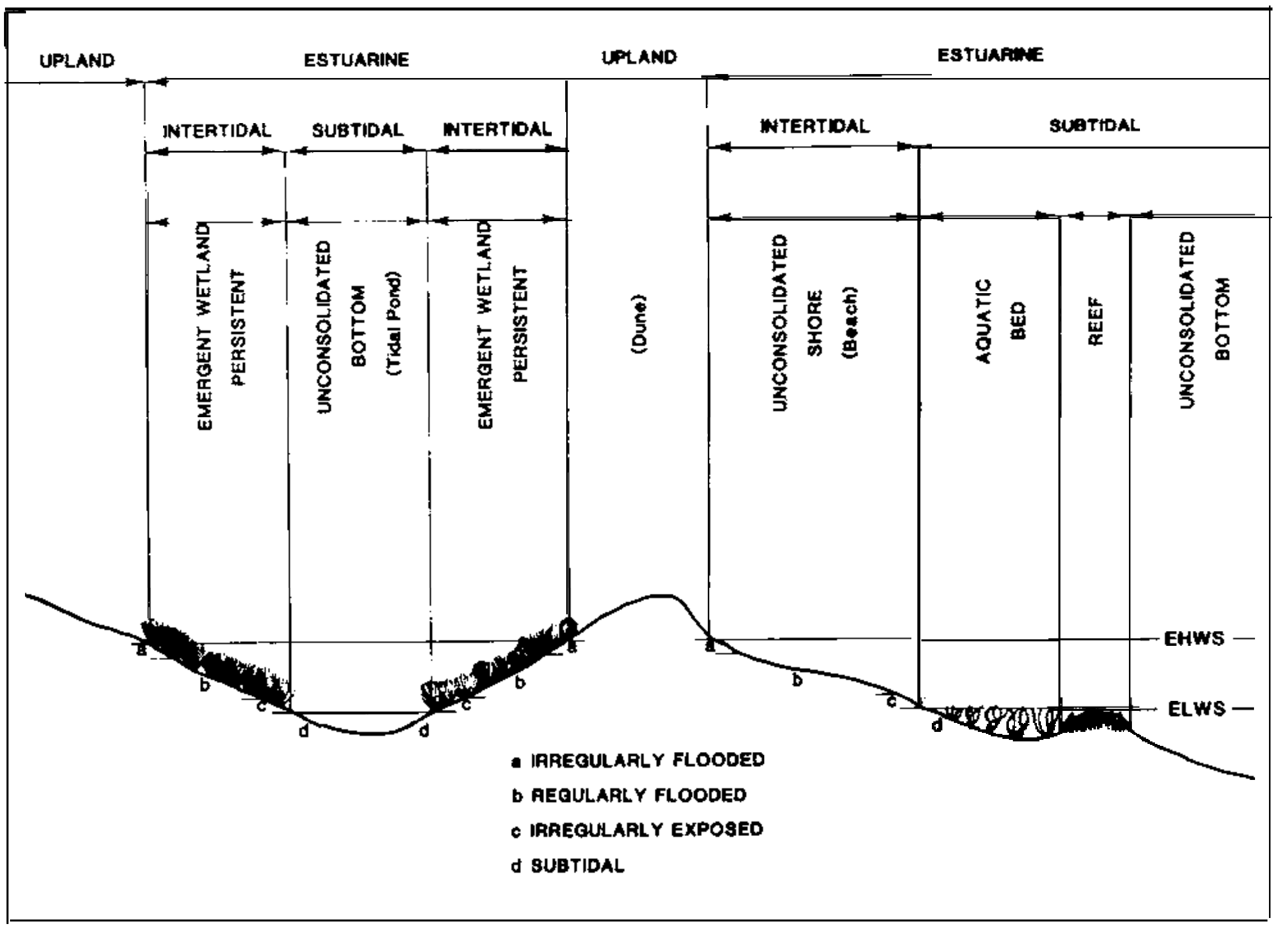
Marine systems include all unsheltered intertidal areas that are covered by undiluted saltwater. Examples include most beaches and tide flats.



Estuarine wetlands

From *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin, et al. 1979)

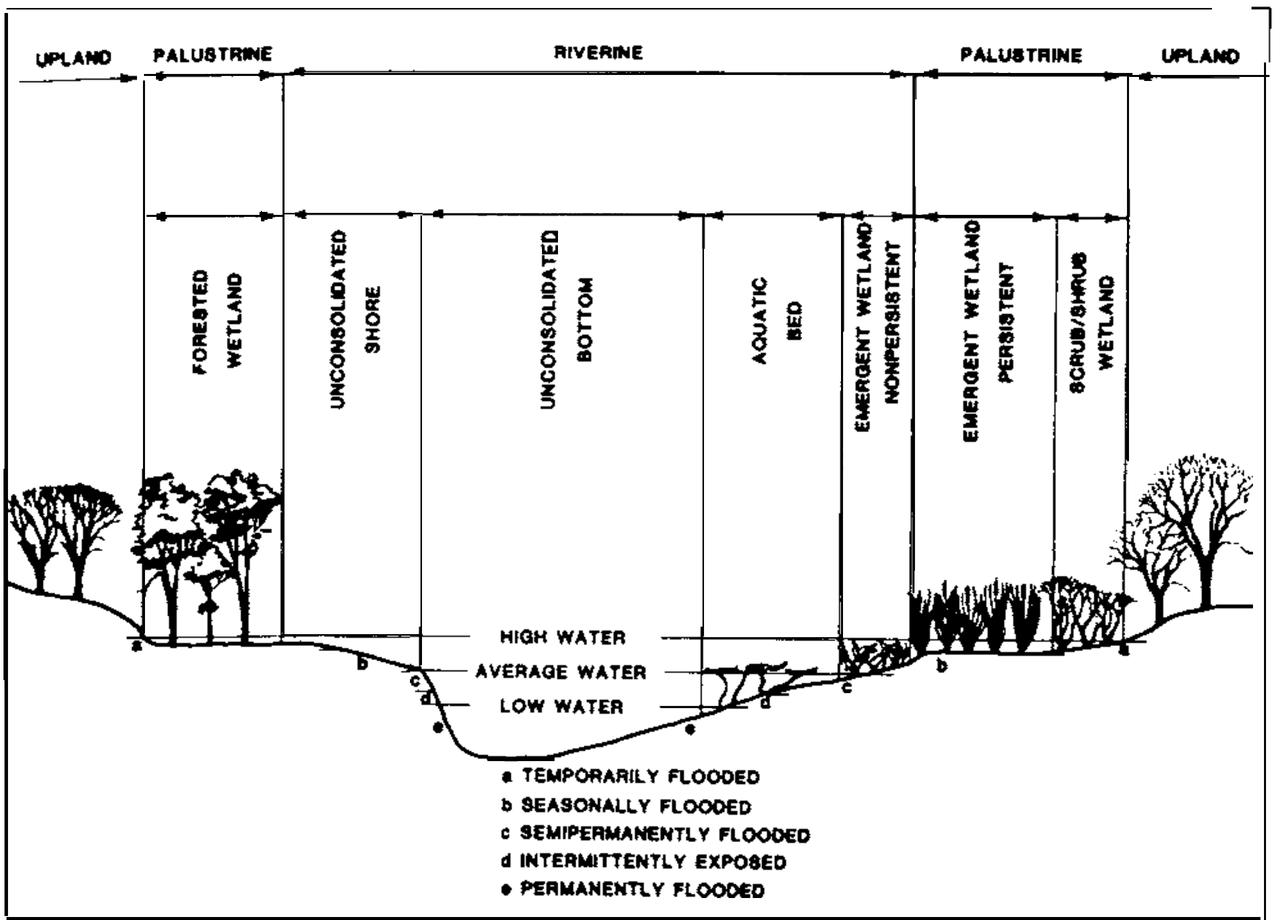
Estuarine systems include all sheltered intertidal areas where incoming fresh water mixes with salt water at least part of the time. These areas include beaches, semi-enclosed bays, salt marshes and swamps that lie near the mouths of rivers.



Riverine wetlands

From *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin, et al. 1979)

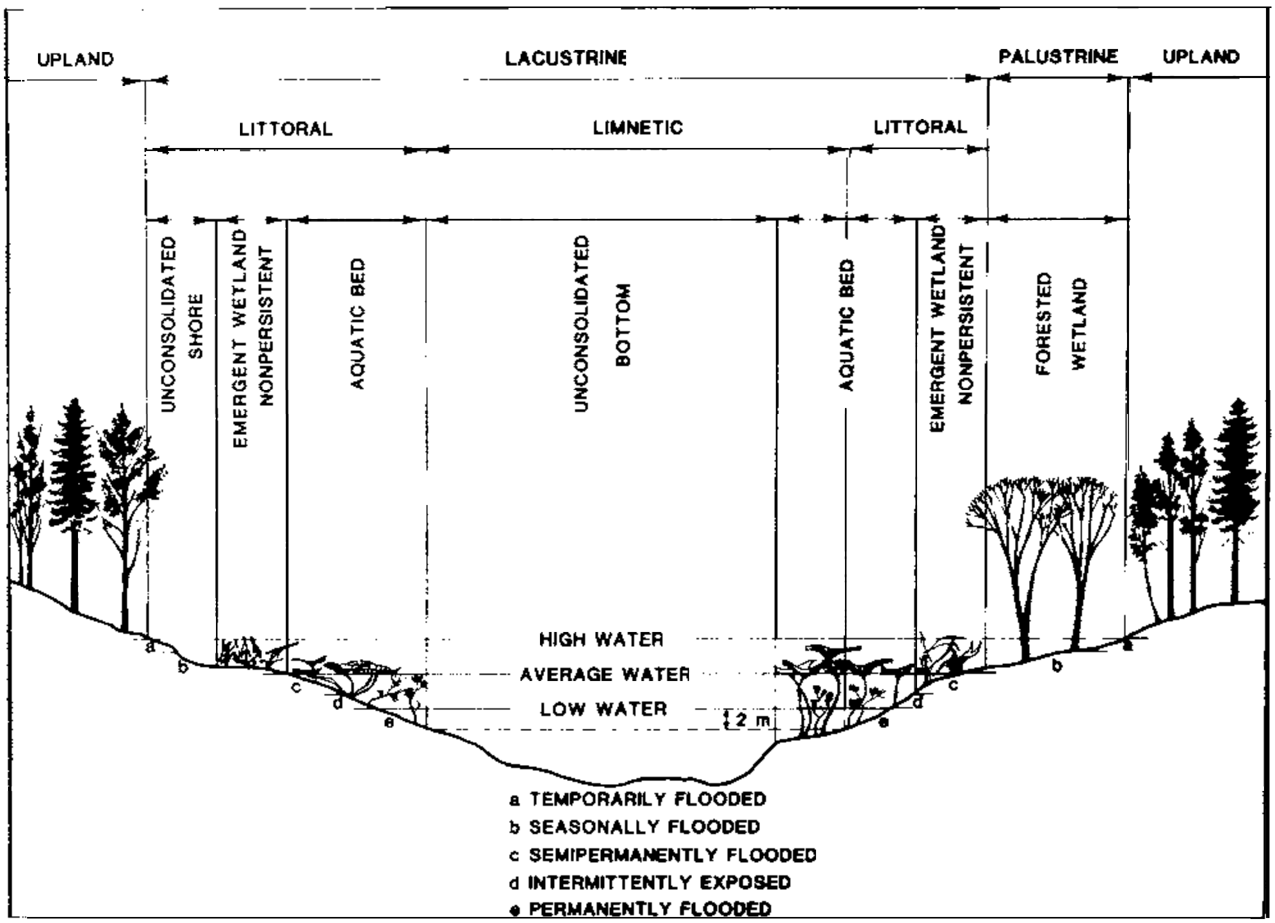
Riverine systems include all fresh water flowing in channels, such as rivers and streams. Streams are further subdivided based upon their velocity and whether they flow year round.



Lacustrine wetlands

From *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin, et al. 1979)

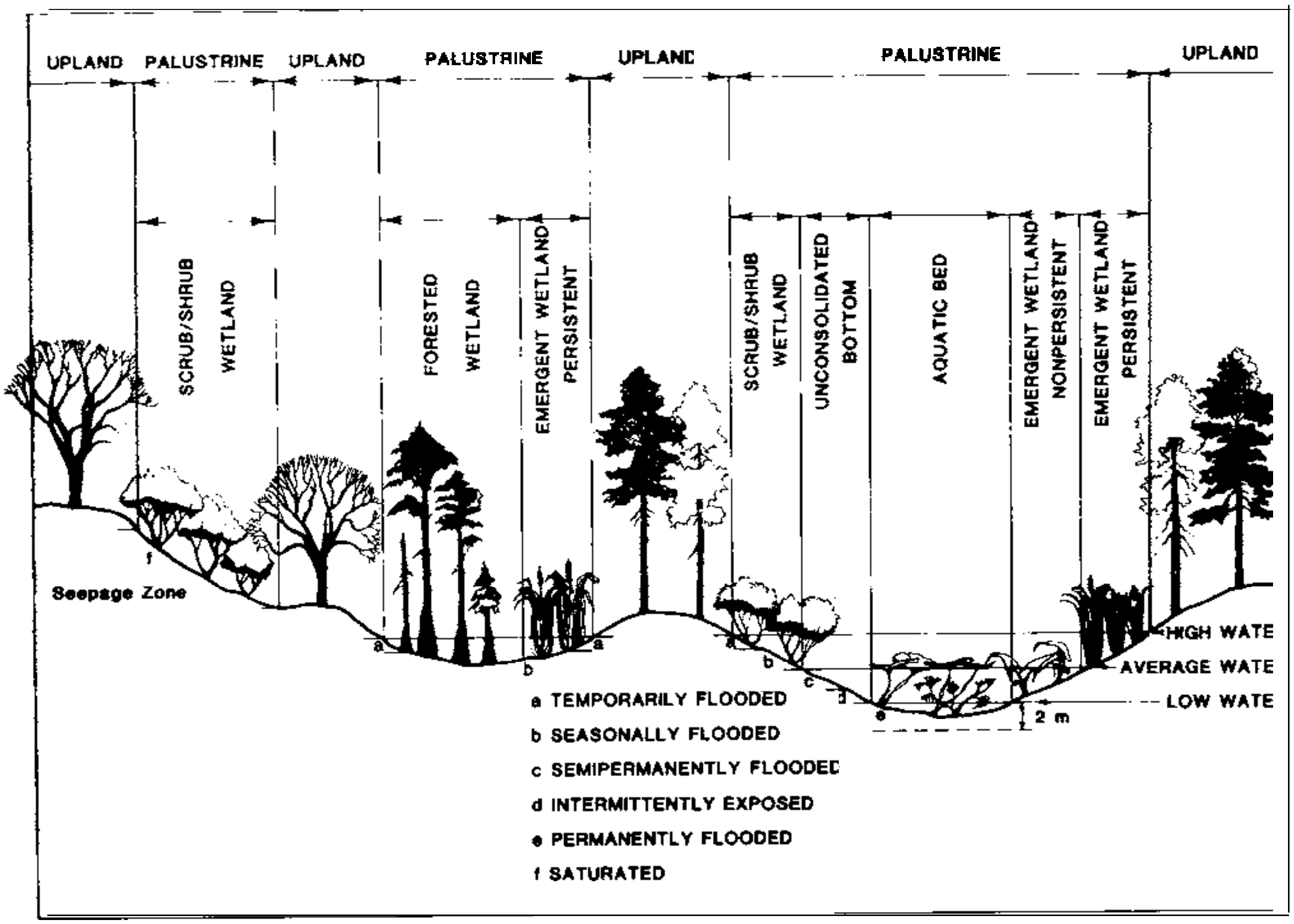
Lacustrine systems include reservoirs or lakes larger than 20 acres with less than 30 percent of their surfaced covered by emergent vegetation.



Palustrine wetlands

From *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin, et al. 1979)

Palustrine systems include freshwater marshes, ponds (covering less than 20 acres or six feet deep), scrub-shrub wetlands, wooded wetlands (swamps), wet meadows, bogs, potholes and desert playas. These are further divided based upon other characteristics such as vegetation, flooding patterns and soil type.



Appendix G
Plant Cards

Introduction

You will find many uses for these plant cards. They make a wonderful field guide. They can be run off on 5" x 7" card stock and laminated. They are used in many activities throughout the curriculum. They contain information that helps students understand the plant's role in the ecosystem. The "Gee Whiz" section help add interest and motivation for learning about the world of botany. The plant cards contain the following information:

Common Name: This is the name people tend to use. Unfortunately, it varies from area to area and is sometimes misunderstood. All capitalized plant and animal names are included in these cards.

Scientific Name: This Latin name does not vary and is used for clear identification and communication.

Wetlands Indicator: This rating tells you how likely it is that a plant will be found living in wetland conditions. These designations are very handy for identifying wetlands by their plant life.

Key: **OBL-** plant is obligate to wetlands; occurs over 99% of the time in wetlands
FACW- plant is facultative to wetlands; occurs 67-99% of the time in wetlands
FAC- plant is facultative; occurs 34-66% of the time in wetlands
FACU- plant is facultative to uplands; occurs l-33% of the time in wetlands
UPL- plant is obligated to uplands; occurs less than 1% of the time in wetlands

Habitat: This tells you the general surroundings in which this plant is found.

Description: This is what the plant looks like.

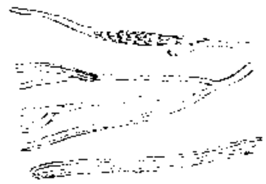
Niche Notes: This describes the plant's relationship to other plants and animals in its habitat.

"Gee Whiz:" Interesting folklore and tales about the plant.

Associates: These plants are likely to be found in the same area.

Common Name: EELGRASS

Scientific Name: *Zostera marina* and *Zostera japonica*



Wetland Indicator: OBL

Habitat: Sandy or muddy intertidal areas.

Description: Long, thin, green leaves characterize both species of eel grass. Z. marina has leaves up to three meters (10') in length. Z .juponica leaves are finer and don'texceed 15 centimeters. The seeds arc contained in translucent packets.

Niche Notes: BRANT geese eat EELGRASS as a staple part of their diet. Ducks and other waterfowl also dine on its seeds and leaves.

"Gee Whiz:" EELGRASS is considered a critical habitat in support of marine fisheries. It is commonly referred to as a nursery for many fish and crusteans.

Associates: Smithora ***naidum*** (Red Fringe), a rose-colored seaweed, grows on EELGRASS blades.

Common Name: PICKLEWEED or GRASSWORT

Scientific Name: *Salicornia virginica*

Wetlands Indicator: OBL

Habitat: Low salt marshes.

Description: PICKLEWEED is a succulent, lacking true leaves. It has thick, fleshy stems that may be tinged with red on the young, growing tips. Tiny, yellow flowers may occur near the tips of the stems. In winter, most of the fleshy growth is gone, leaving woody stems behind.

Niche Notes: Waterfowl eat the stems and seeds.

"Gee Whiz:" PICKLEWEED survives in its salty habitat by concentrating salt in the outer fleshy tips, which are either eaten or drop off. Try one for a treat; they can also be pickled.

Associates: Salt Grass, Arrowgrass, FLESHY JAUMEA

Common Name: AMERICAN THREESQUARE

Scientific Name: *Scirpus americanus*

Wetlands Indicator: OBL

Habitat: Low salt marshes, extending to higher regions

Description: Triangular stems and long, narrow leaves extend ing from the base identify AMERICAN THREESQUARE. ***P*** cluster of brownish flowers protrude from the bottom of its bract which appears as an extension of the stem.

Niche Notes: A variety of geese, ducks, and songbirds dine on this member of the bulrush family. Its seeds are favored, but it! rootstalks are also eaten.

"Gee Whiz:" Provides protective cover for many animals, as well as nesting habitat for many waterfowl.

Associates: SMOOTH CORDGRASS, SEASIDE ARROW GRASS, LYNGBY'S SEDGE

Common Name: SMOOTH CORDGRASS

Scientific Name: *Spartina alterniflora*

Wetlands Indicator: OBL

Habitat: Sandy or muddy areas that are inundated twice daily by the tide.

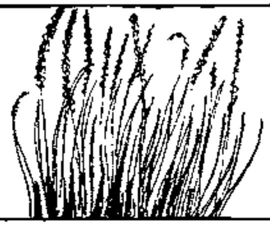
Description: This grass is commonly 1 to 2 meters (3-6') in height. It has large stems about 1 centimeter in diameter. Its long leaves are green in summer and gold in fall. The flower cluster forms a single spike.

Niche Notes: CORDGRASS is an invasive, non-native plant in Washington. It outcompetes other native intertidal plants which are important in supporting a greater diversity of life.

"Gee Whiz:" Provides protectivecover foranimals that also use it for food.

Associates: AMERICAN THREESQUARE, SEASIDE ARROWGRASS, LYNGBY'S SEDGE

Common Name: SEASIDE ARROWGRASS **Scientific Name:** *Triglochin maritimum*



Wetlands Indicator: OBL

Habitat: Saltmarsh areas that are inundated twice daily. It will survive in higher areas, but is unlikely to dominate.

Description: Fleshy, succulent leaves sheathe older, inner leaves. A long flower stalk with green or purple flowers extends above the leaves. Crushed leaves smell like Cilantro.

Niche Notes: Ducks and teal feed on ARROWGRASS.

"Gee Whiz:" This plant has been found in alkaline seeps, east of the Cascades.

Associates: In salt marshes: PICKLEWEED, FLESHY JAUMEA, SALTGRASS;
In brackish marshes: SEDGES, AMERICAN THREE-SQUARE, PACIFIC SILVERWEED

Common Name: SALTGRASS **Scientific Name:** *Distichlis spicata*

Wetland Indicator: FACW

Habitat: High or low saltmarshes and is very salt tolerant.

Description: This fairly short grass, less than 30 centimeters (1') forms dense mats. The leaves are arranged symmetrically in one plane and are sharply angled from the stem. The flower clusters are purple and extend above the stem.

Niche Notes: The rootstalks of SALTGRASS create a dense mat that encourages marsh growth. This provides nesting cover for waterfowl, such as cinnamon teal and shoveller. The seed heads and young plants are food for various ducks and geese.

"Gee Whiz:" Salt crystals may be exuded on the surface of the leaves. This marvelous adaptation gives this grass a grayish appearance and helps one make a definitive identification.

Associates: PICKLEWEED, FLESHY JAUMEA

Common Name: GUMWEED **Scientific Name:** *Grindelia integrifolia*

Wetlands Indicator: FACW

Habitat: Prefers high saltmarshes and surrounding areas.

Description: GUMWEED is up to 80 centimeters tall, highly branched, **and** has lance- or oval-shaped leaves. Its flowers look like small sunflowers and can be seen in spring and summer.

Niche Notes: GUMWEED is of little importance to wildlife.

"Gee Whiz:" Guess where GUMWEED gets its name! The entire plant is sticky to the touch because it exudes **a sticky** coating.

Associates: SALTGRASS. TUFTED HAIRGRASS

Common Name: SEASIDE PLANTAIN **Scientific Name:** *Plantago maritima*

Wetland Indicator: FACW

Habitat: Saltmarshes, but rarely dominates.

Description: This plant resembles SEASIDE ARROWGRASS, but is shorter, only 20 to 30 centimeters (1'). The leaves are more succulent and are often taller than the flower stalks. The plant appears greenish-gray because it is covered with short, woolly hairs.

Niche Notes: Plantain seeds may be eaten by birds or rodents, but are not an important part of their diet.

"Gee Whiz:" Can thrive in intense wind and sea spray.

Associates: DOUGLAS ASTER, SEASIDE ARROWGRASS, LYNGBY'S SEDGE, SALTGRASS

Common Name: PACIFIC SILVERWEED

Scientific Name: *Potentilla pacifica* or *Potentilla anserina*

Wetland Indicator: OBL

Habitat: High saltmarshes and adjacent areas.

Description: SILVERWEED is named for the undersides of its leaves. The top of the many-toothed compound leaves is dark green and smooth. It spreads by runners and has glossy, yellow flowers that resemble buttercups.

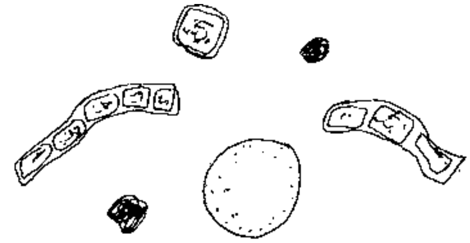
Niche Notes: Rosy finch and snow bunting may eat the seeds of SILVERWEED.

"Gee Whiz:" Native northwesterners ate the roots steamed and dipped in whale oil.

Associates: TUFTED HAIRGRASS, DOUGLAS ASTER, BUTTERCUP, SEDGES, RUSHES

Common Name: PHYTOPLANKTON

Scientific Name: many different species



Habitat: May be found floating near the water surface or in the water column. Can be found in fresh and marine waters.

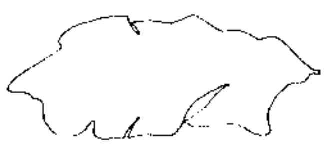
Description : PHYTOPLANKTON come in a wide variety of forms and are fascinating to study. Most PHYTOPLANKTON have a casing made up of silicon.

Niche Notes: PHYTOPLANKTON form the base of most aquatic food webs. They are eaten by ZOOPLANKTON and many small invertebrates.

"Gee Whiz:" Much of the oxygen we breathe is produced by PHYTOPLANKTON. They deserve our attention even if they are small and green!

Common Name: SEA LETTUCE

Scientific Name: *Ulva*



Wetlands Indicator: OBL

Habitat: In marine waters, at or below intertidal areas.

Description: SEA LETTUCE looks like very thin, bright green leaves of lettuce. The blades are translucent and, as in all seaweeds, lack veins. Pieces of SEA LETTUCE that wash up on the shore resemble green cellophane or may be bleached white by the sun.

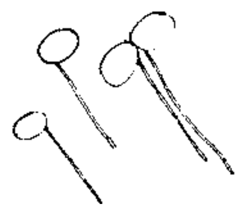
Niche Notes: SEA LETTUCE may be eaten by various plant-eating marine life.

" Gee Whiz:" SEA LETTUCE is also used in oriental soups and dishes.

Associates: FUCUS or ROCKWEED

Common Name: DUCKWEED

Scientific Name: *Lemna minor*



Wetlands Indicator: OBL

Habitat: Floating on quiet ponds and lakes. It prefers sheltered water, over 5 centimeters deep.

Description: DUCKWEED looks like green confetti scattered on the water. The whole plant is only 2 to 3 millimeters across. It has a single root dangling beneath it, but is attached to nothing. Flowers are rare, since most DUCKWEED is sterile.

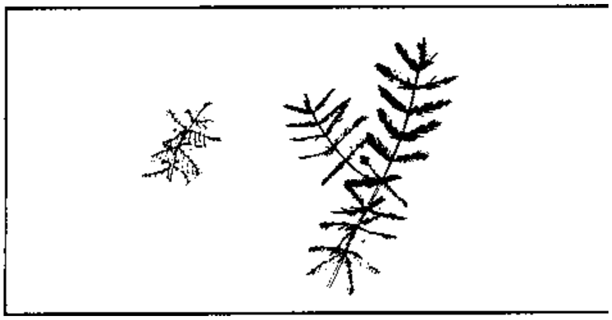
Niche Notes: DUCKWEED is excellent food for ducks! When ducks, BEAVERS and muskrats eat it they also ingest the small animal organisms that live in DUCKWEED, and they get a well balanced meal.

"Gee Whiz: "DUCKWEED produces the smallest flower of all known plants.

Associates: CATTAILS, PONDWEED, LIVERWORT

Common Name: WATER MILFOIL

Scientific Name: *Myriophyllum spp.*



Wetland Indicators: OBL

Habitat: Submerged or floating in ponds and lakes.

Description: The leaflets of MILFOIL are so small they give it a lacy appearance. Occasionally, the plant is known to bear tiny flowers on separate male and female plants.

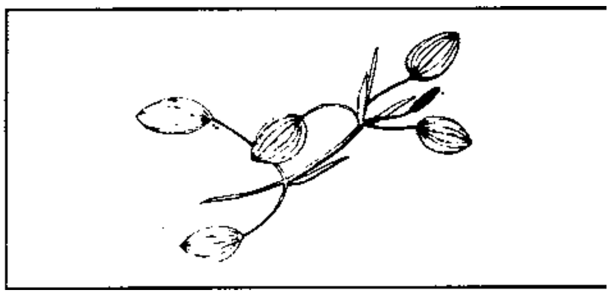
Niche Notes: MILFOIL. particularly the introduced European. variety, creates a monoculture and chokes ponds and lakes. Muskrats, ducks, and some shorebirds will eat MILFOILS.

"Gee Whiz" : Boaters must check their boats and trailers when leaving lakes to prevent the spread of this weed.

Associates: YELLOW POND LILY, BLADDERWORT

Common Name: PONDWEED

Scientific Name: *Potamogeton spp.*



Wetlands Indicator: OBL

Habitat: Found with its leaves floating on lakes and ponds.

Description: PONDWEED has parallel-veined leaves that are oval, if on the surface, and narrower, if submerged.

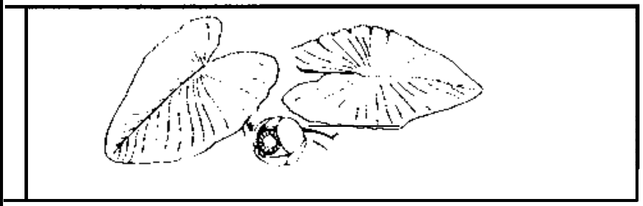
Niche Notes: The 40 or so species of PONDWEED in North America provide shelter or food for a variety of species. Insects and fish find shelter in its foliage. SNAILS, muskrats, ducks, and other waterfowl eat it.

"Gee Whiz:" The roots of PONDWEED are slightly nutty tasting and can be eaten raw in salads or cooked in stew.

Associates: CATTAILS, YELLOW POND LILY, BLADDER-WORT, MILFOIL

Common Name: YELLOW POND LILY

Scientific Name: *Nuphar polysepalum*



Wetlands Indicator: OBL

Habitat: Rooted in lake beds with their leaves and flowers floating on the surface. They do best in areas of still water.

Description: The large, leathery, somewhat arrow-shaped leaf is held on a petiole up to 2 meters (6') long. Large yellow flowers also emerge on the surface of the water, producing edible seeds.

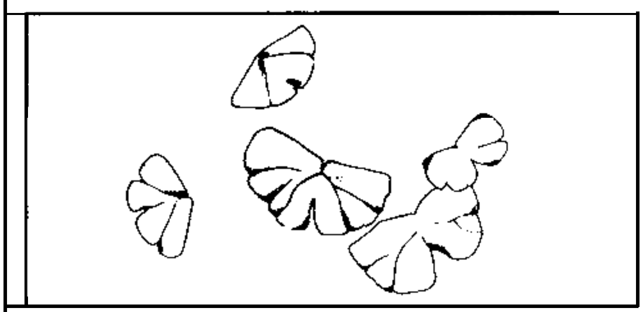
Niche Notes: Water Liliesplay an important role in their aquatic habitat. They provide shelter for young fish and are homes to the eggs of aquatic insects and amphibians. Their roots are eaten by muskrats, ducks, and other animals. They are a great place for frogs and baby ducks to rest.

"Gee Whiz" : Native Americans have many uses for Water Lilies. The roots may be eaten. The seeds are ground into flour or popped up like popcorn for snacks.

Associates: CATTAIL, WATER MILFOIL, BLADDER-WORT, WHITE WATER LILY (Nymphue - a non-native lily)

Common Name: LIVERWORT

Scientific Name: *Ricciocarpus natans*



Wetlands Indicator: OBL

Habitat: Floating on ponds or streams and washed up on nearby mud.

Description: The LIVERWORT looks like a leathery little leaf with 2 or 4 lobes and its underside has rhizoids, root-like extensions, hanging from its underside.

Niche Notes: It is not known if these plants are eaten by wildlife.

"Gee Whiz:" This strange looking little plant is a primitive variety that lacks true leaves, roots, or vascular tissue.

Associates: DUCKWEED, CATTAILS, PONDWEED

Common Name: YELLOW FLAG or IRIS

Scientific Name: *Iris pseudacorus*

Wetlands Indicator: OBL

Habitat: Found in inundated areas of open shorelines or meadows.

Description: Found in dense clumps, 1 meter (3') tall clumps, the YELLOW FLAG may be identified by its broad, thick, parallel-veined leaves. It is easily identified by its yellow blooms that are sometimes tinged with purple. If it isn't blooming, it can be identified from a CATTAIL by the way its leaves overlap fan-like at the base of the plant.

Niche Notes: This non-native plant is probably of European origin.

"Gee Whiz": The YELLOW FLAG is poisonous to many animals, including HUMANS. It causes vomiting.

Associates: CATTAIL, RUSHES, SEDGES

Common Name: SKUNK CABBAGE

Scientific Name: *Lysichitum americanum*

Wetlands Indicator: OBL

Habitat: Only grows in standing water or saturated soils.

Description: One of the first native flowers to bloom in spring, SKUNK CABBAGE is easily recognized by its whorl of huge, up to 1 meter (3') long, leaves. The tiny flowers are surrounded by a large, yellow spathe. Exudes a stinky smell to attract flies that aid in pollination.

Niche Notes: Grouse, pheasants, bear and elk eat its seeds.

"Gee Whiz": SKUNK CABBAGE roots may be cooked and eaten, but the leaves are poisonous if eaten because they contain oxalyic acid crystals. Native Northwesterners also used the leaves to soothe cuts and swellings, line their canoes, and rolled up as cups for holding liquids, berries, or wrapping salmon when baking over hot coals.

Associates: WESTERN HEMLOCK, WESTERN RED CEDAR, RED ALDER, VINE MAPLE, LADY FERN, WATER PARSLEY

Common Name: WATER PARSLEY

Scientific Name: *Oenanthesarmentosa*

Wetlands Indicator: OBL

Habitat: Saturated soils or standing water.

Description: The leaves are twice pinnately compound and toothed. Small, white flowers are borne in clusters. The stems have purple ribs.

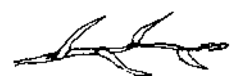
Niche Notes: WATER PARSLEY is considered an introduced species.

"Gee Whiz:" Be careful. WATER PARSLEY resembles poisonous water hemlock. This species was used by Native Northwestern people. The stalks were eaten or made into whistles, and the roots make a potent laxative.

Associates: CATTAILS, YELLOW IRIS, SKUNK CABBAGE, SEDGES, RUSHES

Common Name: MARSH PEPPER or KNOTWEED or SMARTWEED

Scientific Name: *Polygonum spp.*



Wetlands Indicator: FACU - OBL (depends on species)

Habitat: Shallow water, though some species may be able to tolerate saturated soils.

Description: This plant has reddish-purple stems up to one meter (3') tall and covered with small, indented glands. The leaves are lance-shaped and have a sheath around the stems. The very tiny flowers are borne on lateral or terminal stalks.

Niche Notes: Stands of SMARTWEED form excellent duck habitat. Their seeds are eaten by waterfowl and they provide superior cover. The seeds are also favored by a variety of birds such as mourning doves, pheasants, snow buntings, finches, juncos, sparrows, and common redpoles. Western chipmunk, muskrats, moose, and some aquatic insects also dine on SMARTWEED.

"Gee Whiz:" SMARTWEED is also called MARSH PEPPER because of its peppery taste.

Associates: DUCKWEED, CATTAIL, RUSHES, SEDGES

Common Name: MARSH CINQUEFOIL

Scientific Name: *Potentilla palustris*

Wetlands Indicator: OBL

Habitat: Standing water.

Description: Leaves are compound with 5 to 7 toothed leaflets. Long, reddish stems wind underwater. The flowers are deep red to purple in color and arise from the leaf base.

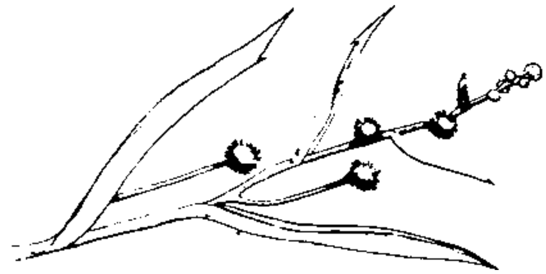
Niche Notes: MARSH CINQUEFOIL's seeds may be eaten by a few birds, but it otherwise is of little use to wildlife.

"Gee Whiz:" Used by Chippewa Indians as a treatment for dysentery and has been historically known as a powerful cure-all.

Associates: CATTAIL, WATER PARSLEY, RUSHES, SEDGES

Common Name: BURREED

Scientific Name: *Sparganium emersum*



Wetlands Indicator: OBL

Habitat: Marshy areas, peaty soils, or slow-moving streams.

Description: Long, flat, spongy leaves emerge or float on the surface. The flowers and seeds are in clusters that look like burrs. Male flowers are on the upper part of the plant. Female flowers are lower and usually lateral.

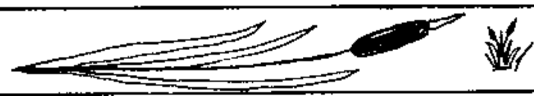
Niche Notes: BURREED is eaten **by** ducks, swans, sandhill cranes, common snipe and muskrat.

"Gee Whiz:" Part of an important group of plants that live half in the water and half out of the water.

Associates: CATTAILS, SEDGES. RUSHES

Common Name: COMMON CATTAIL

Scientific Name: *Typha latifolia*



Wetlands Indicators: OBL

Habitat: Form large stands in quiet, standing water.

Description: The long, narrow, grayish-green leaves of CATTAIL are almost unmistakable. The tiny, separate male and female flowers make up the "Cat's tail." Leaves have pointed tips and a sheathing base.

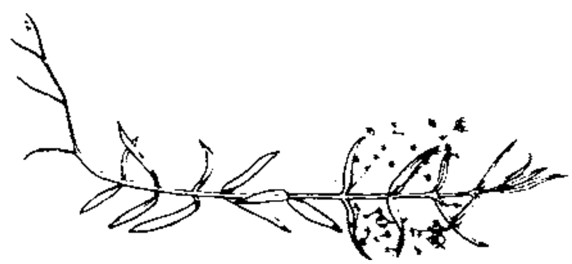
Niche Notes: The tiny, hairy seeds are only eaten by some teal. The roots are a favorite for muskrats. It also provides nesting areas for RED-WINGED BLACKBIRDS and MARSH WRENS. While CATTAIL may provide cover for ducks, it actually invades areas that would supportother more diverse plant communities used for both food and cover.

"Gee Whiz:" CATTAIL roots were eaten by Native Americans. Its leaves were woven into mats, rainwear, and pack sacks. The young stalks arc very tasty in salads. The young 'CATTAILS' (male and female flowers) may be boiled and buttered, then eaten like corn on the cob. But be aware if gathering your own CATTAIL for food. The stands growing in roadside ditches may contain high levels of lead and other contaminants from our motor vehicles.

Associates: YELLOW IRIS, SEDGES, RUSHES

Common Name: MARSH SPEEDWELL

Scientific Name: *Veronica scutellata*



Wetlands Indicator: OBL

Habitat: Wet places from waterside to foothills.

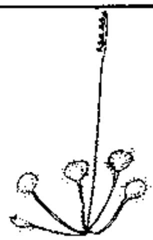
Description: The creeping stems of SPEEDWELL have lance-shaped leaves and bluish flowers.

"Gee Whiz:" SPEEDWELL was called "frog leaves" by one Northwest native tribe.

Associates: CATTAIL, WATER PARSLEY, MARSH PEPPER, SEDGES, RUSHES

Common Name: SUNDEW

Scientific Name: *Drosera rotundifolia*



Wetland Indicator: OBL

Habitat: SPHAGNUM bogs.

Description: Narrow leaves that extend to rounded ends are covered with long, reddish, sticky hairs. The leaves form a whorl. Flowers arise from a stalk at the base of the leaves.

Niche Notes: It isn't known if anything eats SUNDEW.

"Gee Whiz: "SUNDEW are carnivorous. They trap insects on their sticky hairs and dissolve their bodies for the needed nutrients, mostly nitrogen and phosphorous. This is an adaptation for the nitrogen-poor soils in which they live.

Associates: BOG LAUREL, LABRADOR TEA, COTTON GRASS, SPHAGNUM

Common Name: WILD LILY-OF-THE-VALLEY

Scientific Name: *Maianthemum dilatatum*

Wetlands Indicator: FAC

Habitat: Moist, shaded forests or stream banks.

Description: One to three heart-shaped leaves with parallel veins identify this 10 to 30 centimeter (3-12") herb. Flowers are white and stand in a small cluster above the plant.

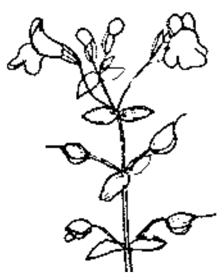
Niche Notes: The berries are eaten to a limited extent by wildlife.

"Gee Whiz:" The tiny red berries were eaten by Native Americans, but not relished. The Quileute name describes them as tasting kind of sour or like whale oil.

Associates: RED ALDER, WESTERN RED CEDAR, WESTERN HEMLOCK

Common Name: YELLOW MONKEY FLOWER

Scientific Name: *Mimulus guttatus*



Wetland Indicator: OBL

Habitat: Wet meadows.

Description: Fleshy, heart-shaped, toothed leaves are arranged on hollow stems that reach up to 1 meter (3'). Bright, yellow flowers with purple markings appear in pairs at the top. They resemble snap-dragons.

Niche Notes: The bottom of the MONKEY FLOWER'S petal serves as a perfect landing pad for bumble bees.

"Gee Whiz:" The leaves make a tasty salad.

Associates: FOXTAILS, SEDGES, RUSHES

Common Name: CREEPING BUTTERCUP

Scientific Name: *Ranunculus repens*

Wetland Indicator: FACW

Habitat: Common in many moist areas, especially deciduous forests and wet meadows.

Description: Soft, hairy compound leaves have three leaflets and stand on long petioles. Five-petaled, yellow flowers develop into round fruits covered in green spikes.

Niche Notes: Small amounts of BUTTERCUP seeds may be eaten by some wildlife. This species of BUTTERCUP was introduced and has flourished. There are also native Buttercup species.

"Gee Whiz:" The roots of the plant were cooked, dipped in seal or whale oil, and eaten with salmon eggs by Native Americans. The leaves and stems are inedible because they contain the toxin ranunculin, a severe gastrointestinal irritant. The name comes from the Latin 'rana', which means frog and probably refers to its watery habitat.

Associates: RED ALDER, WILLOW, SEDGES, RUSHES

Common Name: THREE-LEAF FOAM FLOWER
Scientific Name: *Tiarella trifoliata*

Wetlands Indicator: FAC

Habitat: Prefers moist woods.

Description: Compound leaves arise from the stem, each consisting of three toothed leaflets. Lacy, white flowers are held high on a stalk.

Niche Notes: Grouse may browse on FOAM FLOWER.

"Gee Whiz:" Native Northwesterners chewed FOAM FLOWER leaves as a cough medicine.

Associates: WESTERN HEMLOCK, RED ALDER, VINE MAPLE, LADY FERN, SKUNK CABBAGE

Common Name: FOXTAIL
Scientific Name: *Alopecurus spp.*

Wetlands Indicator: FACW to OBL

Habitat: Very wet soils.

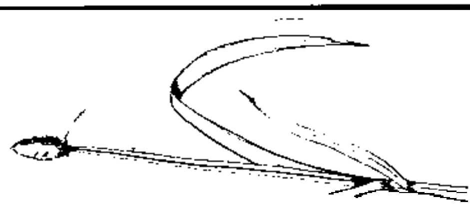
Description: This grass has flat, soft leaves surrounding a hollow 30 centimeter (1' tall) stem. Bristly, little flowers form a cluster resembling a fox tail.

Niche Notes: FOXTAIL is not known to be useful to wildlife.

"Gee Whiz:" FOXTAIL makes excellent forage for wild creatures that don't mind wet places.

Associates: SEDGES, RUSHES

Common Name: SEDGES
Scientific Name: *Carex spp.*



Wetlands Indicator: FACW to OBL

Habitat: SEDGES grow in standing water or saturated soils. Two species, Lyngby's and Slough sedge, are tolerant of brackish water. Lyngby's is more salt-tolerant than Slough sedge.

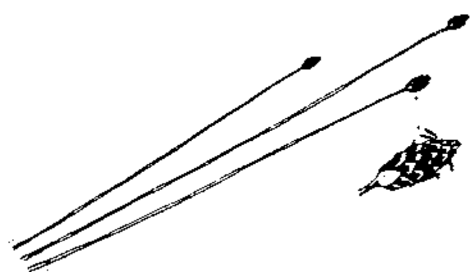
Description: This grass-like plant has triangular stems and fibrous roots. If it has leaves, they are grass-like and shaped like a 'w' when cut across their width.

Niche Notes: The small seeds of SEDGES are eaten by birds such as ducks, rails, grouse, and songbirds. Pika and chipmunks also eat the seeds and leaves. SEDGES provide valuable cover for wildlife.

"Gee Whiz:" Native Northwesterners wove baskets using sedge.

Associates: CATTAILS, REED CANARY GRASS, RUSHES

Common Name: SPIKE-RUSH
Scientific Name: *Eleocharis spp.*



Wetlands Indicator: OBL

Habitat: In clumps in areas with wet soils.

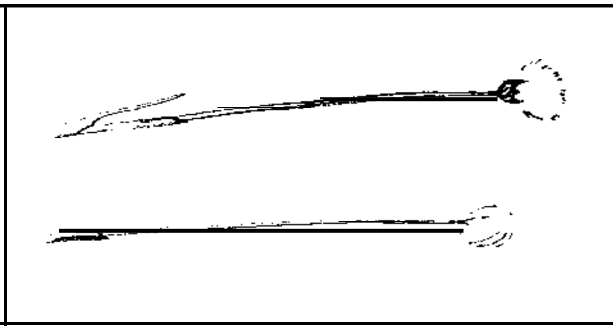
Description: The clumps of rounded or flattened stems are dark green in color. SPIKE-RUSH has no leaves and the flowers form a small brown cluster on the tip of me spikes.

Niche Notes: The seeds and tuberous roots are eaten by waterfowl and marsh birds.

Associates: SEDGES, RUSHES

Common Name: COTTON GRASS

Scientific Name: *Eriophorum chamissonis*



Wetlands Indicator: OBL

Habitat: Younger spongey portions of bogs.

Description: A type of sedge, COTTON GRASS is characterized by a tall, stout stem 30 to 70 centimeters (1-2.5') in height. Leaves, if there are any, are found at the base. The flower cluster, at the end of the stem, develops into a cotton-like tuft.

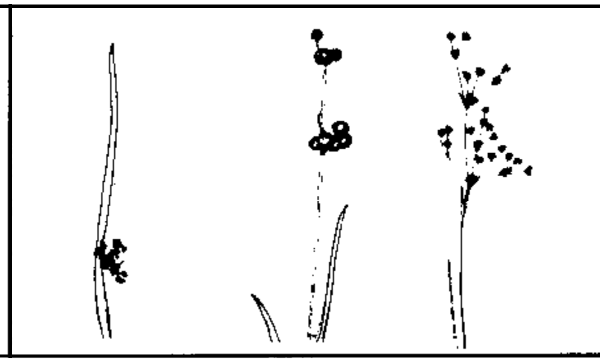
Niche Notes: Birds use the "cotton" tufts for nest material.

"Gee Whiz:" COTTON GRASS is also called cotton sedge.

Associates: LABRADOR TEA, BOG LAUREL, SIJNDEW, SPHAGNUM

Common Name: RUSH

Scientific Name: *Juncus spp.*



Wetlands Indicator: OBL-FACW

Habitat: Saturated soils or even standing water.

Description: Clumps of RUSHES have cylindrical or flattened stems and leaves that sheathe the stem. Clusters of green or brown flowers help botanists identify various species.

Niche Notes: RUSHES are eaten by few species of wildlife, but they are a good source of cover.

"Gee Whiz:" RUSHES are used in weaving baskets .

Associates: CATTAILS, REED CANARY GRASS, SEDGES

Common Name: REED CANARY GRASS

Scientific Name: *Phalaris arundinacea*

Wetlands Indicator: FACW

Habitat: Tolerates a wide range of water conditions.

Description: A strong grass that has hollow stems and upper leaves that stand at 45 degree angles from the stem. Little, scaly flowers are held atop the stem.

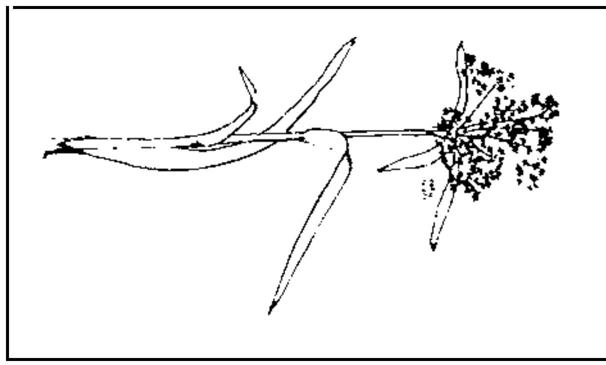
Niche Notes: A few birds eat the seeds. It was widely planted in agricultural areas because of its ability to grow in saturated conditions. The U.S.F.W.S. now discourages farmers from planting it because of its tendency to out compete native vegetation and its low value as forage for wildlife.

"Gee Whiz:" This introduced species is very invasive and out competes other, more desirable species. It also is an abundant pollen producer; not good for those with allergies.

Associates: CATTAIL, SEDGES, RUSHES

Common Name: SMALL-FRUITED BULRUSH

Scientific Name: *Scirpus microcarpus*



Wetlands Indicator: OBL

Habitat: Low, damp areas

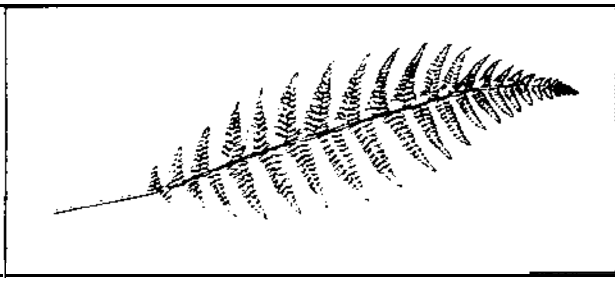
Description: W-shaped, grass-like leaves sheathe a slightly triangular stem that reaches up to 1.5 meters (5') tall. Numerous dark green or brown flowers are held in clusters above the stem.

Niche Notes: The seeds and rootstock are eaten by all sorts of waterfowl, marsh and shorebirds.

Associates: SEDGES, RUSHES

Common Name: LADY FERN

Scientific Name: *Athyrium felix-femina*



Wetlands Indicator: FAC

Habitat: Marshy areas, wet forests, and along streams.

Description: A lacy, delicate, bright green fern, whose fronds are lance-shaped. Its softness will identify it from other ferns. Oval spore clusters may be found on the leaves undersides.

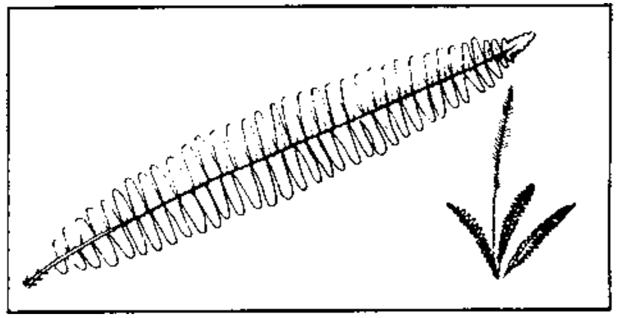
Niche Notes: This fern is of minimal use to wildlife.

"Gee Whiz:" The young, curled fiddle heads of LADY FERN are good either raw or boiled. always wash first for human consumption.

Associates: WESTERN HEMLOCK, WESTERN RED CEDAR, RED ALDER, VINE MAPLE, SKUNK CABBAGE

Common Name: DEER FERN

Scientific Name: *Blechnum spicant*



Wetlands Indicator: FAC+

Habitat: Common in shady, moist forests.

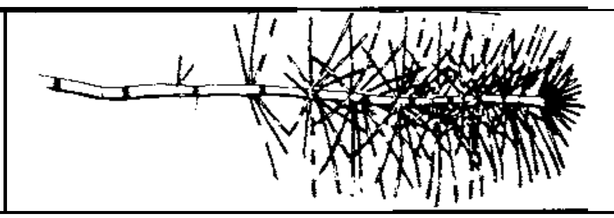
Description: DEER FERN have two kinds of fronds. Vegetative fronds are lance-shaped, but the leaflets are not toothed and are attached directly to the stalk. Fertile fronds shoot above the rest of the plant and have spores on the underside of their thin leaflets.

Niche Notes: Elk find DEER FERN a favorite.

Associates: WESTERN HEMLOCK, LADY FERN, SKUNK CABBAGE

Common Name: HORSETAIL

Scientific Name: *Equisetum sp.*



Wetlands Indicator: FAC

Habitat: Flourish in wet, disturbed areas.

Description: A jointed stem, up to 60 centimeters (24") tall, is surrounded by whorls of wiry branches and small, scaly leaves

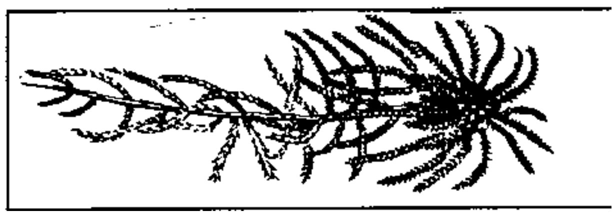
Niche Notes: Whistling swans or a hungry BLACK BEAR may eat HORSETAILS, but overall they are of little value to wildlife.

"Gee Whiz:" HORSETAILS are known as "scouring rush" because the silica in their stems make them tough and abrasive enough to scrub pots. Native Americans also used the stems to polish arrows and for an invigorating body scrub. The juice was used as an eyewash. The spore cone was mashed with salmon eggs and eaten. The stem and root was eaten with whale or seal oil, boiled for a hair rinse, or woven into baskets.

Associates: LADY FERN, SKUNK CABBAGE, MONKEY FLOWER, SEDGES, RUSHES

Common Name: PEAT MOSS

Scientific Name: *Sphagum spp.*



Wetland Indicator: OBL

Habitat: Soggy, acid conditions.

Description: Small mossy plants from grayish- toreddish-green mats in soggy areas. The individual plants have bushy heads of leafy structures above a sparser lower section. Spore producing capsules, when present, rise above the leafy heads.

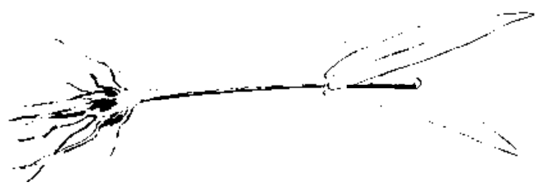
Niche Notes: Not considered a food source for wildlife.

"Gee Whiz:" PEAT MOSS holds many times its weight in water. It is so acidic, it was used during World War I as a sterile dressing for injuries. The mats are often floating and make the soil bouncy. It is often used in gardening today. Native Americans used SPHAGNUM moss as the first disposable diapers.

Associates: LABRADOR TEA, BOG LAUREL, CRANBERRY

Common Name: PURPLE LOOSESTRIFE

Scientific Name: *Lythrum salicaria*



Wetlands Indicator: FACW+

Habitat: Shallow marshes or saturated soils.

Description: This tall, 1 to 2 meter (3-6') plant has long, slender leaves that are often tinged in pink. It has showy, bright purplish-pink flowers in clusters.

Niche Notes: PURPLE LOOSESTRIFE is not important to wildlife. It is an invasive species introduced from Europe.

"Gee Whiz:" Imported plants can upset the delicate balance in a habitat. PURPLE LOOSESTRIFE out competes other native species and chokes them out. It is considered a noxious weed and the WA Dept. of Ecology is encouraging local jurisdictions to eradicate it.
Native Americans used the leaves to treat chronic diarrhea.

Associates: CATTAIL, WILLOW, HARDHACK

Common Name: WAPATO or BROADLEAF ARROWHEAD

Scientific Name: *Sagittaria latifolia*

Wetlands Indicator: OBL

Habitat: Quiet, standing water.

Description: ARROWHEAD earned its name from its distinctly arrowhead-shaped leaves. Small, whiteflowers are formed on a spike.

Niche Notes: The small seeds and starchy roots are eaten by waterfowl and muskrat.

"Gee Whiz:" Native Americans harvested the roots. Often called duck potatoes.

Common Name: REEDGRASS or COMMON REED

Scientific Name: *Phragmites australis*

Wetlands Indicator: FACW+

Habitat: Areas where inundation is erratic. It also tolerates brackish conditions.

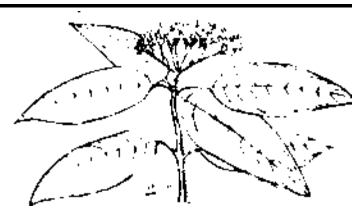
Description: Very tall, 2 to 3 meter (6-9'). stems and long leaves identify this species. The flower is a rush-like spike that is purplish, but fades to straw color.

Niche Notes: This grass invades arcas, driving out other species that are beneficial to wildlife.

"Gee Whiz:" REEDGRASS forms monocultures easily, and is considered a serious pest on the Atlantic Coast. It is only beginning to invade WA wetlands. ***(Formerly called Phragmites australis)***

Common Name: RED-OSIER DOGWOOD

Scientific Name: *Cornus sericia*



Wetlands Indicator: FACW

Habitat: Along streams and ponds. It prefers full sun and ample to moderate water.

Description: The many stems of this shrub are bright red to reddish-purple, but turn gray with age. It grows from 2 to 6 meters (6-l 8') tall. Its leaves have a rounded base and pointed tip and are dark with distinct veins. Flowers occur in flat-topped clusters and the fruits are small and white or pale blue in color.

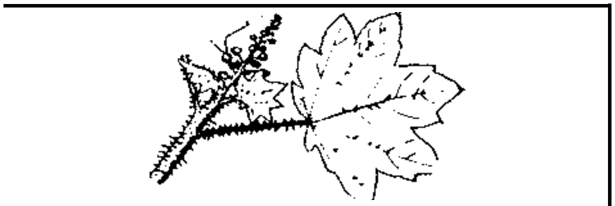
Niche Notes: At least twenty-four species of Northwest birds feed on DOGWOOD. Black-tailed deer and mountain beaver also use it for food. It is valuable for bird cover and nesting.

"Gee Whiz" DOGWOOD is valuable in habitat reclamation projects and is a beautiful shrub. ***(Formerly called C. stolonifera)***

Associates: WILLOW, REED-CANARY GRASS CATTAILS

Common Name: DEVIL'S CLUB

Scientific Name: *Oplopanax horridum*



Wetlands Indicator: FAC

Habitat: Shady, moist woods and near streams.

Description: Once encountered, this plant will never be mistaken. It has large, 1 to 3 meter (3-9') stems and huge leaves armed with yellowish spines.

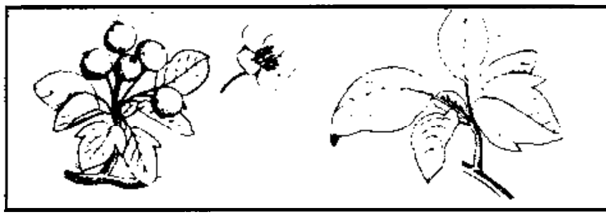
Niche Notes: Most wildlife steer clear of DEVIL'S CLUB. The little, red berries may be eaten by some small birds.

"(**Gee Whiz:"** Even the scientist who named this thought it was horrid (see the Latin name). Northwest Native peoples used the plant, mostly as a source of medicine. The bark can be used to make cold medicine, deodorant, baby talc, or burned and mixed with grease for face paint.

Associates: WESTERN HEMLOCK, RED ALDER, SALMON BERRY, RED ELDERBERRY, LADY FERN. WILD LILY-OF-THE-VALLEY

Common Name: WESTERN CRABAPPLE

Scientific Name: *Pyrus fusca*



Wetlands Indicator: FACW

Habitat: Moist woods, along stream banks, and in bogs.

Description: This shrub has several stems and may be as large as 12 meters (36') tall. It has dark, flaky bark, blunt twigs, and variable shaped leaves. Flowers are white or pink and found in clusters. The small, round fruits are yellow to purplish in color.

Niche Notes: CRABAPPLES are reported to be food for pheasant, grouse, and bears.

"Gee Whiz:" Native Northwesterners ate the fruit of the CRABAPPLE. The lightweight, but tough wood was used for the prongs of seal spears and as a maul. The bark's medicinal properties were used for disorders of the intestines or stomach, eyes, and blood. ***(Formerly known as Pyrus fusca.)***

Associates: WESTERN HEMLOCK, HARDBACK, RED ALDER, LABRADOR TEA

Common Name: SALMONBERRY

Scientific Name: *Rubus spectabilis*

Wetlands Indicator: FAC

Habitat: Moist woods and along stream banks. It prefers full sun or partial shade and at least moderate water.

Description: SALMONBERRY's tangle of curving stems, growing up to 4 meters (12') high, are covered in compound leaves. The leaves have three, triangular, hairy leaflets. The flowers are reddish-purple and the berries are orange to bright red.

Niche Notes: The shrub provides shelter for nesting birds and small rodents. The flowers are a favorite of hummingbirds and butterflies. Both birds and mammals eat the fruit.

"Gee Whiz: " The astringent bark, leaves, and sprouts of SALMONBERRY were traditionally used as a remedy for digestive disorders caused by eating too much salmon and to treat burns. The berries are excellent raw or cooked into jam or pie.

Associates: RED ALDER, VINE MAPLE, LADY FERN, FOAM FLOWER

Common Name: RED ELDERBERRY

Scientific Name: *Sambucus racemosa*

Wetlands Indicator: FACU

Habitat: Prefers full sun and at least moderate water.

Description: Each compound leaf has 5 to 7 sharply-toothed leaflets on a long petiole. The soft, pithy, bluish twigs form a large shrub, 2 to 5 meters (6-15'). Small clusters of white flowers are followed by little, crimson berries.

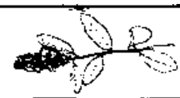
Niche Notes: Though these berries are toxic to humans, 29 species of Northwest birds feed on the berries and deer browse the foliage. Robins and band-tailed pigeons are especially attracted by the fruit.

"Gee Whiz:" The Latin name for ELDERBERRY comes from the word "sambuke" which means "a musical instrument. " The wood has been used since ancient times to make flutes and whistles. The flower clusters are delicious if dipped in batter and cooked as fritters. The berries are reported to be poisonous unless cooked. Since they taste unpleasant, even cooked, it is suggested to leave them for the birds.

Associates: WESTERN HEMLOCK, RED ALDER, VINE MAPLE, DEVIL'S CLUB, DEER FERN, FOAM FLOWER

Common Name: HARDHACK

Scientific Name: *Spiraea douglasii*



Wetlands Indicator: FACW

Habitat: This widespread shrub is found standing in water along stream banks, lakes, bogs, and wet meadows. It tolerates full or partial sun.

Description: This 1 to 2.5 meter (3-8') shrub has oval leaves with teeth only along the upper half of the margins. Tiny, individual, rosy-pink flowers form conical clusters. The seed clusters quickly turn brown and persist through winter.

Niche Notes: Spiraea, also called HARDHACK. is of limited use to wildlife. It provides cover and white-tailed deer are documented to occasionally feed on it. It is a favorite nesting site for common yellowthroat warblers and Virginia Rails. Unfortunately, Spiraea tends to form amonoculture so dense that nothing grows beneath it.

"Gee Whiz:" Spiraea was of limited use to Native peoples. The seeds were boiled for a tea for diarrhea and the wood could be used for spreading and smoking salmon, since it doesn't bum easily.

Associates: RED ALDER, WILLOW, CRABAPPLE, LABRADOR TEA

Common Name: BOG LAUREL

Scientific Name: *Kalmia occidentalis*

Wetlands Indicator: FACW+

Habitat: SPHAGNUM bogs.

Description: Easily confused with LABRADOR TEA, the BOG LAUREL has darker green leaves with a distinctive white midrib. The flowers are saucer shaped and deep rose in color.

Niche Notes: The plant is poisonous to some animals.

"Gee Whiz:" BOG LAUREL is named after Peter Kalm, a botanist who studied under Carolus Linnaus, the man who started our system of naming and classifying plants.

Associates: LABRADOR TEA, SPHAGNUM, CRANBERRY

Common Name: LABRADOR TEA

Scientific Name: *Rhododendron groenlandicum*

Wetlands Indicator: OBL

Habitat: Bogs.

Description: LABRADOR TEA grows as large as 2 meters (6') and is green year-round. Its dark, leathery leaves have rusty colored hairs on their undersides. White flowers are arranged in clusters at the ends of the stems.

Niche Notes: Moose and deer are known to eat this shrub, but it is of limited use to most wildlife.

"Gee Whiz:" LABRADOR TEA can be brewed into a tea, but if it is too strong it is mildly poisonous. ***(Formerly called Ledum.)***

Associates: WESTERN HEMLOCK, HARDHACK. BOG LAUREL, CRANBERRY, SPHAGNUM

Common Name: RED HUCKLEBERRY

Scientific Name: *Vaccinium parvifolium*

Wetlands Indicator: FAC+

Habitat: Some forested wetlands growing out of stumps or logs.

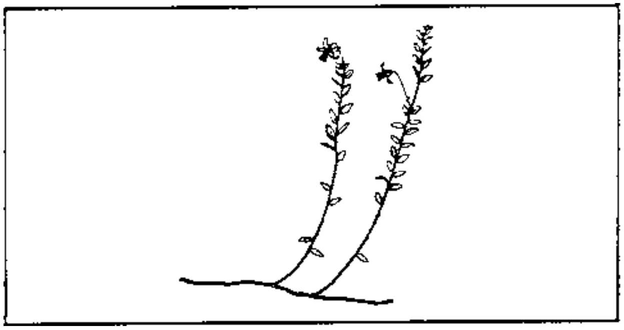
Description: Bright green foliage and angled stems make this shrub easy to identify. The oval leaves are widely spaced. Small, urn-shaped flowers are found at the base of the leaves and yield round, red berries.

Niche Notes: The fruit is eaten by many birds including gulls and grouse. Pika, bear, and deer also eat the foliage and fruit.

"Gee Whiz:" The sour edible berries are easier to harvest if "combed" off the stem.

Associates: SALAL, WESTERN RED CEDAR

Common Name: CRANBERRY **Scientific Name:** *Vaccinium oxycoccus*



Wetlands Indicator: OBL

Habitat: SPHAGNUM bogs.

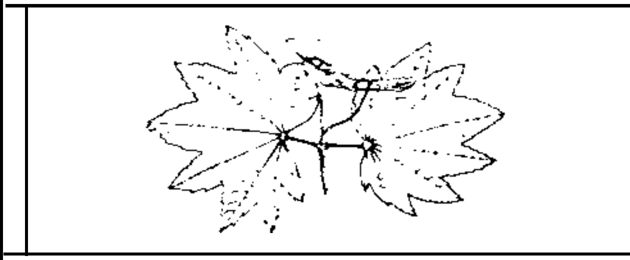
Description: This very small, trailing shrub has leathery, green leaves. Deep pink flowers develop into red, waxy berries.

Niche Notes: CRANBERRIES provide food for birds and small mammals.

"Gee Whiz:" Native Americans collected CRANBERRIES and kept them in boxes until brown. Pioneers to the area prized cranberries and sometimes traded for them.

Associates: LABRADOR TEA, BOG LAUREL, SUNDEW, SPHAGNUM

Common Name: VINE MAPLE **Scientific Name:** *Acer circinatum*



Wetlands Indicator: FAC

Habitat: Grow in tangles along stream banks and in damp woods.

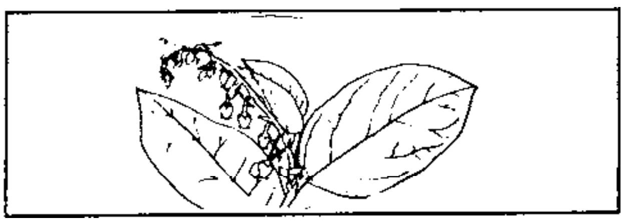
Description: Leafy and wide-spreading, this shrub bears light green leaves that turn bright red in the fall. The leaves are smaller than BIG LEAF MAPLE and have 7 to 9 lobes. It also produces "helicopters," identified by the wide angle between their wings.

Niche Notes: Songbirds and small mammals utilize VINE MAPLE for food, shelter, and nesting.

"Gee Whiz:" VINE MAPLE was an important source of basket making material for Native Americans.

Associates: WESTERN HEMLOCK, WESTERN RED CEDAR, RED ALDER, SKUNK CABBAGE, LADY FERN, WILD LILY-OF-THE-VALLEY

Common Name: SALAL **Scientific Name:** *Gaultheria shallon*



Wetlands Indicator: FACU

Habitat: This is not awetlands species, but may be found in drier areas of forested wetlands.

Description: Dark, leathery leaves and white to pink flowers characterize this very common shrub. It produces abundant, dark, purple, blueberry-shaped fruit.

Niche Notes: Deer browse SALAL. The fruit is popular with song and game birds and small mammals.

"Gee Whiz:" Most agree that SALAL berries are better cooked and sweetened. The foliage is used by commercial florists.

Northwestern Native people ate SALAL berries mashed dried or dipped in whale or seal oil. The leaves were used to make a number of medicines.

Associates: RED HUCKLEBERRY, DOUGLAS FIR

Common Name: SITKA SPRUCE **Scientific Name:** *Picea sitchensis*

Wetlands Indicator: FAC

Habitat: Tolerates full sun or partial shade and ample to moderate water. It does best in foggy, moist atmospheres and tends to be found along the coast from sea level to 2000 feet.

Description: This evergreen tree can reach 60 to 70 meters (180-200') in height. It can be recognized by its thin, grayish-brown scaly bark and droopy branches. The brave may choose to grab the stiff, sharp-needled branches for a painful identification. Individual needles have two white stripes on the upper surface and narrower stripes on the lower. Male cones are red: female cones are reddish- or yellowish-brown and get browner with age.

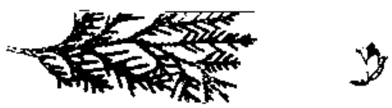
Niche Notes: Seeds are food for wildlife, the tree provides cover andnesting areas, and needles are eaten by blue and spruce grouse.

"Gee Whiz:" Northwest Native peoples used the pitch to caulk canoes, as a salve for wounds, as a chest rub for colds, and even as a chewing gum. The roots were used for baskets and the bark boiled into a tea to stop tickles in the throat. The Makah decorated their hair with its leaves before going to sea.

Associates: WESTERN RED CEDAR, WESTERN HEMLOCK, VINE MAPLE, LADY FERN, SKUNK CABBAGE

Common Name: WESTERN RED CEDAR

Scientific Name: *Thuja plicata*



Wetlands Indicator: FAC

Habitat: Tolerates full sun or partial shade and ample or moderate water. It flourishes in moist areas along water margins.

Description: Red bark that peels in long strips and flat, scale-like needles identify this 60 to 70 meter (180-200') tree. Branches are flattened and droopy with tiny, scaly cones near their ends.

Niche Notes: Wildlife eat the seeds in the small cedar cones. The branches also provide winter forage for some wildlife.

"Gee Whiz:" This tree was of significant importance to Northwest Native peoples. Its bark was gathered and shredded into fibers for clothing, diapers, maps, and sails. The wood could be harvested from living trees by cutting a slice and pulling off planks. The wood is very resistant to decay and made excellent houses and canoes. Roots were woven into baskets and limbs were used to scare away ghosts. The buds were chewed to cure sore lungs and toothaches.

Associates: WESTERN HEMLOCK, RED ALDER, VINE MAPLE, SKUNK CABBAGE, LADY FERN, FOAM FLOWER

Common Name: WESTERN HEMLOCK

Scientific Name: *Tsuga heterophylla*

Wetlands indicator: FACU

Habitat: Prefers partial shade, ample moisture, and little wind. Found in WESTERN RED CEDAR stands that have little undergrowth. It grows rather quickly.

Description: Identified by its droopy branch tips and strongly furrowed, dark bark, this tree grows up to 60 or 70 meters (180-200'). Has soft, flat, round-tipped evergreen needles of varying lengths. Small, oval cones are attached directly to the branches.

Niche Notes: Hemlock provides food for grouse, chickadees, and pine siskin. It is also valuable for cover and nesting.

"Gee Whiz:" Northwest Natives used hemlock pitch for face pain and to prevent sun and windburn. The bark releases a reddish-brown dye when boiled. It was used to dye paddles and fishing equipment to make it invisible to salmon. It also makes a yellowish-brown paint when mashed with salmon eggs. The boiled bark was used as a laxative, eyewash, and cure for sore throats. The boughs were suitable for making temporary shelters.

Associates: WESTERN RED CEDAR, RED ALDER, VINE MAPLE, SKUNK CABBAGE LADY FERN, FOAM FLOWER

Common Name: RED ALDER

Scientific Name: *Alnus rubra*

Wetlands Indicator: FAC

Habitat: Thrives in disturbed areas. It requires full sun and ample or moderate amounts of water. Alder tolerates brackish and very poor soil, and is often found on stream sides and in moist woods.

Description: Alder may be found as a crowded shrub or a tree as tall as 20 meters (80'). The bark is thin, smooth, and marked with horizontal lines called lenticels. Leaves are pointed ovals, with toothed, rolled-underedges. The upper surface is smoothand deep green. The under surface is grayish with red hairs on the veins.

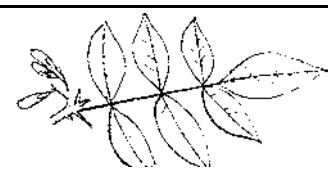
Niche Notes: Birds, such as goldfinches, chickadees, and pine siskins, eat the tiny seeds in alder "cones." Elk and deer may also cat the twigs or foliage. BEAVER browse its leaves.

"Gee Whiz:" Alder actually adds nitrogen to the soil. Bacteria, living in nodules on its roots, take nitrogen out of the air and enrich the soil. Alder provides excellent wood for smoking fish and carving. Its bark was boiled for a dye.

Associates: WESTERN HEMLOCK, BLACK COTTONWOOD, WILLOW, SALMON BERRY, LADY FERN, SKUNK CABBAGE

Common Name: OREGON ASH

Scientific Name: *Fraxinus latifolia*



Wetlands Indicator: FACW

Habitat: Deep, moist soils along streams and wetlands. It can tolerate full sun or partial shade.

Description: This leafy tree grows to 20 meters (66'). Its rough, grayish-brown bark is often covered with lichens and mosses. Individual leaflets are light green on top and pale and hairy on the bottom. They are arranged in a pinnately compound leaf. Ash produces a single-winged fruit.

Niche Notes: Ash is of moderate use to wildlife. Grosbeaks eat the seeds of the female tree. Cedar waxwings and purple martins use the tree for food. The seeds and wood provide food for the Douglas chickeree.

"Gee Whiz:" OREGON ASH is used to make tools and furniture.

Associates: RED ALDER, VINE MAPLE, SKUNK CABBAGE LADY FERN

Common Name: BLACK COTTONWOOD

Scientific Name: *Populus balsamifera*

Wetlands Indicator: FACW

Habitat: Stream banks, lake shores, and in forested wetlands. It requires full sun and lots of water.

Description: Young cottonwoods have smooth, green bark which develops roughened, gray ridges as the tree matures. The adult trees are very large. 50 to 60 meters (160-200') in height. The buds are sticky in winter. The oval, lance shaped leaves are also resinous. Male and female plants are separate trees. Its cottony fruits are noticeable beneath the tree.

Niche Notes: Cottonwoods offer cover and nesting areas for wildlife. Its buds and catkins are a source of food for the blue grouse. Mountain Beavers eat its foliage, buds and bark. Its seeds are eaten by few species.

"Gee Whiz:" Some Northwest Natives made limited use of the wood. The leaves were bruised and made into antiseptic. The tree's gum was also used for this. Some believed the tree had a life of its own. Because of the leaves' flattened petiole, it shakes with very little wind. Some natives refused to even use it for firewood.

Associates: RED ALDER, WILLOW

Common Name: WILLOW

Scientific Name: *Salix spp.*

Wetlands Indicator: range from OBL to FAC

Habitat: Full sun and lots of water. They are found growing on the banks of ponds and streams, or in wetlands.

Description: WILLOW species range in size from small shrubs to medium trees. The deciduous leaves are long and narrow, and usually pointed. Male and females are separate plants. WILLOWS are excellent for reclaiming riverbanks or wetlands, because of their extensive root systems and ability to take root.

Niche Notes: WILLOWS provide cover and attract insects, but are of limited value to wildlife. Grouse and grosbeak will eat its buds or tender twigs. Pika eat its bark, buds and wood. The dusky-footed wood rat eats its foliage and catkins.

"Gee Whiz:" WILLOW bark contains salicylic acid, the active ingredient in aspirin. Native Americans chewed the bark as a pain reliever.

Associates: RED ALDER, BLACK COTTONWOOD, HARDHACK

Common Name: QUAKING ASPEN

Scientific Name: *Populus tremuloides*

Wetlands indicator: FAC+

Habitat: Full sun or partial shade and only moderate water. It is often found in groves. It is tolerant of most soil types.

Description: It hassmooth, greenish-white bark and reaches 15 meters (50') in height. The leaves have deep green upper surfaces and pale undersides. Male and female flower clusters lack petals and occur separately.

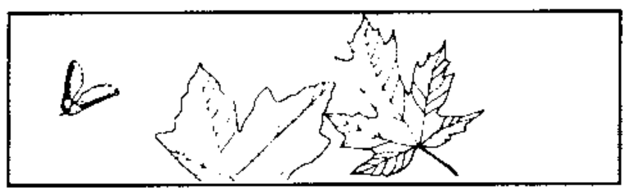
Niche Notes: The resinous buds and catkins are valuable food for grouse in the winter and spring. Its bark and foliage are also enjoyed by browsers, and mountain beavers and porcupine like the wood and bark.

"Gee Whiz:" This tree makes an attractive ornamental. because of its unusual quivering leaves.

Associates: RED ALDER, WILLOW, VINEMAPLE, BLACK COTTONWOOD

Common Name: BIGLEAF MAPLE

Scientific Name: *Acer macrophyllum*



Wetlands Indicator: FACU

Habitat: Transitional areas between wetlands and drier sites.

Description: One large stump may make many stems, so this tree is large, up to 30 meters (90') and spreading. The leaves have the classic look of the Canadian flag and are very large. Small, greenish-white flowers yield little, golden "helicopters."

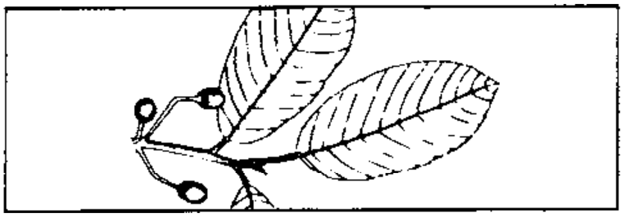
Niche Notes: A wide variety of wildlife use this tree for food, nesting and cover. Small mammals enjoy eating its seeds.

"Gee Whiz:" Northwest Native peoples found MAPLE very useful. Ropes could be made from its bark and the huge leaves were great for covering or laying underneath food. The wood was used by some to smoke salmon, but was more commonly used for carving. It made beautiful dishes, implements, and artwork.

Associates: RED ALDER, VINEMAPLE, SALMONBERRY, LADY FERN

Common Name: CASCARA BUCKTHORN

Scientific Name: *Rhamnus purshiana*



Wetlands Indicator: FAC-

Habitat: Transitional area between wetlands and uplands.

Description: CASCARA is a small tree with a narrow trunk and smooth, gray bark. Its yellow-green leaves are oval and have distinct parallel veins. Small, green flowers develop into small green to purple-black berries.

Niche Notes: Quite a few species eat CASCARA'S fruit. Up to one-quarter of a pileated woodpecker's diet may consist of these berries, when available. Band-tailed pigeons, sapsuckers, thrush, RACCOON, Douglas ground squirrels, wood rats, and MULE DEER also feast on the fruit.

"Gee Whiz:" CASCARA bark is collected and made into a laxative. Native Americans also used it for this purpose and, in addition, used it for other medicines and the berries for food.

Associates: RED ALDER, WILLOW

Resources for Plant Cards - (see Appendix A)

A Field Guide to Wetland Habitats of the Western United States by Janine Benyus

Ethnobotany by Erna Guenther

Funk and Wagnalls Encyclopedia

Modern Biology by Holt, Rinehart and Winston

Northwest Foraging by Doug Benoliel

Wetland Plants of the Pacific Northwest by Fred Weinmann, et. al.

Wetlands and Wildlife: Alaska Wildlife Curriculum by Alaska Department of Fish and Wildlife

Wild Harvest: Edible Plants of the Pacific Northwest, by Terry Domico

Appendix H
Animal Cards

These animal cards will serve many uses. They can serve as a field guide. They are used in many activities throughout the curriculum. The cards include the following information. (Note: Species listed in CAPITALS are described in this card set.)

Common Name: This is the name people tend to use. Unfortunately, it varies from area to area and is sometimes misunderstood. All capitalized plants and animals are included on these cards.

Scientific Name: This name does not vary and is used for clear identification and communication.

Habitat: This will tell you the surroundings in which you are likely to find this animal.

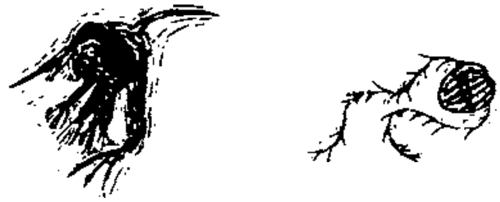
Description: This is what the animal looks like.

Niche Notes: This describes the animal's relationship to other plants and animals.

"Gee Whiz:" Interesting stuff about the animal.

Common Name : ZOOPLANKTON

Scientific Name: *Depends on species*



Habitat: ZOOPLANKTON are found drifting in all types of water.

Description: ZOOPLANKTON consist of every small animal-like organism in the water that is subject to floating in the currents. Some spend their entire life as plankton, while others grow to adult forms, such as oysters, barnacles, or starfish.

Niche Notes: All ZOOPLANKTON must eat, but their diet is as varied as they are. Some eat detritus. Others eat PHYTOPLANKTON. Many eat other ZOOPLANKTON.

"Gee Whiz:" These little creatures, being near the bottom of aquatic food webs, are critical to all creatures on the web who depend on them. All animals (including humans) that eat food from the water have plankton to thank.

Common Name : CLAM

Scientific Name: *Order Bivalvia*

Habitat: Freshwater and marine water.

Description: CLAMS have two shells connected with a hinge.

Niche Notes: CLAMS eat plankton that they collect by filter feeding. CLAMS are food for fish. turtles, RACCOONS, muskrats, birds, and HUMANS.

Common Name : SNAILS

Scientific Name: *Order Gastropoda*

Habitat: Freshwater and marine water. Some SNAILS live in moist terrestrial environments.

Description: SNAILS are easily identified by their spiral shell.

Niche Notes: SNAILS scrape plant and animal matter from surfaces with the help of their file-like tongue called a radula. SNAILS are food for many animals, including fish, SALAMANDERS, turtles, BACKSWIMMERS, WATER STRIDERS, and HUMANS.

"Gee Whiz:" Slugs are a kind of snail without a shell.

Common Name : BLUE MUSSEL

Scientific Name: *Order Filibranchia*

Habitat: Intertidal areas. They often are found attached to pilings and rocks.

Description: This bivalve is easily identified by its blue color.

Niche Notes: MUSSELS are filter feeders. They strain micro-organisms from the water. They are eaten by some birds, sea stars ("starfish"), muskrats, and people.

"Gee Whiz:" MUSSELS attach to surfaces by "byssus" thread, which are exuded from their foot as liquid and harden into extremely strong strands. These strands collect debris and form a habitat for other organisms to live intertwined with the MUSSELS.

Common Name : POLYCHAETE WORM

Scientific Name : *Class Polychaeta*

Habitat: These common annelids, marine relatives of earthworms, live either swimming in the ocean or burrowed in the sediments.

Description: These segmented worms have many setae (bristles) that extend from parapodia (fleshy appendages) on their segmented body. Free-swimming POLYCHAETES often have large jaws.

Niche Notes: The free-swimming worms are voracious predators The burrowing type eat particles from the water and sediments. They are eaten by other worms and a variety of birds.

"Gee Whiz:" Some POLYCHAETES are luminescent (glow in the dark).

Common Name : HERMIT CRAB

Scientific Name : *Family Paruridae*

Habitat: Intertidal areas.

Description: These crustaceans do not have a hard exoskeleton to protect them, instead they use shells from dead gastropods.

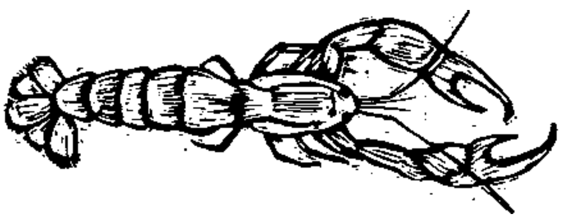
They have soft abdomens and strong appendages; they inhabit empty gastropod shells.

Niche Notes : HERMIT CRABS feed primarily on dead organic material and whatever else crosses their path. They are eaten by some shorebirds and other animals.

"Gee Whiz:" HERMIT CRABS will find a new shelf when they outgrow the one they are living in.

Common Name : GHOST SHRIMP

Scientific Name : *Astacura*



Habitat: Mud of intertidal areas and estuaries.

Description: These small white shrimp live buried in the mud.

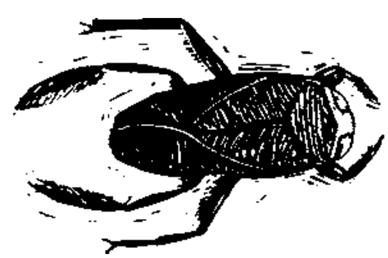
Niche Notes : SHRIMP feed primarily on detritus and anything smaller they run into. They are a favorite food of shorebirds.

"Gee Whiz:" A good way to find these is to go to the shore with a clam gun. Just take a sample of mud as if you were digging CLAMS. Look through the mud for the SHRIMP.

GHOST SHRIMP are also strained from the mud by the gray whale.

Common Name : WATER BOATMAN

Scientific Name : ***Trichocorixiaspp. or Sigara spp.***



Habitat: Margins of lakes, ponds, and estuaries.

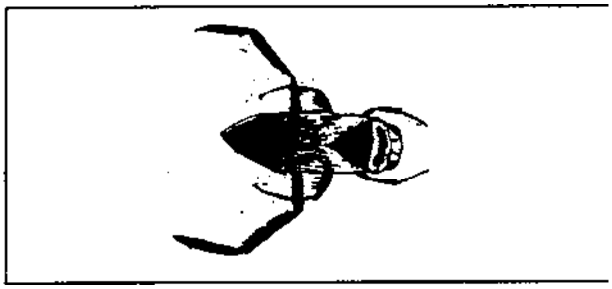
Description : This aquatic insect is spotted or solid gray with red eyes. Even though it resembles the BACKSWIMMER, it is easily identified because it doesn't bite or swim on its back

Niche Notes: WATER BOATMAN eat algae, insect or crustacean larvae, or detritus. They are eaten by DIVING BEETLES, frogs, fish, waterfowl, and shorebirds.

"Gee Whiz:" These insects trap a bubble of water underneath their wings to breathe on their dives to the bottom. This is where they find their favorite foods.

Common Name: BACKSWIMMER

Scientific Name : *Buenoa spp. or Notonecta spp.*



Habitat: Margins of lakes, ponds, and estuaries.

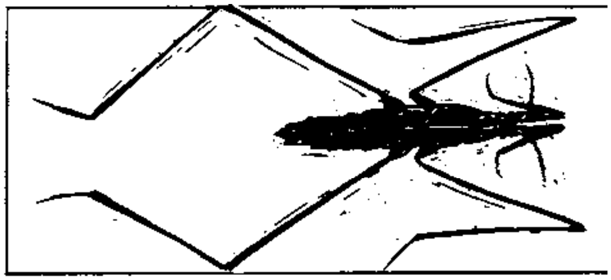
Description: These aquatic insects row themselves through the water on their backs with their long, flattened back legs. Their coloration is the reverse of normal; their backs are light and their bellies are dark.

Niche Notes: BACKSWIMMERS detect their prey with the hairs on their legs, then they inject digestive juices into them. They prefer small insects, SNAILS, or even fish. They are a favorite food of hungry fish.

"Gee Whiz:" Be careful! These guys may bite you.

Common Name : WATER STRIDER

Scientific Name : *Gerris spp. or Metrobates spp.*



Habitat: Common on the surface of lakes, ponds, and streams.

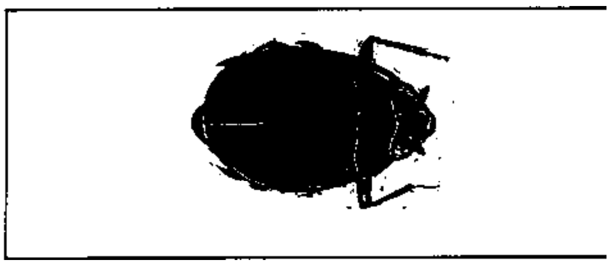
Description : With the help of its long legs and waterproof hairy feet, the WATER STRIDER walks on the surface of the water.

Niche Notes: WATER STRIDERS prefer small living or dead insects for food. They grab their prey, pump in digestive juices, and suck the innards out. Fish dine on WATER STRIDERS.

"Gee Whiz:" If a WATER STRIDER breaks through the surface of the water, it must find something to climb out on or drown.

Common Name : WHIRLIGIG BEETLES

Scientific Name : *Gyrinidae family*



Habitat: In lake, streams, and ponds.

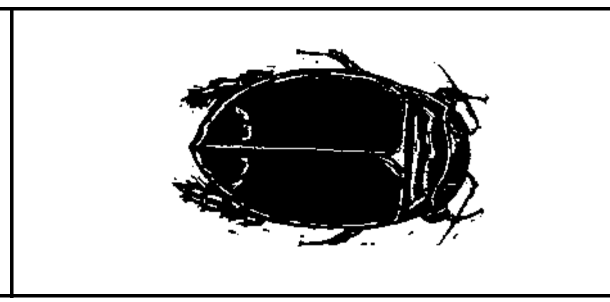
Description: This aquatic insect is blue-blackor dark brown in color. Adults are flattened and oval-shaped, and have eyes that are split so they can see both above and below the water at the same time.

Niche Notes : WHIRLIGIG BEETLES are scavengers and eat small insects. They are capable of hunting at night by sensing disturbances of tiny water waves they create by swimming rapidly. They arc eaten by fish and waterbirds, but are not tasty to many.

"Gee Whiz:" WHIRLIGIG BEETLES swim in circles upon the surface of the water, often in groups. This obvious behavior helps fish identify them as the bad tasting insects they are.

Common Name : DIVING BEETLE

Scientific Name : *Dytiscidae family*



Habitat: Slow-moving waters of ponds, lakes, streams, and estuaries are home to DIVING BEETLES.

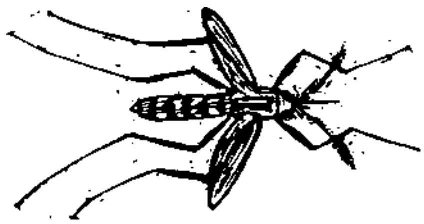
Description: They are black and flattened with hind legs adapted for swimming. The adult is usually suspended from the waters surface, head down. The aggressive larvae crawl on the bottom.

Niche Notes: DIVING BEETLES and their larvae are predators of aquatic Insects, fish, and tadpoles. They are food for fish, waterbirds, and water shrews.

"Gee Whiz:" These insects trap a bubble of water underneath their wings to breathe when hunting underwater.

Common Name : MOSQUITO

Scientific Name: *Culicidae family*



Habitat: Ponds, lakes, and puddles everywhere.

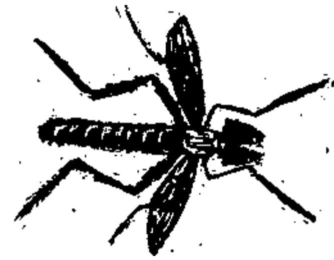
Description: The familiar adult MOSQUITO has along, tubular proboscis for sucking. The larvae are called wrigglers because they wriggle when they swim.

Niche Notes: Adult MOSQUITOES feed on plants; only the female takes a blood meal before laying eggs. The larvae feed on algae, protozoan, and detritus.

"Gee Whiz:" MOSQUITOES help pollinate some species of flowers.

Common Name: MIDGES or GNATS

Scientific Name: *Chironomidae family*



Habitat: Larvae live in water or wet moss. Adults live in swarms over these habitats.

Description: Adults have a body similar to that of a MOSQUITO. The larvae are red, yellowish-green, or white. The pupae often live in little tubes of cemented silt or debris.

Niche Notes: Adults only live for a few days and often don't eat. The larvae may feed on algae, plant material, and other small organisms. MIDGES are food for fish and aquatic animals, birds, shrews, and ground beetles.

"Gee Whiz:" Adult MIDGES do not bite. The red larvae are known as bloodworms.

Common Name : CADDISFLY

Scientific Name: *Order Trichoptera*

Habitat: CADDISFLIES spend most of their life as larvae in freshwater streams and ponds.

Description : Adult flies, who live less than a month, have long antennae and hold their wings like a roof over themselves when resting. Their wings are covered with fine, silky hairs. The larvae have small hooks at the end of their abdomen and build tiny houses of stick, stones, and leaves with beautiful patterns.

Niche Notes: Larvae crawl upon the bottom eating algae and plant debris. The adults feed on flower nectar. Many fish, like SALMON, depend on the larvae for food.

"Gee Whiz:" CADDISFLY larvae are sensitive to poor water quality conditions. Their name comes from "trichos" meaning hair and "optera" meaning wings.

Common Name : DAMSELFLY

Scientific Name : *Suborder Zygoptera*

Habitat: Larvae live on aquatic plants or on the bottom of streams and ponds. The adults live near water.

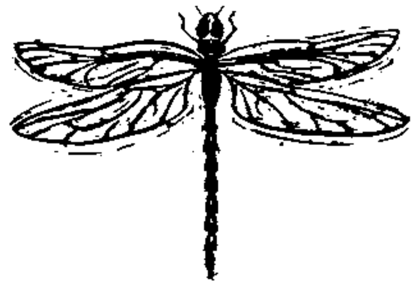
Description: The adult DAMSELFLY looks like a slender DRAGONFLY whose wings fold over their backs when resting. The larvae have a trio of gills that look like three tails.

Niche Notes: Larval DAMSELFLY eat MOSQUITO larvae and other small animals. The adults feed on MOSQUITOES and MIDGES.

"Gee Whiz:" During the age of dinosaurs, DAMSELFLY ancestors had wingspreads of up to 70 centimeters (27.5').

Common Name : DRAGONFLY

Scientific Name: *Suborder Anasoptera*



Habitat: Adults live near the water. The larvae live on the bottom of streams and ponds.

Description: These large insects are easily identified by their huge eyes and four wings held at right angles to the body. The larvae have no protruding gills and large jaws.

Niche Notes : Adults are skilled at catching flies and MOSQUITOES on the wing. The larvae prey on all small animals in the water. They'll also bite you.

"Gee Whiz:" Dragonflies can fly 60 miles per hour and see 360 degrees.

Common Name : MAYFLIES

Scientific Name : *Order Ephemeroptera*

Habitat: Larvae live in clear, fast-flowing streams.

Description: Larval MAYFLIES have two or three fan-like-tails and seven pair of gills on their abdomens. Adults have transparent wings and two or three long thread-like tails.

Niche Notes : Larvae feed on the slime covering rocks, consisting of algae and detritus. The adults don't eat. The larvae are eaten by fish.

"Gee Whiz:" Adult MAYFLIES have no mouth parts and only live for about a day.

Common Name: PACIFIC CHORUS or TREEFROG

Scientific Name: *Pseudacris regilla (Hyla regilla)*

Habitat: Found everywhere in the Northwest, even in urban areas.

Description : Long legs and rounded toe pads help identify this frog. Look for the dark mask reaching from the nostrils to the shoulders.

Niche Notes: Frogs prey on spiders and insects. Their tadpoles eat plant matter. Frogs are food for birds, snakes, and other frogs. Tadpoles are food for insects, fish, SALAMANDERS, and other frogs. Because these frogs can use isolated ponds for breeding, they are able to avoid predation by species that need more permanent sources of water.

"Gee Whiz:" TREE FROGS are well known for their "krr-r-r-ek" noise and are heard almost all year round.

Common Name : BULLFROG

Scientific Name: *Rana catesbeiana*

Habitat: These frogs were introduced to Washington from the eastern United States. They are found in most lowland areas and need permanent water sources.

Description: BULLFROGS are about seven to eight inches long and have green skin covered in spots. They have a fold extending from their eye, over their large tympanum (eardrum), and to their forearm.

Niche Notes: Adult BULLFROGS eat everything including insects, fish, birds, amphibians, reptiles, and mammals. Their tadpoles eat plant matter and live as a tadpole for two to three years. Frogs are food for birds, snakes, other frogs and even HUMANS. Tadpoles are food for everything from CADDISFLY larvae to other frogs.

"Gee Whiz:" These introduced BULLFROGS have nearly wiped out Northern Leopard Frogs and SPOTTED FROGS in Washington. Waterfowl production is down in BULLFROG infested areas and Western Pond Turtle populations are threatened by BULLFROG predation.

Common Name: RED-LEGGED FROG

Scientific Name: *Rana aurora*

Habitat: Found throughout Western Washington.

Description : These frogs are reddish-brown with small black flecks on the back and dark bands on the legs. The underside of the back legs are red. The tadpoles are brown with small dark spots on their backs. The lower body of the tadpoleis white with silvery or coppery spots.

Niche Notes: RED-LEGGED FROGS hunt for much of their food in vegetation around their water source. Their tadpoles eat plant matter. Frogs are food for birds, snakes, other frogs and even HUMANS. Tadpoles are food for everything from insect larvae to other frogs.

"Gee Whiz:" Male RED-LEGGED FROGS call to their mate from two or three feet underwater.

Common Name: TAILED FROG

Scientific Name : *Ascaphus truei*

Habitat: Cold, rocky streams of the Olympic, Cascade, and Blue Mountains. It has also been found in streams in the Willapa Hills and Capitol Forest of southwestern Washington.

Description: This frog is brown, brownish-red or gray and has a vertical pupil in its eye. Males have a small "tail." The tadpoles are black or brown with a white spot on the tip of their tail and a round, sucker-like mouth for holding on to rocks against the current. TAILED FROGS make no noises and lack most of their ear parts, probably as an adaptation to living in a noisy stream.

Niche Notes: TAILED FROGS prey on insects, but never far from their stream. Their tadpoles eat microscopic algae, mostly diatoms. Frogs are food for birds, snakes, and other frogs.

"Gee Whiz:" Sedimentation from timber harvests and road building in some areas have reduced or eliminated populations of TAILED FROGS. Tadpoles live for a long time in their streams; about two years in lower regions and up to four in mountain areas. By the way, the "tail" isn't a real tail. It is used by males during mating.

Common Name : SPOTTED FROG

Scientific Name : *Rana pretiosa*

Habitat: Currently live in the Cascade Mountains, eastern and central Washington. Formerly found in the Puget Sound Lowlands, this species now appears to be almost completely eliminated from that region. It can be found in or near year-round water sources and usually in non-woody wetland.

Description: The spots on this frog have fuzzy edges, light centers and a range of sizes. The underside is orangish-red and looks like it is painted on. Tadpoles don't have spots, but have white bellies.

Niche Notes: Frogs prey on insects. Their tadpoles eat plant matter. Frogs are food for birds, snakes, other frogs and even HUMANS. Tadpoles are food for everything from CADDISFLY larvae to other frogs.

"Gee Whiz:" SPOTTED FROGS make a weak croak and can jump far. Expect their tracks to show this.

Common Name : WESTERN or BOREAL TOAD

Scientific Name: *Bufo boreas*

Habitat: Found everywhere in Washington except the dry areas of the Columbia Basin. These toads are now rare in the lowlands of western Washington and meadows of the North Cascades.

Description : BOREAL TOADS are about three inches long, have warty brown, green, or gray skin and usually have a white stripe down the middle of their back. They have a chunky build and large, oval parotoid glands behind their eyes. These glands give off a white poison when the toad is threatened. Toads are nocturnal and silent.

Niche Notes: Toads eat insects, spiders, and worms. They are eaten by garter snakes, coyotes, RACCOONS, and crows.

"Gee Whiz:" Don't handle toads, frogs or SALAMANDERS if you have insect repellent on your hands; it can severely damage their skin.

Common Name: SALAMANDER

Scientific Name : *Order Urodela*

Habitat: Water or areas with water available year-round.

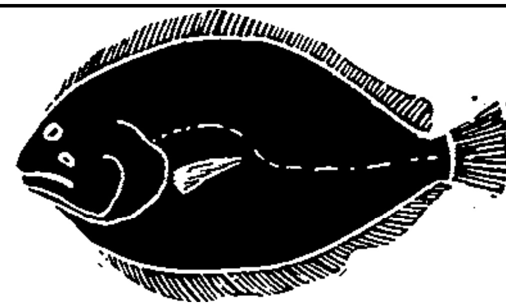
Description: These animals are characterized by their smooth, slimy skin, long body and lack of claws.

Niche Notes: SALAMANDERS eat insects, slugs, worms, and SNAILS. They are eaten by hungry snakes, other SALAMANDERS, frogs, fish and some shrews.

"Gee Whiz:" SALAMANDERS are covered with a distasteful mucus that prevents many animals from eating them. In some, such as the Rough-skinned Newt, the milky mucus is so full of poison that it will kill most vertebrates. Others lose their tails when a predator grabs them.

Common Name : STARRY FLOUNDER

Scientific Name : *Platichthys stellatus*



Habitat: Commonly live in marine waters on soft or sandy bottoms. They tolerate freshwater and can be found in estuaries and up coastal streams.

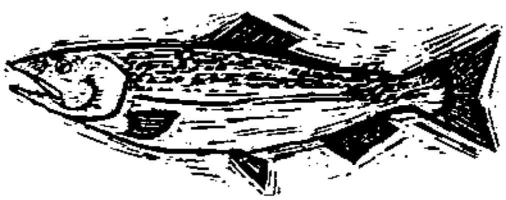
Description: Flounders have a flat, asymmetrical body and blunt snout. They have creamy colored tins with dark stripes. They weigh up to 20 pounds.

Niche Notes: Flounder will eat just about anything smaller than they are, including fish, worms, and shrimp.

"Gee Whiz:" Flounders have two eyes on one side of their head. The cells that become the eye begin development in the normal position, then migrate to the same side of the head.

Common Name : COHO SALMON

Scientific Name : *Oncorhynchus kisutch*



Habitat: Adult salmon live in the sea. They return to spawn in fast-flowing streams with gravel bottoms. The young remain in the stream for one or two years, before returning to the sea.

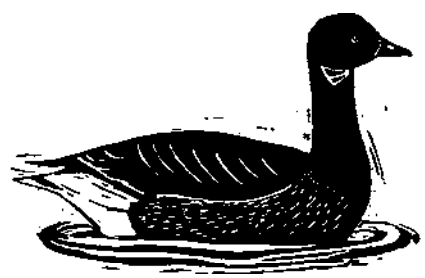
Description : This is a large salmon, reaching up to 90 centimeters (35") and 12 pounds (5.4 kg). They have small black spots on their back and the upper part of their tail fin. They also have gray gums.

Niche Notes: Adult COHO SALMON feed on smaller fish, crustaceans, and invertebrates. The larvae feed on aquatic insect adults and larvae. Young COHO are food for other fish, grebes, and loons. The adults are favored by marine mammals, eagles, bear, and HUMANS.

"Gee Whiz:" COHO must spend a long time in streams. For COHO to survive, the streams they return to must be clean with gravelly bottoms.

Common Name : BRANT GOOSE

Scientific Name : *Brantia bernicla*



Habitat: BRANT nest in the tundraand winter in more southern bays and estuaries.

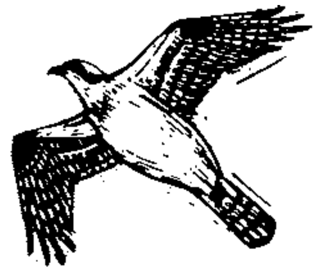
Description: About the size of a mallard duck, the BRANT looks totally black when in the water, except for a white collar. Its black-and-white pattern is seen when in flight.

Niche Notes: BRANT eat EELGRASS and SEA LETTUCE almost exclusively. They are hunted by HUMANS and eaten by foxes, gull, and ravens.

"Gee Whiz:" Listen for their soft "ruk-ruk" call.

Common Name : OSPREY

Scientific Name *Pandion haliaetus*



Habitat: Coasts and inland lakes and rivers on every continent.

Description: This raptor is the size of a large hawk. It is dark brown above and white below. Its head is white with a dark line through the eyes.

Niche Notes: OSPREY eat only fish, which they catch by hovering and then diving, talon first, into the water.

"Gee Whiz:" Because many of the OSPREY's fish are contaminated with toxic chemicals, they have decreased nesting success. Their survival requires active conservation measures.

Common Name : GREAT BLUE HERON

Scientific Name : *Ardea herodias*

Habitat: Fresh and saltwater marshes, coastal mud flats, sand bars, and shallow bays. They require wetlands with tall trees or rock ledges for their nests.

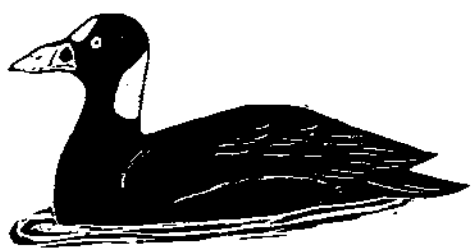
Description: This huge heron has a gray-blue back and wings. It is about four feet tall and weighs about seven pounds. Its wings span six feet.

Niche Notes: Herons wade through the water eating fish, crustaceans, amphibians, and insects.

"Gee Whiz:" Herons fly with their neck folded back on their shoulders, and their long thin legs out behind their bodies. Listen for their loud "kraaks."

Common Name : SURF SCOTER

Scientific Name : *Melanitta perspicillata*



Habitat: Prefer saltwater surf areas. They are abundant on the Pacific Coast and occasionally individuals may visit inland lakes and ponds, but not commonly.

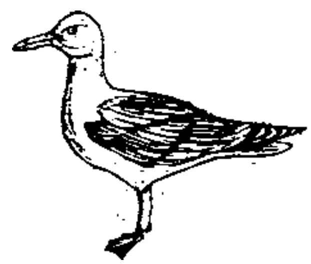
Description: Male SURF SCOTERS are black ducks with prominent white head patches, though these disappear in late summer. His beak is brightly colored with a unique pattern that makes identification relatively easy. The female is dark brown and has less distinct whitish patches on her head.

Niche Note: SURF SCOTERS take much of their food from the breaking surf. They feed on the life found on the ocean bottom.

"Gee Whiz:" When an adult SURF SCOTER takes off or lands, a whistling noise can be heard for quite a distance on quiet days.

Common Name : HERRING GULL

Scientific Name: *Lams argentatus*



Habitat: GULLS prefer coastal areas and inland lakes andrivers.

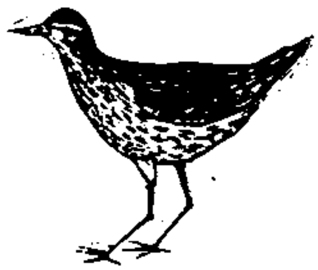
Description : This GULL is about two feet long with a four-foot wingspan. It has black-tipped wings and a bright yellow bill with a red spot.

Niche Notes: GULLS eat fish, crustaceans, marine worms, shellfish, sea urchins, insects, other birds, and bird eggs. The young peck at the red spot on the parents bill to be fed, then the adult regurgitates food for them. GULLS may be eaten by foxes, weasels, and other raptors and carnivores.

"Gee Whiz:" GULLS nest on rocky islands and are very protective. They dive on intruders with their sharp bill and have been known to disgorge the food from their stomachs on the trespasser.

Common Name: SPOTTED SANDPIPER

Scientific Name : *Actitis macularia*



Habitat: Streams, lakes, reservoirs, or almost any body of water surrounded by vegetation or woods. They may be seen on the coast in the winter.

Description : This small sandpiper has peachy or yellowish legs and a white wing stripe. In the spring only, it has large spots on its underparts. It teeters when walking and its wings beat stiffly when flying.

Niche Notes : Sandpipers dine on aquatic insects. crustaceans, and mollusks. They may be eaten by foxes, weasels, and other carnivores.

"Gee Whiz:" Listen for their "peet-weet-weet-weet-weet" or just "peet-weet."

Common Name: RED-WINGED BLACKBIRD

Scientific Name : *Agelaius phoeniceus*

Habitat: Marshes and swamps everywhere are home to this bird. They nest in stands of CATTAIL or other wetland plants.

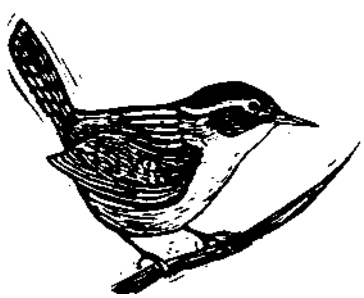
Description: Male BLACKBIRDS are black with red epaulets bordered in a fine yellow margin. The female is brownish.

Niche Notes : BLACKBIRDS eat the seeds of plants and lots of insects.

"Gee Whiz:" BLACKBIRDS claim territories in the marsh and defend them with loud calls of "cheek" or "teeyee" or songs of " konk-la-ree."

Common Name : MARSH WREN

Scientific Name : *Cistothorus palustris*



Habitat: Variety of marshy habitats. They nest in CATTAILS.

Description: MARSH WRENS resemble small sparrows, but hang around RUSH, SEDGE, and CATTAIL areas. Their tail is held at a high angle. Listen for their distinctive "machine-gunfire" song in the spring.

Niche Notes: MARSH WRENS feed on MOSQUITO larvae and insects. They are food for HARRIERS.

"Gee Whiz:" Male WRENS have a number of mates, each of whom builds her own nest.

Common Name : NORTHERN HARRIER

Scientific Name: *Circus cyaneus*

Habitat: NORTHERN HARRIERS formerly called marsh hawks, inhabit meadows, farm fields, and coastal dunelands. They nest on the ground.

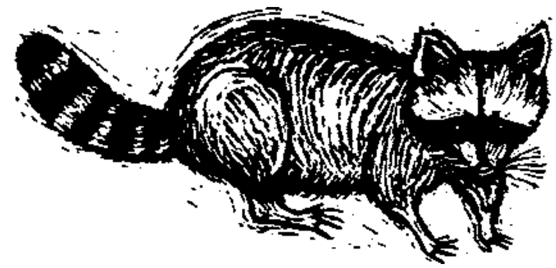
Description : This medium-sized, slim, long-winged hawk is identified by its white rump patch and flying patterns.

Niche Notes: NORTHERN HARRIERS feed mostly on mice and an occasional small bird.

"Gee Whiz:" This HARRIER flies with its wings angled upward when gliding. It also has a habit of flying low over fields in a zig-zag pattern.

Common Name : RACCOON

Scientific Name: *Procyon lotor*



Habitat: Frequent areas near streams and lakes.

Description: This omnivore may weigh up to thirty-fivepounds. They are easily recognized by their mask and striped tail.

Niche Notes: RACCOONS eat a wide variety of food, including crayfish, fish, frogs, mice, larger insects, birds and their eggs, berries, fruit and vegetables.

"Gee Whiz:" RACCOONS wash their food before eating. The "lotor" in its name means "one who washes. "

Common Name: MULE DEER

Scientific Name: *Odocoileus hemionus*

Habitat: All over the Pacific Northwest, from woodlands to deserts.

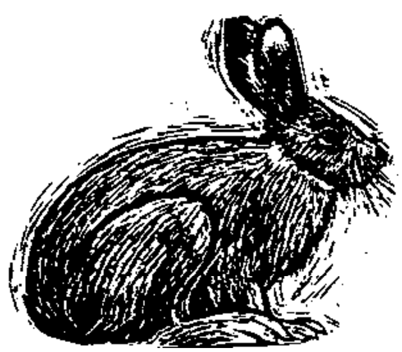
Description : Look for the large ears and black tail markings to identify this common deer.

Niche Notes : Deer are strictly vegetarians, eating leaves, grasses, grains, and tender shoots.

"Gee Whiz:" MULE DEER like salt and are good swimmers. They are often seen at the seashore in *winter.*

Common Name : SNOWSHOE HARE

Scientific Name: *Lepus americanus*



Habitat: Hares frequent forests, brushy areas, swamps, and bogs.

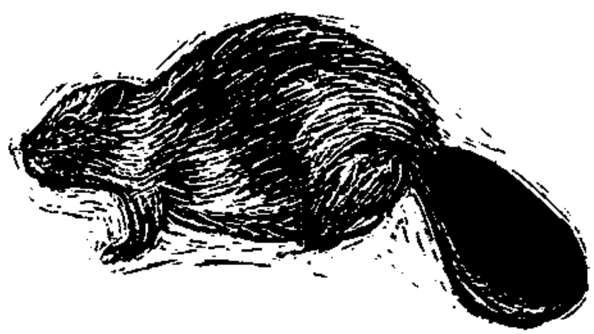
Description : This medium-sized hare has unique hind feet that enable it to walk on snow. In snowy areas, it is white in winter. The rest of the year it is predominantly brown.

Niche Notes : This vegetarian eats grasses, WILLOWS, buds, twigs, and bark. It is food for a variety of carnivores, including raptors and wolves.

"Gee Whiz:" Notice the HARE'S separable toes.

Common Name : BEAVER

Scientific Name : *Castor canadensis*



Habitat: Near freshwater streams and ponds. They construct dams and lodges, creating wetlands.

Description: Weighing up to fifty pounds and strong enough to walk upright on their hind feet, the BEAVER is probably best known for its large, scaly tail.

Niche Notes : These vegetarians eat aquatic plants, bark, twigs, **and** leaves.

"Gee Whiz:" Castoreum, BEAVER musk, is used to mark their territories. HUMANS also use it in making perfume.

Common Names: BLACK BEARS

Scientific Names: *Ursus americus*

Habitat: Forests and all adjoining areas.

Description: The smallest and most common of bears may grow up to seven feet long and weigh up to 450 pounds.

Niche Notes: Bears are omnivores, eating insects, berries, vegetation, fish, small mammals, and fruits

"Gee Whiz:" Stay away from bears. They are quick and strong, climb trees, and swim well. They are generally shy, but must never be underestimated.

Common Name : HUMAN

Scientific Name : *Homo sapiens*

Habitat: HUMANS are found virtually everywhere there is land.

Description : Bipedal mammals. Every individual has a unique appearance.

Niche Notes: HUMANS are omnivorous and quite varied in their diet. They are rarely preyed upon by anything.

"Gee Whiz:" The HUMAN population is increasing by approximately 70 million people per year.

Common Name: MOUSE

Scientific Name: *Family crecetidae*

Habitat: Deer mice prefer woodlands and uninhabited areas. House mice prefer living with us.

Description: All mice in the Pacific Northwest are around six or seven inches long including tail. The species look similar and are usually only identified by experts or after capture.

Niche Notes: Mice are omnivores. They eat seeds, plants, insects, grubs, and dead stuff. They are food for all sorts of carnivorous mammals and birds.

"Gee Whiz:" You can tell a MOUSE track from a shrew track by looking at the pattern the tail leaves. The shrew's tail drags and leaves a distinct trail. Mice tails only leave erratic marks because they don't drag them on the ground.

Resources for Animal Cards (see Appendix A)

A Field Guide to Wetland Habitats of the Western United States by Janine Benyus

Amphibians of Washington and Oregon by William P. Leonard, et. al.

Animal Tracks of the Pacific Northwest by Karen Pandell and Chris Stall

Aquatic Insects and their Imitations by Rick Hafele and Scott Roederer

Ethnobotany by Erna Guenther

Funk and Wagnalls Encyclopedia

Insects of Discovery Park

Modern Biology by Holt, Rinehart and Winston

Northwest Foraging by Doug Benoliel

*"Web **of** Life Cards"* by Judy Friesem

*Wetland Plants **of** the Pacific Northwest* by Fred Weinmann, et. al.

Wetlands and Wildlife: Alaska Wildlife Curriculum by Alaska Department of Fish and Wildlife

Wetlands - The Audubon Society Guide by William A. Niering

*Wild Harvest: Edible Plants **of** the Pacific Northwest,* by Terry Domico

Appendix I
Field Study Tools

Introduction

These tools, many of which are referencedin the activities throughout this book, are inexpensive and easy to build. It is very satisfying for students to construct and then use their own tools in the field.

Nets

A net may be used to collect organisms in the air or water. A bottom sampling net may be used to collect materials along the bottom of a stream.

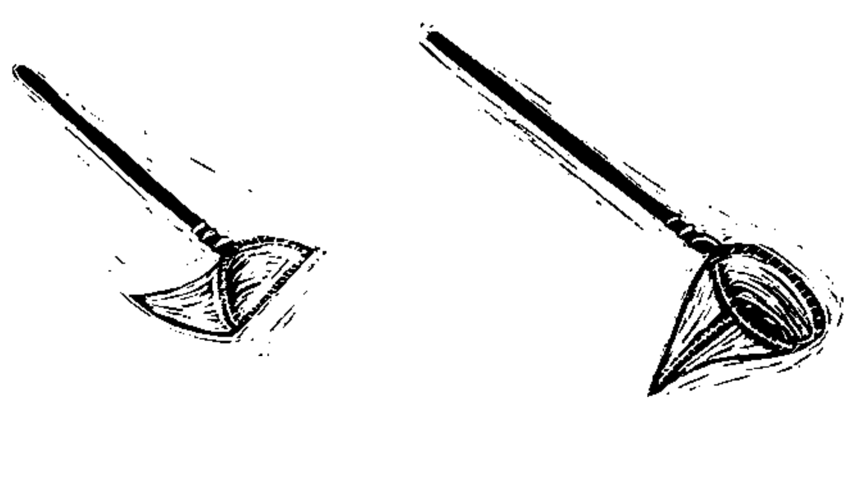
Materials: old nylon stocking or fine-meshed synthetic fabric, heavy tape, broom handle or 3 foot dowel, coat hanger or other stiff wire, needle and thread

Bend wire into desired shape; circular for a collecting net, a flat D-shape for a bottom sampling net. Cover any sharp wire ends with heavy tape.

If using fabric, cut out an 18" square. Fold the square in half to form a triangle and stitch down one side. This cone can be sewn onto the wire loop.

Twist the remaining wire around the dowel or broom handle. Secure with heavy tape if needed.

For an extra strong bottom sampling net add a wooden dowel across the straight leg of the D, and attach dowel or broom handle to both the rounded and straight side of the net opening.



Hankie and Bucket Sampler

You can sample critters from a stream bottom with an old handkerchief and a bucket. Just fill a bucket with about six inches of water. Put three stones from the stream in the bucket. Gently rub the stones until you are satisfied no insects still remain. Pour the water gently through the handkerchief and examine who you have found.

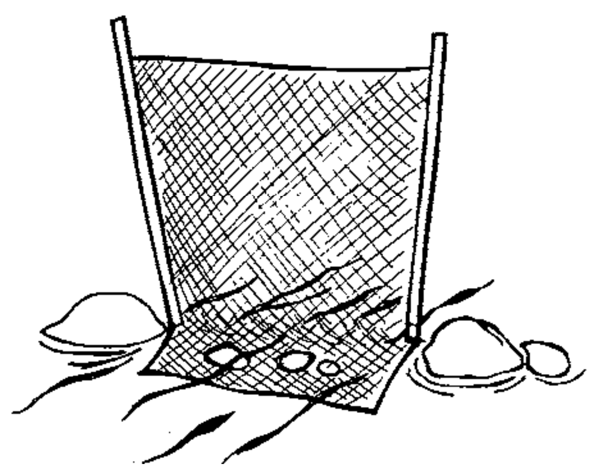
Kick Screen

A kick screen is stretched crosswise in a stream to collect organisms. To use, place sticks so screen is stretched tight and lip is flush with the stream bottom. Kick or stir the substrate a few feet upstream from the net. The organisms dislodged will flow into the net.

Materials: 2-3' length of fiberglass screen, two wooden poles, stapler & staples

Attach the screen to the two poles. Extend the screen underneath the bottom of the dowels to create a small lip to prevent organisms from slipping underneath.

A kick seine can be made the same way with netting instead of screen.



Underwater Viewer

This aids students in seeing under the water by cutting out surface reflection. To use just submerge the plastic-covered end in the water.

Materials: plastic container or coffee can, heavy duty clear plastic wrap and a rubber band

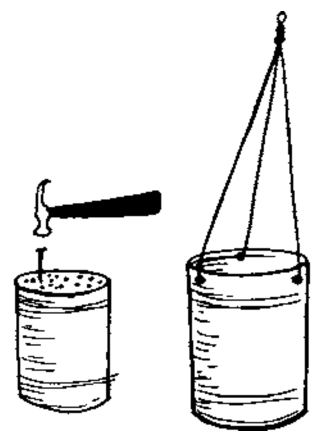
Cut both ends out of your container or coffee can. Make sure there are no sharp edges. If there are, tape them. Stretch the wrap over one end and secure with the rubber band.

Bottom Dredge

This is used to sample the bottom of a waterway. It can pick up organisms and sediments.

Materials: coffee can, hammer and nail, heavy string, heavy fishing weight, heavy duty fishing swivel (optional)

Pound holes in the bottom of the coffee can. Poke three holes in the rim. Attach 2-3'lengths of heavy string to the can holes. Tie far ends together. Add the heavy fishing weight and tow line. Attach a heavy-duty fishing swivel, where the three lines come together to make this easier to use.

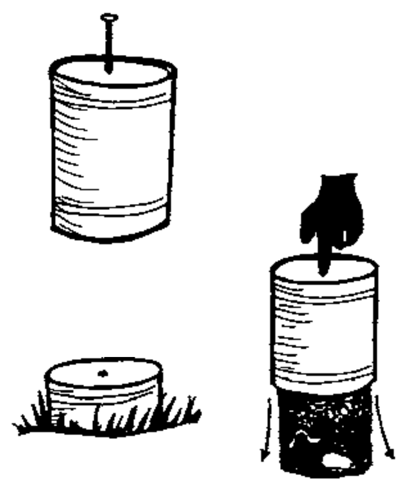


Core Sampler

A core sampler is twisted down into the sediments. When a finger is put over the nail hole, the sample can be drawn upward and slipped onto a pan. It can be examined for invertebrates and sediment characteristics.

Materials: one pound coffee or other sturdy can, nail and hammer

Remove one end of the can. Check for sharp edges!
Punch a nail hole in the other end.



Plant Press

A plant press can be used by students to make collections of wetland plants. Plants are placed between layers of newspaper and corrugated cardboard and pressed until dry. Drying can be aided by setting the press on its side across the gap between two chairs and putting a 40-watt lamp underneath to help circulate air through the corrugated cardboard. The newspaper should be changed daily to prevent the plants molding.

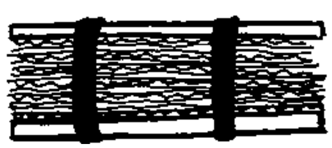
Take very few samples of wetland plants. Be careful not to collect sensitive or endangered species.

Materials: For each press, two pieces of pegboard or plywood, corrugated cardboard, newsprint, straps or old belts.

Cut boards to size. Small individual presses may be made or large ones to handle whole classes. If boards are not rigid, they should be reinforced with wood strips. Cut corrugated cardboard to fit in the press making sure the corrugations all run the same way. Cut newspaper to fit.

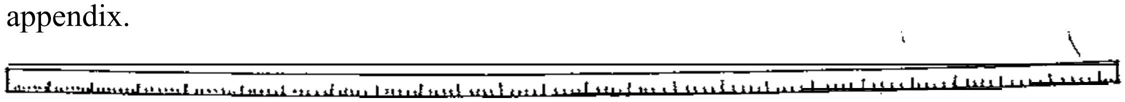
Place a piece of corrugated cardboard on the lower wooden board. Then place two pieces of newspaper or paper towel (the plants go between the newspaper). Then repeat with cardboard and newspaper until you have up to thirty pieces of cardboard. Place the other wooden board on top. Tighten straps around the whole thing.

When the plants are dry, they can be rubber cemented to sheets of white paper and labeled. Herbarium sheets are usually labeled with the common and scientific name, date and place of collection, and the collectors name, all placed in the lower right-hand comer.



Profile Measuring Equipment

This equipment may be used by older students to calculate the slope they are working on in a transect or mapping study. Two pieces of equipment are needed: a range pole and a sighting device. The range pole is easy to make. The sighting device takes more work. The use of these devices is described later in this appendix.



Range Pole

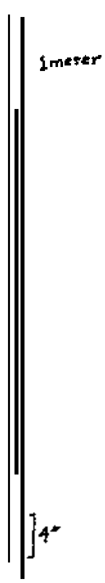
Materials: A tall pole, at least 8' (PVC pipe works well and can even be made to break down into sections), black and red permanent markers, a meter stick

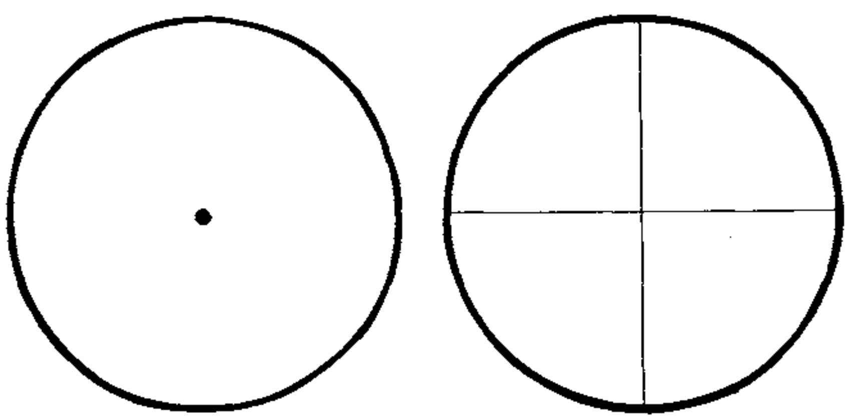
Clearly mark and label the pole every centimeter with the black marker. Every 10 centimeter mark should be made in red to make it easier to read.

Sighting Device

Materials: pointed stake measuring 1" x 2" and 4' long, orange juice can with one end missing, eye screw or cup hook, thread, sinker or weight, patterns for ends of can (see below), hammer and nails, permanent marker or grease pencil, meter stick masking tape.

Mark a black line approximately 4" up from the pointy end of the stake. This is the point to which it will be driven into the ground. Make another line exactly l-meter above the lower mark on the wide side of the stick. Draw a vertical line exactly up the middle of this side. Use the hammer and nail to start a hole about four inches below the l-meter mark. This is where the eye screw or cup hook screw in. Attach the sinker or weight to a piece of thread slightly less than l-meter long. Attach the other end of the string to the eye screw or cup hook making sure the weight hangs above the lower line, so it won't touch the ground.





The orange juice can is the actual sighting device. Use the patterns to mark the location of the hole on the closed end and threads on the open end. Punch a small nail hole where marked. Tape thread to the outside of the can across the opening as marked. Now, lightly tape the whole orange juice can with its middle at exactly a right angle to the l-meter mark on the stick. Do not securely tape until it is checked.

To make sure the orange juice can is attached correctly, lay the sighting device next to the range pole. Lightly mark with a pencil exactly where the threads cross in the can. Have a student hold the range pole against a wall. Have another student hold the sighting device upright a few feet away. Make sure the plumb line is lined up. A third student should look through the hole in the sighting device (orange juice can). The point where the threads cross should exactly line up with the mark on the range pole. If they line up, tape the can securely. If they don't, adjust the can until they do and tape the can securely to the pole.