From The Forest to the Sea

Ecosystem Health

Program Framework

Southeast Island School District
Prince of Wales Island

EcoVan Program Framework

Ecosystem Health

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Purpose

This framework is designed to help the Southeast Island School District, in partnership with the US – Forest Service Thorne Bay Ranger District, develop an integrated forest conservation education program. It will serve as a valuable resource for teachers, as well as a tool that will help develop activities to get students outside and excited to learn about the unique ecosystem they live in. The Ecosystem Health program framework will also provide an opportunity to use local resources to further understanding of the environment, and to encourage exploration and participation in local issues that have direct impact on the lives of the people living in rural Southeast Alaska.

For students: This program framework will give students a chance to explore the forest around them through in-classroom and outdoor lessons, experiments, fieldtrips, guest speakers, action projects and activities focused on the ecosystem that they live in. The integration of many subjects, the various teaching techniques and opportunity for self-directed learning will give the students a quality, hands-on educational experience that they will be able to use in their futures.

For teachers: This framework will give teachers the resources and guidance needed for developing an interdisciplinary ecosystem health program in their classrooms and schools. It will provide the basic information, while also having other avenues available for teachers to explore and develop other aspects of the program.

For the Southeast Island School District: This program will be a link between the schools, teachers and students of the Southeast Island School District providing a consistent resources and an opportunity for district-wide environmental education and action. It will also give more opportunity for student and teacher interaction through the district.

For community: Community members will be given the opportunity to participate in activities as chaperones, speakers or partners in projects. They will benefit from the action projects that take place in conjunction with the EcoVan and may play major roles in the projects.

For environment: This program will help develop a community-wide environmental ethic that will prepare participants to make decisions on environmental issues in the area with a more educated background on the natural world around them. From that there is hope that more positive steps will be taken to improve, conserve and protect the natural environment.

For the Forest Service: This framework provides a program for Forest Service employees to base classroom visits on. It will help to link presentations together, focusing on the overall big picture, rather than many small disconnected topics. This will provide some guidelines to educate the students about the area they live in, developing the idea that everything is connected, not separate entities. It will also give presenters an idea of what the students know, are learning, and will learn, so they can better integrate the topics and ideas into what is already happening in the classroom. This program can also be distributed to other units of the FS.

For Other Agencies and Professionals: This program can also be distributed to other professionals in the field of ecosystem health (AK Dept. of Fish & Game employees, etc...).

Program Goal
To create awareness, build knowledge, and develop the values and skills that are necessary for the students of the Southeast Island School District to make informed decisions and take effective action on environmental issues surrounding ecosystems on a local, statewide, national, and global level.

Sub-Goals for Units:

What is a Watershed? :

- Explore the basic components of a watershed, investigate how those parts interact, and be able to apply that knowledge locally.
- Investigate watershed values from the perspective of the natural and human environment.
- Students will focus on developing personal values and ethics on environmental topics and issues.

Exploring your Backyard:

- Investigate local ecosystems while learning about both the living and nonliving components of those ecosystems.
- Consider the values of ecosystems, both to the natural and human environment.
- Students will focus on developing personal values and ethics on environmental topics and issues.

Human Impacts, Human Actions:

- Explore human impacts on ecosystems, from a personal to global scale, by investigating various issues.
- Investigate ways in which impact can be lessened on a personal to global level.
- Students will focus on local issues, develop an action plan for an issue, and take action, on personal, local and global levels.

Program Objectives

- Give students of the Southeast Island School District quality and practical outdoor educational experiences throughout all levels of their education.
- Give the teachers of the Southeast Island School District a framework to realistically integrate outdoor learning and community resources into their classroom curriculums.
- Provide a list of resources (activity guides, professionals, activity sites, etc…) to the teachers and administration of the Southeast Island School District that will help them develop lesson plans & and activities for the program.
- Meet as many national, state and school district education standards for Science, Math, English, Social Studies, Life Assets & Physical Education as practical.
- Develop a working-relationship between the Southeast Island School District and the US Forest Service – Thorne Bay Ranger District to take full advantage of the community resources available.
- Expose students to their local environment and the issues surrounding it.
- Promote student involvement in community & forest activities.

Audience

Students from eight rural Alaskan schools on POW. Grades K-12 (Levels 1-8): Ages 5-18. Schools consist of 1-7 teachers with 14-75 students; there is also a correspondence system that serves 18 students that live on remote float houses in the district. In most of the communities the families are at 83% poverty level. (taken from SISD website)

Program Stakeholders

Teacher/School District's Role:

The role of the South East Island School District in this framework is to:

1. Help in determining the needs and wants of the students, faculty & staff
2. With the help of a resource guide, select activities based on the framework, that would best suit the needs of the student, teacher and school.
3. Provide input, throughout the process, on what topics should be included in the framework to provide the best overall opportunity for curriculum integration and classroom logistics.
4. Stock the *Eco-Van* with necessary supplies to teach activities that they select.
5. To put the program into action during the school year.

Forest Service's Role:

The role of the US Forest Service Thorne Bay Ranger District in the this framework is to:

1. Provide a framework for curriculum development so there will be a guide for the School District to select lesson plans, activities & supplies for the Eco-Van and surrounding curriculum.
2. Provide a resource guide that lists quality web sites, activity guides, supplies and local resources that the school can use in activity development.
3. To serve as a teaching tool by giving presentations on various topics to students, offering orientation to equipment, gear or a particular site to students and/or teachers, offering expertise on various issues surrounding the forest, and serving as a source for specific information on a given subject to supplement lessons.
4. Reach out to POW communities to help further understanding of issues surrounding the Tongass National Forest and to develop working relationships with them.
5. Offer conservation education trainings for district teachers.

When this program was created, the diverse needs of the students and teachers of the school district were a top priority. Flexibility has been a theme running throughout the development of all aspects of the program. It can be used on a broad range of scales depending on the time constraints and needs of the teacher. One or two lessons could be taught, or the whole program could be adapted and threaded throughout daily classroom activities.

Please keep in mind that this is not an all encompassing program. As a teacher, you know the needs of your students best, and adapting aspects of this program to fit your classroom needs is a critical component to making this program a success.

WHY ENVIRONMENTAL / CONSERVATION EDUCATION?

Environmental education is rooted in the belief that humans can live compatibly with nature and act equitably toward each other. Another fundamental belief is that people can make informed decisions that consider future generations. Environmental education aims for an effective, environmentally literate citizenry who are able to participate with creativity and responsibility in a democratic society.

Environmental education often begins close to home, encouraging learners to understand and forge connections with their immediate surroundings. The awareness, knowledge, and skills needed for this localized learning provide a basis for moving out into larger systems, broader issues, and a more sophisticated comprehension of causes, connections, and consequences.

Many of the characteristics of quality education are integral components of environmental education. It is learner-centered and provides the participants with opportunities to construct their own understanding through hands-on, minds-on investigations. Engaged in direct experiences, learners are challenged to use higher order thinking skills. Environmental education provides real-world contexts and issues from which concepts and skills can be learned. (Taken from the *Guidelines for Excellence in Nonformal Environmental Education Program Development and Implementation (*NAAEE website))

Southeast Island School District - Sites

Correspondence

Hollis

Howard Valentine (Coffman Cove)

Hyder

Kasaan

Naukati

Port Alexander

Port Protection

Thorne Bay

Whale Pass

The Basics - What is Environmental Education:

This framework has been developed based on the principles of Environmental/Conservation Education, the following information was taken from a publication, *Excellence in Environmental Education - Guidelines for Learning,* developed by The North American Association of Environmental Education (NAAEE). As a teacher, it would help to be familiar with the goals of environmental/conservation education as lessons for this program are taught.

> *Excellence in Environmental Education--Guidelines for Learning* is grounded in a widely shared understanding of effective environmental education. For many educators, that understanding begins with two founding documents of the field: the Belgrade Charter (UNESCO-UNEP, 1976) and the Tbilisi Declaration (UNESCO, 1978).

The Belgrade Charter was adopted by a United Nations conference and provides a widely accepted goal statement for environmental education:

> ***The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones.***

A few years later, the world's first intergovernmental conference on environmental education adopted the Tbilisi Declaration. This declaration built on the Belgrade Charter and established three broad objectives for environmental education. These objectives provide the foundation for much of what has been done in the field since 1978:

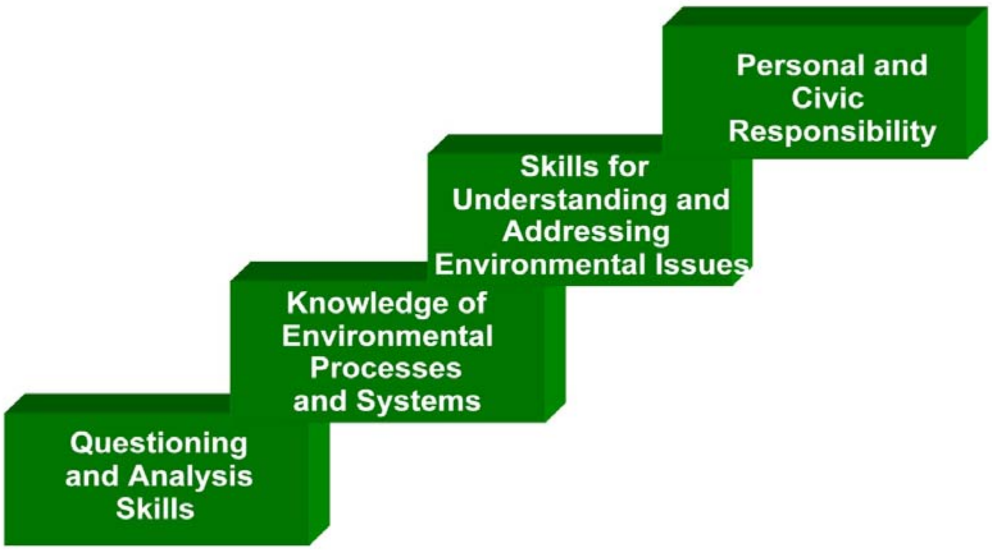
- To foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas;
- To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment;
- To create new patterns of behavior of individuals, groups and society as a whole towards the environment.

As the field has evolved, these principles have been researched, critiqued, revisited, and expanded. They still stand as a strong foundation for a shared view of the core concepts and skills that environmentally literate citizens need. Since 1978, bodies such as the Brundtland Commission (Brundtland, 1987), the United Nations Conference on Environment and Development in Rio (UNCED, 1992), and the Thessaloniki Declaration (UNESCO, 1997) have influenced the work of many educators, highlighting the importance of viewing the environment within the context of human influences. This perspective has expanded the emphasis of environmental education, focusing more attention on social equity, economics, culture, and political structure

Environmental education is rooted in the belief that humans can live compatibly with nature and act equitably toward each other. Another fundamental belief is that people can make informed decisions that consider future generations. Environmental education aims for a democratic society in which effective, environmentally literate citizens participate with creativity and responsibility.

(Taken from North American Association of Environmental Education (NAAEE) website)

The four strands of environmental literacy.



Taken from the EETAP (Environmental Education & Training Partnership) website.

The 5 Basic Components

Environmental Awareness (Questioning and Analysis Skills)
Providing opportunities for students to become more aware of the environment and fostering a learning atmosphere that encourages exploration, and sparks a curiosity to learn more about things around them. (Focus: Levels 1-3)

Environmental Knowledge (Knowledge of Environmental Processes and Systems)
Helping students to understand components, processes and functions of the natural environment through various knowledge based activities. This includes how the environment influence humans and how humans impact it. (Focus: Levels 1-8)

Environmental Values & Ethics (Skills for Understanding and addressing Environmental Issues)
Presenting students with the opportunities to make decisions, and develop their own set of values and ethics using the knowledge that the students have gained and what he/ she is still learning. (Focus: Levels 3-8)

Citizen Action Skills (Skills for Understanding and addressing Environmental Issues)
Giving students an opportunity to learn and practice real life skills that can be used to take action in future issues that are of concern to the student as a world citizen. (Focus: levels 5-6)

Citizen Action Participation (Personal and Civic Responsible)
Providing students with the opportunity to put what they have learned to use in a real-life setting by taking action on an issue of interest. This happens only after developing the necessary knowledge, values and skills. *This level is critical for development of a life-long learning process and for making a difference!* (Focus: Levels 7-8)

Websites for more background info on Environmental Education:

- http://www.naaee.org
- http://www.etap.org
- http://www.eelink.net/principlesofenvironmentaleducation.html

What is the EcoVan?

This program is based on and around The EcoVan, a classroom on wheels (or wings). The van and/or its contents will be traveling around to each school site in the Southeast Island School District at different times during throughout the school year. It will be stocked full of materials and other resources that that are needed to teach the selected program lessons.

There will also be “extra’s” in the EcoVan that will give teachers and students opportunities to explore aspects of conservation education outside of the specific “Ecosystem Health” Program.

The EcoVan will be driven by a school district employee who may or may not have experience in conservation education. *It is the responsibility of the classroom teachers to carry out the lessons of the EcoVan*, although they have options in recruiting guest speakers for selected lessons. The individual staffing the EcoVan will take on responsibility as he/she sees fit.

Materials

Ecosystem Health - Program Framework:

This guide will be available to each teacher in the school district to use in developing the "Ecosystem Health" curriculum for their classroom. Each school site will have a copy, along with the Forest Service and the EcoVan.

Forest Service Teaching Guide - Ecosystem Health Education Program:

This guide is meant to be used as a resource for Forest Service Employees to learn about the "Ecosystem Health" Program and help to integrate their presentation into what has been happening in the classroom.

EcoVan

It will be stocked with the *Ecosystem Health - Program Framework* binder and the basic materials needed to teach the selected lessons. *Please see inventory sheet for more details on what is in the EcoVan.*

The Program Layout

The program framework is organized under the theme of "Ecosystem Health". From there it is broken down into 3 units, each with its own topic addressing an aspect of "Ecosystem Health".

The topics are:
- Unit 1 - What is a Watershed?
- Unit 2 - Exploring your Backyard.
- Unit 3 - Human Impacts, Human Actions.

The units are designed to be very flexible with each one building upon the previous. It is possible to teach parts of all three units over the course of a year, or each unit could be used as a theme for an entire year's worth of lessons.

Lessons

Although teaching all of the lessons in the program results in the most in-depth and well-rounded education in ecosystem health, there is an option to just select certain lessons that will get the "basic ideas" across . The program has been designed to be as flexible as possible with time constraints. The lessons will also give teachers the basic background information needed for the teachers to teach the lesson.

Pre and Post Lessons

Another aspect of the program are Pre and Post lessons for each Unit. These are selected to provide students with additional information that complements what is done when the EcoVan is at the school. Although these lessons aren't critical to getting the general "Ecosystem Health" concepts, they will better prepare the students for concepts that will be introduced and will enhance understanding on many levels.

EXTRA Lessons

These lessons were selected based on their ability to integrate the EcoVan topics into other aspects of you classroom such as journal writing, math lessons, novels to read, art projects, etc… They are not necessary but would help to create a continuous investigation and integration of "Ecosystem Health" into the classroom.

Activities for Higher Level Students

These activities were chosen specifically for higher level students. These activities are generally more involved, and will take a little more time than the normal activities, but will provide students with the opportunity to delve deeper into different areas of study.

Forest Service Interactions

One aspect of the EcoVan program is allowing teachers to use Forest Service employees as an **additional** educational resource. Forest Service employees **should not be used to teach the curriculum**, that is the role of the teacher. **Forest Service employees should be used as a supplement to the teacher.** Forest Service interactions will give students hands on experience and the opportunity to see real-life applications of what they have been learning. There is a list employees willing to provide resources on various topics at the end of each unit.

More options…

Another option that can be taken on in conjunction with the EcoVan is a class project that would start in the beginning of the year and continue throughout the rest of it. It can be a simple project like some of the ideas listed in "Class Projects on pg. 51 or it can be a more comprehensive Community Action Plan (see "Community Action Plan" on Pg. 52) The EcoVan Program focuses on "Action" during the final EcoVan unit but it would definitely be beneficial to start thinking about an action project near the beginning of the program.

Year long class projects have many all around benefits in the classroom. Short term benefits can be seen day to day through smaller learning experiences. At the same time a long term understanding of many skills and subjects are gained and can continue year after year for cumulative learning opportunities .

Example:

For example, if your schools is monitoring rainfall and water level of a local stream, they are learning the "small" skills of data collecting, math and measuring. But, they will also be able to see and compare how rain effects water level on a weekly basis, while keeping track of the data over the school year can have year and multi year learning opportunities! This project can be a link between many disciplines: Science - data gathering, predicting, weather, climate, soils, ecology (the list is unlimited for this subject!) Language Arts - Journaling, essay writing, vocabulary Math - Graphing, data analysis, measuring, comparing etc… Social Studies - How does rain and water level effect people, history of other data trends, etc… Technology - Posting data on the Web, using computer graphing programs, etc…

Many skills from many subjects are often involved in hands on projects like this ! It is a great way to integrate classroom subjects and grade levels!

Program Assessment

Pre-EcoVan Assessment
For Teachers

The following questions are being asked in order to properly assess the program and make improvements throughout the coming years. Your input is very important to the program so please take some time to thoroughly and thoughtfully answer this questionnaire. THANKS FOR YOUR TIME & COMMITMENT!

Please fill this out after initially looking through the Ecosystem Health Program Framework.

#1. What grade level/s do you teach?

#2. What school do you teach in?

#3. How comfortable do you feel teaching "science-based" subjects?
very comfortable comfortable kind of comfortable not comfortable

#4. Do you plan on using the EcoVan/Ecosystem Health Curriculum Framework in your classroom?
Yes No

a. If so, how often do you predict you will use it?
____as much as possible (in many subjects)
____as often as convenient
____here and there (when a lesson sounds fun)
____only for science
____other (please describe________________________________
____)

b. What is the biggest determining factor in the amount of time you will spend on EcoVan lessons? (ie: time, standards, advantages, disadvantages etc…)

#5. Do you feel that you adequately address local issues in your classroom? Why or why not?

#4. Do you feel that you were properly introduced to the Ecosystem Health program?

#5. What else could be provided to help you feel more ready to use the program?

Pre-EcoVan Assessment
For Students

The following questions are being asked so we can work to improve the EcoVan Program in the coming years. Your input is very important to the program so please take some time to thoroughly and thoughtfully answer this questionnaire. Thank You!

#1. What level are you in? _______ #2. Where do you go to school?______________________________

#2. On a scale of 1 – 5 how much do you like spending time outside?

1	2	3	4	5
Not at all!		neutral		I love it!!

a. What do you enjoy doing?

#3. What part of the EcoVan are you looking forward to the most?

#4. What is an ecosystem?

#5. Describe a local environmental or forest conservation issue that you know about. (leave blank if you know of none)

#6. Do you think that you can make a difference in forest conservation issues? If so, how?

Ecosystem Health

Program Assessment

Post EcoVan Assessment
For Teachers

The following questions are being asked in order to properly assess the program and make improvements throughout the coming years. Your input is very important to the program so please take some time to thoroughly and thoughtfully answer this questionnaire. THANKS FOR YOUR TIME & COMMITMENT!

Please fill this out at the end of the year after completing the Ecosystem Health Program Framework. (Use the back of this page if you need more space)

#1. What grade level/s do you teach?_______ #2. What school do you teach in? _____________________

#3. Do you feel more comfortable teaching "science-based" subjects after using the EcoVan Program framework? Why or why not?

#4. How often did you use the Ecosystem Health Program Framework?

____I used it for all of the rotations plus some "extra lessons"
____I just used it when the EcoVan was at the school
____here and there (when a lesson sounded fun)
____only the lessons that already fit into what I was doing in class
____I didn't use the program
____other (please describe________________________________
____)

b. What is the biggest determining factor in the amount of time you spent on EcoVan lessons? (ie: time, standards, ease of use, etc…)

#5. Did your class/school participate in an community action project?

#6. What part/s of the Ecosystem Health Program do you feel were most beneficial to you?

….to your class?

#5. What are some things you liked about the program in general? What could be improved?

Post EcoVan Assessment
For Students

The following questions are being asked so we can work to improve the EcoVan Program in the coming years. Your input is very important to the program so please take some time to thoroughly and thoughtfully answer this questionnaire. Thank You! (You can use the back of the sheet if you run out of room!)

#1. What level are you in? _______ #2. Where do you go to school?________________________________

#2. On a scale of 1 – 5 how much do you like spending time outside?

1	2	3	4	5
Not at all!		neutral		I love it!!

a. What do you enjoy doing?

#3. What EcoVan activities did you like?

#4. What EcoVan activities did you dislike?

#5. What is an ecosystem (leave blank if you don't know) ?

#6. Describe a local environmental or forest conservation issue that you know about. (leave blank if you know of none)

#7. Do you think that you can make a difference in forest conservation issues? If so, how?

From The Forest to the Sea

What is a Watershed?

Unit #1

EcoVan Festival

What is a watershed?
- What watershed are you in?
- Mapping your watershed

Parts of a watershed & the water cycle
- Ground water
- Surface water
- Upland/flood/riparian zones
- Fresh/salt water

Physical & Chemical Properties
- Erosion
- Sedimentation
- Deposition
- Turbidity
- Evapo-transpiration rates
- pH
- Temperature
- Precipitation
- Flow

Why is your watershed important to you and your community?
- How do you use the watershed?
- In what ways do you depend on it?

Exploring Your Backyard

Unit #2

Biotic Environment

What ecosystems are here and what makes them unique?
- Temperate Rainforest
  - -Trees and other plants
  - -Fungi
  - -Birds
  - -Mammals
- Wetlands--Rivers, Streams, and Muskeg
  - -Aquatic Plants
  - -Fish
  - -Amphibians
  - -Aquatic invertebrates
- Ocean
  - -Saltwater plants
  - -Sea birds
  - -Fish
  - -Marine mammals
  - -Marine invertebrates

Abiotic Environment

Geology/topography
Climate & Weather
Ecological Concepts
- Populations
  - -Limiting Factors
  - -Carrying Capacity
- Predator/Prey relations
- Biodiversity
- Biogeography
- Habitat
- Adaptation
- Migration

Human Impacts, Human Actions

Unit #3

What are the causes of impact?
- Locally, nationally & globally

Tracing effects of pollution on:
- Wildlife
- Ecosystems
- Humans
- Economy
- Lifestyles
- Aesthetics

What are ways to lessen impact?
- Personal, community, state, nation, world levels.
- Sustainable lifestyle
- Restoration
- Management
- Careers

Investigate local issues & ways to take action!
- What are different sides of issue?
- What is your view?
- What kinds of actions could be taken?
- What are the steps needed to take action?
- Take Action!
- Evaluate the effects of your actions

Science Fair

What is a Watershed?

Unit 1

Ecosystem Health

What is a Watershed?

Pre-EcoVan Activities
Unit 1

GOAL: To give students background knowledge about water and the water cycle in order to prepare them for the activities they will do during the "What is a Watershed?" unit.

Pre-EcoVan Activityies

- "Imagine!" (WET pg. 157) — Grades 4-8

  Summary: Students take an imaginary journey with water in its solid, liquid and gaseous forms as it travels around the world.
  Subject Areas: Earth Science, Life Science, Language Arts, Fine Arts
  Standards Addressed:
  Activity Time: 20 minutes

- "Stream Sense" (WET pg. 191) — Grades K-6

  Summary: Students use their senses to observe a stream, learning there is more to moving water than meets the eye
  Subject Areas: Earth Science, Fine Arts, Language Arts,
  Standards Addressed:
  Activity Time: 25 minutes

- "H2Olympics" (WET pg. 30) — Grades 4-8

  Summary: Students compete in a Water Olympics to investigate two properties of water; adhesion & cohesion.
  Subject Areas: Physical Science, Mathematics
  Standards Addressed:
  Activity Time: 50 minutes

Concepts to focus on…

- Water gets reused over and over in a continuous, connected cycle.
- Water is an important part of every living thing.
- Fresh water is becoming a limited resource.
- Components of the Water Cycle and the interactions
  - ~Groundwater
  - ~Surface Water
  - ~Precipitation
  - ~Salt water Vs. Fresh water
- Feel comfortable in outdoor setting while "taking in" nature.

GOAL: To introduce students, teachers, parents and community members to the EcoVan and the ecosystems that they live in!

Grades K-4

Grades 5-7

Grades 8

High school students may want to become more involved in the EcoVan Festival by helping to staff stations, organize activities, or assist forest service speakers.

Inviting community members and parents to this event would be a fun introduction to the program. It may inspire them to become more involved in future EcoVan activities.

EcoVan Festival!

a celebration for all ages

Stations

1. Overview of the Year
   Check out the EcoVan! What is in it? What will is be doing throughout the year?
   ~Someone on hand to answer questions.
   ~Have "Fun Bins" set out.
   ~Kayaks and Bikes to try!
2. What is a Watershed?
   Watershed Board
   ~Shows different parts of the watershed.
   ~Demonstrates movement of water through the watershed.
   "An Incredible Journey" (WET pg. 161)
   ~ With the roll of a die, students simulate the movement of water within a natural system.
3. Exploring Your Backyard
   "Ecosystem Scavenger Hunt"
   (Alaska's Ecology pg. 150)
   ~Students participate in a scavenger hunt to identify and review roles of organisms in a local ecosystem.
4. Human Impacts, Human Actions
   "Spinning a Yarn About Ecosystems"
   (Alaska's Ecology pg. 162)
   ~Students learn how changes in one part of an ecosystem can affect other seemingly unrelated parts.
5. Long Term Projects
   The festival is a great time to start a long term project! Here are a couple examples:
   ~"Plant a Tree" (Alaska's Forests pg. 234)
   ~"Create a Classroom Compost Box"
   (Alaska's Ecology pg. 114)

What is a Watershed?

GOAL: To introduce students to the watershed where their school is located, or another that is nearby. Focus on what unique features exist and specific issues or topics surrounding the watershed.

Grades K-4

Grades 5-7

Grades 8

Field Trip!

From headwaters streams to the ocean

Spend a day of exploring various components of a local Watershed, in order to get a broad view of what it is and how it works. (FS employee available to guide the trip, offer maps, and other expertise)

Stop at:

~A headwater stream
~A lake or mid-system stream
~Where fresh and salt water meet

Along the way explore what the differences in the three places…

How much water is there?
Where is it coming from?
What is the quality of the water (in general)
What are the different types of wildlife found there? Why?
What types of habitat do you see?
What depends on this water?
Who depends on this water?
Do you see any problems or issues concerning this watershed?
What could you do about them?

Have students do various journaling activities, or games along the way to tie everything that is talked about at the three places together.

Concepts to Focus on:

- Students should understand the basics of what defines a watershed.
- Encourage students to be excited to learn about what they are seeing in their local natural environment.
- Introduce many topics that will be gone into with more detail throughout the year.

What is a Watershed?

EcoVan Activity Options
Unit 1

GOAL: To explore the basic components of a watershed, investigate how the components interact, and be able to apply that knowledge locally.

Watershed Activities

Grades 4-8

- "Rainy Day Hike" K-2 Option (WET pg. 189)

  Summary: Students are introduced to the concept of watersheds by exploring where water flows over school grounds.
  Subject Areas: Earth Science, Environmental Science, Geography
  Standards Addressed:
  Activity Time: 20-60 minutes (depending on what activities are selected)

Grades 7-8

- "Branching Out" K-2 Option (WET pg. 131)

  Summary: Students use objects to symbolize rivers and streams in a landscape
  and then sing a song with hand motions to illustrate water movement.
  Subject Areas: Fine Arts, Earth Science, Physical Ed.
  Standards Addressed:
  Activity Time: 30-60 minutes (depending on what activities are selected)

Grades 4-12

- "Seeing Watersheds" (DW pg. 4)

  Summary: Seeing a watershed on a map is easy after you learn how to see the parts: main-stem, tributaries, headwaters, mouth and drainage.
  Subject Areas: Natural Science, Geography
  Standards Addressed:
  Activity Time: 45 minutes

Concepts to focus on:

- Students know that where they live and go to school is part of a watershed.
- Identifying where and how water runs on the school grounds.
- Being able to explain why water runs where it does.
- Understanding how water runs on a landscape.
- The components of a watershed & how the parts interact.
- Mapping a watershed.
- How water connects all things in a watershed and outside of a watershed.

What is a Watershed?

GOAL: To expand on the watershed awareness & knowledge that was focused on in Unit 1.

Post-EcoVan Activities

All Grades

- "Rainy Day Hike" (WET pg. 186)

  Part 1 or 2 depending on what was done during EcoVan activities. Some adaptations to activity should be made for levels 1-3.

  Summary: Students are introduced to the concept of watersheds by collecting data water flowing over school grounds.
  Subject Areas: Earth Science, Environmental Science, Geography
  Standards Addressed:
  Activity Time: 50 minutes

- "Sum of the Parts" (DW pg. 114)

  Summary: Students demonstrate how everyone contributes to the impact of a river as it flows through a watershed and recognize that every one's "contribution" can be reduced.
  Subject Areas: Environmental Science, Government
  Standards Addressed:
  Activity Time: 50 minutes

- "Choices & Preferences" (WET pg. 367)

  Summary: Students rank and compare different uses of water. The class develops a "water index," an indication of the group's feelings and values about water and its uses.
  Subject Areas: Mathematics, Environmental Science, Government
  Standards Addressed:
  Activity Time: 50 minutes

Concepts to focus on:

- Identifying where and how water runs on the school grounds.
- Understanding how water flows over a landscape.
- Develop an awareness of our impact on watersheds and develop personal watershed values.

EXTRA EcoVan Activities

- "A House of Seasons" (WET pg. 155) Grades K-3

  Summary: By constructing a "House of Seasons" collage, students observe the role of water in each of the seasons.
  Subject Areas: Earth Science, Fine Arts, Geography
  Standards Addressed:
  Activity Time: 50 minutes

- "Water in Motion" K-2 options (WET pg. 450) Grades 3-6

  Summary: Students create artwork to help the appreciate the movement and sound of water in their environment.
  Subject Areas: Fine Arts, Physical Science, History
  Standards Addressed:
  Activity Time: Part 1 - 30 minutes Part 2 - 30 minutes Part 3 - two 50 minutes

- "Water Models" (WET pg. 201) Grades 4-8

  Summary: Students construct models of the water cycle to illustrate its major components and processes, and adapt their models to show hoe the think water would cycle in various ecosystems.
  Subject Areas: Earth Science, Ecology, Geology, Physical Science
  Standards Addressed:
  Activity Time: two 50 minute periods

- "Great Water Journeys" (WET pg. 246) Grades 7-12

  Summary: Using a global map and a set of clue cards, students locate some significant water journeys.
  Subject Areas: Earth Science, History, Geography
  Standards Addressed:
  Activity Time: 50 minutes

- "River Talk" (DW pg. 37) Grades 6-12

  Summary: Students study the relationship between a pair of watershed words and choose an other pair that demonstrates the same type of analogy.
  Subject Areas: Language Arts, Logic
  Standards Addressed:
  Activity Time: 120 minutes

What is a Watershed?

EXTRA EcoVan Activities
Unit 1

All Grades

- Maintain a “Water Log” through poems, pictures, article reviews, data gathering, and writing.
- Reading list of “fun” water books. Do a book report, presentation or discussion along with it.
- Select and start any long term, ongoing classroom experiments. (ie: Rain gauge, peak stream flow, other stream data collection…)
- Write “Island News” article or draw pictures.

Activities for Higher Levels

- "Super Sleuths" (WET pg. 107)

Grades 6-12

Summary: Students learn about the diversity of waterborne illnesses and the role of epidemiology in disease control by searching for others who have been "infected" with the same water-borne illness as they have.
Subject Areas: Health, Life Science, Geography
Standards Addressed:
Activity Time: 50 minutes

- "Color Me a Watershed" (WET pg. 223)

Grades 9-12

Summary: Through interpretation of maps, students observe how development can affect a watershed.
Subject Areas: Environmental Science, Mathematics, History
Standards Addressed:
Activity Time: 50 minutes

- "The CEO" (WET pg. 300)

Grades 9-12

Summary: Students assume the role of CEOs and analyze the relationship between economic profits and environmental quality.
Subject Areas: Government, Language Arts, Environmental Science
Standards Addressed:
Activity Time: Three 50 minute periods

- "The Price is Right" (WET pg. 333)

Grades 9-12

Summary: Students learn about economics and environmental planning as they calculate the cost of building a water development project.
Subject Areas: Mathematics (Economics), Government, Environmental Science
Standards Addressed:
Activity Time: 50 minutes

- "Hot Water" (WET pg. 387)

Grades 9-12

Summary: Using debate strategies, students learn how to present a valid argument regarding a water-related issue.
Subject Areas: Environmental Science, Government, Language Arts
Standards Addressed:
Activity Time: Two 50 minute periods

What is a Watershed?

Possibilities for Forest Service Interactions

Katherine (KK) Prussian - Hydrologist 828-3222 katherineprussian@fs.fed.us

Hydrology wonder-woman for POW, KK is the gal to go to if you want a presenter on the basics of a watershed, how to map them, the physical properties of the water (ex: erosion, turbidity, pH, temp, precipitation and flow) and also how climate and weather affect a watershed. She is also the mastermind behind the watershed board (a creative way to show kids how ground cover, like forests & muskegs, effects the amount of water in streams & rivers. She is grew up in SE AK and has worked on the island for many years.

- Presentations
    - Watershed Terminology
    - Watershed and Hydrology Process
    - Water Balance
    - Water Quality
    - Watershed Board
- Projects
- Other Resources

Jim Beard - Fish Biologist 828-3209 jmbeard@fs.fed.us

Jim has worked in the fisheries field for over 20 years and would be a great guest speaker about any aspect of fish and their ecology, he's a real fishnerd! He also would be an excellent resource for a talk about watersheds and streams, and how we can impact watersheds. Jim can discuss the big picture with respect to aquatic environments, animals and watersheds. Jim also has experience teaching about marine biology, and is great with kids! Jim is available for:

- Presentations
    - Aquatic Insects
    - Salmon and other Fish
    - Watershed Topics
    - Marine Mammals and Seashore animals and plants
    - Various **Fish and Wildlife** topics
    - Other natural resource topics including careers in natural resources
- Other Resources

Aaron Prussian - Aquatic Ecologist 828-3225 Aaron_Prussian@fs.fed.us

If you want a presenter who will tie all the aquatic components into the big ecosystem picture Aaron is the guy who can do it. From the small parts, like species of fish and aquatic invertebrates, to how what's in the landscape affects the stream, lake or river, to the impacts humans have on watersheds and how we depend on watersheds in our daily lives. Aaron has had experience working with students and has worked in AK for several years. He is a great role model for the students!

- Presentations
    - Aquatic Insects
    - Salmon
    - Various **Fish and Wildlife** topics.
- Other Resources

See Employee Listing on Page 62 for a more detailed list of available Forest Service employees.

Exploring Your Backyard

Unit 2

Exploring Your Backyard

Pre-EcoVan Activities
Unit 2

GOAL: To give students background knowledge about ecosystems and their components in order to prepare them for the activities they will do during the "Exploring Your Backyard" unit.

Pre-EcoVan Activities

Grades 1-6

- "Five Kingdoms But No King" (Alaska's Ecology pg. 58)

    Summary: Students will learn the five kingdoms of living things and be able to identify an example from each kingdom.
    Subject Areas: Science, Language Arts, Art
    Standards Addressed:
    Activity Time: 60 minutes

Grades 3-6

- "What Makes an Ecosystem?" (Alaska's Ecology pg. 147)

    Summary: Students take an imaginary or real walk through the schoolyard and create their own imaginary ecosystems.
    Subject Areas: Science, Language Arts
    Standards Addressed:
    Activity Time: 60 minutes

Grades 3-12

- "It's Alive! Or is it?" (Alaska's Ecology pg. 55)

    Summary: Students work in groups to describe and perform experiments to determine whether and object is living or nonliving.
    Subject Areas: Science, Language Arts
    Standards Addressed:
    Activity Time: 50 minutes

Grades 5-12

- "Forest Food Web Game" (Alaska's Forests pg. 105)

    Summary: Using pictures, students will construct and describe food webs that include the nonliving elements of a forest ecosystem.
    Subject Areas: Science
    Standards Addressed:
    Activity Time: 60 minutes

Concepts to focus on…

- Both living and nonliving components are needed to form an ecosystem.
- The components of an ecosystem are linked by the flow of energy and the exchange of nutrients.
- Living things can be classified into five different kingdoms.

Exploring Your Backyard

EcoVan Activity Options
Unit 2

GOAL: To explore the basic components of the temperate rainforest ecosystem, investigate how the components interact and be able to apply that knowledge locally.

Temperate Rainforest Ecosystem Activities

- "Trees to Imagine" (Alaska Forests pg. 84)

  Grades K-5

  Summary: Students imagine themselves to be trees in the forest.
  Subject Areas: Science, Language Arts, Dramatic Arts
  Standards Addressed:
  Activity Time: 20 to 30 minutes

- "Flipbook Succession" (Alaska's Forests pg. 172)

  Grades 4-8

  Summary: Students walk along a transect line to observe differences in the types and abundance of plants, draw these changes, and make a flipbook to show stages of succession along the transect.
  Subject Areas: Science, Social Studies, Art
  Standards Addressed:
  Activity Time: 50 minutes

- "Forest Ecosystem Scavenger Hunt" (Alaska's Forests pg. 117)

  Grades 5-9

  Summary: Students participate in a scavenger hunt to identify and review roles of organisms in a forest ecosystem.
  Subject Areas: Science
  Standards Addressed:
  Activity Time: 45 minutes

- "How Many Bears Can Live in This Forest?" (WILD pg. 23)

  Grades 5-8

  Summary: Students become "bears" to look for one or more components of habitat during this physically involved activity.
  Subject Areas: Science, Environmental Education, Mathematics
  Standards Addressed:
  Activity Time: 20 to 45 minutes

- "Birds of Prey" (WILD pg. 111)

  Grades 9-12

  Summary: Students interpret data on wildlife populations, generate hypotheses related to the data, and research potential explanations.
  Subject Areas: Mathematics, Science, Environmental Education
  Standards Addressed:
  Activity Time: 45 minutes

Concepts to focus on…

- The specific components that make up a forest ecosystem.
- Habitats and populations local forest ecosystems.
- Ecological factors that influence the change of ecosystems and their components over the course of time.

Exploring Your Backyard

GOAL: To explore the basic components of the wetlands ecosystem, investigate how the components interact and be able to apply that knowledge locally.

Wetlands Ecosystem Activities

- "Water Plant Art" (WILD aquatic pg. 31) — Grades K-4

  Summary: Students create artwork showing aquatic habitats using drawings and pressed aquatic plants.
  Subject Areas: Science, Environmental Education, Expressive Arts
  Standards Addressed:
  Activity Time: 20 to 45 minutes

- "Wetland Metaphors" (WILD aquatic pg. 39) — Grades 5-8

  Summary: Students are presented with a selection of objects to investigate as metaphors for the natural functions of wetlands.
  Subject Areas: Environmental Education, Language Arts
  Standards Addressed:
  Activity Time: 30 to 60 minutes

- "Hooks and Ladders" (WILD aquatic pg. 43) — Grades 5-8

  Summary: Students simulate the Pacific salmon and the hazards faced by salmon in an activity portraying the life cycle of these aquatic creatures.
  Subject Areas: Social Studies, Science, Environmental Education , Expressive Arts
  Standards Addressed:
  Activity Time: 30 to 60 minutes

- "Migration Headache" (WILD aquatic pg. 15) — Grades 5-8

  Summary: Students portray migrating water birds traveling between nesting habitats and wintering grounds.
  Subject Areas: Science, Environmental Education, Expressive Arts
  Standards Addressed:
  Activity Time: 45 minutes

- "Pond Succession" (WILD aquatic pg. 66) — Grades 5-8

  Summary: Students create murals showing three major stages of pond succession.
  Subject Areas: Science, Social Studies, Environmental Education, Expressive Arts
  Standards Addressed:
  Activity Time: 30 minutes

Concepts to focus on…

- The specific components that make up a wetland ecosystem.
- Habitats and populations that occur in local wetland ecosystems.
- Ecological factors that influence the change of ecosystems and their components over the course of time.

Exploring Your Backyard

GOAL: To explore the basic components of the ocean ecosystem, investigate how the components interact and be able to apply that knowledge locally.

Ocean Ecosystem Activities

- "Swimming in an Underwater World" (Animals of the Seas pg. 116) — Grades K-3

  Summary: Students use body movement and pantomime to simulate the swimming motions of various sea animals.
  Subject Areas: Science, Environmental Education, Expressive Arts
  Standards Addressed:
  Activity Time: 20 to 60 minutes

- "Fashion a Fish" (WILD aquatic, pg. 56) — Grades K-4

  Summary: Students design a fish adapted for various aquatic habitats.
  Subject Areas: Science, Expressive Arts, Environmental Education
  Standards Addressed:
  Activity Time: 20 to 45 minutes

- "Turtles Hurdles" (WILD aquatic pg. 158) — Grades 4-8

  Summary: Students become sea turtles and limiting factors in a highly active simulation game.
  Subject Areas: Science, Social Studies, Environmental Education
  Standards Addressed:
  Activity Time: 45 minutes

- "Whale Adaptations" (Marine Mammals pg. 31) — Grades 9-12

  Summary: Students develop an understanding of the specific adaptations that whales have in order to survive in the ocean.
  Subject Areas: Science, Environmental Education, Mathematics
  Standards Addressed:
  Activity Time: 60 minutes

- "Whale of a Tale" (WILD aquatic, pg. 10) 5 to 8 — Grades 5-8

  Summary: Students use computational, graphing, and measuring techniques to draw or sculpture life-size replicas of whales.
  Subject Areas: Mathematics, Expressive Arts
  Standards Addressed;
  Activity Time: 60-120 minutes

Concepts to focus on…

- The specific components that make up different ocean ecosystems.
- Habitats and populations that occur in local marine ecosystems.
- Ecological factors that influence the change of ecosystems and their components over the course of time.

Exploring Your Backyard

Post-EcoVan Activity
Unit 2

GOAL: To expand on the ecosystem awareness & knowledge that was focused on in Unit 2.

Post-EcoVan Activities

- "Wildlife is Everywhere" (WILD pg. 51) — Grades K-4

  Summary: Students search their surroundings for evidence of wildlife.
  Subject Areas: Science, Language Arts, Environmental Education
  Standards Addressed:
  Activity Time: 30 to 45 minutes

- "Animal Poetry" (WILD pg. 282) — Grades 5-8

  Summary: Students go outside to imagine themselves as animals and then write poems.
  Subject Areas: Language Arts
  Standards Addressed:
  Activity Time: 45 minutes

- "Drawing on Nature" (WILD pg. 285) — Grades 5-8

  Summary: Students use techniques of observation and visualization to record wildlife by drawing.
  Subject Areas: Environmental Education, Language Arts, Expressive Arts
  Standards Addressed:
  Activity Time: 45 minutes

- "Enviro-ethics" (WILD pg. 443) — Grades 5-8

  Summary: Students develop and use a "Personal Code of Environmental Ethics."
  Subject Areas: Government, Environmental Science
  Standards Addressed:
  Activity Time: 50 minutes

Concepts to focus on…

- Understanding that wildlife can be found all around.
- Foster emotional connections to our local ecosystems
- Students should develop personal ecosystem values by exploring what different types of ecosystems mean to them.

Exploring Your Backyard

EXTRA EcoVan Activity
Unit 2

EXTRA EcoVan Activities

Grades 4-12

- Choose any or all of the following activities:
  "Investigating Monerans & Protists" (Alaska's Ecology pg. 117)
  "Investigating Fungi" (Alaska's Ecology pg. 119)
  "Investigating Plants" (Alaska's Ecology pg. 121)
  "Investigating Animals in Soil" (Alaska's Ecology pg. 127)
  "Investigating Animals in Water" (Alaska's Ecology pg. 132)
  "Investigating Insects" (Alaska's Ecology pg. 137)
  "Investigating Birds" (Alaska's Ecology pg. 140)
  "Investigating Mammals" (Alaska's Ecology pg. 143)

  Summary: Students learn to recognize and identify local organisms from all five kingdoms and the habitats in which they occur.
  Subject Areas: Science, Math, Language Arts, Art
  Standard's Addressed:
  Activity Time: Ranges from 90 to 100 minutes depending on activity.

Grades 6-8

- "Graphic Populations" (Alaska's Wildlife pg. 113)

  Summary: Students compare graphs for several wildlife populations
  Subject Areas: Science, Math, Language Arts
  Standard's Addressed:
  Activity Time: 2 to 3 hours.

All Grades

- Tide Pool Field Trip

  Take a trip to a local beach at low tide to explore the tide pools. Learn to identify some of the many creatures that survive in this unique ecosystem. Discuss some adaptations these animals possess in order to survive at low tide.

- Rainforest Field Trip

  Hike out into the closest patch of old growth forest and explore your surroundings. Discuss the features of a temperate rainforest, and try to find plants that might be unique to this ecosystem. Look for animal signs! Consider visiting a sight with second growth to compare.

- Muskeg Field Trip

  Explore a local muskeg. Observe up close what makes this ecosystem so different from others. Look for some of the unique plants that grow in the muskeg. For exceptional wildflowers, visit the muskeg in spring.

- Become an Expert!

  Encourage students to learn how to identify local plants and wildlife by teaching them how to use identification field guides. Head out into the schoolyard and see how many different types

Activities for Higher Level Students

Grades 9-12

- "Arctic Survival" (WILD pg. 234)

  Summary: Through a simulation, students will become hunters, gathers, and traders in an attempt to gain food, water, shelter, and heat.
  Subject Areas: Social Studies, Science, Environmental Education
  Standards Addressed:
  Activity Time: Two 45 minute sessions

- "Wildlife Research" (WILD pg. 418)

  Summary: Students evaluate types of research involving wildlife, apply their results to develop individual research proposals that meet criteria for appropriateness, and conduct research.
  Subject Areas: Environmental Education, Science
  Standards Addressed:
  Activity Time: Three 45 minute sessions

- "Dropping in on Deer" (WILD pg. 420)

  Summary: Students estimate population density of deer in a given area by counting deer pellet groups.
  Subject Areas: Environmental Education, Science, Mathematics
  Standards Addressed:
  Activity Time: Three 50 minute sessions, possible field trip

- "When a Whale is Right" (WILD aquatic pg. 94)

  Summary: Students hold a hypothetical meeting of the International Whaling Commission.
  Subject Areas: Social Studies, Environmental Education
  Standards Addressed:
  Activity Time: Three 45 minute sessions

- "The Glass Menagerie" (WILD aquatic pg. 155)

  Summary: Students observe and describe changes in physical characteristics of several different experimental aquatic habitats that they create.
  Subject Areas: Science, Environmental Education
  Standards Addressed:
  Activity Time: Four weeks for classroom observations

- "Sea Turtles International" (WILD aquatic 98)

  Summary: Students portray the political interactions of citizens from different countries who have a variety of perspectives on the conservation of wildlife and habitat.
  Subject Areas: Social Studies, Environmental Education
  Standards Addressed:
  Activity Time: Two 45 minute sessions

Possibilities for Forest Service Interactions

Jim Beard - Fish Biologist 828-3209 jmbeard@fs.fed.us

Jim has worked in the fisheries field for over 20 years and would be a great guest speaker about any aspect of fish and their ecology, he's a real fishnerd! He also would be an excellent resource for a talk about watersheds and streams, and how we can impact watersheds. Jim can discuss the big picture with respect to aquatic environments, animals and watersheds. Jim also has experience teaching about marine biology, and is great with kids! Jim is available for:

- Presentations
  - **Aquatic Insects**
  - **Salmon and other Fish**
  - **Watershed Topics**
  - **Marine Mammals and Seashore animals and plants**
  - Various **Fish and Wildlife** topics
  - Other natural resource topics including careers in natural resources
- Other Resources

Susan Howell - Fish and Wildlife Staff Officer 828-3263

A long time AK resident, Susan has had much experience in the wildlife field but recently switched to management of people. She would be a wonderful person to bring to your classroom to talk about the principles of management and restoration. She would also give a wonderful presentation on careers in the natural resource field and could give an overall view of what is happening on the Forest. Her creativity and excitement would also be of great benefit in selecting class projects. Susan is available for:

- Other Resources

Brandy Prefontaine - Fish Biologist 828-3206 bprefontaine@fs.fed.us

Brandy was raised on Prince of Wales Island, and graduated from Thorne Bay School. She is a great example of how you can start working in High School for the Forest Service and end up with a professional career. Working in the fish and wildlife shop, her expertise is fisheries science. Her passion is plants, and so she can provide a wide array of presentations, projects, and general information from fish and aquatic insects, to native plant species.

- Presentations
  - **Plants** - Forest Gardening with Native Species: using native plant species to prevent erosion and beautify our forests.
  - **Aquatic Insects**
  - **Salmon**
- Projects
  - **Plants** - Students can participate in growing native plant species from seed, then planting them along roads, and other areas. This would be a great long-term project to participate in.
- Other Resources

Possibilities for Forest Service Interactions (cont.)

Aaron Prussian - Aquatic Ecologist 828-3225 Aaron_Prussian@fs.fed.us

If you want a presenter who will tie all the aquatic components into the big ecosystem picture Aaron is the guy who can do it. From the small parts, like species of fish and aquatic invertebrates, to how what's in the landscape affects the stream, lake or river, to the impacts humans have on watersheds and how we depend on watersheds in our daily lives. Aaron has had experience working with students and has worked in AK for several years. He is a great role model for the students!

- Presentations
    - **Aquatic Insects**
    - **Salmon**
    - Various **Fish and Wildlife** topics.
- Other Resources

Ray Slayton - Wildlife Biologist 828-3261 raymondslayton@fs.fed.us

Looking for someone to talk about forest creatures? This is the guys to do it! From specific species, to habitats, to the neat things that happen on an island, to doing deer pellet surveys with the kids…the list goes on! Ray is a great resources for information on the wildlife aspects of ecosystems.

- Presentations
    - **Wildlife Management** - Second Growth Management for Wildlife Benefits
    - Other wildlife-related topics
- Projects
    - **Deer Pellet Surveys**
    - **Bird Surveys**
- Other Resources

See Employee Listing on Page 62 for a more detailed list of available Forest Service employees.

Human Impacts, Human Actions

Unit 3

Human Impacts, Human Actions

Pre-EcoVan Activities
Unit 3

GOAL: To prepare students for the activities they will do during the "Human Impacts, Human Actions" unit by exploring human impacts on ecosystems and actions that can be taken to lessen impact.

Pre-EcoVan Activities

- "Ethi-thinking" (WILD pg. 303) — Grades K-4

  Summary: Students list activities that might be harmful to wild plants and animals and use photos or drawings to pictures, discuss, interpret, and evaluate these activities.
  Subject Areas: Environmental Education, Language Arts
  Standards Addressed:
  Activity Time: 40 minutes.

- "Drawing on Nature" (WILD pg. 285) — Grades 5-8

  Summary: Students use techniques of observation and visualization to record wildlife by drawing.
  Subject Areas: Environmental Education, Language Arts, Expressive Arts
  Standards Addressed:
  Activity Time: 45 minutes

- "Enviro-ethics" (WILD pg. 443) — Grades 5-8

  Summary: Students develop and use a "Personal Code of Environmental Ethics"
  Subject Areas: Language Arts, Social Studies, Environmental Education
  Standards Addressed:
  Activity Time: 60 minutes

- "Whose Problem is it?" (WET pg. 429) — Grades 7-12

  Summary: Students analyze the scope and duration of a variety of water-related issues to understand the relationship between local and global issues.
  Subject Areas: Government, Environmental Science
  Standards Addressed:
  Activity Time: 50 minutes

- "Choices & Preferences" (WET pg. 367) — All Grades

  Summary: Students rank and compare different uses of water. The class develops a "water index," an indication of the group's feelings and values about water and its uses.
  Subject Areas: Mathematics, Environmental Science, Government
  Standards Addressed:
  Activity Time: 50 minutes

Concepts to focus on…

- Develop a set of personal values relating to different ecosystems and what they represent for you, your community, your state, country, the world.
- Learn how to use tool to assess the values of an ecosystem, the impacts we have on the ecosystem and how we can lessen that impact.

Human Impacts, Human Actions

EcoVan Activity Options
Unit 3

GOAL: To explore human impacts on ecosystems from a personal to global scale by investigating various issues.

Human Impact Activities

- "Too Close for Comfort" (WILD pg. 300) — Grades K-4

  Summary: Students experiment with physical distance and levels of comfort in humans, estimate appropriate distances between humans and wildlife under various condition, and summarize reasons to avoid animal discomfort.
  Subject Areas: Science, Environmental Education
  Standards Addressed:
  Activity Time: 30 minutes

- "How Much Paper Do We Use?" (Alaska's Forests pg. 199) — Grades K-5

  Summary: Students keep records of their paper use for one day and calculate the amounts used daily by their classroom and school, and develop a plan to use less.
  Subject Areas: Social Studies, Mathematics
  Standards Addressed:
  Activity Time: 30 to 60 minutes

- "A-maze-ing Water" (WET pg. 219) — Grades K-8

  Summary: Students guide a drop of water through a maze of "drainage pipes" to learn how actions in the home and yard affect water quality.
  Subject Areas: Environmental Science, Health
  Standards Addressed:
  Activity Time: 15 to 120 minutes depending on option chosen.

- "Litter We Know" (WILD pg. 434) — Grades 5-8

  Summary: Students collect and evaluate litter, making collages.
  Subject Areas: Social Studies, Expressive Arts, Environmental Education
  Standards Addressed:
  Activity Time: 45 minutes

- "What's For Dinner" (WILD pg. 96) — Grades 5-8

  Summary: Students list and analyze the sources of food.
  Subject Areas: Science, Language Arts, Environmental Education
  Standards Addressed:
  Activity Time: 20 minutes

Concepts to focus on…

- Understanding the impact we have on both a personal and global scale on different ecosystems.

Human Impacts, Human Actions

GOAL: To explore human actions that can be taken to lessen impact on ecosystems from a personal to global scale.

Human Action Activities

Grades K-4

- "Playing Lightly on the Earth" (WILD pg. 432)

  Summary: Students look for evidence of games that harm the environment and then invent and play games with a benign effect on the environment.
  Subject Areas: Environmental Arts, Science, Expressive Arts
  Standards Addressed:
  Activity Time: 45 minutes

Grades 2-9

- "Watching Your Waste" (Alaska's Ecology pg. 159)

  Summary: Students evaluate their household's or school's output of waste materials and make a waste reduction plan for home or school.
  Subject Areas: Social Studies, Science, Mathematics, Language Arts, Art
  Standards Addressed:
  Activity Time: Varies

Grades 4-9

- "Muskox Return to Alaska" (Alaska's Wildlife pg. 154)

  Summary: Students simulate muskoxen and wolves in a physical activity and then add humans to the game.
  Subject Areas: Science, Physical Education
  Standards Addressed:
  Activity Time: 35 minutes

Grades 7-12

- "Sparkling Water" (WET pg. 348)

  Summary: Students develop strategies to remove contaminants from "wastewater."
  Subject Areas: Environmental Science, Health
  Standards Addressed:
  Activity Time: 120 minutes

Grades 4-12

- "Create and Destroy" (Alaska's Ecology pg. 156)

  Summary: Students create an environment, destroy it, and put it back together.
  Subject Areas: Social Studies, Science, Art
  Standards Addressed:
  Activity Time: 45 to 90 minutes

Concepts to focus on…

- Understanding realistic ways to lessen the impact we have on both our local and global ecosystems.

GOAL: To provide students with the opportunity to share what they have learned with the community and other schools.

All Grades

Science Fair!

A day of fun and community-wide learning!

This event will give students the opportunity to share the projects that they have been working on throughout the year with the communities of POW and the other schools. A fun, fair-like atmosphere where everyone can learn and interact would be a great way to promote community and school involvement in local issues!

- EcoVan Activities

Fun activities for kids to learn even more! Let community members participate. They will enjoy seeing what types of activities students have been doing throughout the year.

- Booths, Posters, Projects

Provide a means for students to display all the neat things that they have been happening in the classrooms all year!

- Forest Service Involvement

The Forest Service can help with activities and provide special visits from Smokey Bear and Sammy the Salmon! Forest Service Employees can also set up their own displays for kids to explore and learn more!

GOAL: To explore human impacts on ecosystems from a personal to global scale by investigating various issues. To explore human actions that can be taken to lessen impact on ecosystems.

Post EcoVan Activities

All Grades

- "Spinning Yarn About an Ecosystem" (Alaska's Ecology pg. 162)

  Summary: Students standing in a large circle represent an ecosystem. Each student represents a different part of an ecosystem. Yarn connects all of the students.
  Subject Areas: Science, Art, Language Arts
  Standards Addressed:
  Activity Time: 30 minutes

EXTRA EcoVan Activities

Grades 5-8

- "Improving Wildlife Habitat in the Community" (WILD pg. 440)

  Summary: Students design and accomplish a project to improve wildlife habitat in their community.
  Subject Areas: Social Science, Environmental Education
  Standards Addressed:
  Activity Time: 45 minutes if hypothetical, longer if project is implemented.

Grades 9-12

- "Bird Song Survey" (WILD pg. 406)

  Summary: Students investigate an area and use bird-counting techniques.
  Subject Areas: Environmental Education, Science
  Standards Addressed:
  Activity Time: varies

Grades 9-12

- "Can Do!" (WILD pg. 446)

  Summary: Students select an environmental project, conduct research, make plans, and follow procedures to accomplish the project.
  Subject Areas: Environmental Education, Social Studies
  Standards Addressed:
  Activity Time: Three 45 minute sessions.

Activities for Higher Level Students

- "Color Me a Watershed" (WET pg. 223)

  Grades 9-12

  Summary: Through interpretation of maps, students observe how development can affect a watershed.
  Subject Areas: Environmental Science, Mathematics, History
  Standards Addressed:
  Activity Time: 50 minutes

- "Know Your Legislation: What's in It for Wildlife?" (WILD pg. 272)

  Grades 9-12

  Summary: Students actively participate in the legislative process.
  Subject Areas: Social Studies, Environmental Education, Language Arts
  Standards Addressed:
  Activity Time: Five 30 minute sessions

- "Back from the Brink" (WILD pg. 355)

  Grades 9-12

  Summary: Students are given background information on the recovery of wildlife species, and they are asked to analyze the issues and make recommendations for their resolution.
  Subject Areas: Science, Language Arts, Social Studies, Environmental Education
  Standards Addressed:
  Activity Time: Three 45 minute sessions

- "I Propose…!" (Alaska's Wildlife pg. 179)

  Grades 9-12

  Summary: Students will explain how regulations are created through the Board of Game process.
  Subject Areas: Government & Citizenship, Social Studies, Language Arts
  Standards Addressed:
  Activity Time: Four 50 minute sessions

- "Wildlife Conservation Conference" (Alaska's Wildlife pg. 92)

  Grades 10-12

  Summary: Students give oral presentations on specific species of Alaskan wildlife, including the life history, population and trend, range, habitat requirements, adaptation strategies, field signs, local uses and stories.
  Subject Areas: Science, Geography, Language Arts, Technology
  Standards Addressed:
  Activity Time: Two 50 minute sessions

Possibilities for Forest Service Interactions

Jennifer MacDonald - Recreation Planner 828-3303 jennifermacdonald@fs.fed.us

Jennifer is relatively new to the Island, and brings a great deal of energy and enthusiasm to her work. She is responsible for developing, planning, and implementing plans for recreational areas such as trails, campgrounds, and picnic areas. She is also responsible for the cave tour program at El Capitan Cave and wilderness management for the Thorne Bay Ranger district's wilderness areas.

- Presentations
    - Leave No Trace/Tread Lightly Ethics
    - Wilderness Education
    - Outdoor Survival Skills
- Other Resources

Melanie Slayton - Realty Specialist 828-3201 mslayton@fs.fed.us

Melanie is the realty specialist for the Thorne Bay Ranger District. Her job includes special permit administration, minerals administration, and land use issues. She would be a great resource for information on a relatively unknown or often overlooked part of the Forest Service.

- Other Resources

See Employee Listing on Page 62 for a more detailed list of available Forest Service employees.

Community Action Plan

Community Action Planning

One of the biggest challenges facing citizens today is their ability to feel like they are making a difference. Having students develop a plan, and take action on an issue that they have interest in will give them the necessary skills, experience, and confidence to be able to take effective action in the future; on any issue in their lives, not just in the environmental realm.

The following is an outline of the steps needed in taking effective environmental action. You can give the students as much freedom as you want in choosing an issue or you can give them a list to choose from. Action plans can be done individually, although it is usually more effective in small groups, as a class or even as a whole school project. The more people involved, the more action that can be taken!

<u>Brainstorming</u> The first step to taking effective action is gathering a list of ideas for all the issues/topics that are of interest to the individual or group for investigation. They should be pertinent to the area. A few good places to look for issue ideas are:

- Environmental issues books
- Internet searches
- What can be seen in your community?
- Talking with people in the area
- Others…

<u>Issue Development</u> Put your issue topic into question format. Make sure that there is actually an issue to be addressed in the question, that it is feasible for the group, that it is a current, and it is specific enough to see results in the time frame available to work in. The goal of the action plan should be to answer the question from many different angles, through many different actions.

Examples of well-developed issue questions:

- How can the community of _________ improve its recycling program?
- What actions can be taken to reduce the amount of waste that is produced in our school?

<u>Initial Investigation</u> After selecting an issue of interest from the brainstorming list and putting it into question format, do a little research on the sides of the issue and the background of it. Do this as a neutral party. Here are some questions that should be addressed:

- Who are the players(the people/groups involved)?
    - o What are their values and beliefs on the issue?
      (see chart on pg.)
- What is the background of the issue?
    - o Scientific/Environmental (could you use data that you will gather during the year?)
    - o Political
    - o Social/Economic
- What actions have been taken in the past? (if any?)
    - o Have they been successful? Why or why not?

Why is this issue important? …on an individual to international level? How does it affect you…as individuals? your families? your school? your community?

Community Action Planning

What can be done? Develop a list of actions that could be taken on an individual to large scale. The most effective action includes a variety of types of action, most of which can be divided into these main categories.

- Persuasive – convincing others, using the information that you have gathered, that a certain idea or action is correct (signs, talking to people, videos, flyers, speakers etc…)
- Consumerism – buying or not buying something to make a statement or support a belief (boycotting and item, buying organic food, buying items with little packaging, etc…)
- Political Action – stating views to groups with decision-making powers(at any level; school boards, town boards, state, national) trying to convince them to take a certain action. (Letter-writing, emailing, presenting at meetings, hosting a discussion, lobbying….etc.)
- Education – Informing others about the issue (talking to people, brochures, educational booths, discussions, etc…)
- Eco-management – taking physical action to improve the environment (planting native plants, removing non-native plants, river clean-ups etc…)

What will you do?

Select an action or actions that you/your group would like to take for this issue.

- What are the advantages and disadvantages of each?
- Which ones will have the most impact and will fit into budget and time constraints?
- What ones are you most excited about or interested in?

Develop a timeline for taking these actions. (See pg. ____ for data chart)

- When will action be taken?
- Who is in charge of this action?
- What are the materials/resources needed?
- Who will be involved? How many people will be reached?

Take Action! Get out and take the action that you have planned and worked on for so long! Have fun but make sure it is safe! You are making a difference!

Evaluation This is one of the most important steps in the process…finding out how effective you were in your actions and what you could do better if you decide to take further action. Sum it all up!

- Do you feel that you were effective through the actions that you took?
- What could you have done to be more effective?
- What were the most challenging things about this project?
- What did you enjoy the most about this project?
- What is the future of this project? Will you continue any aspects of it?
- What did you learn from this project?

The following pages are supplements, worksheets & examples for carrying out an action plan with your students.

Issue:

Players (the people involved)	Values (What do they view as important to them?)	Beliefs (What do they believe to be true about the issue?)	How can they help?

Student Page - Action Timeline

Issue:

Actions	Date(s) Completed By	Who is responsible?	Location	Materials Needed

Resources & Ideas

The following is a list of resources that can be used to supplement the Watershed Health Education Program. Everything from other programs, names & numbers of people, web-sites, books, etc… are listed here. This list is not all inclusive! There are many other valuable resources out there that are not listed here!

LINKS

Great directory of environmental websites for kids! http://www.ivyjoy.com/rayne/environmental.html
Great directory of environmental websites for teachers! http://eelink.net

AGENCY AND PROGRAM WEBSITES

Alaska Dept of Fish & Game

Home-page: www.state.ak.us/adfg/ Good source of local wildlife education projects.
Teachers Resources Web-page: www.sf.adfg.state.ak.us/Region2/ie/Teacher_Resources/html/teachres.htm
Curriculums, standard correlation, fact sheets, teacher training info, student pages...more information than can be listed! It is also well organized and easy to use.
Alaska's Water Watch Program: www.state.ak.us/adfg/sportf/geninfo/aq_ed/awwstml/awwmn1.htm
Good source for stream monitoring program and information.
Alaska Department of Environmental Conservation: www.state.ak.us/dec/home.htm

Alaska Natural Resource and Outdoor Education Association (ANROE)

Home Page: www.anroe.org
Directory of Environmental Educators in Alaska: www.anroe.org/EE%20Directory%20Frames.htm
Aquatic/marine Resources: www.anroe.org/SMCNWS/aquaticcurr.htm
Projects, guides, extra information.

Forest Service

Home Page: www.fs.fed.us
Kid's interactive web-page: www.fs.fed.us/kids/
Direct students here for more "forest based" activities.

Other Projects & Programs

Adopt-A-Watershed Program: www.adopt-a-watershed.org/ A program option for water monitoring.
Alaska Watershed Stewardship Program: www.uaf.edu/coop-ext/landresources/watershed/
A program option for water monitoring.
South East Alaska Discovery Center: www.fs.fed.us/r10/tongass/districts/discoverycenter/index.html
Discovery Southeast Program: www.discoverysoutheast.org Great site for local resources
A River Runs Through Us: www.cnr.usu.edu/bearrivered/ Good example of a well developed watershed program.
Copper River Watershed Project: www.copperriver.org/
United States Geological Survey wwwga.usgs.gov/edu/

ADDITIONAL TEACHING RESOURCES

EE-Link: Great all around source for any environmental education information that you would want to find. Curriculum guides & evaluation, networking opportunities, web and book resources, organizations and programs...tons of quality information! http://eelink.net/

Environmental Education Station: Good resource for intotmation on today's hottest enviornmental issues. http://web.centre.edu/enviro/

Education for Sustainable Development Toolkit: Good, in-depth resource on sustainable living and developing a community action plan. http://www.esdtoolkit.org/

The Electronic Naturalist: A new on-line education program providing a weekly environmental education unit. Each unit has artwork, text, activities, additional web sites, plus online access to a professional naturalist. http://www.enaturalist.org/

CONTACTS

Alaska Department of Fish & Game: Able to provide additional educational resources, speakers and other programs. Great resource for information on South East Alaska!

Wildlife Education Specialist: Kristen Romanoff (907-465-4148) 1255 W. 8th Street, Juneau AK 99802

Aquatic Education Specialist: Jon Lyman (907) 465-6186 P.O. Box 25526 Juneau, AK 99802

In charge of the Alaska Water Watch Program

Southeast Alaska Discovery Center: Other conservation education bins available for use. Also great place to go on a field trip! Receptionist (907) 228-6220 or Leslie Swada (907) 228-6247, Southeast Alaska Discovery Center, 50 Main Street, Ketchikan, Alaska 99901

ORDERING PRODUCTS:

- **Acorn Naturalists:** Wonderful place for ordering all types of environmental educational materials…books, puppets, data collection tools, curriculum guides…etc.! http://www.acornnaturalists.com/store/
- **Ben Meadows** www.benmeadows.com
- **"CLEARING Magazine"** www.clearingmagazine.com
- **"Project Underground"** Cave and bat related information.
  "Learning to Live with Karst" www.AgiWeb.org
  American Cave Conservation Association Inc. www.cave.org
- **Forestry Suppliers** www.forestry-suppliers.com
- **Envision Environmental Education** A source for ordering ground water models.
  http://www.envisionenviroed.net/
- Create your own watershed kit https://secure-site.securesites.com/watershed_kit_order.html
- **EnviroMedia** - Good source for video series on many topics http://www.envmedia.com/index.htm
- **Alaska Wildlife Curriculum** activity guides "***Alaska's Ecology***", "***Alaska's Forests and Wildlife***", "***Alaska's Tundra and Wildlife***", "***Wildlife for the Future***" and the **"Alaska Ecology** Cards" can be ordered from:
  Wizard Works , P.O. Box 1125, Homer, AK 99603, (907) 235-8757

MAGAZINES

For Kids

"Elements" http://www.elements.nb.ca/kids/ (online)

"EEK!" http://www.dnr.state.wi.us/org/caer/ce/eek/ (online)

"Zoobook Magazine" www.zoobooks.com

For Teachers

"**Green Teacher: Education for Planet Earth"** A great resource for all types of classroom environmental education. Tips, other resources, lessons and activities, news articles. http://www.greenteacher.com/

"The Environmental Magazine" http://www.emagazine.com/

CURRICULUMS & ACTIVITY GUIDES:

- Project WET (grades K-12) www.projectwet.org
- Project WILD (grades K-12) www.projectwild.org
- Project WILD Aquatic www.projectwild.org
- Project Learning Tree (grades Pre-K—8) www.plt.org
- Alaska Wildlife Curriculum (K-12) http://www.state.ak.us/adfg/wildlife/geninfo/educate/awc.htm
- The Water Sourcebook (grades K-12) http://www.epa.gov/safewater/kids/wsb/
  Lesson plans are available online!
- Ocean Science Teacher Resource Center http://www.vims.edu/bridge/
  Ocean based lessons and activities

OVERALL ENVIRONMENTAL ED. WEBSITE FOR AK
Alaska Natural Resource & Outdoor Education Association http://www.anroe.org/

**Excellent Reference for Sustainable Living Sites – Basically covers all aspects.
http://condor.stcloud.msus.edu/~dmichael/eco/

WASTE & POLLUTION

- Reduce, Reuse, Recycle! All of these are important, sometimes reduce & reuse even more than recycling because individuals can do it! It is also important to remember that it is all a circle (encourage buying of recycled materials to create more of a demand for recycling!).
  - http://recycline.com/
  - http://www.ecomall.com/biz/recycle1.htm (also as cool "Recycling Facts" at bottom of page)
  - Lesson Plans Page…has thousands of Lesson Plans…here are a couple:
    - Lesson Plan on Taking action: http://www.lessonplanspage.com/more/tetodo.htm
    - Rate your lunch bag! http://www.lessonplanspage.com/more/ratealunchbagteacher.htm

- Littering It effects the beauty of the area, animals health, water quality, and even the economy because people don't want to visit a "dirty" looking area.

- Automobiles & Travel - Driving an automobile is the number one thing that individuals do to negatively impact the environment. Not only when they are driven but, also the natural resources they require, their manufacture, their life span, resources they need when in use (gas, oil, transmission fluid, tires, etc…), and what happens after they 'die'. Alternatives include: biking, walking, car pooling, buying a fuel-efficient car and making one trip to do multiple things.

- Water – What do we value it for? How do we impact it? How does it impact us? Travel, drinking and cooking water, watering plants, making things grow, fishing, the whole lifestyle of SE AK is based off of water! There are tons of options!
  - http://www.projectwet.org/
  - There are many joint sites with the Energy Websites

- Energy - Where does it come from? How much do you/your school use? Can you save money? There are many things that can be done to reduce energy consumption. Put on more layers instead of turning up the heat (or burning more wood) or keeping the heat low at night, turning off lights and appliances when not it use, unplugging appliances when not being used (they suck energy even though they aren't 'on'), hang laundry out to dry when possible, open windows instead of turning on air conditioning, use sunlight as much as possible for lighting and heat (there have been studies done that says this improves student performance),
  - http://www.uwsp.edu/cnr/wcee/keep/
  - http://www.eere.energy.gov/kids/
  - http://www.create.org.uk/
  - http://www.energy.gov/kidz/kidzone.html
  - http://www.ase.org/greenschools/
  - http://www.energy.gov/efficiency/
  - http://www.rmi.org/sitepages/pid468.php

- **Composting:** Easy to start at school with lunch scraps. Can be done inside or outside and be incorporated into a gardening program (which can be integrated into the organic & locally grown food idea). Reduces school waste…increases soil fertility and garden production when used!
  - http://cfe.cornell.edu/Compost/schools.html (for older kids)
  - http://yucky.kids.discovery.com/flash/worm/ (for younger kids)
  - http://www.toguide.com/stmatthewsumc/Garden/Compost/compost.html

HEALTH

- **Food:** Organic vs. Non-organic - and how it affects your health. Genetically Engineered foods. Farm/ gardening/lawn practices (factory farming, pesticide/herbicide application, etc…)
- **Personal Hygiene:** Cosmetics, shampoos, conditioners, lotion, soap and almost all "beauty products" we use have man-made chemicals in them. Over years of use these products can cause serious health problems. You can buy natural products or even make your own soap, chap-stick, or lotion. Also there have been many studies done on Feminine Hygiene products and there are some studies on severe health effects caused by bleach and other chemicals in tampons & pads.
- **Cleaning Products:** Many of today's cleaners have warnings on them of the toxin ingredients they have. Realize the residue that is left over after cleaning with these substances can have impact on air quality in the home and school and also effect water quality and anyone who touches the surface after it has been "cleaned". There are many recipes for cleaners out there that do just as good of job cleaning without the toxic side effects. Plus they are often cheaper!
  - http://www.cleaningrecipes.com/
  - http://www.americanhomeownersonline.com/rhu/courses/mini31008.cfm

ETHICS

- **Green Living:** What is it? It is not just the actions you take to lessen your impact on the environment but it is also the ethics & values behind those actions.
- **Leave No Trace:** An ethic for living lightly on the land while recreating in the out of doors.
  - http://www.lnt.org/

COMMUNITY

- **Aesthetics:** The quality of the environment around you can have big impacts on the quality of life that you live.
  - For example: Native vegetation in yards and on streets, planting trees (also improves air quality), recycling programs will reduce landfill space needed, communities will look more inviting and encourage visitors to stay (economic impacts).
- **Houses:** When building and remodeling homes a lot of money can be saved over the long run by installing features like passive solar heat (windows in the right placesJ), renewable sources of heat, water conserving faucets and shower heads, energy efficient light bulbs…

Class Projects

One way to integrate the EcoVan ideas into your everyday classroom with a little extra time & effort, is to decide on a class project in the beginning of the year and continue it throughout the school year. It can be small scale or large. and could also be continued year after year, creating some really wonderful, long-term projects for the school!

Here are some ideas:

- Set up a rain gauge and monitor the amount of rain your school site receive.** *
- Put a meter stick in a near by stream and record the rise and fall of water levels. (if another classroom is doing rain data...does your information have any relation to each other?)** *
- Do some research and announce weekly EcoTips or EcoFacts every week at your school. (Example: bring your lunches in a reusable container instead of throwaway materials)
- Pull exotic species along roads in you community (thistle, foxglove etc…)*
- Establish a partnership with Naukati school to compare contrast karst watershed and traditional watershed.*
- Enroll you class in the Adopt-A-Stream or Adopt-A-Highway Program.** *
- Pick up litter weekly on your school grounds.
- Start a recycling program.
- Start an Eco Newsletter to distribute to your school, the district or the community.
- Write articles about the EcoVan activities for the Island News.
- Start a compost program with school food scraps.
- Make a list of EcoGoals that you want to accomplish and accomplish them throughout the year. Keep track of your progress!
- Fundraise to get energy efficient light bulbs (or other ideas) installed in a public building.
- See if you can reduce the amount of __________(ie: energy, paper, waste, etc…) that is consumed in your school or class. Can you reduce the consumption even more over the course of the year?
- Start a school garden or greenhouse program.*
- Grow and plant native flowers in your community.
- Help with Forest Service revegetation projects.*

Summary: Develop a poster that brainstorms ways to conserve water in the classroom and home, add to the list throughout the year and implement the lifestyle changes.

The list could be much longer with a little more creativity. Let the kids brainstorm! Some of these projects could be integrated into a larger community environmental action plan or they could be the action plan your class selects (depending on the grade level and motivation of the students).

** These programs might be of use to state or national water monitoring programs. Check out the list of Resources on the previous pages for programs or agencies that might be interested. (ie: the Forest Service could be interested in the water quality data that students gather)

*FS employee may be available to help with this project.

Forest Service Employee Listing

Forest Service Interactions

A crucial part of the EcoVan program is making forest service employees available to teachers and students as educational resources. Forest Service employees can offer their expertise on specific subject areas, provide information about their chosen professions, and often serve as excellent examples and role models for students. Though many Forest Service employees are enthusiastic about environmental education, not all are comfortable giving formal presentations. Taking this into account, under each employees name is a description of their expertise and a list of the types of interactions they would like to be involved in. The interactions are broken down into three categories:

PRESENTATIONS

- Many employees are willing to give presentations on their areas of expertise, and some are even willing to create a presentation specific to what is being taught in your classroom at any given time. Please keep in mind that giving a presentation on a topic other than what is listed will require more preparation time for employees, and so they will need advance warning. **To schedule a presentation with an employee contact them directly or contact your EcoVan Coordinator.**

PROJECTS

- An important part of the EcoVan curriculum is getting students to be involved. One way to accomplish this is to have students participate in projects through Forest Service employees. There are several employees that have projects that students could participate in. As a part of these projects, students would actually be collecting usable data that employees often need to complete their own projects.

OTHER RESOURCES

- This category includes all the ways in which employees are will to be involved with students and education, without necessarily giving formal presentations. Some of these interactions could include the following:
  - **Email contacts** - employee may be willing to answer a student's, class's, or teacher's questions via email.
  - **One-on-one interviews** - employee willing to do one-on-one interview with a student
  - **Meeting with teacher** - is willing to answer questions over the phone, or in person
  - **Lending resources** - such as books, aerial photos, etc.
  - **Recommending further references** - other people, websites, films, books
  - **Making maps**
  - **Work study**
  - **Job shadowing**
  - **Other ideas**

☆ Whenever requesting any type of resource from a Forest Service employee please keep try to give them advance warning, and ample time. Also understand that education, though valued by employees, is not always included in their job description, and so they may not always be able to fulfill requests. ☆

Fish, Wildlife & Watersheds

Jim Beard - Fish Biologist 828-3209 jmbeard@fs.fed.us

Jim has worked in the fisheries field for over 20 years and would be a great guest speaker about any aspect of fish and their ecology, he's a real fishnerd! He also would be an excellent resource for a talk about watersheds and streams, and how we can impact watersheds. Jim can discuss the big picture with respect to aquatic environments, animals and watersheds. Jim also has experience teaching about marine biology, and is great with kids! Jim is available for:

- Presentations
  - **Aquatic Insects**
  - **Salmon and other Fish**
  - **Watershed Topics**
  - **Marine Mammals and Seashore animals and plants**
  - Various **Fish and Wildlife** topics
  - Other natural resource topics including careers in natural resources
- Other Resources

Susan Howell - Fish, Wildlife, Watershed Staff Officer 828-3263 smhowell@fs.fed.us

A long time Alaska resident, Susan's training and expertise is in the wildlife field but recently switched to management of fish and watersheds too. She would be a wonderful person to bring to your classroom to talk about the principles of fish, wildlife, and watershed management and restoration. She would also give a wonderful presentation on careers in the natural resource field and could give an overall view of what is happening on the Forest. Her creativity and excitement would also be of great benefit in selecting class projects. Susan is available for:

- Other Resources

Brandy Prefontaine - Fish Technician 828-3206 bprefontaine@fs.fed.us

Brandy was raised on Prince of Wales Island, and graduated from the Thorne Bay School. She is a great example of how you can start working in High School for the Forest Service and end up with a professional career. Working in the fish and wildlife shop, she has experience in both fisheries and hydrology. Her passion is plants, but she can also provide a wide array of presentations, projects, and general information from fish and aquatic insects, to native plant species.

- Presentations
  - **Plants** - Forest Gardening with Native Species: using native plant species to prevent erosion and beautify our forests.
  - **Aquatic Insects**
  - **Salmon**
- Projects
  - **Plants** - Students can participate in growing native plant species from seed, then planting them along roads, and other areas. This would be a great long-term project to participate in.
- Other Resources

Aaron Prussian - Fish Biologist 828-3225 aaronprussian@fs.fed.us

If you want a presenter who will tie all the aquatic components into the big ecosystem picture Aaron is the guy who can do it. From the small parts, like species of fish and aquatic invertebrates, to how what's in the landscape affects the stream, lake or river, to the impacts humans have on watersheds and how we depend on watersheds in our daily lives. Aaron has had experience working with students and has worked in AK for several years. He is a great role model for the students!

- Presentations
    - **Aquatic Insects**
    - **Salmon**
    - Various **Fish and Wildlife** topics.
- Other Resources

Katherine (KK) Prussian - Hydrologist 828-3222 katherineprussian@fs.fed.us

Hydrology wonder-woman for POW, KK is the gal to go to if you want a presenter on the basics of a watershed, how to map them, the physical properties of the water (ex: erosion, turbidity, pH, temp, precipitation and flow) and also how climate and weather affect a watershed. She is also the mastermind behind the watershed board (a creative way to show kids how ground cover, like forests & muskegs, effects the amount of water in streams & rivers). She is grew up in Southeast Alaska and has worked on the island for many years.

- Presentations
    - **Watershed Terminology**
    - **Watershed and Hydrology Process**
    - **Water Balance**
    - **Water Quality**
    - **Watershed Board**
- Projects
- Other Resources

Ray Slayton - Wildlife Technician 828-3261 raymondslayton@fs.fed.us

Looking for someone to talk about forest creatures? This is the guy to do it! From specific species, to habitats, to the neat things that happen on an island, to doing deer pellet surveys with the kids…the list goes on! Ray is a great resource for information on the wildlife aspects of ecosystems.

- Presentations
    - **Wildlife Management** - Second Growth Management for Wildlife Benefits
    - Other wildlife-related topics
- Projects
    - **Deer Pellet Surveys**
    - **Bird Surveys**
- Other Resources

Geology & Archaeology

Jim Baichtal - Geologist 828-3248 jbaichtal@fs.fed.us

Jim really knows his rocks! (and a bunch of other really cool stuff!) He is the island expert on karst and caves and is also involved with some really cool archeological digs! He has lived on the island for years and knows a lot about the history of what has happened here. Jim is an excellent resource to come into your classroom to teach or to just answer questions that you, as a teacher, may have.

- Presentations
    - * Various **Geological** topics
- Other Resources

Terry Fifield - Archaeologist 826-1642 tfifield@fs.fed.us

Terry Fifield is the Forest Service Archaeologist for Prince of Wales Island. He and his family have lived in the Craig and Klawock area since 1994. As the island's archaeologist for the past 11 years Terry has been involved in discovery of the Thorne River Basket (6,000 year-old spruce root basket), archaeological investigations at On Your Knees Cave (site of discovery of the oldest know human remains in Alaska), the Coffman Cove Community Archaeology Project, numerous Native American Rock Art recording efforts, and a variety of other projects. He has a special interest in working with schools and tribes to promote a conservation ethic in the study of past cultures in Southeast Alaska. Terry brings a crucial human and cultural aspect to science, and works exceptionally well with kids!

- Presentations & Field Trips
    - * Various **Archaeological** topics
- Other Resources

Timber & Silvicutlture

Kristen Lease - Forestry 828-3260 kristenlease@fs.fed.us

Kristen has been a Forester in Southeast Alaska for about 3 years, in both Wrangell and Thorne Bay. She has been working in the natural resources field since she was 15; working on trail crews, as a wilderness ranger, doing forest inventory, and fighting wildland fires. As a Forester she works laying out and cruising timber sales, and writing the timber sale contracts. From forestry techniques and studies, to how forestry practices impact watersheds and how the FS works to lessen the impact, Kristen would do a wonderful job in portraying the facts to the kids.

- Presentations
    - * Various **Forestry** Topics, including: Tree Aging, Tree Measurements, Tree and Plant ID, Timber Uses, Special Use Forest Products, Logging interactions with the ecosystem.
- Other Resources

Timber & Silvicutlture (cont.)

Pat Tierney - Forestry 828-3216 pjtierney@fs.fed.us

Pat is a forester with training in silviculture and forest ecology. He has worked for the Forest Service for 25 years. Pat is passionate about environmental education, and is excited to be available as a resource to teachers and students.

- Presentations
    * Silvicultural and forestry related topics: forest ecology, second growth management
    * Tree ID
- Other Resources

GIS & Planning

Marlin (MG) Day - GIS/Planning 828-3217 mday@fs.fed.us

Marlin is incredible in developing computer maps that contain an array of information. He would be the guy to talk to about developing a map of your local watershed or teaching kids about the GIS program. He could also go into land use planning and the considerations that are taken when planning on where to put a road, buildings or other developments.

- Other Resources

John Stevens - GIS/Planning 828-3218 jhstevens@fs.fed.us

John is also an amazing resource for developing computer maps as well as aerial photos. He would be another person to talk to about developing a map of the area surrounding your school that could contain a wide array of information, from local fish streams to timber harvest areas.

- Other Resources

Engineering

Dale Fife - Engineer 828-3255 dfife@fs.fed.us

Dale is a long time Thorne Bay resident. He works as an engineer for both the Thorne Bay and Craig Ranger Districts. The engineering crew is responsible for locating, designing, and building all Forest Service Roads, recreational sites, buildings, and much much more. They also have excellent surveying and drafting skills. His skills and personality make him a great contact for information about Forest Service engineers and what they do.

- Other Resources

Jason Johnston - Engineering 828-3258 jasonjohnston@fs.fed.us

Jason works as an civil engineer and has been in Thorne Bay a little over a year. Jason's background includes surveying, structural design, using AutoCAD, road location and design, trail design and construction, and bridge inspection. He would be an excellent contact for all sorts of information regarding engineering, and is great with kids!

- Other Resources

Recreation & Lands

Tory Houser - Recreation Planner 826-1614 vhouser@fs.fed.us

Tory is a recreation planner for the Craig Ranger District. She has worked on Prince of Wales Island. for about a year and a half. She is responsible for developing and implementing plans for recreational areas such as trails, campgrounds, cabins and picnic areas. Tory is also responsible for the interpretation and education program and wilderness management for Prince of Wales Island.

- Presentations
    - Leave No Trace/Tread Lightly Ethics
    - Wilderness Education
    - Outdoor Survival Skills
- Other Resources

Jennifer MacDonald - Recreation Planner 828-3303 jennifermacdonald@fs.fed.us

Jennifer is relatively new to the Island, and brings a great deal of energy and enthusiasm to her work. She is responsible for developing, planning, and implementing plans for recreational areas such as trails, campgrounds, and picnic areas. She is also responsible for the cave tour program at El Capitan Cave and wilderness management for the Thorne Bay Ranger district's wilderness areas.

- Presentations
    - Leave No Trace/Tread Lightly Ethics
    - Wilderness Education
    - Outdoor Survival Skills
- Other Resources

Melanie Slayton - Realty Specialist 828-3249 mslayton@fs.fed.us

Melanie is the realty specialist for the Thorne Bay Ranger District. Her job includes special permit administration (e.g. outfitter & guides), minerals administration (e.g. rock/dirt permits), and land use issues (on Forest Service property). She would be a great resource for information on a relatively unknown or often overlooked part of the Forest Service.

- Other Resources

Forest Fire Management

Harvey McDonald - District Fire Management Officer 828-3214 hmcdonald@fs.fed.us

Harvey has worked in Thorne Bay for about 20 years. He is the Fire Management Officer for the district, and would be an excellent resource for students. Harvey is well versed in fire safety and is great with kids!

Works Cited

Alaska Wildlife Curriculum
Alaska Wildlife Curriculum 2001
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Wildlife Education Coordinator
Division of Wildlife Conservation
333 Raspberry Rd.
Anchorage, AK 99518-1599
907-267-2168
robin_dublin@fishgame.state.ak.us

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Activity Listings

Ecosystem Health

Activities Listed Alphabetically

Activity Name	Source	Unit
"A House of Seasons"	Project Wet, pg. 155	What is a Watershed?
"A-maze-ing Water"	Project Wet, pg. 219	Human Impacts, Human Actions
"Animal Poetry"	Project Wild, pg. 282	Exploring Your Backyard
"Arctic Survival"	Project Wild, pg. 234	Exploring Your Backyard
"Back From the Brink"	Project Wild, pg. 355	Human Impacts, Human Actions
"Bird Song Survey"	Project Wild, pg. 406	Human Impacts, Human Actions
"Birds of Prey"	Project Wild, pg. 111	Exploring Your Backyard
"Branching Out"	Project Wet, pg. 131	What is a Watershed?
"Can Do!"	Project Wild, pg. 446	Human Impacts, Human Actions
"Choices & Preferences"	Project Wet, pg. 367	Human Impacts, Human Actions
"Color Me a Watershed"	Project Wet, pg. 223	What is a Watershed? Human Impacts, Human Actions
"Create and Destroy"	Alaska's Ecology, pg. 156	Human Impacts, Human Actions
"Drawing on Nature"	Project Wild, pg. 285	Human Impacts, Human Actions
"Dropping in on Deer"	Project Wild, pg. 420	Exploring Your Backyard
"Enviro-ethics"	Project Wild, pg. 445	Human Impacts, Human Actions
"Ethi-thinking"	Project Wild, pg. 303	Human Impacts, Human Actions
"Five Kingdoms But No King"	Alaska's Ecology, pg. 58	Exploring Your Backyard
"Flipbook Succession"	Alaska's Forests, pg. 172	Exploring Your Backyard
"Forest Ecosystem Scavenger Hunt"	Alaska's Forests, pg 117	Exploring Your Backyard
"Forest Food Web Game"	Alaska's Forests, pg. 105	Exploring Your Backyard
"Graphic Populations"	Alaska's Wildlife, pg. 113	Exploring Your Backyard
"Great Water Journeys"	Project Wet, pg. 246	What is a Watershed?
"H2Olympics"	Project Wet, pg. 30	What is a Watershed?
"Hooks and Ladders"	Project Wild Aquatic, pg. 43	Exploring Your Backyard
"Hot Water"	Project Wet, pg. 387	What is a Watershed?
"How Many Bears Can Live in This Forest?"	Project Wild, pg. 23	Exploring Your Backyard
"How Much Paper Do We Use?"	Alaska's Forests, pg. 199	Human Impacts, Human Actions
"I Propose…!"	Alaska's Wildlife, pg. 179	Human Impacts, Human Actions
"Imagine!"	Project Wet, pg. 157	What is a Watershed?
"Improving Wildlife Habitat in the Community"	Project Wild, pg. 440	Human Impacts, Human Actions
"Investigating Animals in Soil"	Alaska's Ecology, pg. 127	Exploring Your Backyard
"Investigating Animals in Water"	Alaska's Ecology, pg. 132	Exploring Your Backyard
"Investigating Birds"	Alaska's Ecology, pg. 140	Exploring Your Backyard
"Investigating Fungi"	Alaska's Ecology, pg. 119	Exploring Your Backyard
"Investigating Insects"	Alaska's Ecology, pg. 137	Exploring Your Backyard
"Investigating Mammals"	Alaska's Ecology, pg. 143	Exploring Your Backyard
"Investigating Monerans & Protists"	Alaska's Ecology, pg. 117	Exploring Your Backyard
"Investigating Plants"	Alaska's Ecology, pg. 121	Exploring Your Backyard
"It's Alive, Or is it?"	Alaska's Ecology, pg. 55	Exploring Your Backyard
"Know Your Legislation: What's in it for Wildlife"	Project Wild, pg. 272	Human Impacts, Human Actions
"Litter We Know"	Project Wild, pg. 434	Human Impacts, Human Actions
"Marsh Munchers"	Project Wild Aquatic, pg. 34	Exploring Your Backyard
"Migration Headache"	Project Wild Aquatic, pg. 15	Exploring Your Backyard
"Muskox Return to Alaska"	Alaska's Wildlife, pg. 154	Human Impacts, Human Actions
"Playing Lightly on the Earth"	Project Wild, pg. 432	Human Impacts, Human Actions
"Pond Succession"	Project Wild Aquatic, pg. 66	Exploring Your Backyard
"Rainy Day Hike"	Project Wet, pg. 189	What is a Watershed?
"River Talk"	Discovering a Watershed, pg. 37	What is a Watershed?

EcoVan Program Framework

Ecosystem Health

Activities Listed Alphabetically

Activity Name	Source	Unit
"Sea Turtles International"	Project Wild Aquatic, pg. 98	Exploring Your Backyard
"Seeing Watersheds"	Discovering a Watershed, pg. 4	What is a Watershed?
"Sparkling Water"	Project Wet, pg. 348	Human Impacts, Human Actions
"Spinning Yarn About an Ecosystem"	Alaska's Ecology, pg. 162	Human Impacts, Human Actions
"Stream Sense"	Project Wet, pg. 191	What is a Watershed?
"Sum of the Parts"	Discovering a Watershed, pg. 114	What is a Watershed?
"Super Sleuths"	Project Wet, pg. 107	What is a Watershed?
"The CEO"	Prject Wet, pg. 300	What is a Watershed?
"The Glass Menagerie"	Project Wild Aquatic, pg. 155	Exploring Your Backyard
"The Price is Right"	Project Wet, pg. 333	What is a Watershed?
"Too Close for Comfort"	Project Wild, pg. 300	Human Impacts, Human Actions
"Trees to Imagine"	Alaska's Forests, pg 84	Exploring Your Backyard
"Watching Your Waste"	Alaska's Ecology, pg. 159	Human Impacts, Human Actions
"Water in Motion"	Project Wet, pg. 450	What is a Watershed?
"Water Models"	Project Wet, pg. 201	What is a Watershed?
"Water Plant Art"	Project Wild Aquatic, pg. 31	Exploring Your Backyard
"Wetland Metaphors"	Project Wild Aquatic, pg. 39	Exploring Your Backyard
"What Makes an Ecosystem"	Alaska's Ecology, pg. 147	Exploring Your Backyard
"What's For Dinner?"	Project Wild, pg. 96	Human Impacts, Human Actions
"When a Whale is Right"	Project Wild Aquatic, pg. 94	Exploring Your Backyard
"Whose Problem is it?"	Project Wet, pg. 429	Human Impacts, Human Actions
"Wildlife Conservation Conference"	Alaska's Wildlife, pg. 92	Human Impacts, Human Actions
"Wildlife is Everywhere"	Project Wild, pg. 51	Exploring Your Backyard
"Wildlife Research"	Project Wild, pg. 418	Exploring Your Backyard

EcoVan Program Framework

Ecosystem Health

Activities Listed by Unit

Activity Name	Source	Unit
"Color Me a Watershed"	Project Wet, pg. 223	What is a Watershed?
"A House of Seasons"	Project Wet, pg. 155	What is a Watershed?
"Branching Out"	Project Wet, pg. 131	What is a Watershed?
"Great Water Journeys"	Project Wet, pg. 246	What is a Watershed?
"H2Olympics"	Project Wet, pg. 30	What is a Watershed?
"Hot Water"	Project Wet, pg. 387	What is a Watershed?
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EcoVan Program Framework

Ecosystem Health

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"Color Me a Watershed"	Project Wet, pg. 223	Human Impacts, Human Actions

EcoVan Program Framework

Ecosystem Health

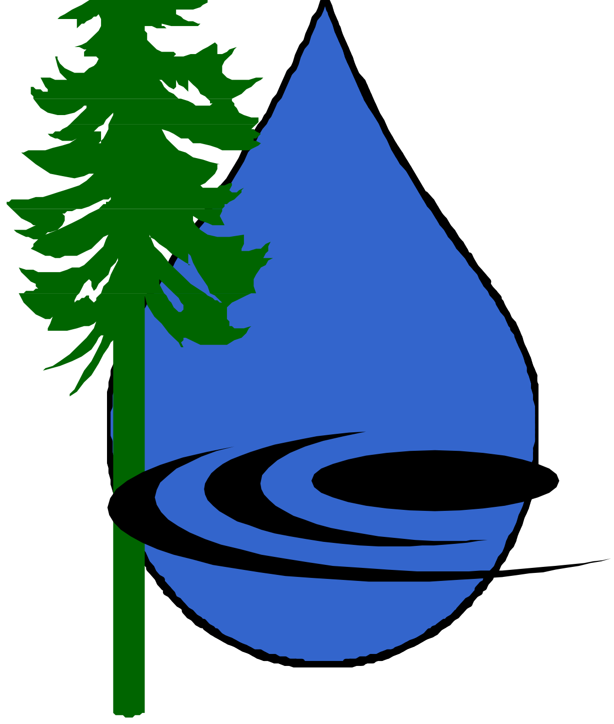
Activities Listed by Grade Level

Activity Name	Grade Level	
"A House of Seasons"	K-3	
"A-maze-ing Water"	K-12	
"Animal Poetry"	5-8	
"Arctic Survival"	9-12	
"Back From the Brink"	9-12	
"Bird Song Survey"	9-12	
"Birds of Prey"	9-12	
"Branching Out"	7-8	
"Can Do!"	9-12	
"Choices & Preferences"	7-12	
"Color Me a Watershed"	9-12	
"Create and Destroy"	4-12	
"Drawing on Nature"	5-8	
"Dropping in on Deer"	9-12	
"Enviro-ethics"	5-8	
"Ethi-thinking"	K-4	
"Five Kingdoms But No King"	1-6	
"Flipbook Succession"	4-8	
"Forest Ecosystem Scavenger Hunt"	5-8	
"Forest Food Web Game"	5-12	
"Graphic Populations"	6-8	
"Great Water Journeys"	7-12	
"H2Olympics"	4-8	
"Hooks and Ladders"	5-8	
"Hot Water"	9-12	
"How Many Bears Can Live in This Forest?"	5-8	
"How Much Paper Do We Use?"	K-6	
"I Propose…!"	9-12	
"Imagine!"	4-8	
"Improving Wildlife Habitat in the Community"	5-8	
"Investigating Animals in Soil"	4-12	
"Investigating Animals in Water"	4-12	
"Investigating Birds"	4-12	
"Investigating Fungi"	4-12	
"Investigating Insects"	4-12	
"Investigating Mammals"	4-12	
"Investigating Monerans & Protists"	4-12	
"Investigating Plants"	4-12	
"It's Alive, Or is it?"	3-12	
"Know Your Legislation: What's in it for Wildlife"	9-12	
"Litter We Know"	5-8	
"Marsh Munchers"	K-4	
"Migration Headache"	5-8	
"Muskox Return to Alaska"	4-9	
"Playing Lightly on the Earth"	K-4	
"Pond Succession"	5-8	
"Rainy Day Hike"	4-8	
"River Talk"	6-12	

Ecosystem Health

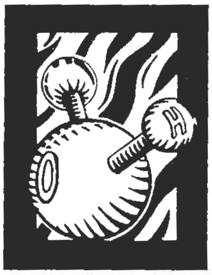
Activities Listed by Grade Level

Activity Name	Grade Level	
"Sea Turtles International"	9-12	
"Seeing Watersheds"	4-12	
"Sparkling Water"	7-12	
"Spinning Yarn About an Ecosystem"	K-12	
"Stream Sense"	K-6	
"Sum of the Parts"	4-8	
"Super Sleuths"	7-12	
"The CEO"	9-12	
"The Glass Menagerie"	9-12	
"The Price is Right"	9-12	
"Too Close for Comfort"	K-4	
"Trees to Imagine"	K-5	
"Watching Your Waste"	2-9	
"Water in Motion"	3-6	
"Water Models"	4-8	
"Water Plant Art"	K-4	
"Wetland Metaphors"	5-8	
"What Makes an Ecosystem"	3-6	
"What's For Dinner?"	5-8	
"When a Whale is Right"	9-12	
"Whose Problem is it?"	7-12	
"Wildlife Conservation Conference"	10-12	
"Wildlife is Everywhere"	K-4	
"Wildlife Research"	9-12	



Project WET

H_2Olympics



■ **Grade Level:**
Upper Elementary, Middle School

■ **Subject Areas:**
Physical Science, Mathematics

■ **Duration:**
Preparation time: 40 minutes
Activity time: 50 minutes

■ **Setting:** Classroom

■ **Skills:**
Analyzing (formulating questions, identifying components and relationships)

■ **Charting the Course**
Preceding this lesson, introduce the structure and behavior of the water molecule ("Molecules in Motion"). This activity can be done in conjunction with "Hangin' Together" to help students understand the forces that contribute to water's properties. This activity supports concepts presented in "Thirsty Plants," "Get the Ground Water Picture," "Let's Even Things Out," and "Aqua Notes."

■ **Vocabulary**
adhesion, cohesion, capillary action, surface tension

Can you make water defy gravity?

Summary

Students compete in a Water Olympics to investigate two properties of water, adhesion and cohesion.

Objectives

Students will:

- demonstrate adhesive and cohesive properties of water.
- relate adhesion and cohesion to daily activities.

Materials

- *Beaker or measuring cup with narrow spout*
- *Yarn (soaking wet)*
- *Container to hold water*
- *Colored water*
- *Music taped from the Olympics or other sports programs* (optional)
- *Copies of **H_2Olympics Score Sheet***
- *Water*
- *Paper and drawing materials*

To simplify setting up the activity, materials for each event are listed separately. (Each event requires water.)

Event 1

- *Clear plastic cups*
- *Two dollars in pennies*

Event 2

- *Eyedropper*
- *Penny*

Event 3

- *Boat pattern*
- *Stiff cardboard*
- *Scissors*
- *Soap chips* (shaved from a bar of soap)
- *Large aluminum trays*
- *Stopwatch*

Event 4

- *Paper clips*
- *Fork*
- *Magnifying glass*
- *Clear plastic cups*

Event 5

- *Several brands of paper towels*
- *Tall glasses*
- *Tape*
- *Ruler*
- *Scissors*

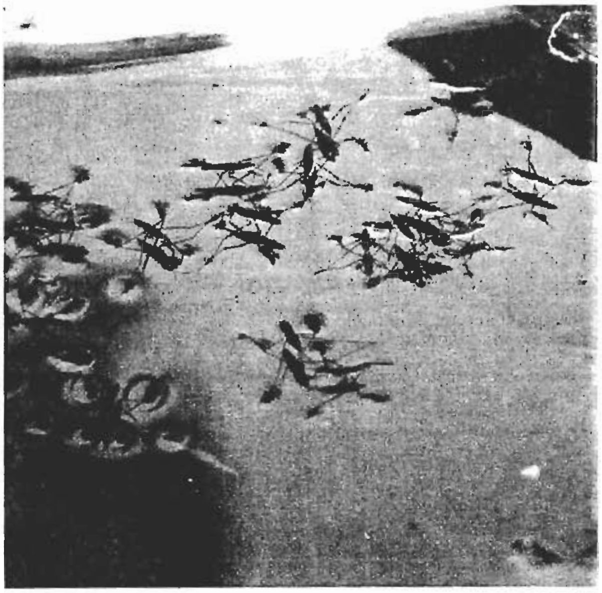
Making Connections

Students see signs of water's adhesive properties daily (e.g., water beading on the surface of a glass); however, they may not appreciate how unique this quality is. Learning how a water strider skates over the surface of water or how water travels upward through soil gives students opportunities to explore further the structure and behavior of the water molecule.

Background

The nature of the water molecule causes it to be attracted to other water molecules as well as to molecules of other substances. Without these qualities, plants could not get water, and blood would have difficulty traveling through the body. The attraction between water molecules is called cohesion. The attraction of the water molecule to other materials, like glass or soil, is called adhesion.

Evidence of water's attraction to itself can be seen by simply looking at its surface. If a glass is filled to the brim and more water is added gently, the level of the water will exceed the top of the glass. The cohesive force between water molecules causes the water surface to behave as though it is covered by a thinly stretched membrane that is always trying to contract. This phenomenon is



Water striders can skate on water because they do not break the surface tension. JENNIE LANE

called surface tension. In many ways, surface tension is like water's skin.

Water's surface is so strong it can even support paper clips and needles. Surface tension is important to the survival of many aquatic organisms, including insects. The water strider lives on the surface of fresh water. Compared to a piece of wood floating in the water, paper clips and water striders are not actually floating. Instead, they are held up by bonds between water molecules (see "Hangin' Together"). Floating objects do break the surface tension of water. They stay afloat because water molecules deeper in the water can support the weight of the objects.

Soap also breaks surface tension. For example, when a small piece of cardboard cut into the shape of a boat is placed on water, it will stay in one place. This is because water is equally attracted to all sides of the cardboard. When soap is placed at the back end of the cardboard boat, water molecules are still pulling at the front end of the boat, but not the back end. (The soap reduces the pull of water molecules on the back end of the boat.) This causes the boat to move forward. (An analogy would be a tug of war. The rope is the boat and the people pulling on each side are the water molecules. If several people on one end let go [representing the addition of soap], the rope [boat] would be pulled toward the opposite end.)

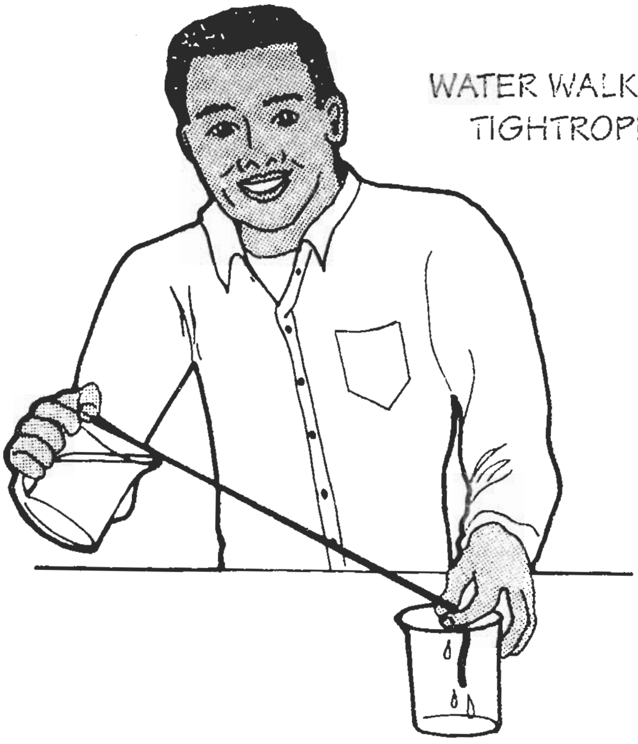
The same forces that cause water to be attracted to itself cause it to adhere to other substances. If this didn't happen, water would slide off everything like water off a duck's back.

Water appears to defy gravity as it moves up a paper towel, through spaces among soil particles, or along a piece of yarn at an angle to the ground. This is called capillary action and results from water molecules being attracted to molecules of the towel (or soil or yarn) and to each other. However, the molecules can only travel so far before the force of gravity overcomes the attraction of water to itself and to other molecules.

Procedure

▼ *Warm Up*

Show students a beaker partially filled with colored water, an empty container, and the yarn. Tell them that you are going to make water defy gravity as it "walks a tightrope" from the beaker to the container. Hold beaker and yarn as indicated in the illustration, *Water Walks a Tightrope.* Slowly pour the water down the yarn. (You might want to practice first!) Can students explain how water moves along the yarn? Tell them they will conduct a series of events that will help them understand this demonstration and other feats of water.



H_2Olympics Score Sheet

TEAM NAME: ______________________________ Date: ______________

Team member(s): ____

Event 1. Pole Vaulting: Over the Top!

Read the directions through before you begin this event. How many pennies do you think you'll be able to add before the water spills over? ______

Directions: Fill a clear plastic cup with water until it is even with the rim. Add pennies, one at a time. Keep track of the number of pennies added. Continue until the water spills over the side. Repeat for the other team member.

Describe or draw the surface of the water:

Number of pennies added,
team member 1: ______ team member 2: ______

Event 2. The Balance Beam: A Penny for Your Thoughts!

Read the directions before you begin this event. How many drops of water do you think you'll be able to put on the penny? _____

Directions: Using an eyedropper, place as many drops of water on the penny as possible without spilling over the edge. Keep track of the number of drops. Continue until water spills over or the water drop collapses. Repeat for the other team member. Record the scores.

Describe or draw how the water appeared on the penny before the drop collapsed:

Number of drops,
team member 1: _____ team member 2: _____

Event 3. Sculling: Bubble Power!

Directions: Cut out two boat shapes from a piece of cardboard (see pattern). In the rear of each boat, cut out a small notch. Place a soap chip in the notch of one boat. Place the boats in a tray of water and describe what happens.

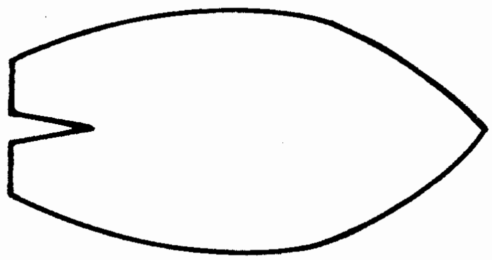
What caused the boat to move? (Hint: Place a drop of water on the table. What happens to it when you put a soap chip in it?)

Design a better shape for the boat so that it will move faster and in a straight line. Experiment with different shapes of boats, placement of the soap chip, and size of the soap chip.

Choose the best design and place the boat at one end of the tray at the start line. Time it until it crosses the finish line.

How long did it take to cross the finish line?

____



BOAT PATTERN

H_2Olympics Scoreboard

	EVENT 1 Pole Vaulting (number of pennies)	EVENT 2 Balance Beam (number of drops)	EVENT 3 Sculling (number of seconds)	EVENT 4 Backstroke (number of paper clips)	EVENT 5 Slalom (height)	
					1st Towel	2nd Towel
Team:						
Team:						
Etc.						

▼ *The Activity*

1. **Divide the classroom into sections; an Olympic event will take place in each area.** Banners can be designed to identify each event.

2. **Divide the class into small teams.** Each team should represent a body of water (e.g., the Atlantic Ocean team, the Columbia River team, the Lake Travis team, etc.). Begin the games with each team presenting its members to the class.

3. **Play the Olympics theme song. Tell students they will be participating in a Water Olympics to demonstrate some amazing feats of water.**

4. **Students complete the events in any order.** Directions for the events are on the *H_2Olympics Score Sheet*. Results should be recorded on their score sheets and on a scoreboard posted in the front of the room.

▼ *Wrap Up*

Have students compare the results of the different events. Ask them to explain the role of cohesion (water's attraction to itself) and adhesion (water's attraction to other materials) in each activity.

Remind students of the water walking the tightrope during the ***Warm Up***. Can they explain how water's attraction to the yarn and to itself keeps water from falling toward the ground? If water is poured too quickly, gravity will overpower water's cohesive and adhesive forces.

Have students develop a system to hand out medals to the winners of each event. Students should be encouraged to make sure each team gets some type of medal (include criteria such as teamwork, creativity, cooperation, etc.).

Assessment

Have students:
- demonstrate water's cohesive and adhesive properties (step 4).
- draw a picture of water moving along yarn or of a water drop and identify where adhesion and cohesion occur (***Wrap Up***).

Extensions

Students can investigate how soil absorbs water to explore adhesion and cohesion further. Challenge students to concoct a soil that will absorb the most water. Have students collect soil samples and remove excess water by leaving the samples spread out in the sun for about six hours. Instruct them to describe their soil recipe and why they think it will absorb water well. After the samples are dried, provide students with the following instructions:

- Use a cup with tiny holes punched in the bottom. Record the weight of the cup: ____. Fill the cup with your soil; pack it tightly. Record the weight of the cup and the soil, and subtract the weight of the cup. How much does the dry soil weigh? ____ Place the cup in a pan filled with a shallow layer of water. After thirty minutes, remove the cup from the water and carefully wipe excess water from the sides and bottom. Weigh the cup and soil and subtract the weight of the cup and dry soil. How much water did your soil absorb? ____

Compare the surface tension of other liquids. Using a magnifying glass, investigate drops of water, hydrogen peroxide, and alcohol. How do they differ? Can a paper clip be supported on the surface of each of these liquids?

Resources

Hurd, Dean, et al. 1988. *Prentice Hall Physical Science*. Englewood Cliffs, N.J.: Prentice Hall, Inc.

Lamb, William G., et al. 1989. *HBJ Physical Science*. Orlando, Fla.: Harcourt Brace Jovanovich, Inc.

Watson, Philip. 1982. *Liquid Magic*. New York, N.Y.: Lothrop, Lee & Shepard Books.

Event 4. Backstroke: Clipping Along!

Read the directions before you begin this event. How many paper clips do you think your team can suspend on the surface of water?

____

Directions: Try placing a paper clip on the surface of water. (Hint: Lay the paper clip on the prongs of a fork and lower it into the water.) Use a magnifying glass to observe the surface of the water where it comes in contact with the paper clip. Draw a picture or describe what this looks like.

____

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____

See how many paper clips you can suspend on the water's surface. Repeat for your other team member.

Number of paper clips suspended on the surface of water,

team member 1: _____

team member 2: _____

Event 5. Slalom: Weaving In and Out!

Directions: Cut out strips of two brands of paper towels—one you think will absorb the most water and one you think will absorb the least. Explain your reasoning.

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Tape one end of each towel to the middle of a pencil. Lay the pencil on top of a tall glass. Figure out how much water will need to be added to the container to immerse the ends of the paper towels ½ inch (1.5 cm) into the water. Remove the towels, fill the container to that level, and put the towels back in. Let the paper towels absorb water until the water stops rising. Use a ruler to measure the height absorbed above the water for each towel.

Height for first towel: ______

Height for second towel: ______

COPY

Super Sleuths

Grade Level:
Middle School, High School

Subject Areas:
Health, Life Science, Geography

Duration:
Preparation time: 50 minutes
Activity time: 50 minutes

Setting: Classroom

Skills:
Organizing (matching, recording); Analyzing (inferring, determining cause and effect); Interpreting (drawing conclusions)

Charting the Course
A similar sleuthing activity is presented in "The Poison Pump," in which students identify the source of a cholera epidemic. "No Bellyachers" addresses how waterborne diseases spread and can be prevented. This activity can serve as an ice breaker. When two people who have the same disease meet, the facilitator provides them with the disease and its description.

Vocabulary
waterborne disease, epidemiologist, pathogen, bacterium, protozoan, virus, water treatment

If you like mystery and intrigue, this activity is for you.

Summary

Students learn about the diversity of waterborne illnesses and the role of epidemiology in disease control by searching for others who have been "infected" with the same water-borne illness as they have.

Objectives

Students will:

- identify the role of water in transmitting diseases.
- compare symptoms of several waterborne diseases.
- analyze the characteristics of environments that promote the transmission of these diseases around the world.

Materials

- *Symptoms of diseases* (Make at least 2 copies of the *Symptom Cards* pages; cut and put them into separate envelopes, one disease per envelope. Make sure the order of *Symptom Cards* is different for envelopes containing the same disease. If more than 24 students in class, make extra sets. See illustration, page 110.)
- *Copies of Disease Descriptions*
- *Pencils and note pads* (optional)
- *World map*
- *Newspapers/magazines*

Making Connections

Students may remember news stories about contaminated water causing disease or recall camping when they purified lake or stream water by boiling it. Some students may know that waterborne diseases are the number one killer of children worldwide. Learning about all the diseases that could be contracted through contaminated water helps students gain an appreciation for clean drinking water.

Background

Waterborne diseases are those acquired through the ingestion of contaminated water. About 80 percent of all diseases are water-related. In many of these illnesses, water infiltrated with sewage spreads the disease. An infected person or animal may pass pathogenic bacteria, viruses, or protozoa through waste into the water supply.

The microorganisms that cause illness cannot be seen, smelled, or tasted; contaminated water often appears fresh and clear. This causes particular concern with municipal water supplies. Contamination may not be detected until a noticeable number of people have become ill.

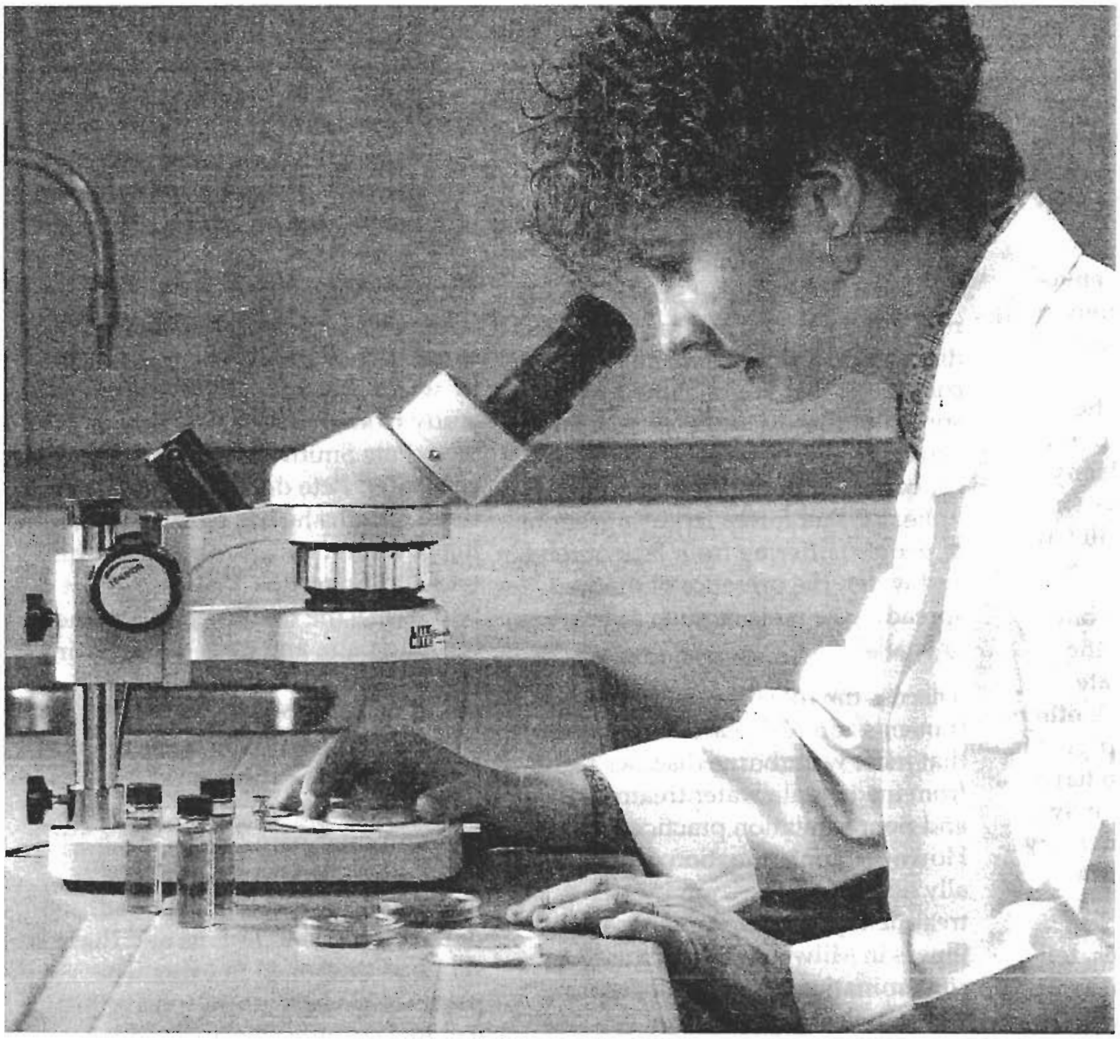
Most ailments caused by ingestion of water infiltrated with sewage are intestinal, causing gas, cramping, and diarrhea. Some pathogens (harmful microorganisms) attach to intestinal linings and produce toxic materials which the body then tries to purge. Others invade intestinal epithelial cells and cause inflammation but do not produce toxins. Fluids containing disease-fighting white blood cells are secreted into the intestine to aid in attacking or flushing the harmful organisms from the body. Unfortunately, this loss of fluids also causes dehydration, the major concern in patients with these types of diseases.

If the patient is very young, elderly, or malnourished, dehydration can be life-threatening. Children with diarrhea must be closely monitored. They have not developed the immunities of adults, and their systems can be quickly overwhelmed by the sheer number of pathogens. As many as one-third of pediatric deaths in developing countries are attributed to diarrhea and the resulting dehydration. Africa, Asia, and Latin America experience an estimated 3-5 billion cases of diarrhea, with 5-10 million deaths, each year. *Vibrio cholerae*, *Salmonella* sp., and *Shigella* species of bacteria are among the leading causes of bacterial diarrhea.

Bacteria are everywhere, including in our water. However, water supplies are monitored to prevent contamination by fecal pathogens in concentrations that will produce infections in humans. Water treatment facilities routinely test for these pathogens by checking levels of indicator bacteria, such as *Escherichia coli* (a common organism in our intestines). If these organisms rise above a set level, fecal contamination has occurred and more intensive water testing should begin. This does not mean other pathogens are present, but serves as an "indicator" that they may be. It may be necessary to accelerate water treatment procedures. Also, the source of contamination must be located and protective measures taken to avoid further contamination.

Until recently, Americans have regularly suffered through epidemics of waterborne illness such as cholera and typhoid fever. Improvements in wastewater disposal practices and the development, protection, and treatment of water supplies have significantly reduced the incidence of these diseases. The treatment and chlorinating of municipal water have made infection by microorganisms rare in developed countries; however, in many developing countries treatment of wastewater is minimal or nonexistent. In some cases, sewage and other wastes are dumped directly into rivers that are used by people downstream for drinking and washing.

Epidemiologists study the incidence, transmission, distribution, and control of disease. When outbreaks of a particular disease occur, epidemiologists research symptoms, incidence, and distribution of the cases; they try to determine the cause of the disease, its means of spreading, and possible methods for controlling or preventing the illness. With waterborne diseases, determining how the water supply was contaminated is critical to solving the problem. The case histories of affected patients and any associations among patients help epidemiologists solve the mysteries of disease.



Epidemiologist studying bacteria cultures. COURTESY: HACH COMPANY

Procedure

Warm Up

Ask students if they can identify the world's number one killer. Explain that thousands of children die each year from diarrhea. Tell students that diarrhea is caused by microorganisms such as bacteria, viruses, and protozoa. What do students think is the source of these organisms?

Show students two glasses of water: one murky due to sediment, the other clear—but possibly containing pathogens. Ask them, "Which glass of water would you prefer to drink?" Make the point that disease-causing organisms can be found in clear, "clean-looking" water.

The Activity

1. **Tell students that, like epidemiologists, they are going to compare symptoms and mode of transmission of diseases that they and a few others in the class have "acquired."**

2. **Hand out the symptom envelopes and *Disease Descriptions*, one to each student.** Students will consider symptoms, who was infected, and the site of infection, attempting to find others in the class who have the same illness. Many students in the class will have similar symptoms, but only a few will have the same disease.

3. **Direct students to select one card or clue randomly from the envelope. Have them circulate throughout the room and ask others about their symptoms. Their goal is to locate other students who have similar symptoms.** Students may take notes or this may be a memory exercise. Students can have fun acting out certain symptoms.

4. **After one or two minutes, tell students to remove a second symptom card from their envelopes. They should continue to search for others with the same illness.** Continue this process until all clues have been removed from the envelopes and everyone has found at least one other person sharing the same waterborne disease.

Wrap Up and Action

Reading their list of symptoms to the class and reviewing *Disease Descriptions*, students should identify their illnesses. Have them infer how they contracted the disease, how the disease was transmitted, and how it can be prevented. Discuss the control cards; these cards describe conditions that are not related to waterborne diseases. (For example, the person was tired in the late afternoon because he or she worked long days, and the pain and rattling in the chest were likely caused by smoking.)

Students may conduct research to confirm their answers and to investigate where these diseases occur throughout the United States and the rest of the world. They can plot their diseases on a world map and discuss conditions that might allow for the spread of these diseases (e.g., inadequate water treatment systems, concentrated population, political upheaval that forces large migrations of people suffering from lack of food and water, the presence of disease-spreading organisms such as beavers or snails).

Discuss the role of water in the transmission of disease. Emphasize that most waterborne diseases result from inadequate water treatment and poor sanitation practices. However, contamination occasionally occurs despite sound water treatment practices. An outbreak of illness in Milwaukee was caused by contamination of the city's drinking water with *Cryptosporidium* sp. This outbreak was particularly disturbing because modern filtration systems were not effective; that is, the organism was so small it passed through the filters. Discuss cases of hikers and travelers becoming ill after consuming water they thought safe. Stories or films may be available on these subjects. Discuss how the cause and transmission of disease are studied by epidemiologists.

Assessment

Have students:

- describe the symptoms of several waterborne diseases (step 3 and ***Wrap Up***).
- relate how some waterborne diseases are transmitted (***Wrap Up***).
- analyze conditions that promote the spread of waterborne diseases (***Wrap Up***).
- research the occurrence of diseases and plot their locations on a world map (***Wrap Up***).

Extensions

Some chemical contaminants that cause illness can also be transmitted by water. Read the following case study to students.

Pete Smith is a 40-year-old carpenter. Pete does not smoke. For three months he has been complaining of numbness and tingling in his toes and fingertips. Within the last two weeks the tingling has become a burning pain, and he is experiencing weakness in his hands when attempting to grip tools. He is generally in good health, but about four months ago he experienced three to four days of fever, cough, diarrhea, and muscular pain.

When he was examined, a doctor discovered that Pete had dark-colored skin lesions and that his skin had thickened in areas. The palms of his hands and soles of his feet had cornlike elevations. He was also found to be anemic (depleted of red blood cells, causing paleness, weakness, and breathlessness).

For ten years Pete has lived in the same house in an agricultural area, and his water comes from a well. He has been married for one year. His wife does not share his symptoms.

Ask students to speculate if Pete's illness is a waterborne disease. Have them cite reasons for their answers.

After a physician conducted numerous tests and studied Pete's family health history, Pete was found to be suffering from chronic arsenic poisoning. When Pete's well water was tested, it was found to contain high levels of arsenic. Arsenic can enter water from natural sources (such as arsenic-containing bedrock) or from arsenical pesticide runoff. (Pete's wife did not get ill because she had only lived in the area for one year, and frequently drank juice and other liquids instead of well water.)

Students may wish to research other illnesses associated with chemical contaminants and create clue cards. Another example is infantile methemoglobinemia, a.k.a. blue baby disease, which is caused by high levels of nitrates in water.

Resources

Craun, Gunther. 1986. *Waterborne Diseases in the United States*. Boca Raton, Fla.: CRC Press.

Craun, Gunther. 1990. *Waterborne Disease Outbreaks: Selected Reprints of Articles on Epidemiology, Surveillance, Investigation, and Laboratory Analysis*. Cincinnati, Ohio: Health Effects Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

Kroehler, Carolyn. 1990. *What Do the Standards Mean: A Citizens' Guide to Drinking Water Contaminants*. Blacksburg, Va.: Virginia Water Resources Research Center.

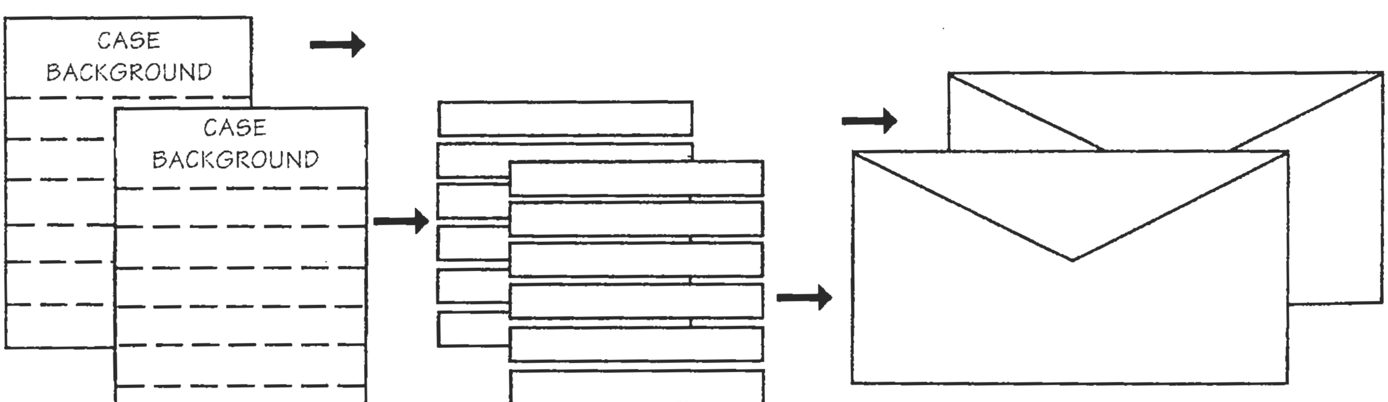
Rouech, Berton. 1953. *Eleven Blue Men and Other Narratives of Medical Detection*. Boston, Mass.: Little Brown.

U.S. Department of Health and Human Services. Agency for Toxic Substances and Disease Registry. 1990. *Arsenic Toxicity* (June).

Zinsser, Hans, Wolfgang Joklik et al., eds. 1992. *Microbiology*. Norwalk, Conn.: Appleton & Lange.

For information about occurrences of specific diseases within the United States and around the world, students can contact the Center for Disease Control, 1600 Clifton Road NE, Atlanta, GA 30333. (404) 639-3311.

INSTRUCTIONS FOR PREPARING SYMPTOM CARDS



Make two photocopies of each case background card (more for larger classes).

Cut each set of cards into strips along the dotted lines.

Put each set of case background strips into separate envelopes (exclude name of the disease) and hand out to students. (Be sure the case background strips are mixed up within the envelope.)

Common Waterborne Diseases and Symptom Cards

Typhoid fever, caused by *Salmonella typhi* bacteria.

Case background:

Symptoms occurred ten days after attending a family camp
Discovered that camp's sewage system was faulty and chlorinator was not functioning
Family reunion used same camp the previous week; two people attended who had recently recovered from typhoid fever.
Began feeling lethargic with general aches and pains
Malaise — general weakness and discomfort, and anorexia — loss of appetite
Developed high fever, became delirious
Tender abdomen with rose-colored spots on skin

Legionnaire's disease, caused by *Legionella pnuemophilia* bacteria.

Case background:

Chain smoker living in warm climate
Lives in a home that is constantly air conditioned during summer months
Sudden onset of fever that progressed to a high fever with shaking chills
Developed a cough and excessively rapid breathing
Pain in chest; lungs have rattling sound when breathing
General, diffuse muscular pain and tenderness
Intense headache and mental confusion

Cholera, caused by *Vibrio cholerae* bacteria.

Case background:

Recently returned from Bangladesh
Symptoms occurred two days after eating fruit thoroughly washed at outdoor pump
Family members have begun coming down with the same symptoms
Severe dehydration
Painless diarrhea, vomiting
Severe muscular cramps in arms, legs, hands, and feet
Eyes and cheeks appear sunken; hands have dish-washing appearance

COPY

Amebiasis, caused by *Entamoeba histolytica*, a protozoan.

Case background:

- Returned from Thailand two weeks ago
- Drank unbottled water
- Feverish
- General abdominal discomfort and tenderness, especially on lower right side
- Dysentery
- Tires easily, mental dullness
- Moderate weight loss

Enterotoxigenic *E. coli* gastroenteritis, caused by *E. coli bacteria*.

Case background:

- Just returned from visiting friends in Mexico
- Symptoms began 12 hours after drinking several swallows of water from a bucket pulled from a well
- Experiencing dehydration caused by diarrhea
- General, diffuse muscular pain and tenderness
- Low-grade fever
- Nausea, vomiting
- Abdominal cramps

Giardiasis, caused by the *Giardia lamblia* protozoan.

Case background:

- Symptoms occurred two weeks after backpacking trip
- Filled water bottle with clear, fresh-tasting water from a stream below a beaver dam
- Abdominal cramps
- Intermittent dysentery (which is greasy and odorous)
- Excessive intestinal gas
- Malaise — general weakness and discomfort
- Weight loss

Salmonellosis, caused by species of *Salmonella* bacteria.

Case background:

- Lives on a ranch that raises cattle and chickens
- Symptoms occurred 10 hours after drinking from pump outside of barn (ground water may have been contaminated by surface water in the pasture after heavy rain)
- Malaise — general weakness and discomfort
- Fever
- Dysentery
- Abdominal cramps
- Nausea and vomiting

Shigellosis, caused by species of *Shigella* bacteria.

Case background:

- Four years old
- Symptoms began 15 hours after bobbing for apples in pre-school class
- Severe abdominal cramps
- Frequent, painful dysentery
- Blood and mucus in stool
- High fever, chills
- Dehydration

Hepatitis A. caused by *Hepatitis A* virus.

Case background:

- Visited favorite beach and swam with friends
- Malaise — general weakness and discomfort
- Anorexia — loss of appetite
- Fever
- Nausea, mild diarrhea
- Jaundice — yellowing of skin and whites of eyes
- Sick for a week

Control Card. (Individual has no waterborne illness.)

Case background:

- Lives in an apartment in the city
- Chain smoker living in a warm climate
- Drinks tap water
- Pain in chest; lungs have rattling sound when breathing
- Visited favorite beach and swam with friends
- Recently visited an alligator farm
- Eats lots of fresh seafood

Cryptosporidiosis, caused by *Cryptosporidium*.

Case background:

- Four years old
- Attends a daycare center five days a week
- Diarrhea
- Nausea and vomiting
- Fever
- Sucks thumb
- Recently swam in a local pond

Control Card. (Individual has no waterborne illness.)

Case background:

- Lives on a ranch that raises cattle and chickens
- Just returned from visiting friends in Mexico
- Lives in a home that is constantly air conditioned during summer months
- Is tired in the late afternoon
- Often conducts pack trips in the mountains
- Works 14 hours a day, usually seven days a week
- Drinks eight glasses of water per day

Disease Descriptions

Typhoid fever, caused by *Salmonella typhi* bacteria.

(Now uncommon in the U.S., this is usually acquired during foreign travel. During the first half of this century it was the most commonly reported cause of waterborne disease in the U.S. It can be acquired by contact with contaminated water, swimming, etc. In 1907, Mary Mallon, nicknamed "Typhoid Mary," was identified as a carrier of the disease. She transmitted the disease while working as a cook in restaurants and private homes in New York City. She escaped authorities for eight years, but was finally apprehended in 1915. She infected some 50 people, with three cases resulting in death. In 1973 a major outbreak of typhoid fever affected 225 people in a migrant labor camp in Dade County, Florida. The well that supplied water to the camp was contaminated by surface water.)

Legionnaire's disease, caused by *Legionella pnuemophilia* bacteria.

(Found naturally in water environments; bacteria often colonize artificial water systems such as air conditioners and hot water heaters, and can be inhaled with aerosols produced by such systems. Smoking and lung disease increase susceptibility to disease.)

Cholera, caused by *Vibrio cholerae* bacteria.

(This disease is extremely contagious; if untreated, dehydration can lead to death. Cholera originated in Europe and was spread to the United States by transatlantic liners through New Orleans. It reached California through the forty-niners in their quest for gold. Recent outbreaks of cholera have occurred throughout the United States. Along the Gulf Coast, water and seafood were identified as contributing to the outbreaks. In Louisiana, undercooked crab was the culprit, and in Texas in 1981, people were infected by eating cooked rice that had been washed with contaminated water.)

Amebiasis, caused by *Entamoeba histolytica*, a protozoan.

(This disease usually occurs in tropical areas where crowding and poor sanitation exist. Waterborne outbreaks are now rare in the United States.)

Enterotoxigenic *E. coli* gastroenteritis, caused by *E. coli bacteria*.

(Leading cause of infant morbidity worldwide. Visitors to Latin American countries who partake of the food and water occasionally come down with "traveler's diarrhea," also known as "turista" or "Montezuma's Revenge." A large outbreak of this disease occurred in 1975 in Crater Lake National Park, Oregon. About 2,000 park visitors and about 200 park employees became ill after consuming water that had been contaminated by sewage.)

Giardiasis, caused by the *Giardia lamblia* protozoan.

(Sickness results with only a low dose of the protozoan; it is the most commonly reported causative pathogen of waterborne outbreaks. The giardia protozoan is killed by boiling water for at least five minutes or is removed by passing water through a filter whose pore size is at least 0.2 microns.)

Salmonellosis, caused by species of *Salmonella* bacteria.

(This is carried by humans and many animals; wastes from both can transmit the organism to water or food. The largest waterborne salmonella outbreak reported in the United States was in Riverside, California, in 1965 and affected over 16,000 people.)

Shigellosis, caused by species of *Shigella* bacteria.

(Most infection is seen in children 1-10 years old; a very low dose can cause illness. Waterborne transmission is responsible for a majority of the outbreaks.)

Hepatitis A. caused by *Hepatitis A* virus.

(Third most common cause of waterborne disease in U.S. The term hepatitis relates to inflammation of the liver.)

Cryptosporidiosis, caused by *Cryptosporidium*.

(This was first identified as a cause of diarrhea in people in 1976. It can be transmitted through contact with animals [particularly cattle and sheep], other humans [especially in daycare centers], and contaminated water supplies.)

Branching Out!

■ Grade Level:
Middle School

■ Subject Areas:
Earth Science, Geography

■ Duration:
Preparation time: 50 minutes
Activity time: two 50-minute periods

■ Setting: Classroom

■ Skills:
Organizing (mapping); Analyzing (contrasting and comparing); Applying (predicting); Evaluating (testing, critiquing)

■ Charting the Course
Prior to or in conjunction with this activity, students can investigate the role their schoolyard plays in a watershed in "Rainy-Day Hike." The concept of watersheds is explored further in "Just Passing Through" and "Color Me a Watershed." Students can investigate how drainage patterns influence human settlements and ecosystems in "Water Crossings."

■ Vocabulary
drainage basin, watershed, divide, tributary, runoff

Is it possible to cross the Mississippi River in one step?

▼ Summary
Students build a model landscape to investigate how water flows through and connects watersheds.

Objectives
Students will:
- predict where water will flow in watersheds.
- describe drainage patterns in watersheds.

Materials
- *Overhead transparency or copies of* ***Branching Patterns***
- *Blue-colored water*
- *Spray bottles or sprinkling cans*
- *Drawing paper and pencil*
- *Blue pencils*
- *Tracing paper or blank transparency sheets*
- *Copies of a local map showing rivers*

NOTE: In this activity students build a model of a watershed. This is presented as a class activity, but smaller groups of students can construct their own models. Students can build a temporary, simple model or a more durable version that can be used in subsequent activities. The materials for both are listed below.

Temporary model*
- *White scrap paper, newsprint, or butcher paper*

Permanent model
- *Papier-mâché materials* (strips of newspaper dipped in a thick mixture of flour and water)
- *Water-resistant sealer and white paint* (or white waterproof paint)

Both models will require:
- *5 to 10 rocks, ranging from 2 to 6 inches (5 to 15 cm) in height* (If groups of students are making their own models, each group will need its own rocks.)
- *Square or rectangular aluminum tray, large enough to hold rocks*
- *Plastic wrap* (Thick plastic wrap from a grocery or butcher shop works well.)

Making Connections
Children have watched water flowing down a street during a heavy rainstorm and may have asked: Where does all the water go? Viewing turbulent waters in a stream, students may have wondered: Where does all the water come from?

The pattern water makes as it flows through a watershed is familiar to students who have drawn pictures of trees or studied the nervous system. By investigating drainage patterns, students consider how watersheds distinguish different land areas.

Background
When the ground is saturated or impermeable to water during heavy rains or snowmelt, excess water flows over the surface of land as runoff. Eventually, this water collects in channels such as streams. The land area that drains water into the channels is called the watershed or drainage basin.

Watersheds are separated from each other by areas of higher elevation called ridge lines or divides. Near the divide of a watershed, water channels are narrow and can contain fast-moving water. At lower elevations, the slope of the land decreases, causing water to flow more slowly. As smaller streams merge together, the width of the channel

*TEMPORARY MODEL ADAPTED WITH PERMISSION FROM "FLOWING TO THE RESERVOIR: WHAT IS A WATERSHED?" *WATER WISDOM*. BOSTON, MASS.: MASSACHUSETTS WATER RESOURCES AUTHORITY.

increases. Eventually, water collects in a wide river that empties into a body of water, such as a lake or ocean.

From an aerial view, drainage patterns in watersheds resemble a network similar to the branching pattern of a tree. Tributaries, similar to twigs and small branches, flow into streams, the main branches of the tree. Streams eventually empty into a large river, comparable to the trunk. Like other branching patterns (e.g., road maps, veins in a leaf, the human nervous system), the drainage pattern consists of smaller channels merging into larger ones.

Watersheds are either closed or open systems. In closed systems, such as Crater Lake in southwest Oregon or the Great Salt Lake in Utah, water collects at a low point that lacks an outlet. The only way water naturally leaves the system is through evaporating or seeping into the ground. Most watersheds are open: water that collects in smaller drainage basins overflows into outlet rivers and eventually empties into the sea.

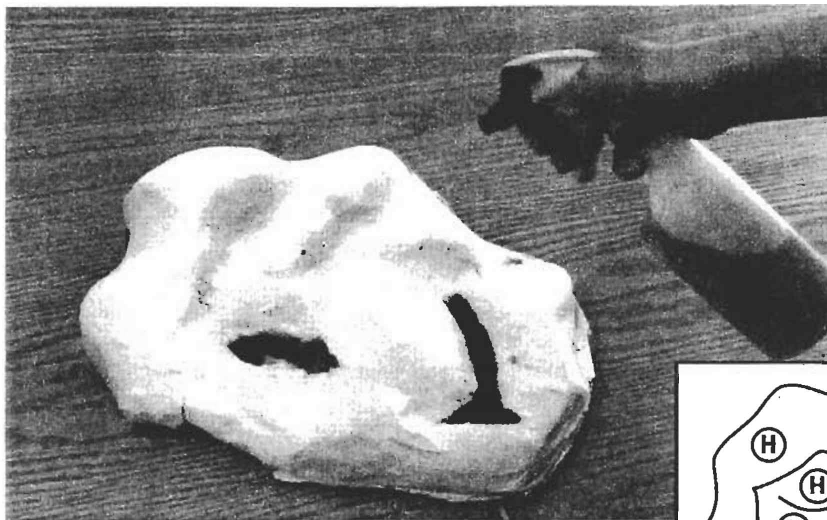
Procedure

▼ *Warm Up*

Show students copies or an overhead of *Branching Patterns* (the outlines of a watershed's drainage pattern, a tree in winter, the human nervous system, and a road map). Ask them what all the pictures have in common.

▼ *The Activity*

1. **Depending on whether a temporary or more permanent model is being built, have students do the following:**



Temporary model:

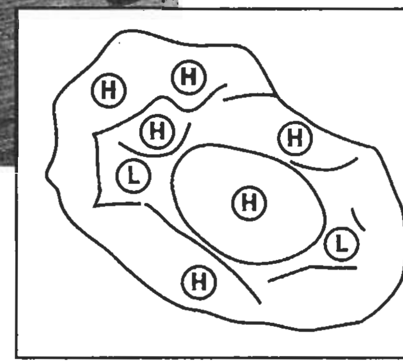
Instruct students to wrap rocks with white scrap paper and lay them in a square or rectangular aluminum tray. Place larger rocks near one end of the tray. Cover the rocks snugly with plastic wrap.

Permanent model:

Have students lay rocks in a square or rectangular aluminum tray, with larger rocks near one end. Snugly cover the rocks and exposed areas of the tray with plastic wrap. Apply strips of papier-mâché to cover the rocks. For a sturdier model, apply several layers of papier-mâché. When the mâché has dried, coat the model with waterproof sealant and white paint or waterproof white paint.

2. **Have students sketch a bird's-eye view of the model.** (See model sketch.) They should mark points of higher elevation with "H"s and low spots with "L"s. To identify possible ridgelines, connect the "H"s.

3. **Tell students that the model will soon experience a rainstorm. Where do they think water will flow and collect in the model? Have them sketch predictions on their drawings.** Show them crevices in the model and possible locations of watersheds.



4. **Spray blue-colored water over the model and note where it flows.** (See photo.) Water may need to be sprayed for several minutes to cause a continual flow. Assist students in identifying branching patterns as water from smaller channels merges into larger streams.

5. **Have students use blue pencil to mark on their drawings the actual branching patterns of water.** Some imagination and logic may be required. Ask them to confirm the locations of watersheds by noting where water has collected in the model.

6. **Have students determine if smaller watersheds overflow into larger ones.** Does all the water in the model eventually drain into one collection site (open watershed system)? Does the model contain several closed watershed systems (collection sites that lack an outlet)?

▼ *Wrap Up*

Have students place tracing paper or an overhead transparency over their drawings and draw the drainage pattern. Compare the traced lines to the branching patterns presented during the ***Warm Up*** and contrast with drawings of other students. Discuss how all the networks involve smaller channels merging together and becoming larger.

Provide each student with a copy of a local map. Have students locate streams and rivers and note where smaller rivers flow together or merge into larger ones. Ask them to encircle land areas they think drain into the rivers.

Have them pick one river on the map and follow its path in two directions. If all of the river is pictured, one direction should lead to the headwaters or source (where the line tapers off). In the opposite direction, the river will merge with another river or empty into a body of water.

Have students write a story or draw a picture about a local river. Have them describe how water moves to the river from surrounding land areas or tributaries and then flows to a larger body of water.

Assessment

Have students:

- predict where water will flow and collect in their watershed model (step 3).
- test their predictions and use the results to confirm or modify their projected drainage patterns (steps 4 and 5).
- compare the drainage pattern of watersheds to other branching networks, such as a road map, tree, or the human nervous system (***Warm Up*** and ***Wrap Up***).
- write a story about or draw a map of drainage patterns in their watershed (***Wrap Up***).

Extensions

Have children compare their drawings or stories to *Where the River Begins*, a story by Thomas Locker. In the book, two boys and their grandfather follow a river to its source.

If the model were a real land area, do students think the drainage patterns would be the same thousands of years from now? Have students consider the effects of natural and human-introduced elements (e.g., landslides, floods, erosion, evaporation, water consumption by plants and animals, runoff from agricultural fields or residential areas, dams).

Students may want to finish their models by painting landscapes and constructing scale models of trees, wetlands, and riparian areas. They may introduce human influences such as towns and roads. Natural and human-made environmental problems, such as landslides and erosion, could be incorporated into the design.

As in the game "Pin the Tail on the Donkey," blindfold students and have them randomly touch a point on a map of the North American continent, the U.S., or their state. Have students explain likely routes water would flow to that area.

Advanced students may want to make a topographic map of their model. Totally waterproof the model. Submerge it, 1/2 inch (1-2 cm) at a time, in water. At each increment, while viewing from above, trace the water level onto a sheet of glass or plastic covering the model.

K-2 Option

Have children focus on how smaller streams merge into larger ones. Gather pruned branches and let students investigate how the main branches "branch out" into smaller ones. If branches are not available, students can make a branching system out of pipe cleaners.

Help students imagine a drop of water flowing down the twig to the larger branches and finally to the main branch. Students can paint or decorate the branch and name the rivers. Into what body of water might the large river (the main branch) flow?

Relate the branch to a river flowing near or through the community. What smaller channels might feed into this river? Where do students think the water in the river goes? Help them to imagine the water flowing into a larger river and finally to a lake or to the sea.

Lead them in the following hand motions to represent small rivers flowing into larger rivers. A simple song about rivers can accompany the motions.

A babbling brook (hold arm in front of body and wiggle fingers) flows into a small river (place both arms together and wave them in a serpentine motion). The water from smaller rivers goes into a large river (have students merge together in a column) and travels to the sea or lake (students move to a place in the room designated as the sea or a lake and dance in the area like waves splashing about).

Resources

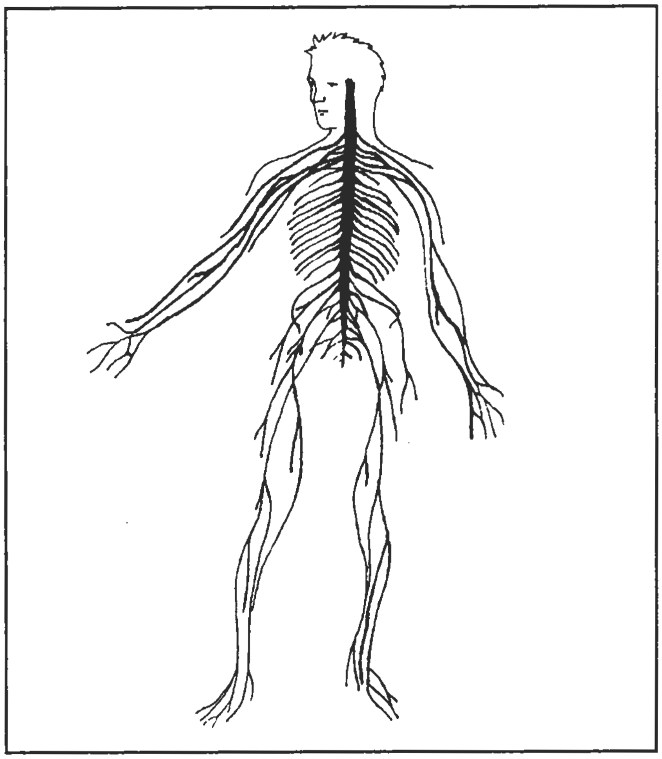
Coble, Charles, et al. 1988. *Prentice Hall Earth Science*. Englewood Cliffs, N.J.: Prentice Hall, Inc.

Holling, Clancy. 1941. *Paddle to the Sea*. Boston, Mass.: Houghton Mifflin Company.

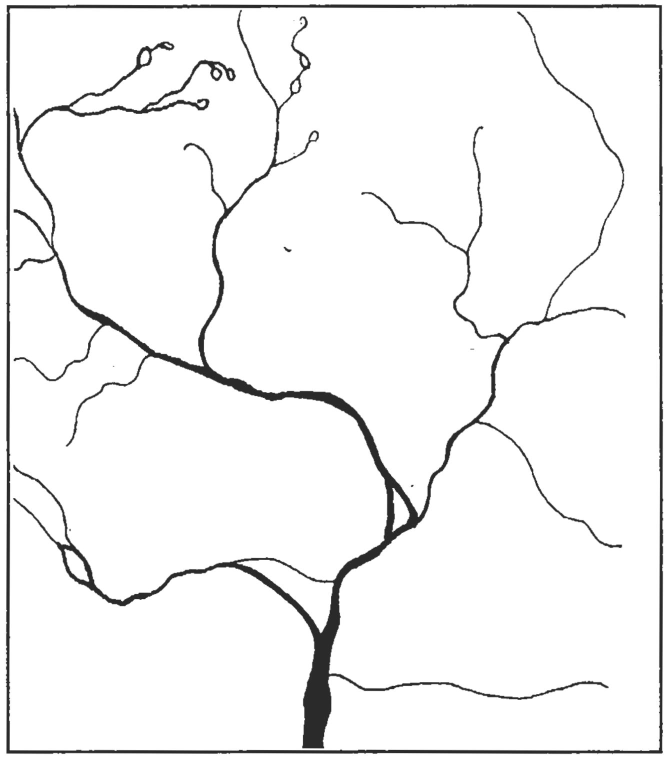
Locker, Thomas. 1984. *Where the River Begins*. New York, N.Y.: Dial Books.

Tresselt, Alvin. 1990. *Rain Drop Splash*. New York, N.,Y.: Morrow.

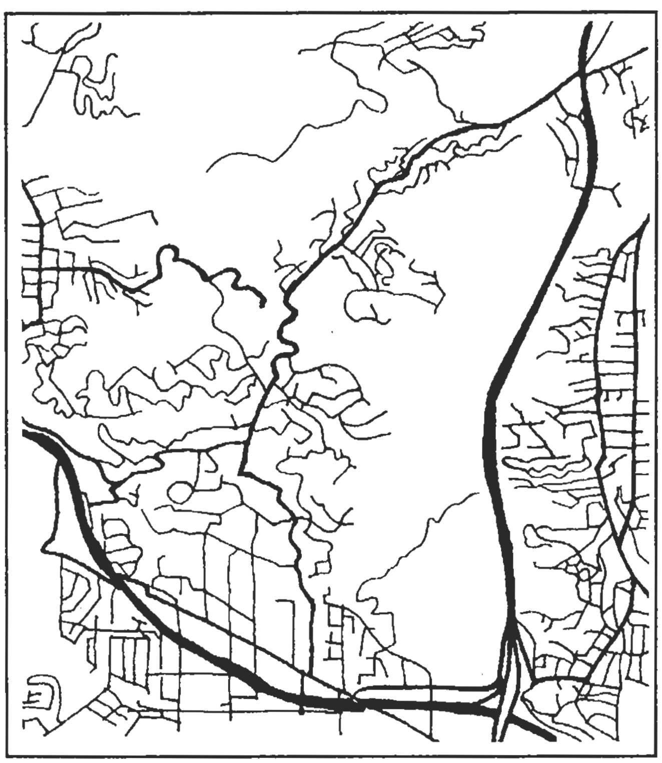
Branching Patterns



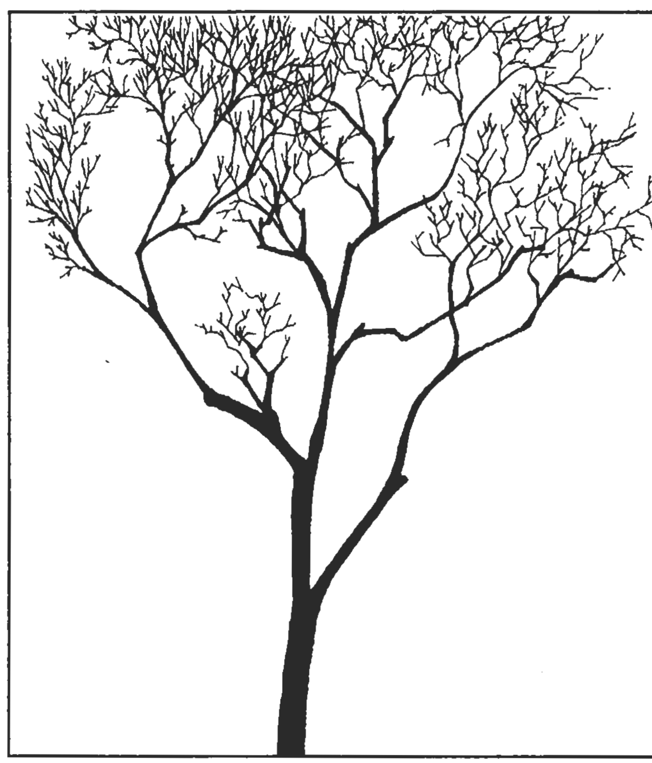
Human nervous system



Watershed drainage pattern



Road system



Tree in winter

A House of Seasons

Grade Level:
Lower Elementary

Subject Areas:
Earth Science, Fine Arts, Geography

Duration:
Preparation time: 30 minutes
Activity time: 50 minutes

Setting: Classroom

Skills:
Gathering information (collecting); Organizing (sorting); Analyzing (comparing); Presenting (drawing)

Charting the Course
Conducting "Water Match" prior to this activity helps students identify the three states of water. Aspects of water in the seasons can be further researched in "The Thunderstorm."

Vocabulary
seasons

"April showers bring May flowers," "Sunshine and showers make up summer hours," "Frost on the pumpkin," and "A winter wonderland" . . . What do all these descriptions have in common?

Summary

By constructing a "House of Seasons" collage, students observe the role of water in each of the seasons.

Objectives

Students will:

- recognize the presence of water within each season.

Materials

- *Old children's or nature magazines* (Check libraries and recycling centers.)
- *Scissors*
- *Glue*
- *Construction paper*
- *Tape*

Making Connections

People have different attitudes about each of the seasons. Often these relate to the presence of water and its various forms. Students' observation skills can be enhanced when they look for signs of water in photographs of different seasons.

Background

As the seasons change, so can the quantity and forms of precipitation. In the summer, long, hot, humid days can produce spectacular thunderstorms. In late fall, water can be seen when dew forms frost on the grass and windowpanes. Water in winter is used in snowball fights and in snow fort building. In spring, melting snow and plentiful showers create puddles, which are often a nuisance but can also be great fun!

Not all parts of the country experience four distinct seasons. Some places, such as the South, have a dry season, a wet season, and a cool season. No matter where in the country we live, variations in weather occur throughout the year. These wet, wonderful changes influence how we plant our crops, plan vacations, and perhaps even view the world.

Procedure

Warm Up

Ask students to describe the different seasons. Write down or note their responses. Circle or have students identify how many of their descriptions involve water in some form (snow, rain, puddles, etc.) Which season do they like best? Why?

The Activity

1. **Organize students into small groups. Have students look through children's or nature magazines. Ask them to locate and cut or tear out pictures that show the different seasons. Encourage students to look especially for pictures that contain water images.** Students may also draw pictures of the seasons.

2. **Tell students to arrange the pictures in four piles, one pile for each season.** For organizational purposes, have students sort by placing each picture on a different colored piece of construction paper, representing each season (i.e., white for winter; green for spring; yellow for summer; red for fall). (For regions of the country with just two or three seasons, classify pictures accordingly.)

3. **Have each student fold a piece of paper into quarters, dividing it into**

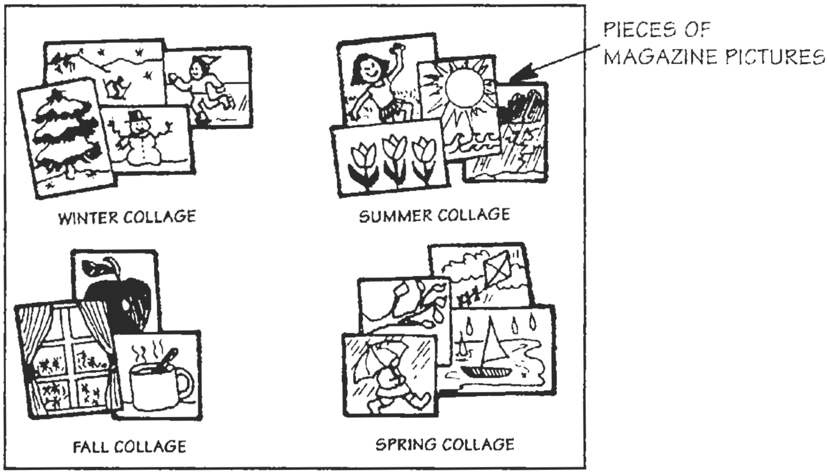
four equal sections. Instruct students to make collages of the photographs. Keep each season within its quarter section. (An option is to have students contribute their pictures to a large class collage, constructed by the teacher.)

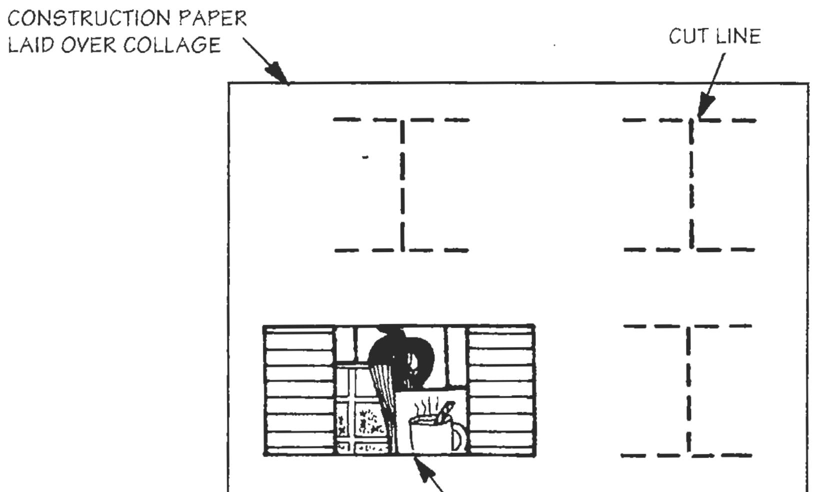
4. **Discuss the presence of water in each season. Have students compare how water looks in spring, summer, fall, and winter.** Do they think there is a different quantity of water in each season? Does water have anything to do with why they do or do not like a season? How do people manage water during different seasons (e.g., sprinkle lawns during hot and dry times, shovel snow)?

5. **Give each student a sheet of construction paper. Have them cut four shuttered windows in the paper. The location of the cuts should correspond to the placement of the seasons in the collage.** Teachers may wish to pre-cut the windows. (An alternative activity is to create a "Book of Seasons." Collages of different seasons can be stapled together and students can design an attractive cover.)

6. **Have students lay the construction paper over their collage and tape the edges to the collage. When they open the windows, they should see winter, summer, fall, and spring scenery.** Students may want to draw a house around their windows. Have them tell or write a story, poem, or song about the House of Seasons, that is, a house in which each window offers a view of a different season.

Wrap Up and Action
Have students share their collage with a friend. See if the friend can identify the season and describe what water looks like in that season.





Assessment
Have students:
- identify or draw pictures of the seasons (step 1).
- sort pictures into seasons (step 2).
- design a House of Seasons collage (steps 5 and 6).
- compare the appearances of water in each season (step 4).

Extensions
Older students could add to their collage newspaper headlines about water in the seasons. They can also investigate how the angle of the Earth's axis, and Earth's rotation around the Sun causes seasons.

Have students use their own photographs of the seasons to create a collage.

Resources
Borden, Louise. 1989. *Caps, Hats, Socks, and Mittens: A Book about the Four Seasons*. New York, N.Y.: Scholastic.

Gilmore, Julie, et al. 1993. *Pathways: Increasing Environmental Literacy Through the Arts*. Kelly, Wyo.: Teton Science School.

Hughes, Shirley. 1988. *Out and About*. New York, N.Y.: Lothrop.

Kahl, Jonathan. 1992. *Wet Weather: Rain Showers and Snowfall*. Minneapolis, Minn.: Lerner.

Imagine!

Grade Level:
Upper Elementary, Middle School

Subject Areas:
Earth Sciences, Life Sciences, Language Arts, Fine Arts

Duration:
Preparation time: 10 minutes

Activity time: 20 minutes

Setting: Anywhere

Skills:
Gathering information (listening); Interpreting (relating)

Charting the Course
Prior to this activity, students should learn about physical and chemical processes of water, specifically "Water Models," which covers evaporation and condensation. To support student understanding of the water cycle they can participate in the activity "The Incredible Journey."

Vocabulary
evaporation, condensation, precipitation

What would it be like to take a journey as a water molecule?

Summary

Students take an imaginary journey with water in its solid, liquid, and gaseous forms as it travels around the world.

Objectives

Students will:

- identify changes in states of water that enable water to move through the water cycle.
- describe the water cycle.

Materials

- *Audio recordings of water sounds* (water lapping on the shore of a pond, a storm, ocean waves, streams, a waterfall) (optional)
- *Copy of **Water Cycle Journey*** (script)

Making Connections

Students usually learn about the processes in the water cycle through indirect approaches such as diagrams and experiments. Using their imaginations, students discover what happens to water as it moves above, over, and under Earth's surface.

Background

Water can be found almost everywhere at any given time. As it changes forms, it travels throughout the world in the water cycle.

If you were able to travel with a water molecule, you would explore ocean depths, float through the atmosphere, splash down on a prairie, and weave among soil particles deep underground. How does water travel to all these places?

The processes that drive the water cycle are evaporation, condensation, transpiration, and precipitation. They are powered by solar energy and gravity. Causing water vapor to rise into the atmosphere, solar energy evaporates water from soil, plants, oceans, lakes, and streams. When it condenses in the atmosphere as rain, snow, hail, or sleet, gravity pulls it down again.

Because of the nature of water movement, a water molecule may be used over and over again throughout the centuries. The water you drink today could have dribbled down the back of a dinosaur, been locked in a glacier during the last ice age, spent 30,000 years in the ocean depths, or floated in a cloud over ancient Egypt!

Procedure

▼ Warm Up

Ask students to diagram or write a description of the water cycle and describe the processes that occur as water moves from one location to another.

▼ The Activity

1. **Ask students what it would be like to travel with water as it moves through the water cycle.**

2. **Tell students that you are going to take them on a journey through the water cycle with their imaginations. They should sit quietly and may wish to close their eyes.** You will be relating ideas and events and they should create pictures in their minds.

3. **Begin the tape of water sounds and start reading the script, *Water Cycle Journey*. Keep your voice even, level, and clear. Pause 2–3 seconds when you encounter the symbol "..............." to let students imagine what you are describing.**

COURTESY: EVERGLADES NATIONAL PARK

Wrap Up

After the reading, ask students for their impressions. Have students list the major parts of the journey. Where did they go and how did they get there? Have each student diagram or write a description of the water cycle and relate events in the exercise to the diagram/description.

Instruct students to look for and record water movements that occur in the water cycle in their everyday lives (rain, evaporating puddles, a cloud, an animal drinking water). Have students keep track of relative humidity reports to remind them that even when they can't see water, it is moving in the air around them. Keep a class record of these events and reports. Have students create their own water journeys. An alternative is for students to create a comic strip of a water molecule traveling through the water cycle.

Assessment

Have students:
- identify the states of water as it moves through the water cycle (***Warm Up*** and ***Wrap Up***).
- describe the places water goes as it moves through the water cycle (***Wrap Up***).
- describe the processes that enable water to move (***Wrap Up***).

Extensions

Have students write a script for other parts of the water cycle. What happens when ground water is absorbed by a plant, when water from a stream is drunk by an animal, or, when river water is used for industrial or municipal purposes?

Students can create drawings, poems, or other artwork to reflect their perceptions of the water cycle.

Resources

Alexander, Gretchen. 1989. *Water Cycle Teacher's Guide*. Hudson, N.H.: Delta Education, Inc.

Ewing, Margaret S., and Terence J. Mills. 1994. "Water Literacy in College Freshmen: Could a Cognitive Imagery Strategy Improve Understanding?" *Journal of Environmental Education* (25) 4: 36-40.

Mayes, Susan. 1989. *What Makes Rain?* London, England: Usborne Publications.

Schmid, Eleonore. 1990. *The Water's Journey*. New York, N.Y.: North-South Books.

Audio recordings of water sounds:

Alpine Stream. 1994. North Sound, North Word Press Inc.

Ocean Encounter. 1994. North Sound, North Word Press Inc.

Solitude Series. Contact: The Moss Music Group Inc., 48 West 38th Street, New York, NY 10018.

Water Cycle Journey

THE POOL

It is a beautiful summer day.........the sky is blue.........white puffy clouds float overhead ....the sun is shining.........the ground is warm......a songbird sings in a nearby tree ....Imagine a still pool of water.........it is surrounded by soft green grass and tall trees .... you are a water molecule in the pond ....moving gently back and forth......... you can feel other water molecules around you .... you are all gently moving against each other ....touching.........close.........a gentle wind ripples the surface.........tiny waves move along ....you are bounced into each other......... you are all rocking back and forth ....the sun warms the surface of the water ....you are close to the surface.........now you are right at the surface.........you begin to move more rapidly ....the warmth and energy of the sun continue to strike you.........you become more energized and move more quickly.........suddenly you burst from the surface.........you are released into the air.........you have moved away from the others and you gently float alone.........invisible to the human eye.........apart from any other water molecules.

THE ATMOSPHERE

You float in the air and rise slowly.........there is great space around you.........you can see the pond below.........it grows more distant......... you continue to rise.........around you, you can see other water molecules.........but they are on their own.........you cannot reach out and touch them.........they, like you, continue to float and rise into the atmosphere......... as you rise, it is getting cooler.........your movement becomes slower.........a tiny particle floats by you .... you grab on to it.........another water molecule grabs on to the same particle......... then another and another......... you all begin to bond to each other making the particle larger and larger......... you see other particles with water molecules attached......... everything around you begins to form patterns......... the patterns are like giant diamonds.........light passes through these ice crystals and creates prisms and tiny rainbows ....more and more water molecules come together.........you feel them surround you .... you are becoming heavier......... heavier .... heavier......... you begin to fall.........

THE SNOW

You are falling faster.........faster......... wind blows you up and around......... you swirl about......... trees appear.........then a white blanket below.........gravity takes you to the blanket......... you land on the surface......... above you and around you other particles fall .... you become part of the white blanket ....everything becomes quiet and cold......... all around you stillness settles in.........

THE BIG MELT

Gently, ever so slowly......... a soft light begins to appear around you......... a gradual brightness .... the light brings warmth with it......... you begin to move ever so slowly......... as the light brightens the warmth increases .... you move back and forth......... around you water molecules begin to slip away......... they seem to move downward, sliding along......... you and surrounding water molecules are suddenly released and begin to slide.........

DOWN THE MOUNTAIN

As you tumble downward, you feel other water molecules push together around you......... suddenly you burst to the surface......... the sun is bright.........the air is fresh and dry.........it invigorates you......... all around you there are water molecules .... traveling quickly......... all moving down a hill......... more groups of molecules join you......... more......... and more......... all traveling down quickly......... as you travel you see trees, grasses......... you come upon a large tree.........you bump against the roots and slow down.........

INTO THE GROUND

Gravity begins to pull at you.........you seep into the ground, weaving among sand and soil particles.........flowing underground is like moving, slow motion, through a dark obstacle course.........you are now deep underground, surrounded by soil particles.........suddenly, your movement seems to be more horizontal, the pressure of other molecules behind you pushes you along.........it appears lighter up ahead.........you and surrounding molecules spring out of the ground......... tumbling over ground, you continue your gradual descent to the foot of the mountain.........

BIG RIVER

Gradually you slow down......... you sense a gradual decrease in the slope of the land......... you now move gracefully in a large mass of water......... other streams contribute to your journey......... more and more water molecules collect together ....this is the big river......... along you travel......... other particles swirl around you......... you and other molecules work together to carry the particles.........you move more slowly now.........the slope is slight......... the slower you go the less energy you have to carry the particles .... the particles slip from your grasp and sink but you move on.........

THE GIANT POOL

Ever so slowly the water moves toward the open......... grassy banks give way to cement canals......... all around you civilization makes itself known......... cars......... people .... even an airport......... the sounds are loud and constant......... eventually you feel a change ....all around you are new materials .... molecules of other substances.........they are strongly attracted to you......... these are the salts.........they fill in the gaps between you and other water molecules......... you and other particles continue to move about.........

WHAT NEXT?

There are many options open to you......... where will you go?......... the sun's energy may invigorate you, you could break away and float into the sky again ....other water molecules may hold on to you, you could swirl around the surface......... gravity may pull at you, you could explore the darkness of the deep......... a fish swims by, now there's a possibility......... imagine where you will go next......... picture it in your mind......... when you know where you are or will go, when you are ready, open your eyes.........

Rainy-Day Hike

Grade Level:
Upper Elementary, Middle School

Subject Areas:
Earth Science, Environmental Science, Geography

Duration:
Preparation time:
Part I: 30 minutes
Part II: 30 minutes

Activity time:
Part I: 50 minutes
Part II: 50 minutes

Setting:
Classroom, schoolyard

Skills:
Gathering information (collecting, observing); Organizing (mapping); Analyzing; Interpreting

Charting the Course
This activity provides a good introduction to watersheds. Students make a model of a watershed in "Branching Out!" Students can investigate the possible effects of the run-off from their schoolyard in "A-maze-ing Water." Following this activity, students can explore aspects of nonpoint source pollution in "Sum of the Parts."

Vocabulary
watershed, nonpoint source pollution

What do a puddle on your playground and a nearby lake or stream have in common?

Summary

Students are introduced to the concept of watersheds by collecting data about water flowing over school grounds.

Objectives

Students will:

- identify the watershed in which their school is located.
- explain the role the schoolyard plays in the watershed.

Materials

- *Maps of the local community, showing streams, lakes, and topography*
- *Drawing paper*
- *2 sets of copies of the **Legend***
- *Waterproof outerwear*
- *Clipboards or sturdy cardboard with rubber band to secure paper* (Tape 2 pieces of cardboard to form a book; students can close map inside cardboard to keep it dry.)
- *Plastic wrap*
- *Pencils*

Making Connections

Students may be familiar with the idea of a watershed, but unaware that they live and attend school within one. Observing water flowing through and collecting on their school grounds provides students with direct experience in their watershed.

Background

Puddles, streams, and lakes all have something in common. They collect water that has drained from watersheds. Watersheds are like funnels; they are drainage basins where surface water runs off and drains into a common collection site. Watersheds are separated from each other by land forms (ridge lines or mountain divides). Water falling on each side of the divide drains into different watersheds and collection sites.

Surface runoff flows over a school's grounds on its way to the collection site (e.g., a river); therefore, schoolyards are part of a watershed. (Puddles are the collection sites of mini-watersheds: land surrounding puddles are the mini-drainage basins that empty into the puddle.) When the puddles overflow or the soil becomes saturated, water is released.

Often, materials carried by water to the school grounds (e.g., litter, twigs, leaves, oil) are left behind. Surface water leaving the school grounds may carry materials to the collection site of the watershed. These materials include soil, leaves, and twigs; litter; oil and gasoline from parking lots; and fertilizer from lawns.

As water flows from the school grounds, it combines with runoff from other land areas within the drainage basin. Materials from these other places are added to the water. While some substances decompose, settle out, or are filtered by soil, other matter continues to travel long distances downstream. Organic materials carried by the water nourish aquatic life. Some substances are toxic, however, and can endanger organisms consuming or living in the water.

Contaminants whose entry point into the watershed is difficult to locate are classified as nonpoint source pollutants. Along with residential areas, agricultural fields, and paved parking lots, school grounds can contribute nonpoint source pollutants. The schoolyard contributes point source pollution when the source of the pollutant can be traced back to a specific location on the school grounds (e.g., sewer, ditch, pipe).

Procedure

Warm Up

Show students a map of the community and identify local rivers or lakes. Ask the class if they think a connection exists between their schoolyard and these bodies of water. Tell the class they will take a fair-weather and a rainy-day hike, to study what happens to the water that falls on and flows over their school property.

Although plans for a rainy-day hike will generate student excitement, the wait for a wet day may prove discouraging. The lack of rain offers the opportunity to discuss with students the idea that people do not control the rain or other aspects of the weather. Remind students that even if people cannot "control" the weather, they can often predict it.

Have students listen to, watch, or read weather reports. When is rain predicted? Students can mark the calendar with the date and continue "preparations" for the hike.

The Activity

Part I

1. **In planning for the rainy day, have students create a map of the school grounds. Divide the grounds into sections and assign groups to map each area.** Orient students to which direction is north so all maps face the same direction.

2. **Remind groups to include the following: school buildings, parking lots, designated playgrounds, natural areas (trees, grass, flower gardens), with emphasis on water features like streams, temporary and permanent ponds, and constructed water features like bird baths and fountains.**

3. **After students have completed their initial mapping, if there is a school building in their area, have them consider the following questions.** Can they determine where the water that falls on the roofs goes? Does it flow off the roof into gutters that lead to waterspouts or does it fall directly onto the ground? Have students place an "X" on the buildings to indicate the location of waterspouts.

4. **Make two copies of student maps, one for the fair-weather hike where students make predictions of water flow and one for the rainy-day hike when students check their predictions.**

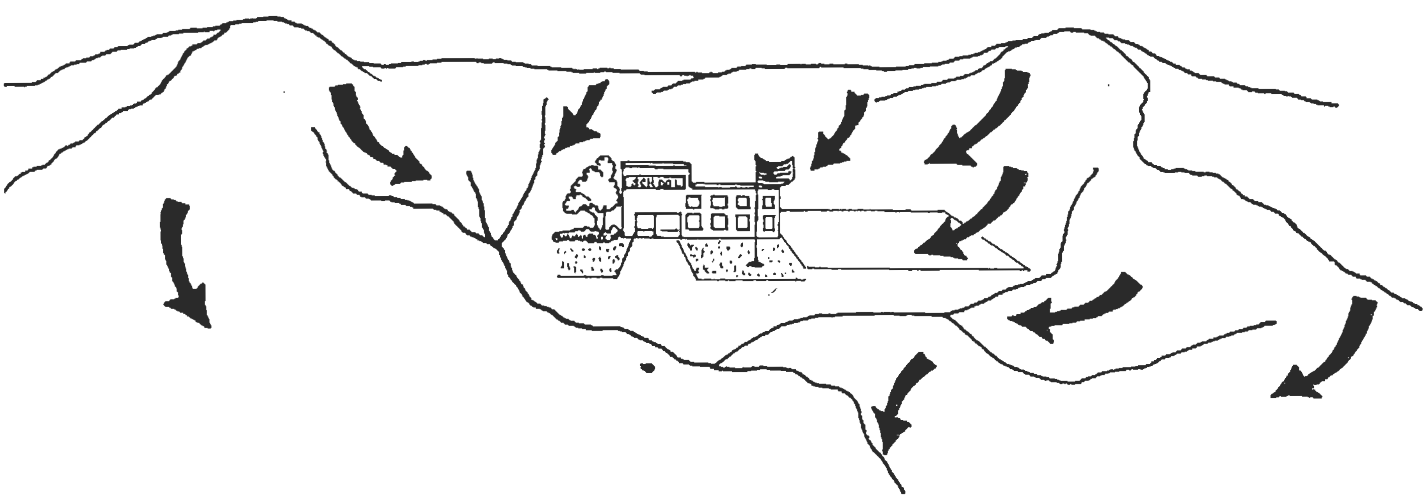
5. **For the fair-weather hike, give each group a copy of their mapped section and the *Legend*. Have each group predict the direction water will flow through their section.** Where do students think water will be stored? Are there ponds or low spots?

6. **Have students survey the ground area of their section for possible sources of point and nonpoint contamination (oil stains on parking lots, trash, tainted soil near the school dumpster). What materials could be on the roof of the school building that could be washed off during a rain (bird and rodent droppings, insects, dirt, roofing materials, leaves, twigs, etc.)?**

7. **Assemble the map sections from the groups and post in the classroom. Have them summarize their predictions.** How do the predictions of individual groups relate to each other? Where do students think water flows onto the school grounds? Where will it flow off the school grounds?

Part II

1. **On a rainy day, have students dress properly; take them outside and begin a simple tour of the school grounds. Have students identify patterns of water flow.** Discuss what influences the direction water moves. Have students:



- note slopes, depressions, cracks in the sidewalk, erosion trails, rocks, buildings, gardens, trees, etc.
- compare how fast or slow water flows in different places.
- identify ways water affects the surface of the school grounds (e.g., watering plants, eroding soil, piling up litter, washing away litter).
- note water flowing from the roofs of buildings and waterspouts.

2. **Divide the class into their original groups and give each group a copy of their unmarked map section and the *Legend*.** Have students indicate the following on their maps: direction and patterns of flowing water; natural and unnatural materials being carried onto and off their study area; and areas of standing water. Remind students to use pencils—ink runs. They can cover their note pads with plastic wrap or cardboard when they are not writing.

3. **When students have completed their investigations, assemble the map sections and post.** Arrows of adjacent map sections should line up. If they don't, discuss reasons for discrepancies.

▼ *Wrap Up and Action*

Have students summarize the general pattern of surface water as it flows across the school property. They should identify areas where the flow of water is slowed by landforms and vegetation, collects in depressions, and flows off school property. Have them compare the completed map on the rainy-day hike to the map indicating their predictions. How accurate were their predictions?

Referring to a community map, discuss the school's location within a watershed. Trace the likely course of runoff from the school grounds into a local lake or river.

City engineers or planners have information on storm drainage systems, or can identify destinations of storm water runoff from streets and parking lots.

Have the class list uses of water in local lakes or rivers (e.g., drinking water, animal habitat, irrigation, swimming, fishing, etc.). Do any activities occurring on your school grounds affect, positively or negatively, the water moving across it?

Some school property plans incorporate surface water treatment systems, such as detention ponds, to reduce materials carried by runoff. Ask the principal for a copy of the school site plan. Does the plan show the surface water management system for the school?

If students believe their school grounds contribute to erosion or to point or nonpoint source pollution, they may want to develop a plan to improve the area. They can plant trees or a garden, encourage parking lot patrons to keep their cars in tune, promote wise use of fertilizers and pesticides, etc.

Assessment

Have students:

- predict the movement of water and possible contaminants across their school grounds (*Part I*, steps 5 through 7).
- identify the school's location within a watershed or in relation to a body of water (*Wrap Up*).
- list ways the school grounds positively affect water passing through the watershed (*Wrap Up*)
- locate sources of point and nonpoint source pollution on the school grounds (*Wrap Up*).

Extensions

To increase the detail of their study area maps, students may include measurements of slope. Slopes can be classified as level, gentle, moderate, or steep. How does steepness of slope affect rates of water flow, erosion, and sediment load? To measure slope, one student stands at the top of the study area (top of the slope) and another student, holding a meter stick, stands at the bottom. The run or distance between the two students is measured. The student at the top holds one end of a string at his ground level and the other end is extended to the student at the bottom of the slope. A level is needed to ensure the string is held straight. The point at which the string intersects the meter stick held by the second student is the rise. Slope gradient is calculated by dividing the rise by the run.

$\frac{\text{rise}}{\text{run}}$ = slope gradient (expressed as a percentage)

On a community map, have students use pins to locate the school and their homes. Do students share the same watershed address as the school? They can observe surface runoff to see where the water goes. Topographic maps may help locate ridge lines within the community.

K-2 Option

Have students work in small groups to investigate sites of flowing water on the school grounds. They should observe what is in the water. Caution them not to touch the water, especially if the water is running off a parking lot. Children can search the area for natural materials with which to construct tiny boats. Have boat races to see how far and where the boats travel. Students can draw pictures describing what the tiny boat might encounter if it flowed off the school grounds. Discuss reasons why the school grounds must be kept clean.

Resources:

Doppelt, Bob. 1993. *Entering the Watershed: A New Approach to Save America's River Ecosystems.* Washington, D.C.: Island Press.

Dorros, Arthur. 1991. *Follow the Water From Brook to Ocean.* New York, N.Y.: Harper Collins.

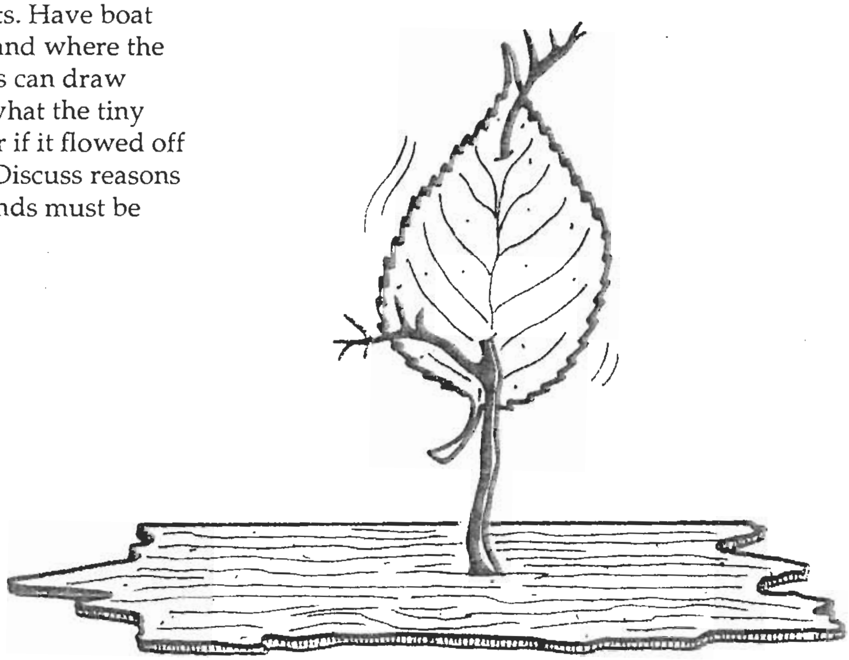
Holling, Clancy. 1941. *Paddle to the Sea.* Boston, Mass.: Houghton Mifflin Company.

Locker, Thomas. *Where the River Begins.* New York, N.Y.: Dial Books.

Miller, G. Tyler, Jr. 1990. *Resource Conservation and Management.* Belmont, Calif.: Wadsworth Publishing Company.

Project WILD. 1992. Activities "Puddle Wonders," "Where Does Water Run Off After School?" and "Watershed." *Aquatic Project WILD.* Bethesda, Md.: Western Regional Environmental Education Council.

Notes



Legend

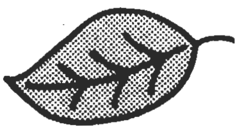
arrows indicate direction of water flowing onto and away from study area

a leaf indicates natural materials, such as leaves, soil, and twigs, that might have been carried onto study area from another location

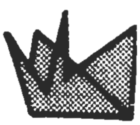
a puddle shows where water collects in the study area

a crumpled ball of paper indicates unnatural materials, such as litter, oil, and chemicals, that might have been carried onto the study area from another location

a flower shows things that help slow the flow of water



a shaded leaf indicates natural materials that are being or could be carried away from the study area



a shaded, crumpled ball of paper indicates unnatural materials that are being or could be carried away from the study area

Stream Sense

Grade Level:
Lower Elementary, Upper Elementary

Subject Areas:
Earth Science, Fine Arts, Language Arts

Duration:
Preparation time: 50 minutes

Activity time: two 50-minute periods

Setting: A local stream

Skills:
Gathering information (observing, recording)

Charting the Course
Have students explore what they think and feel about streams with an adapted version of "Idea Pools." In "Rainy-Day Hike," students study how their schoolyard may affect the health of neighboring streams. Activities on watersheds (e.g., "Branching Out!") could follow this activity. Journaling (see "Water Log") could be introduced through this activity.

Vocabulary
observation

What does your nose know and your ear hear about a stream?

Summary

Students use their senses to observe a stream, learning there is more to flowing water than meets the eye.

Objectives

Students will:

- recognize how their senses provide them with details about stream ecosystems.

Materials

- *Touch-and-feel bags* (a dark-colored bag with sample materials that could be found near a stream: a cattail, a pebble, a shell, a twig, etc.)
- *Copies of the* ***Sensory Observation Sheet***
- *Pencils and crayons*
- *Journals* (optional)
- *Camera* (optional)
- *Tape recorder* (optional)
- *Binoculars* (optional)
- *Magnifying lenses* (optional)
- *Sample foods* (edible plants and seeds) *that could be found near a stream* (optional)
- *Spray bottle* (optional)
- *Collecting apparatus, such as buckets, tweezers, nets, etc.* (optional)

Making Connections

Many people enjoy the sights and sounds of a babbling brook. People find comfort through the sense of touch and recall distant memories through certain smells. Often people depend on only their vision to gather details about their environment. By making careful observations, students experience how their other senses (besides sight) provide them with additional information about the environment.

Background

Sense organs—eyes, ears, nose, tongue, and skin—are needed to detect the surrounding environment. With information it receives through the senses, the brain interprets what we see, hear, smell, taste, and feel. In addition to translating the information it receives, the brain also relates these details to memories and thought processes. In this way, recognition and learning take place.

In most humans, sight is the predominant sense organ. When an individual uses *all* of his or her senses to investigate the environment, the brain receives a broader range of information. This information provides the opportunity for more thorough learning.

A stream provides an ideal opportunity for people to use all their senses. People hear water rushing over rocks and lapping at the banks. They feel a breeze against their skin, and hear insects buzzing and chirping among the willows. The air around the stream feels moist and carries a variety of particles from flowers, damp earth, and chemicals in the water to their noses. Along the banks and in shallow portions of the stream, a variety of materials of different shapes and textures can be touched.

It is important to protect the senses. Safety rules should be followed when students explore a stream.

Procedure

▼ *Warm Up*

Review the five senses (sight, sound, touch, smell, and taste). Discuss how they are used in daily life. Ask students about previous trips or visits to natural areas. How were their senses involved in these visits?

Ask students to describe how they observe things. Do they think it is possible to observe using all their senses?

▼ *The Activity*

1. **Distribute touch-and-feel bags to groups of students. Ask them to identify the objects inside by touch alone. Ask where they might find all these items.**

2. **Tell students they will be visiting a stream and will be recording how they use their senses to observe the stream. Discuss the** ***Stream Walk Safety Rules.***

3. **Hand out copies of the** ***Sensory Observation Sheet.*** **Explain that when they record their observations, students should write things down or draw things as they perceive them.** For example, when they look at things they should describe shapes and colors. When they hear things they can write down imitations of the sound (e.g., peep, peep, gurgle, gurgle, swish, swish, shooooosh!).

4. **Throughout the trip, remind students about using their senses. Ask students to find a quiet spot near the stream and have them sit very still to look, smell, listen, and feel.** Older children may want to sit for 15 minutes or more, while for younger students 2 or 3 minutes is probably enough. During this time, students can complete their observation sheets. If they bring their journals, they may be inspired to write poems or draw pictures. Students may want to take photographs or tape record sounds.

5. **Other sensory activities that students could do at the stream include the following:**

- Have them block one or more of their senses (e.g., close their eyes, cover their ears, plug their noses). How does this affect their other senses? Did students hear better when they could not see?
- Have a student guide a blindfolded partner to his or her quiet site. Have the partner recall sounds, smells, and feelings he or she experienced along the way.
- Supply students with ways to improve the ability of their senses (e.g., use binoculars, spray water on their noses [moisture traps scent particles], cup their hands behind their ears).

6. **Following are questions that could be asked of students before, during, or after the stream visit:**

Sight: What plants and animals do they see? Does the appearance of the stream vary with location? Is the stream fast or slow moving? How can they determine its speed?

Sound: What sounds does the stream make? Can they hear animals? What does the wind sound like?

Smell: How do smells near the stream compare to those on a road or in a home? Does the water smell the same as tap water?

Touch: What does the stream water feel like? How does soil near the stream feel compared to soil in the woods or schoolyard? Are the rocks in the stream smooth or rough?

▼ *Wrap Up and Action*

Have students share their *Sensory Observation Sheets* with the class. Ask them to create a mobile that includes things they observed with each of

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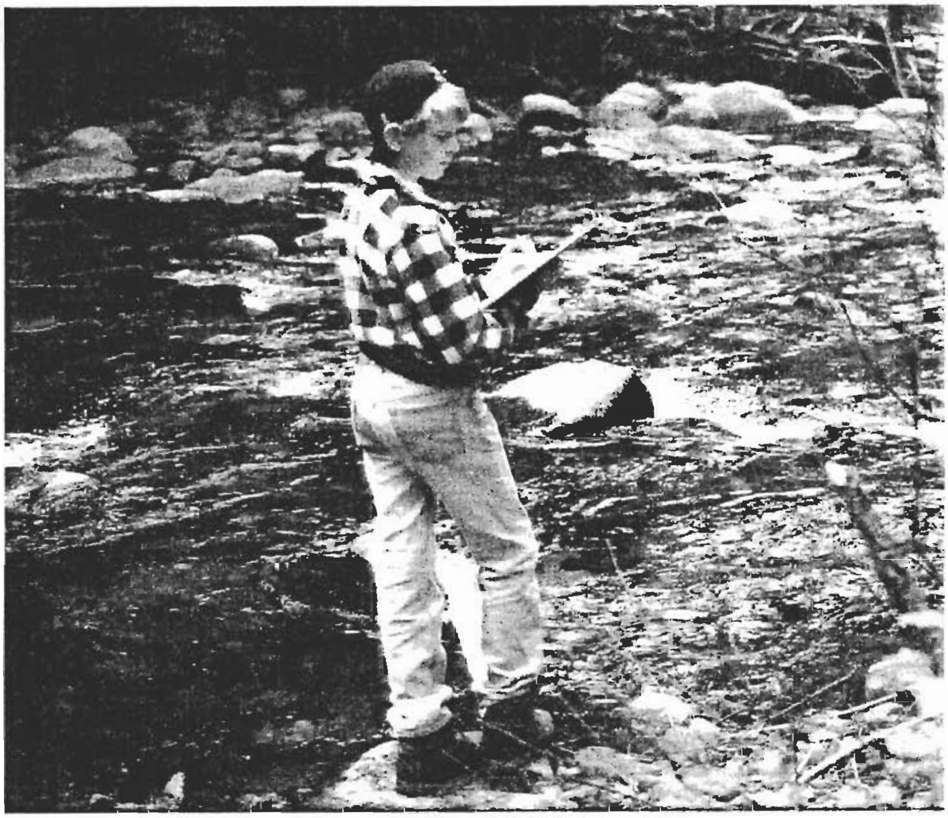
Stream Walk Safety Rules

Notes for the Teacher:

1. Visit the stream first to determine if it is safe for students to visit. Check stream depth, velocity, and temperature. Also look for walking conditions, potentially dangerous wildlife, poisonous plants, etc.
2. Bring along a first-aid kit.
3. Define stream walk boundaries; make sure students understand that staying within the boundaries protects wildlife and students.
4. Locate a place where students can wash hands after the visit.

Rules for the Students:

1. Students should stay with their assigned buddies.
2. Students should wear old athletic shoes or boots because they will likely get wet and muddy.
3. Students should not enter the stream without supervision.
4. Students should not touch wildlife or taste anything (plants or water) unless permitted by teacher.



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their senses at the stream. Have students create a display board titled *Sensory Observations of a Stream.*

Assign students to create sensory guide sheets for other people who visit the stream. The brochure or sheet could identify specific locations where people could make observations or it could be more general, listing sights, sounds, smells, and touchable objects near the stream.

Assessment

Have students:

- record observations (sights, sounds, smells, or textures) of a stream environment (steps 3 and 4).
- create a mobile that includes things perceived through their senses at the stream site (***Wrap Up***).
- create a sensory guide sheet to educate others about what they might see, hear, touch, and smell at a stream (***Wrap Up***).

Extensions

Many state departments of natural resources, government agencies, water conservation agencies, education departments, and extension agencies have developed programs for studying and monitoring streams. Check the **Resources** section for a selected list of agencies and programs. Following is a brief description of some stream-related activities.

Resources

Water quality monitoring programs:

The Adopt-a-Stream Foundation, P.O. Box 5558, Everett, WA 98206.

Adopt-a-Watershed, Education Coordinator, California Association of Resource Conservation Districts, 1970 McKain Rd., Calabasas, CA 91302.

Global Rivers Environmental Education Network, 721 East Huron Ave., Ann Arbor, MI 48104. (313) 761-8142.

Sensory awareness resources:

Carson, R. 1956. *A Sense of Wonder.* New York, N.Y.: Harper & Row.

Cornell, J. 1979. *Sharing Nature with Children.* Nevada City, Calif.: Dawn Publications.

Herman, M., J. Passineau, A. Schimf, and P. Treur. 1985. *Teaching Kids to Love the Earth: Sharing a Sense of Wonder . . . 186 Outdoor Activities for Parents and Other Teachers.* Duluth, Minn.: Pfeifer-Hamilton Publishers.

Milord, S. 1989. *The Kids' Nature Book: 365 Indoor/Outdoor Activities and Experiences.* Charlotte, Vt.: Williamson Publishing Co.

Following is a partial list of agencies, organizations, and authors who offer stream-related resources:

Cromwell, Mare, et al. 1992. *Investigating Streams and Rivers.* Global Rivers Environmental Education Network, 721 East Huron Ave., Ann Arbor, MI 48104. (313) 761-8142.

Delta Labs. 1987. *Adopt-A-Stream Teacher's Handbook.* Rochester, N.Y.: Delta Laboratories, Inc.

McCollim, Lori. 1994. *Water We Here For?* Bozeman, Mont.: Project WET Montana.

Save our Streams Program. Izaak Walton League of America, 1401 Wilson Blvd., Level B, Arlington, VA 22209.

The Stream Scene: Watersheds, Wildlife and People. 1990. Portland, Oreg.: Oregon Department of Fish & Wildlife.

Other Things to Do at a Stream

Observations

What color is the water?

Is it always this color? Does it change throughout the day? What about during different seasons? Find an object that has a similar color to the water. Learn how water gets its color . . . Hint: it has something to do with light!

Can you see the bottom?

Is the water clear or murky? Collect a jarful of water and time how long it takes material to settle. Try this at different times of the year. Is it the same each time?

What is on the bottom?

Look at the bottom. Obtain a sample and describe what it feels like. Is it sandy or rocky? Is it mushy or coarse? Record the size of the rocks or pebbles. Are they rough and angular or round and smooth? Can you tell where they came from?

What lives in the stream?

Look for big things and little things, plants and animals, fast movers and slow movers. Filter the water, look under logs and rocks, stir up the bottom and see what flows into a net. Keep a record of what you find. NOTE: Try not to disturb or harm living things. Return them after observation.

What's along the banks?

Look at the different plants and animals that live near the stream. Keep an inventory of trees, flowers, birds, mammals, and insects that you see. Remember to look and not touch. If samples are collected for classroom study, try to return them safely.

Describe the soil on the banks. Are the banks easy to walk on or are they slippery? Do you see signs of erosion or parts of the banks sliding into the river?

Take measurements!

Is the water cold or warm?

Measure its temperature with a thermometer. Check different locations along and within the river—are they all the same temperature? What about at different times of the day or year?

How fast is the water moving?

See how long it takes for an object to float a certain distance (e.g., 20 yards). Divide the time into the distance to determine how fast the water is moving (e.g., yards per second).

Water quality

(See list of water quality monitoring programs in **Resources** section.)

Many state agencies and biological supply companies have information and kits you can use to test water quality. Check out why and/or how to test for each of the following: dissolved oxygen, pH, nitrates, phosphates, chlorine, hardness.

Taking action

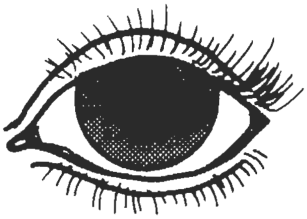
Do you see any signs of pollution or litter? Talk with teachers or parents about organizing a stream cleanup. Collect and dispose of litter. (Be sure to wear heavy gloves.)

Design posters or make announcements on the radio about caring for the stream. (Ask local radio stations about making a public service announcement.)

Water Log

Record monthly observations in water journals to monitor changes over time.

Sensory Observation Sheet

Sights	Smells
	
Touch	**Sounds**
	

Water Models

■ **Grade Level:**
Upper Elementary, Middle School

■ **Subject Areas:**
Earth Science, Ecology, Geology, Physical Science

■ **Duration:**
Preparation time: 30 minutes
Activity time: two 50-minute periods

■ **Setting:** Classroom

■ **Skills:**
Gathering information (observing, researching); Analyzing; Applying (making models); Presenting

■ **Charting the Course**
"Piece It Together" and "Wet Vacation" help students understand more about climates and ecosystems. Other water cycle activities include "The Incredible Journey," and "Imagine!" Further investigations of climate and culture are found in "The Rainstick" and "Raining Cats and Dogs."

■ **Vocabulary**
climate, condensation, ecosystem, evaporation, precipitation, transpiration, water cycle

Does water move through the water cycle in a desert as it would in a rain forest?

Summary

Students construct models of the water cycle to illustrate its major components and processes, and adapt their models to show how they think water would cycle in various ecosystems.

Objectives

Students will:

- recognize the roles of condensation and evaporation in the water cycle.
- relate the water cycle to different climates and ecosystems around the world.

Materials

- *Heat source*
- *Frying or cooking pans*
- *Ice*
- *Duct tape*
- *Large plastic or glass jars with tops* (Students can bring empty pickle or peanut butter jars from home.)
- *Water*
- *Sand*
- *Rocks*
- *Items that represent components of different climates or ecosystems* (collected by students)
- *Heat-resistant gloves* (or oven mitts)
- *Copies of* ***Water Cycle in a Jar***
- *Copies of* ***Observation Sheet***

Making Connections

When it rains and when water flows down a river, students see evidence of water moving through the water cycle. But some components of the water cycle are not visible to the eye and may be overlooked. Constructing water cycle models can help students better appreciate how evaporation and condensation help move water through the environment and around the world.

Background

Earth's water supply is finite, and this same water has been moving over, on, and under Earth's surface for thousands of years. The continual movement of water— often called the water cycle— collects, purifies, and distributes water around the world. The pull of gravity, electromagnetic forces, and the sun's energy keep water in continual motion.

Solar energy heats water on Earth's surface and in oceans, streams, lakes, soil, and vegetation and causes it to evaporate into the atmosphere. Heat from the sun also causes snow and ice to melt and then evaporate. Sometimes snow and ice can evaporate directly rather than going to the liquid state first; this process is called sublimation. Winds and air masses, also energized by the sun, flow around the globe, carrying water vapor with them. Falling temperatures cause water vapor to condense into tiny droplets that form clouds or fog. Water then leaves the atmosphere as precipitation (rain, snow, hail, etc.). Water often leaves the atmosphere many miles from where it originated. About 77 percent of the precipitation over the surface of Earth falls into the oceans. Water that falls on the ground seeps downward through soil and permeable rock formations, flows over the surface, or evaporates again.

There are three major climates (polar, temperate, and tropical). At the poles the air is cold and dry. The Arctic and the Antarctic are covered with snow throughout most of the year. Limited sunlight and cold temperatures allow very few plants to exist. Examples of plants that live in the tundra of the Arctic include mosses, lichens, and other plants that grow close to the ground. Although water at the poles stays frozen for a long time, sometimes it does evaporate. The water vapor eventually condenses and falls back to Earth as snow or it may be carried by global wind currents to other parts of the planet. At lower latitudes, the snow may melt and be absorbed by plants or flow for a while over the surface.

Tropical climates are hot and humid. The tropics, especially the rain forests, are densely populated by a great diversity of plants. Very tall trees, whose tops form a dense canopy, cover much of the land area. Some plants growing beneath this crown cover have large leaves to catch sunlight that filters through the canopy, while others (epiphytes) grow far above the ground on the branches of taller trees. The ground is moist throughout most of the year, so plants do not need to grow deep roots to find water. Rain forests create their own weather systems. Water evaporates from the ground or from plants (through transpiration) and rises to the top level of the trees, where it condenses and then falls back to the ground. The water may flow over the surface, be absorbed by plants, or filter to the ground. Some water vapor does eventually escape to the atmosphere, where global winds carry it to other places.

While weather at the poles and in the tropics is fairly consistent throughout the year, the temperate climates (Earth's mid-latitude regions) experience seasons. A variety of plants live in this climate, such as deciduous trees, flowering plants, mosses, and grasses. Their life cycles and growing patterns must comply with the changing seasons. In this climate, water flows over the surface, seeps underground, freezes, and evaporates. Water moves through the atmosphere as vapor, eventually falling back to Earth—sometimes many miles away or in a different climate.

Geographic qualities, such as nearness to the ocean, elevation, and extent of land mass, create a variety of ecosystems within the temperate climate. For example, deserts are hot and dry. To live in these conditions, some plants, such as mesquite, have extremely deep root systems. Other plants, such as cacti, have fleshy tissue and very few pores, so they can retain large quantities of water instead of losing it through transpiration.

The processes of evaporation and condensation within all these climates help water move around Earth's surface. In this way, water is used and reused, with all parts of Earth eventually sharing the same water.

Procedure

▼ *Warm Up*

Set up the following teacher demonstration:

- Place a hot plate or other heat source on a table at the front of the room.
- Place a pot of water over the heat source.
- Once the water is hot, hold a pan of ice above the rising water vapor. (Wear heat resistant gloves for protection.)
- Drops of water vapor should condense on the bottom of the pan of ice.
- The drops of liquid water will fall and return to the pan of hot water.

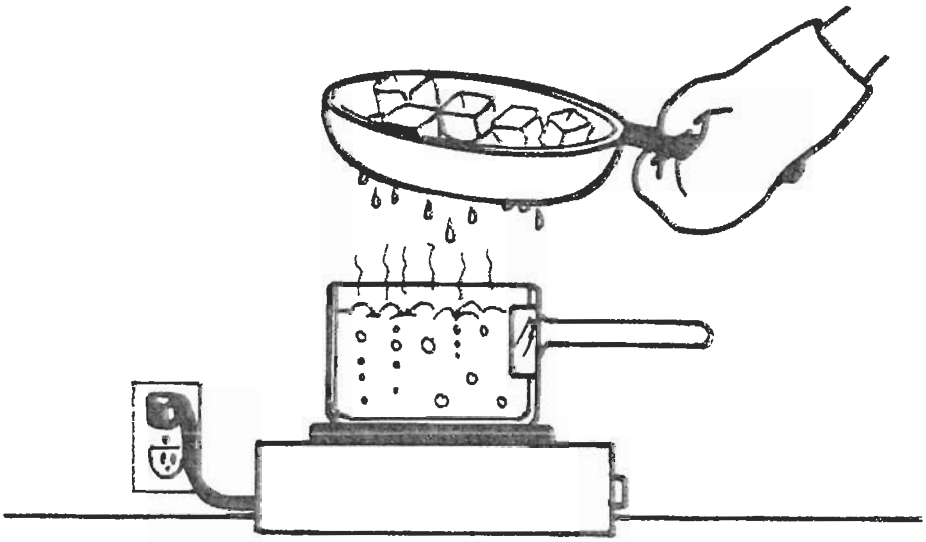
Have the students make a list of observations and explain each. Ask students to list the processes that are occurring and how these might be exhibited in nature.

▼ *The Activity*

1. **Provide groups of students with a copy of *Water Cycle in a Jar* and have them construct their model and record observations on the *Observation Sheet*.**

2. **Have students summarize their observations, identifying and explaining the processes of evaporation and condensation. Help students understand the role of solar energy in these processes.** Runoff, filtration through sand, and other aspects of the water cycle can also be discussed.

3. **Discuss the role of plants in the water cycle. Have students research different climates (polar, temperate,**



tropical) and/or ecosystems around the world (rain forest, desert, tundra, etc.).** They should focus their search on learning how water moves in the area. Would water evaporate quickly? Would there be much standing water? Does water remain frozen? Students could further their investigations by finding out what plants live in the area. How do they manage to live in these different climates?

4. **Challenge students to adapt their jar model to represent the climate or ecosystem they are studying.** For example, if the model represents a desert, they could put in tiny cacti, sand, and a little water, and place it in the sunlight.

▼ *Wrap Up*

Have students present their models to the class and describe how water moves within the model and within the climate or ecosystem represented by the model.

After the presentations are complete, draw a large circle on the floor that represents Earth. Bisect the circle with a line to indicate the equator. Have students arrange their models comparable to where they are located on Earth. (An alternative is to lay a world map on the ground.) Students should extrapolate how evaporation and condensation and other processes of the water cycle help water travel from one part of the world to another. Have students summarize how the world shares water.

Assessment

Have students:

- construct a simple model of the water cycle and identify the processes of evaporation and condensation (steps 1 and 2).
- create a model simulating the water cycle of different climates or ecosystems throughout the world (step 4).
- use the model to explain how the world shares water (*Wrap Up*).

Extensions

Involve students in the following activities to further explore condensation and evaporation. Hand out paper towels soaked with equal amounts of water to groups of students. Charge them with finding the fastest way to dry the towels using only things they find in the room. Students should discover that motion, heat, and increasing the exposed surface help the water evaporate more quickly. Discuss where the evaporated water goes. Challenge students to retrieve water from the air. Discuss the process of condensation. Provide helpful hints by having metal or glass containers and ice water available.

Resources

Alexander, Gretchen. 1989. *Water Cycle Teacher's Guide*. Hudson, N. H.: Delta Education, Inc.

Biological Science Curriculum Study. 1987. *Biological Science: An Ecological Approach*. Dubuque, Iowa.: Kendall/Hunt Publishing Company.

Cast, Vance C. 1992. *Where Does Water Come From?* Hauppauge, N.Y.: Barron's Educational Series, Inc.

Hurd, Dean et al. 1988. *Physical Science*. Englewood Cliffs, N.J.: Prentice Hall.

Lamb, William G., Mapi M. Cuevas, and Robert L. Lehman. 1989. *Physical Science*. Orlando, Fla.: Harcourt Brace Jovanovich, Inc.

Mayes, Susan. 1989. *What Makes It Rain?* London, England: Usborne Publications.

Schmid, Elenore. 1990. *The Water's Journey*. New York, N.Y.: North-South Books.

Notes ▼

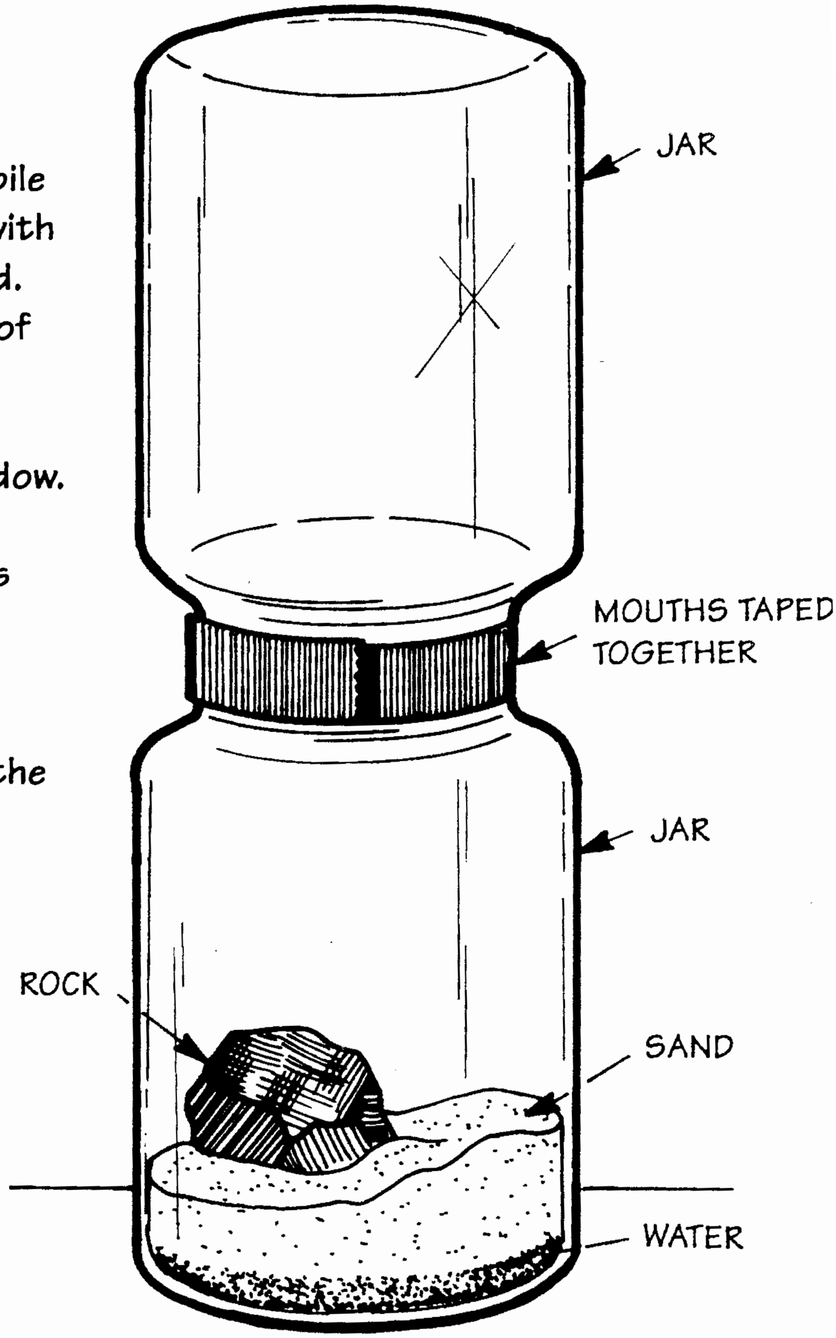
Water Cycle in a Jar

1. Take two identical jars; put a pile of sand in one and saturate with water. Place a rock in the sand. Tape together the open ends of the two jars. (See diagram.)

2. Put the jars near a sunny window.

3. Observe the jars several times during the day for a period of at least a week.

4. Record your observations on the observation sheet.



Observation Sheet
Water Cycle Model

Team Members: ____ Date: ____________________

____

	Day 1	Day 2	Day 3	Day 4	Day 5
Solar Energy Record: Good/Fair/Poor	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:
Evaporation Record: Good/Fair/Poor	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:
Condensation Record: Good/Fair/Poor	ob. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1 obs. 2: obs. 3:
Water Level (measure in inches or centi-meters)	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1: obs. 2: obs. 3:	obs. 1 obs. 2: obs. 3:

What time of day does condensation usually appear? ______________________________

What processes are occurring to make these changes? ______________________________

What is the role of sunlight and temperature? ______________________________

Conclusions: ____

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COPY

A-maze-ing Water

Grade Level:
Lower Elementary, Upper Elementary, Middle School

Subject Areas:
Environmental Science, Health

Duration:
Preparation time:
Option I: 15 minutes
Option II: 50 minutes

Activity time:
Option I: 30 minutes
Option II: three 50-minute periods (includes drying time for maze)

Setting: Classroom

Skills:
Organizing (manipulating materials); Interpreting (identifying cause and effect); Applying (designing)

Charting the Course
Prior understanding of how water flows through a watershed supports this activity ("Branching Out!"). Students can investigate the role their school plays in adding to the city's runoff in "Rainy-Day Hike." The activity "Sum of the Parts" can be adapted to include the schoolyard as a nonpoint source contributor.

Vocabulary
storm drain, nonpoint source pollution, runoff, contaminants

Imagine turning on your water tap and having everything that you dumped into the gutter last week flow into your glass.

Summary

Students guide a drop of water through a maze of "drainage pipes" to learn how actions in the home and yard affect water quality.

Objectives

Students will:

- describe urban forms of pollution.
- provide reasons why people should monitor what they put on their lawns or in streets.
- identify ways to treat urban runoff.

Materials

For Option 1:

- *Can or bottle labeled "chemicals" or "oil"*
- *Chalk*
- *Pieces of self-sticking paper, flour, or other materials to represent pollutants found in urban runoff*

For Option 2:

- *Cardboard 8 inches (21.3 cm) x 10 inches (25.4 cm)* (1 per student or group)
- *Wax paper*
- *Tape*
- *Wood glue*
- *Clay or modeling dough* (Following is a simple recipe for modeling dough: Knead together 1 cup (22.4 g) flour, 1/2 cup (11.2 g) salt, 3/4 cup (180 ml) boiling water, 1 tablespoon (15 ml) salad oil, and 1 tablespoon (5 g) alum [optional]; if too sticky, add more flour and salt.)
- *Water*
- *Sugar, salt, pepper, food coloring, oil, and other materials to represent pollutants found in urban runoff*
- *Wax marking pencil*
- *Pipette or eyedropper*
- *Pencil and paper*

Making Connections

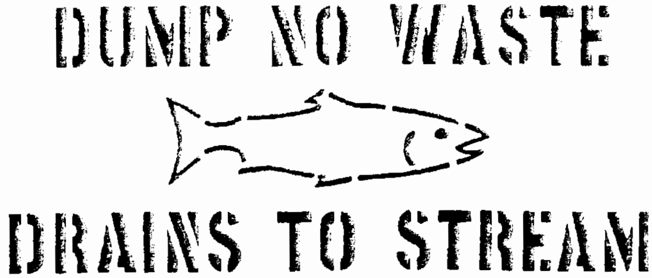
Most students have washed family cars, seen litter on the sidewalk, or walked a dog. In urban settings, car wash detergent, litter, animal waste, paint, and oil all wash into the street and down storm drains. Investigating what happens to these materials after they enter drainage systems helps students understand how these materials can affect water supplies and aquatic plants and animals.

Background

Removing water quickly and efficiently from city streets, parking lots, and schoolyards following precipitation or snowmelt is an important task for municipal governments. Water flowing through city drainage pipes is often referred to as an urban watershed. Before storm drainage systems were common, cities experienced localized flooding because of poor or nonexistent drainage patterns and flooded sewer systems that overflowed with storm water. Both circumstances caused significant health and safety concerns that warranted solutions. Today, most city governments require housing developers to install city-approved storm water drainage systems.

Traditionally, water diverted to storm water systems received little or no treatment before flowing into a stream or body of water. Environmental agencies found that water draining off lawns, sidewalks, driveways, parking lots, and streets carried significant amounts of pollutants. These pollutants included fertilizers, motor oil, litter, pesticides, animal waste, and other contaminants. Receiving waters were degraded, and aquatic plants and animals were affected. Some communities resolved the problem by channeling storm runoff into a wastewater treatment plant. But this is an expensive procedure, and some plants are unequipped to process the inorganic materials found in urban runoff. A more cost-effective system was needed to treat storm water discharge. The scenario below describes one such water treatment system.

> Imagine the parking lot of a large shopping center. Each year thousands of cars park in the lot, each depositing a small amount of engine oil- and grit (loosened road materials). A gentle rain begins to wash the lot. At the lot's lowest point, oil- and gas-tainted runoff water begins to flow into the street's gutter. A few blocks away, an urban river flows, filled with floating debris, sediment, and multi-colored water from another street, then another, and another. The flow now nearly fills a ditch constructed to channel urban runoff. From a distance the storm water in the drainage system appears dark-colored. Perhaps the road salt used to melt ice on roads and sidewalks has mixed in. How about the paint a neighbor pours into the gutter? The pet waste near the sidewalk? Whoosh, more water moves by! What next? What about the nearby stream and the people using water downstream for their drinking supply?
>
> You follow the water to a large pond that the city constructed to catch storm water. The water in the pond is now moving slowly through cattails and other emergent wetland vegetation, and its color has started to change. Where is the debris and the sediment? And what about other waste materials? A woman from the city health department tests the water as it enters a small stream; she concludes that the water is cleaner than the river it is about to enter.



Solutions to urban storm water pollution problems require participation by everyone. Homeowners can help by carefully following directions when applying pesticides and fertilizers, using biodegradable products whenever possible, cleaning up pet wastes, not disposing of household wastes in the street, and fixing oil leaks in vehicles. City sanitation departments can supply information on proper disposal procedures for paint cleaners, used oil, or leftover paint. In addition to developing wetland systems to help treat urban runoff, many city governments periodically sweep roadways to remove wastes. They plant greenways and preserve green space to help filter runoff from streets and parking lots.

Procedure

▼ *Warm Up*

Show students a can or bottle labeled "chemicals" or "oil." Tell students you need to dispose of the chemicals and plan to dump them in the street in front of the school. Ask students if they think this is a good idea. Have students describe what they think will happen to the waste material. Read the first paragraph of the scenario in the **Background**. Ask students what they think might happen to the runoff.

▼ *The Activity*

Following are two options for simulating urban runoff being collected within a storm drain system.

Option 1

1. **Discuss how water is used to clean things, such as the surface of a table after a spill. Relate how rainwater washes the outdoors.** Explain that as it flows over plants, soil, and sidewalks, it picks up and carries away soil and other materials. Inform students that cities use water to clean the waste from city streets and sidewalks. Often the water goes down storm drains, collects in pipes, and flows to a river or a treatment plant. (If a media center or water table is available, younger students can use pieces of tubing and plastic pipe to create a mini-water transport system. They can explore how pipes help water travel over distances by pouring water into one end of a tube and watching it run out in a different location.)

2. **Draw a simple but large maze on the school blacktop (see example on page 222) or arrange the chairs in the classroom to form the maze. The maze represents underground pipes that collect and transport surface water that has flowed down storm drains. Have students run the maze. Inform them they are water flowing through the drainage pipes to the river or treatment plant.**

3. **Discuss sources of water that run into the storm sewer system (streets, lawns, parking lots, etc.).** What might this water carry? (Oil from cars, fertilizers, litter.)

4. **To simulate surface water transporting pollutants into drainage pipes, have several students**

position themselves along edges of the maze. They represent storm drains and the contaminated water flowing through them. They should hold pieces of self-sticking paper or bowls of flour to symbolize the pollutants. When other students run through the maze, the students representing storm drains stick pieces of paper or sprinkle flour onto the clothing of the maze runners to represent contaminated water mixing with water (that may or may not be clean) flowing through the system.** Allow students to take turns playing different roles.

5. **After several trips through the maze, discuss what happens to this dirty water.** What if it flows into the river? Can treatment plants process all the waste? Have students summarize why they should not litter.

6. **To represent a treatment system, have two students stand at the maze exit. Similar to the game London Bridge, the two treatment students "trap" each passing water student and remove as many pollutants as possible before he or she goes into the river.** What are students' attitudes about the quality of this water passing into the river?

Option 2

1. **Prepare or have students make mazes representing storm pipes carrying away street runoff.** A suggested pattern is provided on page 222. Build each maze on a piece of cardboard covered with wax paper. The walls of the maze are made from clay or modeling dough. Coat the walls and floors of the maze with wood glue and allow to dry. (Allow one day for clay to dry, and one day for glue to dry.)

2. **The maze should have one starting point and two exits.** One exit leads to a sewage treatment plant, and the other flows into a stream. Use a wax pencil to label the exits.

3. **Have students list materials people purposefully or inadvertently add to gutters and storm drains.** Have students draw a picture of a city street depicting these activities. They can switch drawings with a partner to see if their classmates can identify the polluting activities.

4. **Place drops of food coloring, salt water, and sugar water mixed with pepper on different places in the maze.** (See *Suggested Maze Pattern.*) Allow one day for the water to evaporate. Drops of oil can also be placed at certain locations. These all represent contaminants added to urban waste systems.

5. **Tell students to place a drop of water at the starting point and to tilt the maze so that the drop flows slowly toward one of the exits.** Toward which one should they aim?

6. **As the drop flows through the paths, it should pick up dye from the food coloring, particles from the salt and pepper, and possibly oil droplets.** This represents water moving through a municipal storm water system.

7. **When the drop reaches the exit, have students describe what the drop looks and feels like. If it ended in the treatment plant, the drop gets replaced with a clean drop of water. If it ended in the overflow ("untreated water" exit), the drop is added to a cup labeled "stream."**

Wrap Up and Action

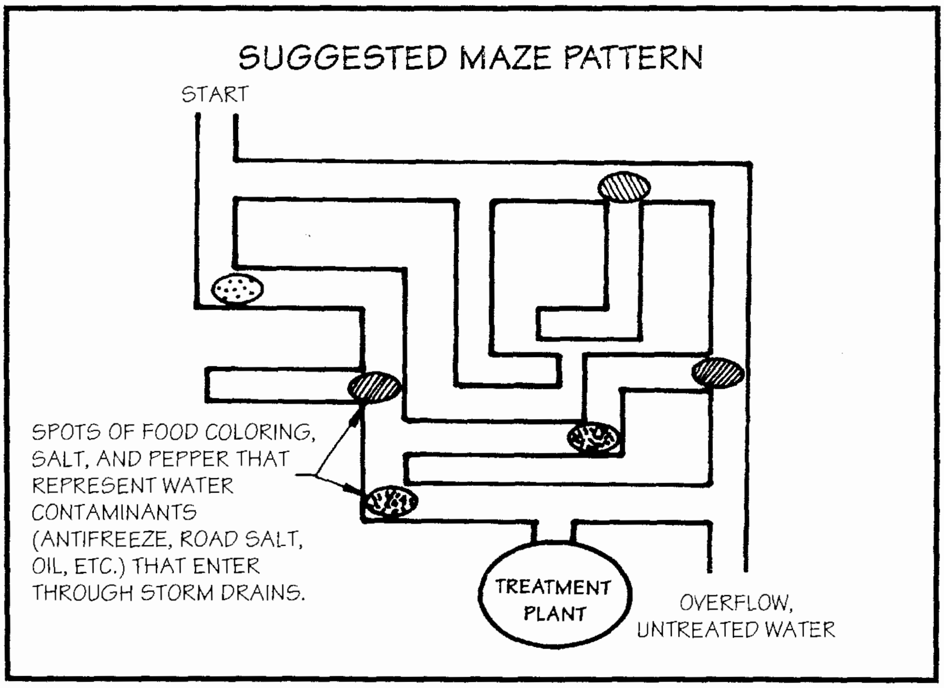
Discuss the problems associated with untreated urban runoff entering rivers or other bodies of water. Have students identify or research ways contaminated water affects aquatic life and drinking water supplies.

Introduce students to the many actions people can take to limit contaminants entering urban runoff. These include properly disposing of pet waste and litter, and discarding chemicals and oils according to manufacturer's directions. Inform students that many cities have developed systems to treat runoff. Refer to the scenario in the **Background** and read the second paragraph.

Have students contact their local wastewater treatment plant or public works department to determine whether their street runoff enters the treatment plant or if it flows directly into the river or filters into ground water systems.

Students may want to begin a storm drain monitoring program. This involves sending messages to the community illustrating how and why it should monitor what flows down streets into storm drains. Students can design a brochure describing ways individuals can reduce their contribution to surface and ground water pollution via urban runoff. Students can contact recycling centers, wastewater facilities, or their state department of natural resources to research ways individuals can reduce the amount of fertilizers and pesticides they use, choose alternatives to home and garden chemicals, and safely dispose of household wastes. If the city or county recycling office has a hazardous waste collection program, this could be included in the brochure as well.

In addition to the brochure, students can start a stenciling program. Students can make or purchase a stencil (see **Resources**) with a message about monitoring what flows down storm drains (e.g., "DUMP NO WASTE—DRAINS TO STREAM"). The stencils are used to spray-paint the message near neighborhood storm drains. Students can include information about the stenciling and its intent in their brochure, which they deliver to community members who live near the drains. Make sure students obtain permission from city or county public works departments before beginning the project.



Assessment
Have students:
- identify urban sources of pollution (***Warm Up***, **Option 1**, step 3, and **Option 2**, step 3).
- design mazes to simulate storm water drainage systems (**Option 2**, steps 1-4)
- explain why certain materials should not be dumped into the street or used carelessly (**Option 1**, step 5 and ***Wrap Up***).
- design a brochure describing steps individuals and communities can take to prevent surface water contamination (***Wrap Up***).

Extensions
Students can research alternatives to house and lawn chemicals and cleaning agents. Contact the local recycling center, the waste treatment facility, or a local environmental group for details. Invite a representative from the local water treatment plant to enrich the activity. Visit a local gas station and have the manager explain what happens to oil after cars are serviced.

Resources
Cole, Joanna. 1986. *The Magic School Bus at the Waterworks.* New York, N.Y.: Scholastic, Inc.

Environmental Concern Inc., The Watercourse, and Project WET. 1995. Activities "Treatment Plants" and "Water Purifiers." *WOW! The Wonders of Wetlands.* Published through a partnership between Environmental Concern, Inc., St. Michaels, Md., and The Watercourse, Bozeman, Mont.

The Water Education Foundation, 717 K Street, Suite 517, Sacramento, CA 95814. (916) 448-7699.

For information on storm drain monitoring and stenciling programs, contact:

Step Coordinator, Oregon Department of Fish and Wildlife, P.O. Box 59, 2501 S.W. First Avenue, Portland, OR 97207.

Earthwater Stencils, 4425 140th SW, Dept. WT, Rochester, WA 98579.

Center for Marine Conservation, 306A Buckroe Avenue, Hampton, VA 23664.

Color Me a Watershed

- **Grade Level:** High School
- **Subject Areas:** Environmental Science, Mathematics, History
- **Duration:** Preparation time: Option 1: 10 minutes Option 2: 10 minutes Option 3: 10 minutes Activity time: Option 1: 40 minutes Option 2: 50 minutes Option 3: 40 minutes
- **Setting:** Classroom
- **Skills:** Gathering information (calculating); Analyzing (comparing); Interpreting (identifying cause and effect)
- **Charting the Course** Prior to this activity, students should have a general understanding of watersheds ("Rainy-Day Hike" and "Branching Out!"). Activities in which students compare runoff from different surfaces are "Capture, Store, and Release" and "Just Passing Through."
- **Vocabulary** discharge, watershed, runoff

What might make a watershed blue . . . or brown . . . or green?

Summary

Through interpretation of maps, students observe how development can affect a watershed.

Objectives

Students will:

- recognize that population growth and settlement cause changes in land use.
- analyze how land use variations in a watershed can affect the runoff of water.

Materials

- *Maps and photographs of community, past and present* (optional)
- *Copies of* ***Maps A, B, and C***

For Option 1:

- *Colored pencils*

For Options 2 and 3:

- *Calculator*
- *Copies of the chart* ***Area of Land Coverage***
- *Copies of the chart* ***Volume of Rain and Volume of Runoff***

Making Connections

Learning about the past refines our current perspectives and helps us plan for the future. Historical, sequential maps provide graphic interpretations of watershed history. By comparing past and current land use practices, students can recognize trends in development; this knowledge can help them appreciate the importance of watershed management.

Background

Resource managers and policymakers use maps to monitor land use changes that could contribute to increased amounts of runoff flowing into a river. Vast amounts of public and private time, energy, and money have been invested in research projects specifically designed to collect land use data. Land uses that are monitored include, but are not limited to: urban (residential, parks, and businesses); agriculture (pastures and corn, soybean, wheat, sunflower, tomato, pineapple, and lettuce production); industry; transportation systems (roads, railroads, and trails); and public lands (refuges, parks, and monuments).

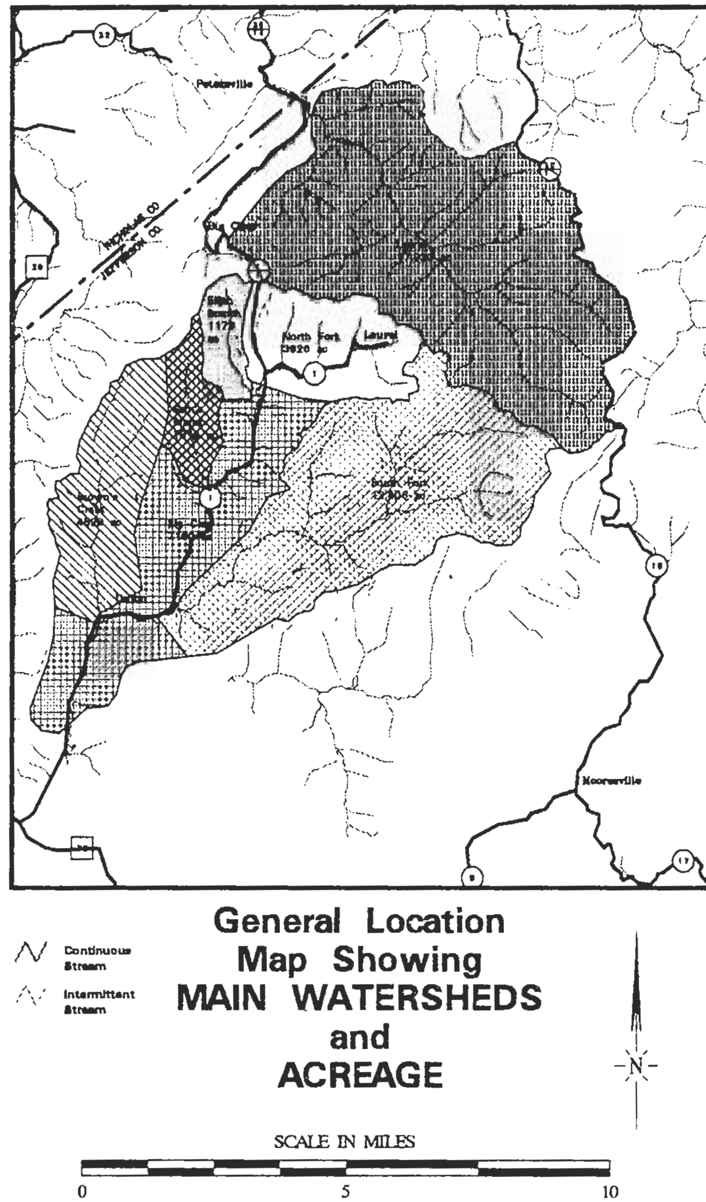
Land use changes can have significant impact on a region's water resources. Streams, lakes, and other bodies of water collect water drained from the surrounding land area, called a watershed or drainage basin. After periods of precipitation or during snowmelt, surface water is captured by the soil and vegetation, stored in ground water and in plants, and slowly released into the collection site (e.g., a stream).

Resource managers are developing and using Geographic Information Systems (GIS) to store data and generate land use maps electronically. Although the process of collecting the data is tedious work, the ease of generating usable maps and map overlays is significant. For example, a water manager could generate a map that shows a river's watershed and major tributaries, its floodplains, and the locations of urban dwellings (homes and businesses), to display areas likely to be impacted by floods. This information is valuable to local governments, planners, Realtors, bankers, homeowners, and others. This map could also be compared to similar land use maps from 10, 20, or 30 years ago.

One way watershed managers study drainage basins is by measuring streamflow. Determining how much water is discharged by a watershed involves measuring the amount of water (volume) that flows past a certain point over a period of time (velocity). Streamflow is measured in cubic feet per second (cfs) or cubic meters per second (cms).

By measuring the amount of water flowing through a stream channel over a period of years, scientists calculate average streamflow. When streamflow changes significantly from its normal quantities, watershed managers investigate reasons for this anomaly. The amount of water discharged by a watershed is influenced by soil conditions, vegetative coverings, and human settlement patterns. Wetlands, forests, and prairies capture and store more water than paved roads and parking lots. Consequently, urban areas will have more runoff than areas covered with vegetation.

Water managers carefully assess land use changes and set development policy accordingly. For example, in areas that are susceptible to erosion, the incorporation of soil conservation measures (e.g., planting cover crops on farmland and establishing grassed waterways) can significantly reduce erosion and stream sediment load. Managers may designate lands so susceptible to erosion that landowners are required to plant vegetation on them. In urban areas, local governments may set aside natural areas to serve as filters for storm water runoff, based on runoff data and stream water quality problems. In each situation, using maps to understand past and present land use helps water managers better predict future problems.



Sample GIS map.

Procedure

▼ *Warm Up*

What did the land and water around cities like Los Angeles, Portland, Minneapolis, Houston, Chicago, New Orleans, Miami, or Washington, D.C., look like 100 or 50 years ago? How has growth changed each region? Ask students to imagine their community 100 years ago. They may want to refer to old photographs or news stories. Was the school in existence? What happened when water fell on the ground then, compared to now? If a body of water is near the school, would its appearance and condition have been altered over the years? Tell students that maps can teach us about the past and possibly answer questions such as these.

The Activity

Provide students with copies of *Maps A, B,* and *C*. Explain that they represent aerial views of a watershed taken at different times. To simplify map interpretation, the borders of the watershed coincide with the edges of the grid. In addition, the outlines, of various land areas (e.g., wetlands, forests) align with grid lines.

Following are three options for interpreting changes in the watershed presented on the maps. The first option may be more appropriate for younger students, but can help all students complete **Options 2** and **3**. Students should be able to multiply and calculate percentages to complete the second and third options.

Option 1

1. **Tell students to look at *Maps A, B,* and *C*. Explain that they represent changes in this land over a 100-year period. Have students look at the key for each map. Instruct them to designate each land area with a different color (e.g., color all forest areas green).** They should use the same color scheme for all maps.

2. **When students finish coloring, have them compare the sizes of the different areas on each map and among maps.** Ask them to compare plant cover and land use practices in each of these periods. They may note changes in croplands, forests, grasslands, wetlands, urban land uses, etc.

3. **Discuss one or more of the following questions:**
   - What happens to the amount of forested land as you go from *Map A* to *Map C*?
   - Which map has the most land devoted to human settlements?
   - Where are most of the human settlements located?
   - What effect might these human settlements have on the watershed?
   - Would you have handled development differently?

Option 2

1. **Have students determine the land area of each of the maps.** Each unit in the grid represents 1 square kilometer; there are 360 square kilometers (or 360,000,000 m^2) on each map.

2. **For each map, have students determine how much area is occupied by each type of land coverage (e.g., forest, wetland, and farmland).** Responses can be guesses or exact calculations. For example, for *Map A*, 17 of the grid units are occupied by wetlands. By dividing 17 by the total number of units (360), students should calculate that 4.7% of the land area is wetlands. The amount of land allotted to wetlands, forests, etc. will change for each map, but the amount of stream coverage (111 squares or 30.8%) will remain constant. Students should record their answers in the *Area of Land Coverage* chart.

NOTE: Most watershed calculations employ standard measurements: inches and cubic feet per second (cfs). However, to facilitate students' computations, metric measurements are used here.

3. **Tell students that the watershed has received 5 cm (0.05 m) of rain. (Although rain does not normally fall evenly over a large area, assume that the 5 cm of rain fell evenly over the entire watershed.) By converting both the rainfall and the land area to meters, students can calculate the amount of water (m^3) which fell on the land.** 18,000,000 m^3 of rain fell on the watershed (0.05 m x 360,000,000 m^2 = 18,000,000 m^3). Of this 18,000,000 m^3 of rain, 5,550,000 m^3 landed on the stream (111,000,000 m^2 x 0.05 m = 5,550,000 m^3). This might seem like a large quantity of water, but if 5 cm of rain did fall evenly on a watershed of this size, the stream would receive this volume of water. (NOTE: 100 cm = 1 m; 1,000,000 m^2 = 1 km^2.)

4. **Ask students to estimate the amount of water that would be drained from the land into the stream.** Tell students that for the watershed represented by *Map A*, 2,767,500 m^3 of rain was runoff (i.e., the water flowed into the stream and did not soak into the ground, did not evapo-

ANSWER KEY: AREA OF LAND COVERAG3E

	MAP A 100 years ago		MAP B 50 years ago		MAP C Present	
Land coverage	km^2	%	km^2	%	km^2	%
Forest	189	52.5	162	45	111	30.8
Grassland	20	5.6	14	3.9	6	1.7
Wetland	17	4.7	13	3.6	5	1.4
Residential	13	3.6	33	9.2	58	16.1
Agriculture	10	2.8	27	7.5	69	19.2
Stream	111	30.8	111	30.8	111	30.8

rate, and was not used by plants or animals). (Runoff volumes are provided in the *Answer Key* below. In **Option 3**, students can calculate runoff for each land area.)

5. **Discuss changes in land coverage represented in *Maps A* through *C*. Ask students if they think the amount of runoff would increase or decrease.**

6. **Tell students that when 12,450,000 m³ of rain fell on the land represented by *Map A*, 2,767,500 m³ was runoff. For *Map B*, 3,612,500 m³ was runoff. For the *Map C*, 4,797,500 m³ was runoff. Discuss the following questions in addition to those listed in Option 1.**

- Which absorbs more water, concrete or forest (or wetlands or grasslands)?
- Which map represents the watershed that is able to capture and store the most water?
- What problems could arise if water runs quickly over surface material, rather than moving slowly or soaking in?
- How might the water quality of the stream be affected by changes in the watershed?

Option 3
Have students determine how the figures in Option 2 were obtained. In the chart ***Volume of Rain and Volume of Runoff***, each land area has been assigned a proportion of the water that is not absorbed or that runs off its surface. Using the information from this chart and from the *Area of Land Coverage* chart, have students calculate the amount of water each land area does not absorb. For example, for the forested land in *Map A*, 189 km^2 x 1,000,000 m^2/km^2 = 189,000,000 m^2 of land. Multiply this by the amount of rainfall (189,000,000 m^2 x 0.05 m = 9,450,000 m^3). Since 20% of the rainfall was runoff, 1,890,000 m^3 of water drained into the stream from the forested land (9,450,000 m^3 x .20).

NOTE: The figures for percent runoff are based on hypothetical data. To determine how much water is absorbed by surface material, one needs to know soil type and texture, slope, vegetation, intensity of rainfall, etc. In addition, many farms and urban areas practice water conservation measures that help retain water

ANSWER KEY: VOLUME OF RAIN AND VOLUME OF RUNOFF

	MAP A 100 years ago		MAP B 50 years ago		MAP C Present	
Land coverage and % runoff	**volume m^3**	**runoff m^3**	**volume m^3**	**runoff m^3**	**volume m^3**	**runoff m^3**
Forest 20% runoff	(9.45×10^6) 9,450,000	(1.89×10^6) 1,890,000	(8.1×10^6) 8,100,000	(1.62×10^6) 1,620,000	(5.55×10^6) 5,550,000	(1.11×10^6) 1,110,000
Grassland 10% runoff	(1.0×10^6) 1,000,000	($.1 \times 10^6$) 100,000	($.7 \times 10^6$) 700,000	($.07 \times 10^6$) 70,000	($.3 \times 10^6$) 300,000	($.03 \times 10^6$) 30,000
Wetland 5% runoff	($.85 \times 10^6$) 850,000	($.0425 \times 10^6$) 42,500	($.65 \times 10^6$) 650,000	($.0325 \times 10^6$) 32,500	($.25 \times 10^6$) 250,000	($.0125 \times 10^6$) 12,500
Residential 90% runoff	($.65 \times 10^6$) 650,000	($.585 \times 10^6$) 585,000	(1.65×10^6) 1,650,000	(1.485×10^6) 1,485,000	(2.9×10^6) 2,900,000	(2.61×10^6) 2,610,000
Agriculture 30% runoff	($.5 \times 10^6$) 500,000	($.15 \times 10^6$) 150,000	(1.35×10^6) 1,350,000	($.405 \times 10^6$) 405,000	(3.45×10^6) 3,450,000	(1.035×10^6) 1,035,000
Total runoff		2,767,500		3,612,500		4,797,500
Total runoff plus stream discharge (5,550,000 m^3)		(8.3175×10^6) 8,317,500		(9.1625×10^6) 9,162,500		(10.347×10^6) 10,347,500

and prevent it from streaming over the surface. The information in the chart is intended only for practice and comparisons.

Wrap Up and Action

Have students summarize how changes in the land affect the quantity and quality of runoff in a watershed. Discuss land use practices in the community and how they may affect water discharge in the watershed. Take students on a walking tour around the school and community, and note areas that contribute to or reduce storm runoff. (For example, parking lots, paved roads, and sidewalks promote runoff; parks, wetlands, and trees capture water.)

Students could attend a public meeting in which changes in land use for their community are being discussed.

If students were to draw a fourth map of the same area 100 years in the future, how would it appear? Have students plan a city that contributes positively to a watershed. They should contact city planners or conduct library research to support their projections.

Assessment

Have students:

- compare land area occupied by farms, towns, and natural areas in a watershed during different time periods (**Options 1** and **2**).
- describe how surface runoff is influenced by changes in land use (**Option 2**).
- calculate quantities of runoff from different land areas in a watershed (**Option 3**).

Upon completing the activity, for further assessment have students:

- design a city plan that regulates urban runoff.

Extensions

Have students explore changes in their own community. Sources of historical and current maps include the Natural Resource Conservation Service, the Bureau of Land Management, the U.S.D.A. Forest Service, the U.S. Geological Survey, or a local public works department. Sometimes libraries contain historical, hand-drawn maps from the 1700s to the 1900s. Resource people in these agencies or the community will also have information and perspectives about past, present, and future water use.

Students may want to conduct a more accurate analysis of the degree to which different surface areas are permeable to water. Contact conservation agencies or extension agents in the community to learn how different soil types affect runoff.

Several books for young people powerfully describe and illustrate the effects of human development on land areas. Students may want to compare the changes indicated by the maps to changes portrayed in *Window*, by Jeannie Baker, or other sources.

Students can use computer technology to increase their understanding of geographical features, through Geographic Information Systems (GIS). Contact Charlie Fitzpatrick, ESRI K-12 Education and Libraries, 3460 Washington Drive, Suite 101, St. Paul, MN 55122. (612) 454-0600, ext. 26).

Or e-mail cfitzpatrick@esri.com for information about how to order and use ArcView, a computer program that enables learners to investigate GIS files.

Resources

Baker, Jeannie. 1991. *Window.* New York, N.Y.: Greenwillow Books.

Guling, Cynthia L., and Kenneth I. Helphand. 1994. *Yard Street Park.* New York, N.Y.: John Wiley & Sons.

Huff, Barbara A. 1990. *Greening the City Streets: The Story of Community Gardens.* St. Louis, Mo.: Clarion Publishing Co.

Leopold, Luna B. 1974. *Water: A Primer.* San Francisco, Calif.: W. H. Freeman & Co.

Patterson, Mark, and Ron Mahoney. 1993. *Environmental Education Software and Multimedia Source Book.* Moscow, Idaho: University of Idaho Agricultural Publications.

Smith, Daniel S., and Paul Cawood Hellmund. 1993. *Ecology of Greenways.* Minneapolis, Minn.: University of Minnesota Press.

Notes

Great Water Journeys

■ **Grade Level:**
Middle School, High School

■ **Subject Areas:**
Geography, Earth Science, History

■ **Duration:**
Preparation time: 20 minutes

Activity time: 50 minutes

■ **Setting:** Classroom

■ **Skills:**
Gathering information (reading, listening, researching); Organizing (mapping); Applying (designing); Presenting

■ **Charting the Course**
How water travels over Earth's surface is addressed in "Branching Out!" In "Water Crossings," students investigate how early travelers overcame or utilized watercourses. How water moves around the world through the water cycle is introduced in "Imagine!". "Piece It Together," "Wet Vacation," and "A Drop in the Bucket" are related activities that investigate distribution of water around the world.

■ **Vocabulary**
migration

What do Lewis and Clark, gray whales, and coconuts have in common?

Summary
Using a global map and a set of clue cards, students locate some significant water journeys.

Objectives
Students will:
- locate a few of the diverse pathways water travels around the globe.
- describe how water provides an important mode of transportation for plants and animals.

Materials
- *Pencils*
- *Copies of* ***Water Journey Trivia Clues and Summaries***
- *An encyclopedia* (optional)
- *Copies of* ***Global Map***
- *A world atlas*
- *Wall map*

Making Connections
Students are accustomed to thinking of airplanes and cars, highways and train tracks when they consider making a journey. But, unless they live in a region where water transportation is common, water travel is not likely to play a part in their lives. In "Great Water Journeys," students learn the vital role water has played in transporting plants, people, and other animals around the world.

Background
Water is a restless element, driven by solar energy, wind, gravity, and pressure (for glaciers and some ground water). It can be an obstacle to travel, as in the case of river crossings, and a dangerous medium (ocean storms or fast rivers), but it can also be the very highway that makes travel possible.

People, other animals, and plants move (and migrate) in response to a variety of environmental and social conditions. Sometimes water journeys are a matter of accident or coincidence. A tree falls into a flooding river, travels halfway across a continent, and ends up snagged in the trestles of a railroad bridge. In other cases, plants and animals have evolved to take advantage of water travel as part of their survival strategy. Some water plants have buoyant seeds that will float until they reach a favorab habitat in which to take root. Many aquatic species rely on water transportation in the course of their seasonal migrations, traveling to and from food sources, spawning grounds, and suitabl climates.

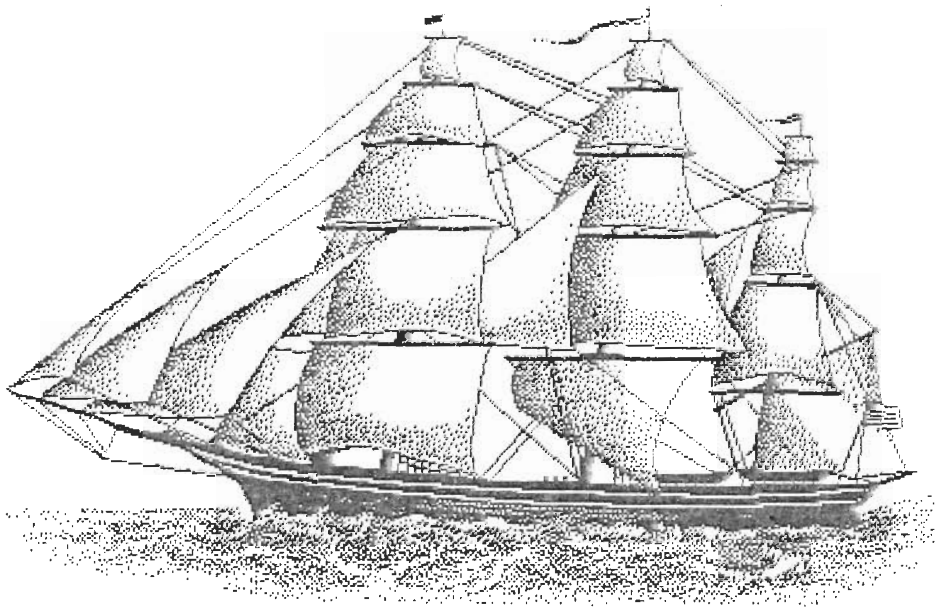
Human water journeys throughout history have been motivated by various factors. Social oppression can cause whole sectors of a population to move away, sometimes by boat or across frozen expanses of water. Starvation, changing climate, and natural disasters are all capable of precipitating mass human movements. Curiosity or a desir for riches has sparked other water explorations. In island and coastal cultures, people constantly move across the water out of necessity or to benefit from their aquatic surroundings.

Gravity pulls water downhill, eventuall into the sea. Winds and the rotation of Earth combine to power ocean currents, like rivers within the sea. On many of these journeys, water carries myriad passengers along with it, destined for new homes, new discoveries, and unexpected adventures.

Procedure
▼ *Warm Up*
Ask students to think back to the last journey they took that involved water travel (even a short trip or water cross-

ing). If they have never traveled by water, ask if they would like to take a water journey. Ask them to think about places where water provides the most efficient, or perhaps the only, transportation (oceans, swamps, cliffy coastlines, tropical forests).

Briefly discuss how plants and animals have been transported around the world by water. Have students think of three famous water journeys taken by humans. (People of local fame or from folklore and fiction, like Huck Finn, are acceptable.) See if students can think of examples of any plant, animal, or water molecule journeys.



The Activity

1. **Divide the class into small groups. Tell students that they will be playing a geographic water journey trivia game.** They should pool their knowledge to identify specific water journeys.

2. **Inform the groups that they will hear three clues about each of nine water journeys, labeled "A" through "I." Based on the clues, they should try to guess who or what did the traveling. The first group to guess correctly receives a point and a summary card describing the journey.**

3. **Read the clues out loud for each card and allow time for the groups to discuss their guesses.** Make sure each group gets at least one summary card. (Some groups may receive a point but no card for a correctly guessed journey; the card is given to another group.)

4. **After all the summary cards have been distributed, tell groups to read their cards and, if possible, supplement the information with readings from science texts and history books.**

5. **Hand out copies of the *Global Map* to each group. Based on their summary cards and any other information, each group should sketch the path they think the subject of their summary card(s) traveled.** The starting and ending points are indicated on their summary cards, but remind students that the shortest distance between A and B is not always the best path. Mountain ranges or deserts, contrary winds or stormy seas may create obstacles. Students may consult a world atlas, if necessary.

6. **When students think they have the correct pathway, have them check the master map and compare their routes against the actual ones.** Discuss any major discrepancies. What explanations for the differences can they provide? (Consult the atlas or world map as necessary.) Ask students to erase and redraw any of the routes that were inaccurate on their first attempt.

Wrap Up

Have each group give a class presentation about the water journey they studied. Encourage them to be accurate, but creative. On a class map, they should show the pathway of the journey and tell the other groups to copy the route onto their own maps. Have the class make one master map of great water journeys, to be posted in the school library.

Have each small group brainstorm a few other great water journeys. After selecting one, they should come up with several appropriate clues and try to draw a route on their map as accurately as possible. (Some research time may be necessary.) Groups can take turns presenting clues and trying to stump other teams with their water journey trivia.

Assessment

Have students:

- plot water pathways based on geographic clues (step 5).
- compare and evaluate projected water journeys versus actual travel routes (step 6).
- develop a presentation about a great water journey (*Wrap Up*).
- research and create their own water journey trivia clues and summary cards (*Wrap Up*).

Extensions

Students may be interested in writing short fictional adventure stories about a character (plant, animal, water molecule) as it makes a water journey, such as the one described in *Paddle to the Sea* by Clancy Holling (1941). In *Paddle to the Sea*, a young boy living within the St. Lawrence River drainage basin carves a Native American figure paddling a canoe. He places the carving on a snow bank and waits for spring, when the snow will melt and carry "Paddle to the Sea" away. The little boat encounters many people as it makes its way through the Great Lakes and beyond. The story provides insight into watersheds and the culture of the Great Lakes regions.

Orient students to watercourses by having them trace the routes of the major North American rivers (e.g., Colorado, Columbia, Mississippi, Missouri, Rio Grande), as the water moves from each river's headwaters (starting point) to its confluence (end point or where it enters another river). Have students estimate the distances water travels using the map scale.

Resources

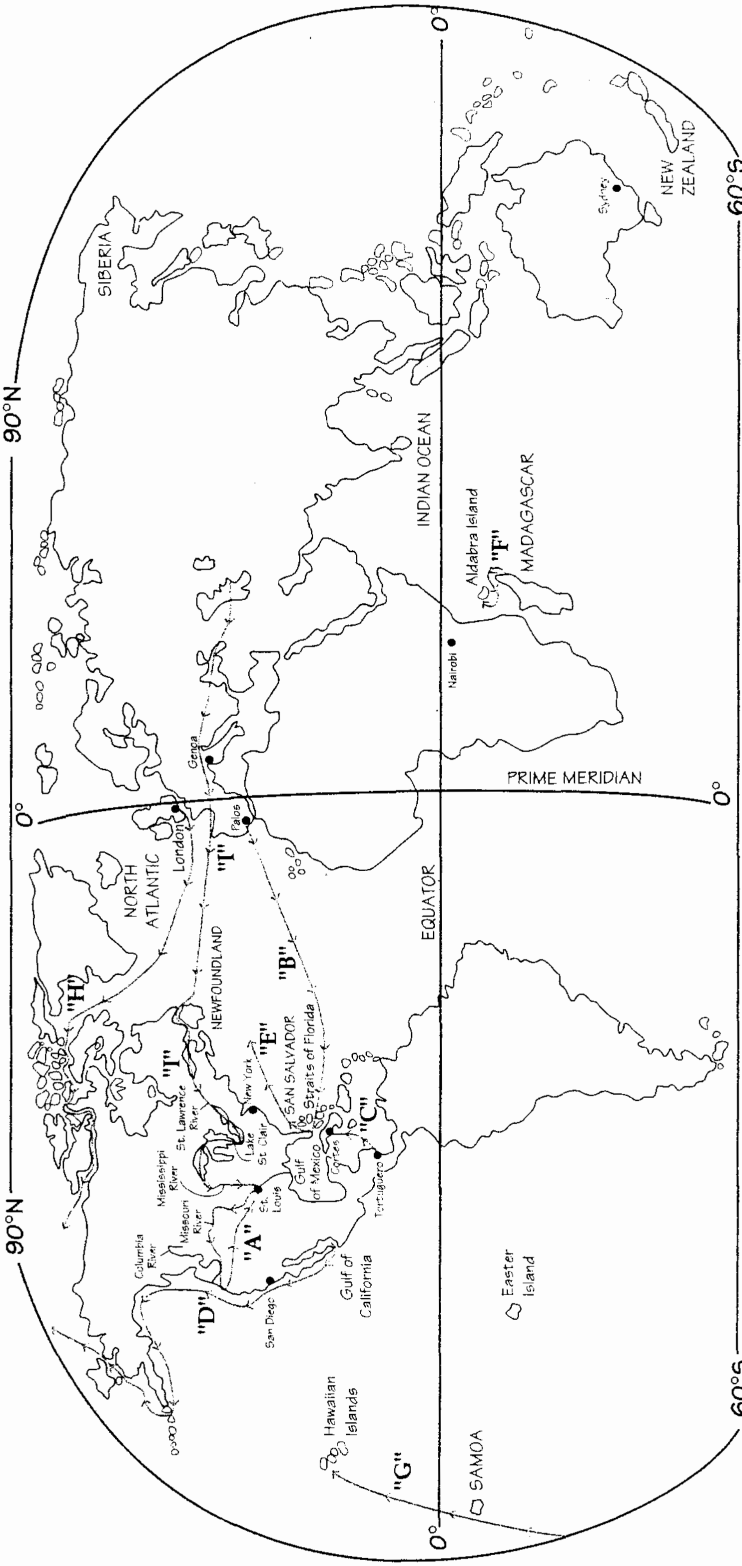
Fritz, Jean. 1994. *Around the World in 100 Years*. New York, N.Y.: G. P. Putnam's Sons.

Holling, Clancy. 1941. *Paddle to the Sea*. Boston, Mass.: Houghton Mifflin Company.

Mason, Anthony. 1993. *Children's Atlas of Exploration*. Brookfield, Conn.: Quarto Publishing.

Zebra Mussel Watch, University of Wisconsin Sea Grant Institute, 1800 University Ave., Madison, WI 53705-4049. (608) 262-0645.

Answer Key for Global Worksheet



Water Journey Trivia Clues and Summaries

Journey "A"

Clues:

- The president of the United States requested this journey in the first years of the 1800s. If it hadn't been for the Louisiana Purchase, the trip might never have been taken.
- Many new species of plants and animals were discovered and named, including the grizzly bear.
- They were just a couple of ramblin' guys, but sometimes they had help from an extraordinary Native American woman, Sacajawea.

Summary:

Meriwether Lewis and William Clark, along with their company (consisting of more than 30 people), spent more than two years (1804-1806) exploring the wild frontiers of what is now the western United States. Their journey took them up the Missouri River to its headwaters, across the Continental Divide and the Rocky Mountains, and down the watershed of the Columbia River to reach the Pacific Ocean. After spending a miserable winter there, they retraced their route to St. Louis, exploring the Yellowstone River along the way.

They were sent on their mission by President Thomas Jefferson, largely to secure America's claim to the recent Louisiana Purchase. Accompanying the party were William Clark's slave, York, and the wife of an interpreter, Sacajawea, who brought her young son. Remarkably—in a journey of that duration and covering thousands of uncharted miles—only one man in the expeditionary party perished. Charles Floyd died of appendicitis on August 20, 1804.

Water Path:

Start: St. Louis, Missouri **End:** St. Louis, Missouri

Journey "B"

Clues:

- My three ships were the *Pinta*, the *Niña*, and the *Santa Maria*.
- When I touched land at the end of my voyage, I thought I had reached the Orient.
- My claim to be the first European in the New World is now in doubt.

Summary:

Christopher Columbus, born in 1451 in Genoa, Italy, went to sea at the young age of 14. After a decade or more of sailing adventures, Columbus harbored a growing ambition to achieve great glory, and great wealth, by sailing westward over the Atlantic. As years passed he became obsessed with his goal.

It wasn't until 1492 that Columbus secured the support of Ferdinand and Isabella, sovereigns of Spain, that would allow him to set out. He left from the port of Palos on August 3, 1492. His voyage to a landfall on the Caribbean island of San Salvador covered 3,066 miles (4,913 km) and took 33 days. On October 12, 1492, Columbus set foot on land he thought was part of the Orient. It was a misconception he carried to his deathbed in 1506.

His voyage has been credited with the "discovery" of America, a land long inhabited by native peoples. But more recent information indicates that the first European visitor here may well have been Saint Brendan of Ireland or Norse explorer Leif Ericson.

Water Path:

Start: Palos, Spain **End:** San Salvador

Journey "C"

Clues:

- I was tagged on a beach in Costa Rica, late one moonlit night, and was found one year and 800 miles later on the coast of Cuba.
- My children were hidden under layers of warm sand.
- Chances for my survival have improved since humans started putting escape devices on fishing nets.

Summary:

Green sea turtles are a threatened and endangered species. They live in both the Atlantic and Pacific Oceans and migrate across long stretches of open water. Browsing in beds of turtle grass, they prefer shallow water vegetation for their food. Their habit of basking in the sun out of water is unique for marine turtles. Adults can attain shell lengths of 3-6 feet (1-2 m) and weigh up to 300 pounds (150 kg).

Along with other species of marine turtles, green sea turtles lay their eggs in sand pits at specific beach locations scattered around the world. Green sea turtles are known to live as long as 20 years, and will, in that life span, travel many thousands of kilometers. (This specific journey was verified by tagging studies.)

As with many marine turtles, the green sea turtle's future is uncertain. Destruction of nesting beaches and the practice of raiding nests for eggs threaten the species' continuation.

Water path:

Start: Tortuguero, Costa Rica **End:** Cortes, Cuba

Journey "D"

Clues:

- I "talk" in songs.
- Each year I migrate between two watery homes—one in the Arctic and one off the west coast of Mexico.
- My babies are called calves, and at birth are 15 feet (5 m) long.

Summary:

Summering each year in the north and wintering in the Gulf of California, where they give birth to their young, California gray whales spend their lives in the Pacific Ocean. From late May through October, they reside in the north, where they seem to be limited by pack ice in the Arctic Ocean. They concentrate along the coasts of Alaska and Siberia, feeding on a rich ocean harvest in shallow waters.

From the end of October through January, the gray whales move south, staying within a few miles of shore most of the time and traveling at an average rate of 115 miles (185 km) per day.

By February the gray whales have reached the warm tropical waters near the Gulf of California. Calves are born, usually in shallow lagoons. Although just 15 feet (5 m) long at birth, gray whales reach lengths of up to 42 feet (14 m) and weigh as much as 36,000 pounds (16,500 kg) as adults.

Water path:

Start: Gulf of California **End:** Off coast of Siberia or Alaska

Journey "E"

Clues:

- I am a river of water 1,000 times bigger than the Mississippi River, and I have no banks.
- England is warmer than Newfoundland because of me.
- Ships use me to increase their speed.

Summary:

The Gulf Stream originates in the Gulf of Mexico, passes through the Straits of Florida, then flows northward across the Atlantic toward Europe. Powered by ocean currents, the Gulf Stream moves as fast as 70 miles (112 km) per day and has a rate of flow 1,000 times that of the Mississippi River.

Ships ride the Gulf Stream to shorten their sailing times, and animal and plant species also hitch rides on the current. The Gulf Stream parallels the eastern coast of North America and is separated from the shore by a zone of chilly water, known to sailors as the "cold wall." By the time the Gulf Stream reaches Newfoundland, it has slowed to approximately 10 miles (16 km) per day. It continues east toward Europe, becoming the North Atlantic Current.

Much of Europe has a warmer climate than corresponding latitudes in North America. These gentler climates can be traced, at least in part, to the moderating effect of the warm Gulf Stream.

Water path:

Start: Gulf of Mexico **End:** The North Atlantic off European Coast

Journey "F"

Clues:

- I travel by water, but don't need a boat.
- I will grow into a tropical tree, associated with beaches and islands.
- My milk is used in Asian curry dishes.

Summary:

Coconuts are less dense than water, so they can float. The outer husk encloses the critical nut, which is capable of riding ocean currents for up to four months without dying. With luck, and favorable currents, the coconut will wash up on a beach, where it can sprout and send down roots.

Once established, coconut trees grow with a pronounced lean toward the sea, so that when their seeds drop, they will land in sand below the high-tide mark and be carried away on their journey.

This specific coconut voyage began on the island of Madagascar, off the east coast of Africa, and ended on a small volcanic island called Aldabra, 250 miles (400 km) away in the Indian Ocean. It rode the Equatorial Counter Current.

Water path:

Start: Madagascar **End:** Aldabra

Journey "G"

Clues:

- We are the original colonists of America's 50th state.
- Our boats were held together by coconut fiber.
- We were also the first people known to colonize New Zealand and Easter Island.

Summary:

Polynesians in the South Pacific were accomplished sailors thousands of years before Columbus was born. Because they live in a section of the world full of small islands, Polynesians have counted boats and ocean travel as a part of their culture for millennia. Evidence indicates that Polynesians purposefully explored and colonized much of the Pacific, including the Hawaiian Islands.

Polynesians traveled in double canoes capable of carrying hundreds of passengers. These boats were lashed tightly together with twine made from coconuts, and their sails were woven from other plant fibers. Their astonishing skill as navigators took them as far afield as Easter Island, New Zealand, and Hawaii. Traveling from Samoa to Hawaii required an ocean voyage of 5,000 miles (8,000 km).

Water path:

Start: Samoa **End:** Hawaii

Journey "H"

Clues:

- Sir John Franklin, along with 128 others, died trying to navigate me.
- I am icebound much of each year, and sometimes for years at a time.
- Darkness reigns over me for half of each year.

Summary:

In the late 1800s and early 1900s the quest for a Northwest Passage to the Orient fueled a feverish competition between European expeditions. Dozens of men, scores of ships, and more than a few fortunes were lost in the process. Expeditions often spent years frozen in the ice pack, suffered the effects of scurvy and other diseases, and endured the rigor of Arctic storms and six months of night, all to pioneer a route that would never result in any prize other than geographic conquest.

The islands north of the Canadian mainland bear the names of these explorers, their sponsors, and the homes they must have longed for through the long winter nights.

It was Roald Amundsen, the Norwegian who would also be the first to reach the South Pole, who finally navigated the tortuous, ice-locked Northwest Passage, during the years 1903-1906.

Water path:

Start: London, England **End:** North coast of Alaska

Journey "I"

Clues:

- I was unintentionally introduced into the United States in the late 1980s; I was carried in freshwater ballasts (loads that provide stability) of ships traveling from Europe.
- I am only about 2 inches (5 cm) long, and have a hard, striped shell; like my American cousin, I secrete tough fibers which I then use to attach myself to rocks, boats, pipes, and many other things.
- Much to the dismay of the fishing industry and water treatment plants, my population is quickly growing and expanding into each of the Great Lakes as well as to connecting rivers . . . If my population continues to grow, I may appear in a river near you!

Summary:

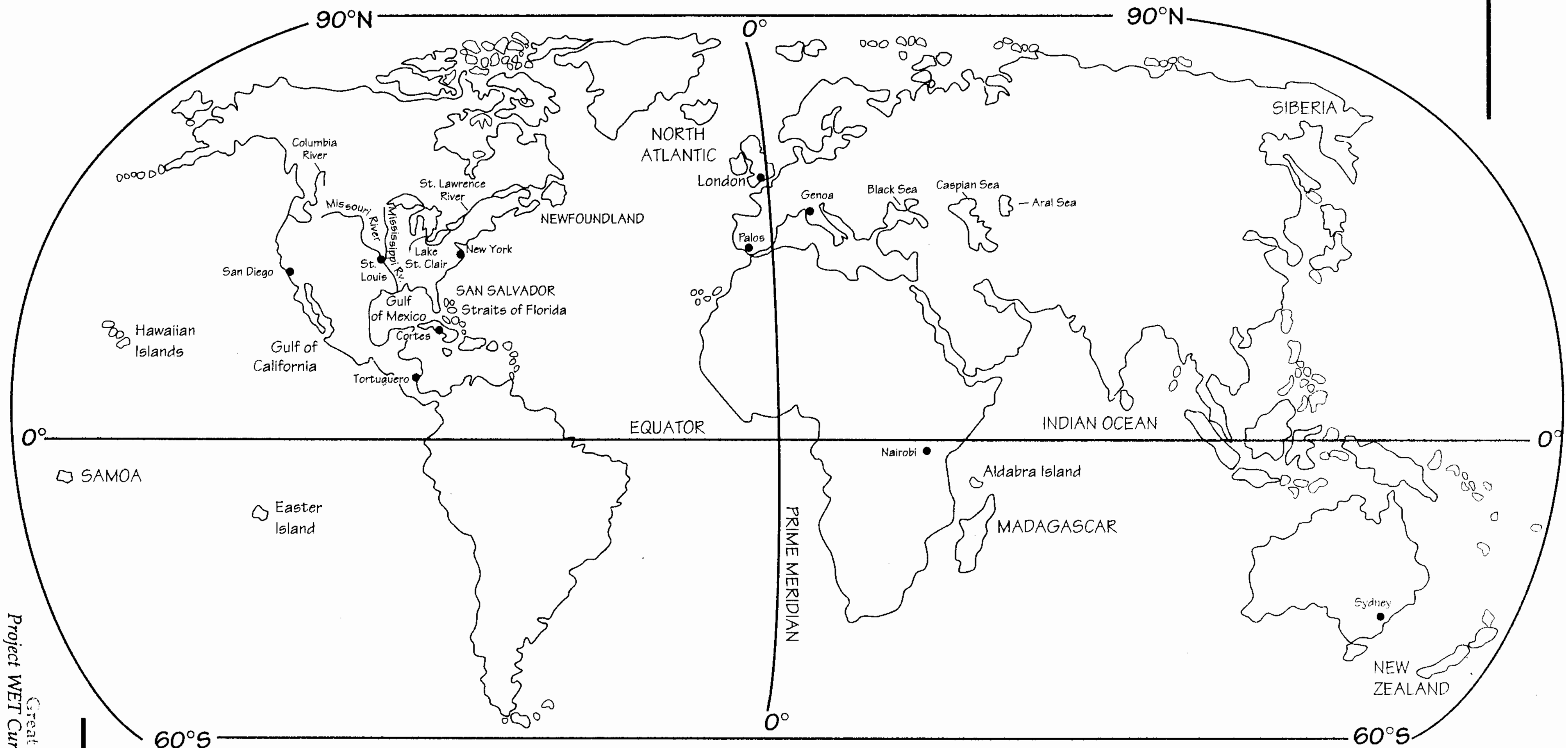
Zebra mussels are freshwater mollusks. It is believed they originated in the Black and Caspian Seas and were carried by ship through fresh waters in Europe. They were accidentally introduced to the United States in the mid-1980s. The mussels spread quickly down the St. Lawrence River and through the Great Lakes. They were first discovered in Lake St. Clair in 1988. They are expected to spread to a majority of United States waterways within a decade. The spread of zebra mussels throughout freshwater systems is attributed to their ability to cling like barnacles to almost any surface, some of which (boats, drifting materials, and fishing equipment) unintentionally transport the mussels to new locations. They have a high reproduction rate and lack natural predators in this new habitat.

The growing population of zebra mussels causes many problems. They colonize on pipes, clogging and contaminating water treatment systems; they remove large quantities of nutrients and outcompete native organisms; they foul beaches and jam boat engines. Communities, industries, and businesses are currently spending hundreds of thousands of dollars to eliminate zebra mussels.

Start: Black Sea **End:** Mississippi River

Global Map

Name: ______________________ Date: __________



NOTE: If possible, enlarge this map on the copier to fit a 8 1/2 " x 14" (legal) or 11" x 17 " sheet of paper.

The CEO

■ Grade Level:
High School

■ Subject Areas:
Government, Language Arts, Environmental Science

■ Duration:
Preparation time: 30 minutes

Activity time: three 50-minute periods

■ Setting:
Classroom, community businesses (optional)

■ Skills:
Gathering information; Analyzing; Presenting

■ Charting the Course
"Water Works" is a related activity in which students investigate the interdependence of various water users in a community. In "Perspectives," students can analyze pros and cons of suggested environmental management policies.

■ Vocabulary
Water-related issue

As the Chief Executive Officer (CEO) of a company, why should you consider how water quality relates to your liquid assets?

Summary

Students assume the role of CEOs and analyze the relationship between economic profits and environmental quality.

Objectives

Students will:
- identify components of an environmental management program.
- analyze the relationship between economic benefits and environmental quality.
- apply environmental management strategies in the production of a product.

Materials

- *Paper and writing materials*
- *Newspaper or magazine articles about business and the environment*

Making Connections

Many students know that the goods they buy have been made by someone else and that the manufacturing process involves the use of water and other natural resources. They should also understand that if a company is going to stay in business, its profits must be greater than its expenses. By researching how businesses balance economic profit with environmental stability, students (tomorrow's CEOs) may better appreciate how essential the adequate supply of clean water is to the manufacturing of products they use.

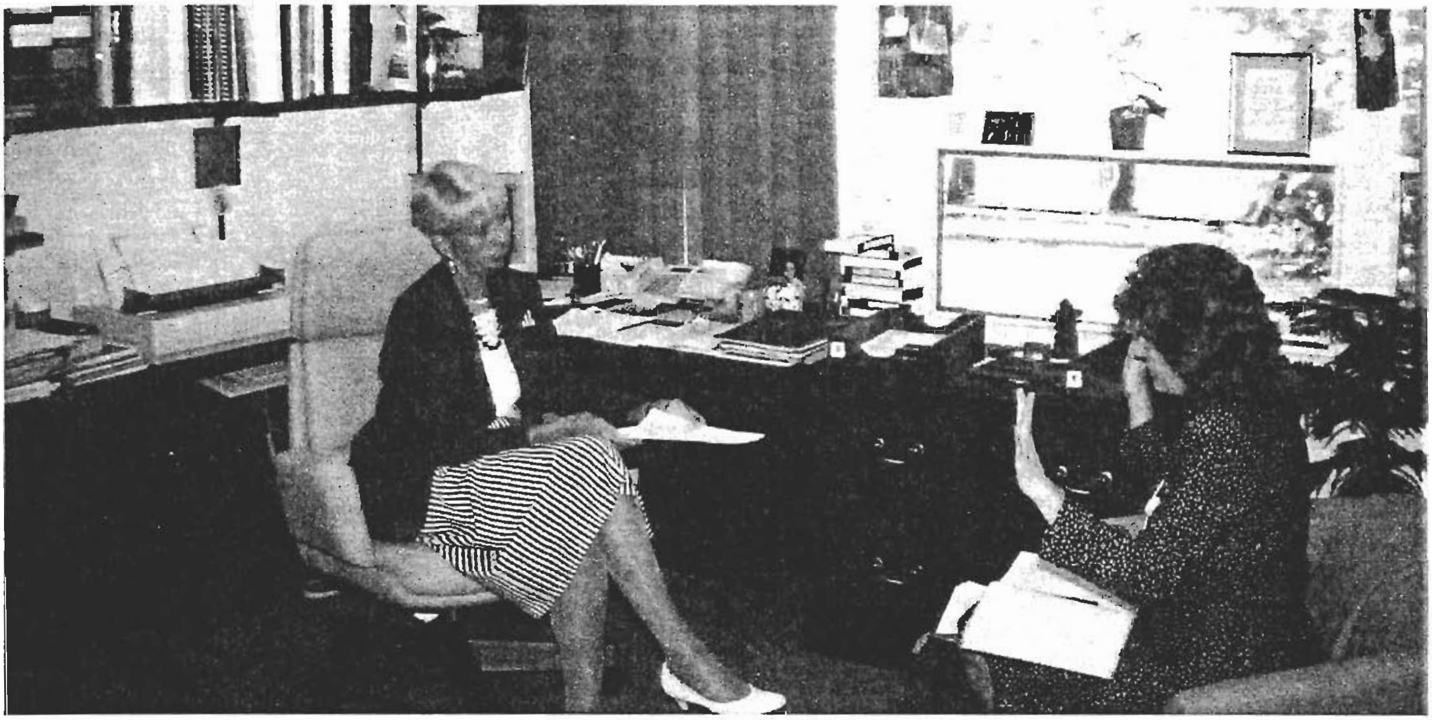
Background

The relationship of the environment, the business community, and the general public is interwoven and intricate. Earth provides the resources needed to grow, process, and/or manufacture the products that people need and want: the iron to build railroads, the gas for the family car, the water used for manufacturing, even the baking soda found in some toothpastes.

People generate the demand for products. Historically, protecting the environment while providing goods and services has not been a priority of consumers or businesses. Today, a new attitude about protecting the environment has emerged among consumers. The public call is for sustainable development, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

Ensuring sustainable development has become a key responsibility of many companies' Chief Executive Officers. A CEO, whether of an international corporation or a family farm, must consider economical, social, political, and environmental factors. To remain in business, the costs of implementing an environmental protection program must be balanced with the margin of profit. Visionary businesses have embraced this challenge by developing corporate environmental management programs involving environmental policy, improvement, and education.

The success of a corporate environmental management program involves careful analysis of products and their life cycles. A typical product life cycle involves the following: conception and research, design and development, extraction and/or use of raw materials or resources (timber, minerals, water), a manufacturing process, product packaging, storage, distribution, marketing, use by consumers, and eventual disposal by consumers.



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Each aspect of a product's life cycle can involve the use of water.

The environment needs the help of businesspeople and consumers alike. Becoming involved with the environment is also the smart choice from a strictly business point of view. Many consumers are trying to minimize their negative impact on the environment by using fewer resources and trying to reduce their contribution to landfills. Aware that products they use consume resources and produce wastes, many consumers are demanding that these products should be "environmentally friendly," not causing undue damage to the environment. Anticipating the public concern for natural resource conservation and implementing effective environmental management policies can significantly improve a company's goodwill and success in the marketplace.

Procedure

▼ *Warm Up*

Ask students to identify some of the products they use every day. Have them consider the natural resources used to manufacture these products. To what extent do students think water is required? Do the production processes impact the environment?

Do students think one person is responsible for ensuring the development, distribution, and sale of a product? Inform them that many companies have a Chief Executive Officer who does just that. Would they want to become the CEO of a company? What do students think are some of the responsibilities of a CEO? Check to see if protecting the environment and managing resources are among the list of responsibilities.

▼ *The Activity*

1. **Tell students they will now have the opportunity to become CEOs.** For this activity, students will focus on only one responsibility of a CEO: developing and maintaining an environmental management program.

2. **Discuss how environmental activities can affect the production of goods and services.** How will future production of goods or services be affected if the stability of the resource base is threatened? Read or review articles about business and the environment. What relationships do students recognize between economic profit and environmental quality?

3. **Before students can become CEOs of their own companies, they will need to do some research. Have students work in small groups, identifying some local businesses**

and contacting them for information. The most efficient way for them to gather information is through interviews. Discuss interviewing techniques and have the class develop a set of questions to ask community business people about creating and maintaining an environmental management program. NOTE: Protocol for conducting interviews requires sending a letter of request that states the purpose of the interview. A follow-up phone call may be necessary. Review the set of questions. Dress professionally and listen carefully. Send a thank you letter within one week of the interview. Students may be able to talk directly to the CEO or may communicate with a representative.

Students might also conduct a job-shadowing session to observe a CEO at work, or they can review company reports to gather additional information.

They should determine one or more of the following:

- purpose of the company (past, present, and future plan)
- clientele/customers
- the product's life cycle and the segments of the life cycle with which the company is directly involved (manufacturing, sales, waste management, etc.)
- how the product is manufactured (What resources are used in the production process? How is the resource obtained? Is environmental policy in place regarding resource extraction and/or use?)
- the role the environment plays in business management decisions (Are sales influenced by environmental policy? How has the company been affected by environmental regulations? Is the company involved in environmental improvement projects?)
- environmental management record (e.g., participation in supporting sustainable development, outreach programs, partnerships with environmental groups, supporting education projects, or community service activities).

4. **Depending on time and resources, have groups do one of the following:**

- Imagine that one student in the group is the CEO of the company interviewed; the others are stockholders. Students should prepare a report about the environmental management record of the company. What are its strengths and weaknesses? What recommendations for change would they make?
- Develop and produce a simple product to sell as a fund-raiser. (Funds raised can be used for a field trip, class picnic, donation to an environmental group, support for a community service project.) Plan for each of the steps of the life cycle of the product. Develop an environmental management program to guide production processes. Describe the results of the effort in an article for the school newspaper or the business section of a local paper.

▼ *Wrap Up*

Have students summarize the responsibilities of a CEO. Is this a career path they might choose? Challenge students to explain the importance of balancing economic profit with environmental quality. Have students express their views about achieving sustainable development.

Each group could send a copy of i final report to the CEO of the real company. This would be a positiv signal that young people are interested in environmental managem programs and may, in some cases lead to changes in the way the company does business.

Assessment

Have students:

- research and report on the resp sibilities of a CEO regarding th management of natural resourc (steps 3 and 4).
- evaluate the environmental management program of a loca company (step 4).
- produce a product, utilizing environmental management strategies (step 4).
- analyze the relationship betwe economic profit and environme tal quality (***Wrap Up***).

Extensions

If students send a copy of their report to the CEO, they could conduct a follow-up interview to ascertain the CEO's responses and recommendations.

Resources

Coddington, Walter. 1993. *Environ mental Marketing: Positive Strategie for Reaching the Green Consumer*. N York, N.Y.: McGraw-Hill, Inc.

Hiam, Alexander. 1990. *The Vest-Pocket CEO*. Englewood Cliffs, N. J Prentice Hall.

World Commission on Environme and Development. 1987. *Our Comr Future*. Oxford, England: Oxford University Press.

Hot Water

Grade Level:
High School

Subject Areas:
Environmental Science, Government, Language Arts

Duration:
Preparation time: 30 minutes

Activity time: two 50-minute periods

Setting: Classroom and library

Skills:
Gathering information (researching); Organizing; Analyzing; Interpreting; Applying (designing, composing); Evaluating; Presenting (debating)

Charting the Course
Students can investigate the scope and duration of water-related issues in "Whose Problem Is It?" Exploring water values and dilemmas helps students understand issues involving water ("Choices and Preferences, Water Index," "Dilemma Derby," and "Perspectives"). In conjunction with this activity, students can participate in "Idea Pools." Other forms of conflict resolution are presented in "Water Court."

Vocabulary
debate

Have you ever had to talk your way out of hot water?

Summary

Using debate strategies, students learn how to present a valid argument regarding a water-related issue.

Objectives

Students will:

- apply basic principles and strategies in debating water resource issues.
- recognize the effectiveness of reason-based versus emotion-based presentations.

Materials

- *4 x 6 inch (10 x 15 cm) note cards*
- *Copies of* ***Debate Ballots***
- *Video of actual debate* (optional)

Making Connections

Students will be able to recall at least one time when they had a disagreement with a friend, parent, or teacher. They may have been in conflict over a minor incident, yet found themselves determined to win the argument. Participating in a formal debate helps students practice skills— such as impromptu speaking, effective listening, critical thinking, and sound reasoning—that help them to express their point of view and support their side of an argument.

Background

Every day, thousands of debates occur on water issues around the world—debates on topics that range from personal concerns to major issues, such as the loss of wetlands. For every water resource issue, a variety of individual views exist regarding how to resolve a problem. Interested parties, such as resource managers, community members, and business, or agricultural representatives, desire to have their solution enacted. However, if they cannot communicate their positions effectively, their views will not be well received and may not be taken seriously. Never in the history of resource management has communication been more important than it is today.

Debate provides an opportunity for individuals to present their respective views regarding an issue. Debate involves two kinds of speeches: constructive and rebuttal.

Constructive speeches support and defend a viewpoint, while rebuttal speeches refute an opposing one. In other words, during the constructive speeches, each debater presents arguments supported by evidence (acquired through research and written on note cards) in favor of his or her viewpoint; and during the rebuttal speeches, each presents arguments, supported by evidence, to disprove or discredit the opposing viewpoint.

Procedure

Warm Up

Present and review with students a well-known issue, such as capital punishment or the reintroduction of wolves. Discuss different viewpoints people may have regarding these issues.

Have students brainstorm a list of controversial water topics that are characterized by two opposing viewpoints. Write the ideas on the board, presenting each issue in the form of a proposition. (For example, "There should be no further large-scale hydroelectric development in the United States.") Other examples of topics include: pros and cons of water storage, use of pesticides and herbicides, drought management, and water rights.

The Activity

1. **Inform students that they are going to conduct a debate about an issue. Review debating procedures and related terminology.** (Refer to **Background** and the following steps.)

2. **Explain that the purpose of a debate is to provide an opportunity for two opposing sides to defend or argue a given proposition (viewpoint).** One side will present positive support, and the other will argue against the proposition. Whichever side presents the strongest evidence will influence the action taken regarding this particular proposal.

3. **Have students pair up. Assign each pair of students the responsibility of representing a particular viewpoint (pro or con) of a specific issue.** For example, you may assign two students to argue for hydroelectric development and two to argue against; two for recreational uses of streams and two against (perhaps favoring irrigation uses, etc.). An alternative is to organize students into groups and assign two groups to opposite sides of the same issue. Group members work together to research and prepare their position on the issue. One member of each group is appointed spokesperson. Be sure each issue has both affirmative and negative representation.

4. **Have students research their assigned water issue and record pertinent information on note cards. The evidence they collect must either support the particular viewpoint they are representing or refute opposing arguments.**

5. **Two pairs of students assigned to opposite sides of an issue will sit at the front of the classroom; students should stand when speaking. The remaining students will act as judges, keeping score and deciding who wins. The debaters will present their arguments in accordance with the following form (based on the *Oregon Style of Debate*):**

SIMPLIFIED DEBATE SCHEDULE FOR 2 SPEAKERS (based on the Oregon Style of Debate)	MINUTES (MIDDLE SCHOOL)	MINUTES (HIGH SCHOOL)
Affirmative Constructive Speech	4*	8*
Cross-examined by the Negative	2	3
Negative Constructive Speech	4	8
Cross-examined by the Affirmative	2	3
Negative, Rebuttal	2	3
Affirmative, Rebuttal	2	3

* maximum time allowed in minutes

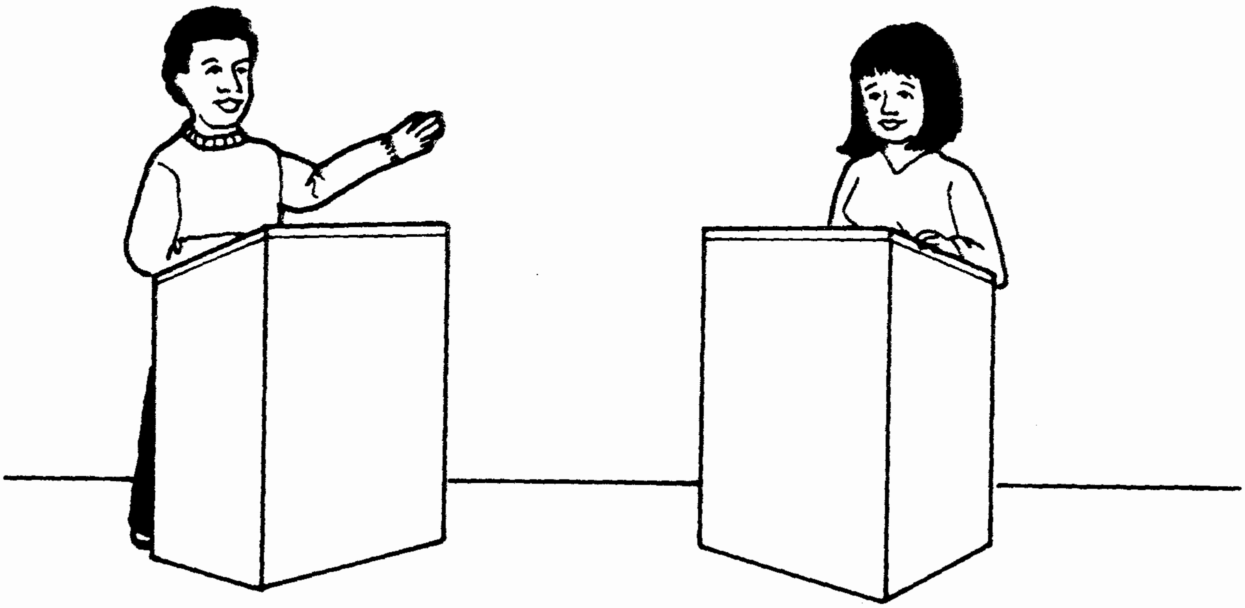
6. **Toss a coin to determine who (affirmative or negative) gives their constructive speech first. Either speaker may give the first rebuttal. Preparation time for rebuttal may be allowed, but such time shall not exceed three minutes.**

7. **The judging will be done by assigning values from 1 to 4 (with 1 being the most convincing argument and 4 being the least convincing) for both the constructive and rebuttal sections.** During the debate the judges will take notes on the arguments. At the end of the debate the results are tabulated, and the team with the lowest cumulative number of points wins.

In scoring, consider the following:

ANALYSIS:	getting to the heart of the question
PROOF:	supporting contentions with sufficient and convincing evidence
ARGUMENT:	sound reasoning; logical conclusions
ADAPTATION:	clashing with or responding to the opposition
REFUTATION:	destroying opponents contentions; reinforcing your own
ORGANIZATION:	clear, logical presentation of material
SPEAKING:	effective delivery; favorable impact on audience

NOTE: Remember that although one team has been determined the "winner," both teams have contributed to a deeper understanding and appreciation of water issues and the controversies involved.



▼ *Wrap Up*

Ask students how they felt about the outcome of each debate. Have them summarize which approach worked (and which did not work) in the debate. Discuss how strategies and skills acquired during the debate can be applied to other areas of students' lives.

Assessment

Have students:

- design an affirmative or negative constructive argument using well-reasoned evidence (step 4).
- present an affirmative or negative constructive argument and participate in cross-examination and rebuttal on a water-related issue (step 5).
- evaluate the proceedings of a debate (step 7 and ***Wrap Up***).

Extensions

Have students apply their skills to write a constructive letter to the editor of a newspaper, expressing their views about a water issue. (Remind students that they will be submitting their work to the editor as individuals; they should not imply that their school supports their opinions, unless they receive permission to do so.)

Resources

Basic Debate: For the Novice Debater. Contact: National Textbook Company, 4255 W. Touhy Avenue, Lincolnwood, IL 60464-1975.

Debate video. 1986. Contact: Dale Publishing Company, P. O. Box 151, Grandview, MO, 64030. Topic: 1986; Resolved, that the federal government should establish a comprehensive national policy to protect the quality of water in the United States.

An Introduction to Debate. Contact: National Federation of State High School Associations, 11724 Plaza Circle, P.O. Box 20626, Kansas City, MO 64195

Miller, G. Tyler, Jr. 1990. *Resource Conservation and Management*. Belmont, Calif.: Wadsworth Publishing Company.

Project WILD. 1992. Activities "To Dam or Not to Dam" and "Facts and Falsehoods." *Aquatic Project WILD*. Bethesda, Md.: Western Regional Environmental Education Council.

Graves, William, ed. 1993. "Water: The Power, Promise, and Turmoil of North America's Fresh Water." *National Geographic Special Edition* (November).

Debate Ballot

Team's Name: ____________________ Judge' s Name: ____________________

Affirmative Number__________ Negative Number__________ Round__________

DIRECTIONS: Circle the number that best describes the debater(s) you judged, and record your comments below. Remember, a score of 1 = the most convincing argument, and a score of 4 = the least convincing argument.

Overall Affirmative:	**1**	**2**	**3**	**4**	**Overall Negative:**	**1**	**2**	**3**	**4**
Constructive Speech:	**1**	**2**	**3**	**4**	**Constructive Speech:**	**1**	**2**	**3**	**4**
Cross Examination of Negative:	**1**	**2**	**3**	**4**	**Cross Examination of Affirmative:**	**1**	**2**	**3**	**4**
Rebuttal:	**1**	**2**	**3**	**4**	**Rebuttal:**	**1**	**2**	**3**	**4**
Comments:					**Comments:**				

I determine the debate to have been won by __________. Reasons for my decision are:

____
Judge's Signature

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The Price Is Right

■ **Grade Level:**
High School

■ **Subject Areas:**
Mathematics (Economics), Government, Environmental Science

■ **Duration:**
Preparation time: 30 minutes
Activity time: 50 minutes

■ **Setting:** Classroom

■ **Skills:**
Gathering information (calculating, measuring); Analyzing (comparing and contrasting); Evaluating; Presenting

■ **Charting the Course**
Students should conduct "Wet-Work Shuffle" prior to this activity to understand water treatment systems. These systems are further explored in "Reaching Your Limits" and "Sparkling Water." Other water management projects that require consideration of costs and benefits are found in "Humpty Dumpty," "Super Bowl Surge," and "Dilemma Derby."

■ **Vocabulary**
easement, municipal water system, well field

When you pay your water bill, what exactly are you paying for?

Summary
Students learn about economics and environmental planning as they calculate the cost of building a water development project.

Objectives

Students will:
- calculate the costs involved in supplying clean water to consumers and removing wastewater.
- recognize that cost and environmental considerations influence the planning and construction of water projects.

Materials

- *Sample water bill* (optional)
- *Copies of* ***Student Data and Instruction Sheet***
- *Copies of* ***Water Development System Map***
- *Calculators*
- *Ruler*

Making Connections

Students who earn their own spending money likely understand the value of certain things, such as compact disks, snack foods, or gas for their cars. They have probably heard adults complain about paying bills, such as the water bill. They may wonder why we pay for water. Learning the real and sometimes hidden costs and processes involved in supplying clean water to and removing wastewater from homes helps students appreciate the value of water resources.

Background

Individuals, businesses, communities, states, and countries are all involved in water resource economics on a daily basis. The cost of water influences individual and community decisions, such as whether to take long showers, whether to purchase a new water-efficient irrigation system, and whether to upgrade a wastewater plant.

When current water supplies no longer meet the needs of a growing community or when the waste generated by this growing population becomes too much for a treatment plant to process, water management decisions must be made. Options include reducing water consumption through conservation, installing more efficient water technologies, and building new treatment facilities. People may be asked to approve an increase in taxes or an increase in water or wastewater treatment bills to cover additional costs. Whatever option is chosen, chances are public funds will be needed; therefore, citizens will have opportunities to voice their opinions and to raise concerns. Most levels of government conduct public planning forums.

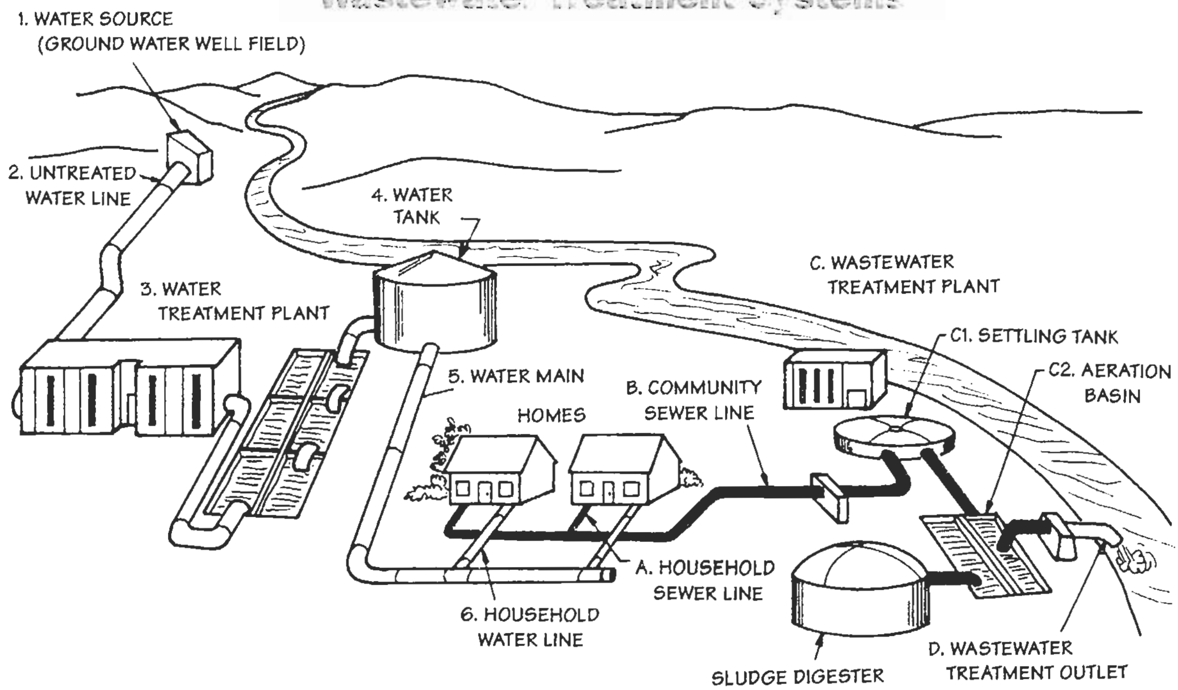
There is far more to constructing a water project than meets the eye. Aside from the construction of the physical plant, surveying potential sites, engineering water lines, establishing operation systems, and maintaining production also contribute to the cost. The list in the side bar on page 335 highlights costs associated with various water projects. (Costs vary among different regions of the country.)

Procedure

Warm Up

Show or describe a water bill to students. What do they think is involved in establishing the cost of water? Why does water need to be paid for? To help students appreciate the costs involved in securing water resources, have students play a price guessing game. Using the list of sample costs on page 335, ask them to guess the cost of a particular

Components of Municipal Water and Wastewater Treatment Systems



ADAPTED FROM "A WATER SYSTEM" (POSTER), BY PERMISSION. © 1988, AMERICAN WATER WORKS ASSOCIATIO

project. Instruct them to guess "higher" or "lower" until they reach the correct price.

Ask students to diagram how they think water gets from a water source to their homes, and from their homes back to the water source. Review the *Components of Municipal Water and Wastewater Treatment Systems* with students. What do students think of the costs reflected in a water bill now?

The Activity

1. **Explain to students that their task is to help a community redesign their municipal water and wastewater treatment systems.** A new water treatment plant has already been built, but they need to construct water lines through which untreated water can flow from the source (a ground water well field) to the new plant. In addition, a new wastewater treatment plant must be built and sewer lines run from the community to the plant. Both construction projects need to use Best Management Practices; "best" can be defined as the route and location that require the least costs and have fewer environmental effects. NOTE: Real-life situations would involve many other considerations for choosing the best location, including health concerns, substrate conditions, aesthetics, political matters, and so forth.

2. **Divide the class into small groups; supply each group with a copy of the *Water Development System Map* and review its contents and environmental features. Give each group a copy of the *Student Data and Instruction Sheet* and discuss.**

3. **Allow time for groups to identify what they think is the best location for each project.**

Wrap Up

Have each group present its proposed plan and calculated costs for class review. Group members should summarize considerations and factors they used to help them make the decision. Encourage students to provide constructive criticism for the proposed plans. Can the class reach consensus regarding where to locate the projects?

Present students with the *Answer Key*. Do students agree with the solutions given in the key? Tell students that if this was a real-life situation, other factors and conditions would come into play, and the actual locations might be different. In other words, students may have justifiable reasons why their proposals are better.

Inform students that in some situations, citizens must pay additional taxes to fund the construction of water management projects. How do

Household

a. 200-foot-deep (60 m) well, $2,400
b. bathroom faucet, $65
c. dishwasher, $410
d. 16- x 32-foot (5 m x 10 m) swimming pool, $16,000
e. portable hot tub for six, $6,000
f. hot water heater, 50 gal. (190 l), gas, $350
g. septic system, $5,000

City (50,000 residents plus businesses)

a. new 6 million-gallon (22.8 million l) water storage tank or reservoir, $5 million
b. wastewater treatment plant, $45 million
c. water treatment facility (to treat drinking water), $8 million
d. water transmission mains, $370,000 (cost per mile [1.6 km])
e. full-coverage sprinkler system for 18-hole golf course, $480,000
f. sewer outfall main, $350,000 (per mile [1.6 km])
g. manhole, $2,000

County

a. 250-foot (76 m) riprap and jetty along bank of badly eroding stream, $150,000

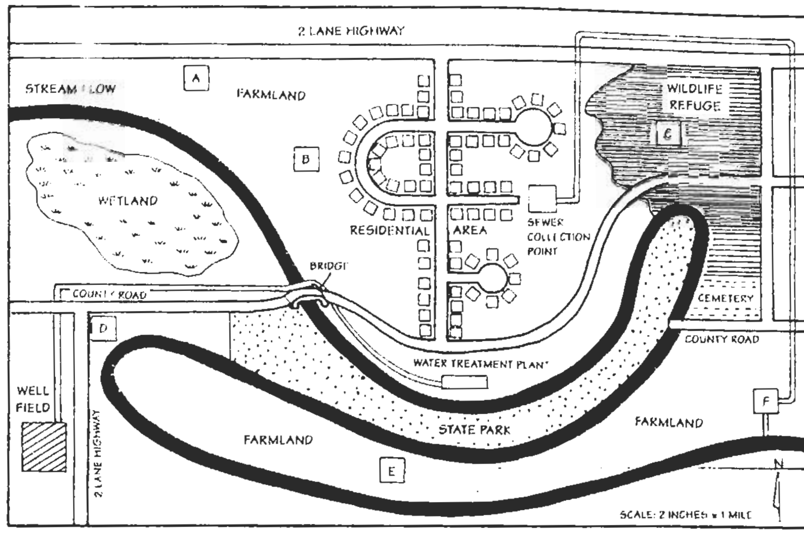
State

a. two interstate bridges crossing river, each 300- x 75-feet (91 m x 21 m), $2.2 million

National

a. Hoover Dam Project (1935), $385 million
b. Central Valley Project (1955), $400 million
c. Panama Canal (early 1900s), $380 million
d. restoring a portion of the Kissimmee River, $400 million

Answer Key



they feel about citizens incurring the cost of the project through increased taxes? Do students think they would willingly pay the price for new water supplies? Which would they rather do: change their habits and use less water, or pay more money for increased supplies? Discuss how the cost of water management projects is often a prohibiting factor to building new systems.

Have students learn about water projects in local communities. How much did they cost? Who paid for them?

Assessment

Have students:

- analyze what factors affect water use charges (***Warm Up*** and ***Wrap Up***).
- calculate the cost to build an untreated water line, a wastewater treatment plant, and sewer lines (step 3).
- determine the route for an untreated water line to a treatment plant, select a site for the construction of a wastewater treatment plant, and justify their choices (step 3 and ***Wrap Up***).
- evaluate other students' selected locations for water projects (***Wrap Up***).

Extension

Have students role-play bankers and project designers. The project designers request a loan for their water development system. Because the bank will only loan funds to one group of project designers, students should be well prepared to answer the banker's questions, such as "How much money do you need?" "What is your economic justification for the loan?" and "How do you intend to repay this loan?" The banker will consider the best designed project plans, proposed budget, and responses to questions when determining the loan recipient.

Resources

Barnes, D., et. al. 1981. *Water and Wastewater Engineering Systems.* London, England: Pitman Books Limited.

Cheremisinoff, Paul N. 1993. *Water Management and Supply.* Englewood Cliffs, N. J.: PTR Prentice Hall.

Student Data and Instruction Sheet

Instructions

Read the following information and refer to the map and data to find the best locations for the untreated water line and the wastewater management plant.

Untreated Water Line

- sketch possible routes for the water line
- calculate costs for each route
- assess environmental impacts of each route
- use the above information to determine the most cost-effective and environmentally sensitive route

Wastewater Treatment Plant

- consider placing the wastewater treatment plant at each of the six designated sites on the map
- assess the best location based on the following:
  - costs (of running a single major sewer line from town to the plant)
  - environmental concerns (specifically, proximity to discharge site [the river], direction of streamflow, quality of ground water being drawn into pumping wells, quality of river water that could become part of the ground water)
  - legal placement of wastewater lines (it may be unlawful to cross wetlands, public property, state parks, or wildlife refuges)
  - aesthetics and health issues (including odor, downstream flows, and landscape considerations)
- use the above information to determine the most cost-effective and environmentally sensitive location

Prepare a presentation for your classmates, including reasons why you think your routes and sites are the best.

Data

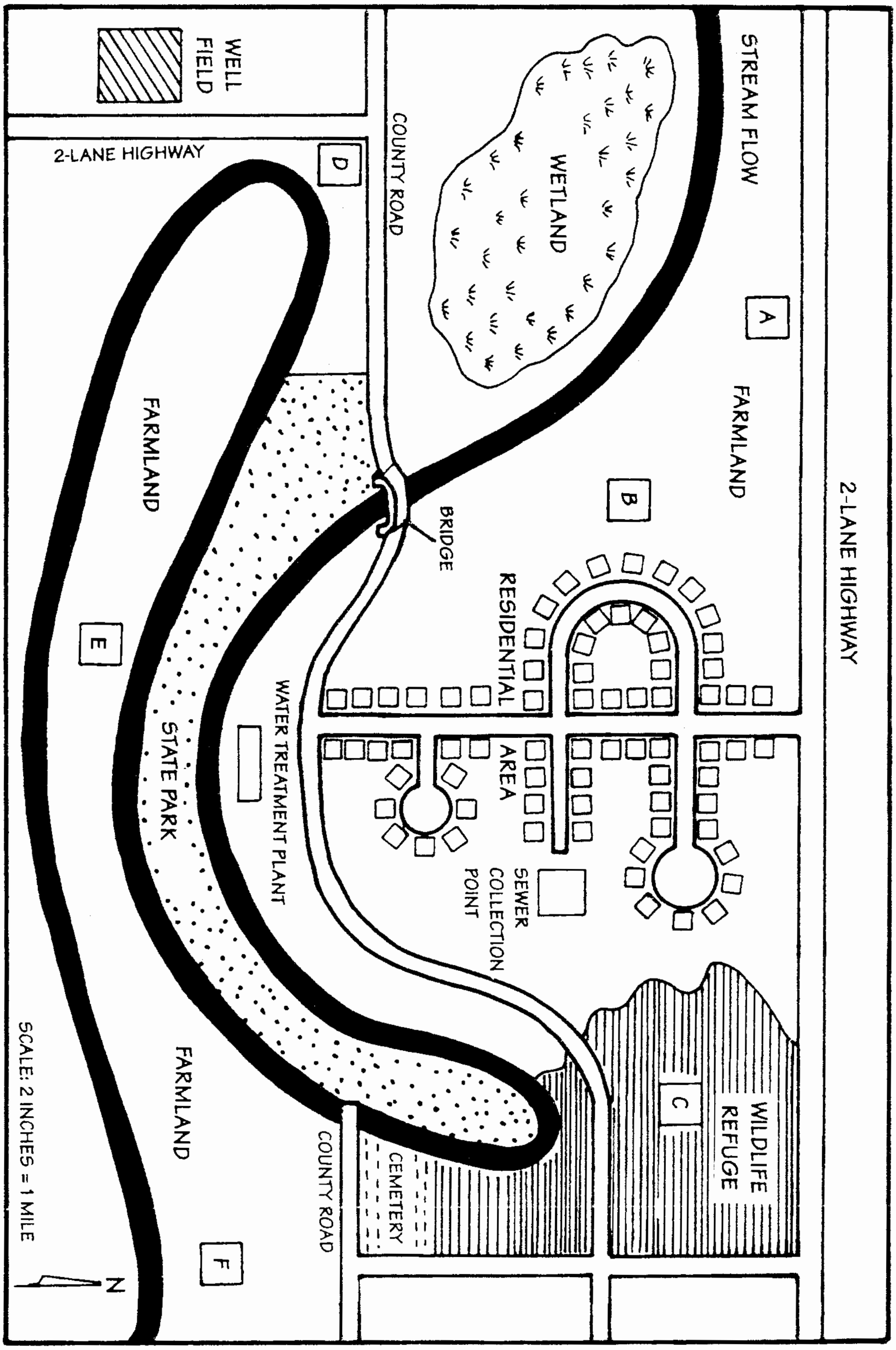
NOTE: The following are hypothetical costs; they include materials and labor. Contact local engineers, treatment plants, and construction companies to obtain costs more relevant to your community.

- untreated water line (runs from well field to plant) = $12/foot ($40/meter)
- main sewer line (runs from sewer collection point to wastewater treatment plant) = $9/foot ($30/meter)
- wastewater treatment plant = $45,000,000
- easement on farmland = $1,000 per linear mile
- construction of lines under existing two-lane highway = $100,000
- construction of line to cross river (this complicated process involves permits and completing environmental impact statements) = $500,000
- construction of line to cross existing bridge = $50,000
- construction of line to cross wetland = illegal

COPY

Water Development System Map

Name: ______________________________ Date: ______________



Sparkling Water

Grade Level:
Middle School, High School

Subject Areas:
Environmental Science, Health

Duration:
Preparation time:
Part I: 50 minutes
Part II: 10 minutes

Activity time:
Part I: two 50-minute periods
Part II: 30 minutes

Setting: Classroom

Skills:
Organizing (charting); Applying (predicting, experimenting); Evaluating (analyzing, testing)

Charting the Course
Students can relate water treatment processes to the water cycle ("The Incredible Journey" and "Imagine!"). The basic components of a wastewater treatment system are addressed in "Wet-Work Shuffle" and "The Price Is Right." In "Super Bowl Surge" students investigate the impact of a combined sewer system overflowing during peak demand.

Vocabulary
wastewater treatment

What happens to water after it swirls down the drain?

Summary

Students develop strategies to remove contaminants from "wastewater."

Objectives

Students will:

- describe the processes for treating wastewater.
- compare how water is cleaned in the water cycle to how it is cleaned in contemporary water treatment systems.
- list nontoxic household cleaning methods.

Materials

- *Water*
- *Safety goggles*
- *A gallon-sized (3.8 l) container*
- *Small containers, about 3-ounce capacity (100 ml)*

Wastewater materials:

- *Coffee grounds*
- *Salt*
- *Vegetable oil*
- *Soil*
- *Yeast*
- *Soap*
- *Food scraps*
- *Vinegar*

Possible water cleaning materials:

- *Screens to use as filters*
- *Coffee filters*
- *Bleach*
- *Alum* (available at grocery stores in the baking section)—see safety alert, page 352.
- *Bowls or cups*
- *Straws or pipettes*
- *Spoons*
- *Baking soda*
- *Charcoal*
- *Talc*
- *Rocks and sand*

Possible testing materials:

- *pH paper*
- *Brown paper bag*
- *Wax paper*

Making Connections

Almost every city in the United States has some kind of wastewater treatment plant—it is the law! We often take for granted those processes which ensure that water we have used is clean when released back into streams, lakes, or ground water. By attempting to clean their own sample of "wastewater," students gain an appreciation for the processes involved in keeping water sources clean.

Background

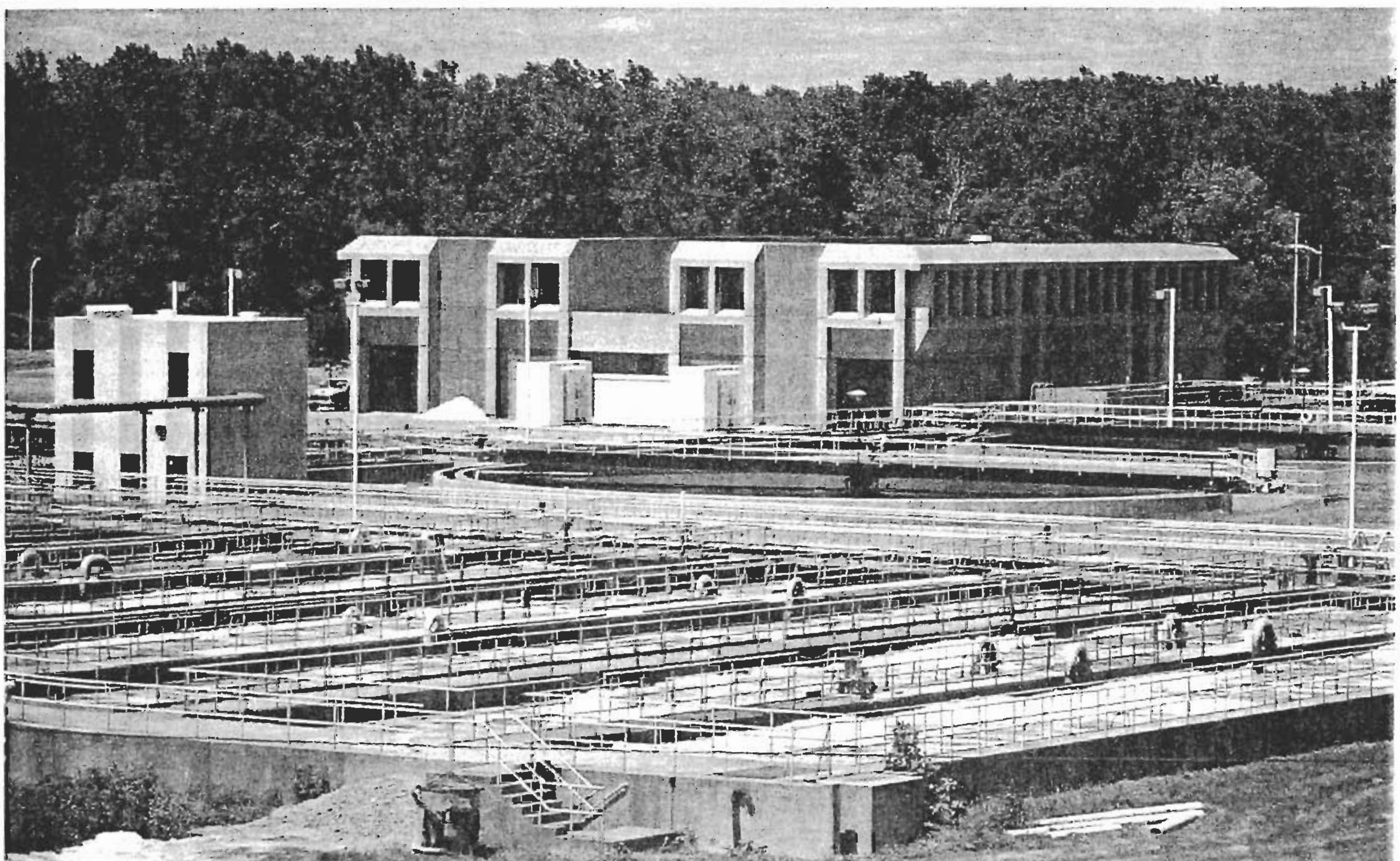
In the United States, some streams and rivers were once so polluted that one of them even burned. (So much oil and chemical waste were in the Cuyahoga River that it caught fire in 1969.) Our rivers, lakes, and even oceans were once thought to be capable of carrying off and mysteriously treating our liquid wastes. Cities pumped raw sewage from homes and businesses directly into rivers. Factories sent water that had been used in manufacturing processes, untreated, into streams, lakes, and oceans. As this practice continued and populations expanded, water supplies degraded to the point of posing serious health hazards. The country collectively and systematically tackled, initially with much controversy, this point source pollution problem.

This effort required a broad shift in attitude. Incorporating wastewater treatment into cities and businesses was costly. Citizens had to vote for higher taxes to pay for cleaner water. Factories had to raise prices to pay for new treatment equipment. (For example, the United States and Canada have spent billions of dollars in constructing water treatment plants to improve the water quality of Lake Erie.)

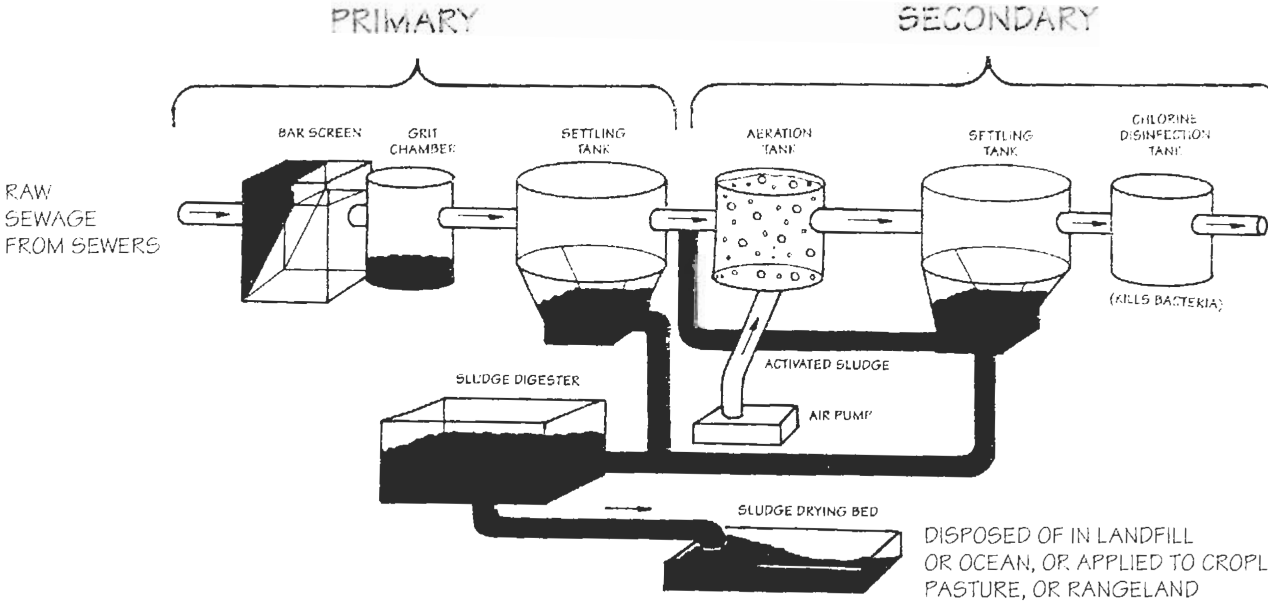
The process used in contemporary wastewater treatment plants is similar to the natural process by which water is cleaned while moving through the water cycle. For example, as water flows through a river into a lake, it can pick up contaminants. While in the lake, these contaminants often sink to the bottom; this process is called settling. Because soil is a natural filtering mechanism, substances can be removed from water as it moves through soil. During evaporation, water is purified when individual water molecules break away from liquid water, leaving other materials behind. This action is called distillation.

From a historical perspective, as human populations grew and areas became settled, the demand for clean water exceeded the rate at which it could be naturally purified. Therefore, wastewater treatment plants became necessary. The addition of more complicated materials to the waste stream required more elaborate treatment as well.

The simplest form of wastewater treatment (primary treatment) involves filtration and settling procedures. In addition, waste materials that float are skimmed from the top. Forty-five to 50 percent of pollutants are removed utilizing primary techniques. In addition, most developed countries have a secondary process of waste treatment. Secondary treatment, mainly a biological process, removes from 85 to 90 percent of remaining pollutants.



Wastewater treatment plant, Erie, Pennsylvania. ROBERT K. GRUBBS, N E STOCK PHOTO



ADAPTED WITH PERMISSION FROM *ENVIRONMENTAL SCIENCE: SUSTAINING THE EARTH*, G. TYLER MILLER, JR. ©1991, WADSWORTH PUBLISHING CO

Helpful microorganisms consume most of the waste material in aerator tanks. Solids and microorganisms are separated from the wastewater in secondary settling tanks. Adding a disinfectant (such as chlorine) kills any remaining disease-causing organisms. The water leaves the treatment plant, to be released into nearby waterways.

Despite these processes, small amounts of undesirable materials can still remain in treated water. These include nitrates, phosphates, and heavy metals. Other chemicals, from pesticides and cleansers, may also remain in treated water. Some advanced plants have a third stage of waste treatment that helps remove most of these materials. These processes include filtration through activated carbon to remove organic materials, distillation to remove salts, and flocculation. Flocculation involves adding a coagulant or a chemical (such as alum) to water, which causes suspended particles to clump together and settle out. Unfortunately, since these advanced treatment plants are expensive to build and operate, few communities have them. Many environmental consulting agencies are promoting the concept of engineered wetlands as a means of using natural processes to treat all wastewater.

Solid materials removed from wastewater are called sludge. In some cases sludge can be used as fertilizer for crops. At other times, it is buried or burned. If sludge is improperly treated or disposed of, it may contaminate water again.

Because some pollutants are extremely difficult to remove from wastewater, the best solution is to avoid putting them in water in the first place. Often the source of these pollutants is the kitchen, garage, or bathroom. When people pour oil, paint thinner, or pesticides down the drain, they add chemicals that may not be removed from water during treatment. Many household cleansers have caustic chemicals that lower water quality. Fortunately, alterna-tive methods exist for ke
house clean; many of the
involve using baking soc
vinegar. Although such
may require a little more
will not add toxic chemi
drinking water.

Procedure

▼ *Warm Up*

Ask students to describe
cycle. Within the water
do students think water
cleaned? Discuss filterin
and distillation processe
we treat water, instead
up to nature? Discuss h
lation growth and the a
chemicals. Have studen
of the river (the Cuyahc
burned in 1969? Today
cleaner.

Have students make a l
that could be found in
Why are these things n
found in lakes or strean
students to write a para
draw a picture describi
think wastewater is cle

▼ *The Activity*

Part I

1. **Involve students in making wastewater. Add soil, coffee grounds, vegetable oil, soap, salt, vinegar, yeast, and food scraps to a gallon jug of water.**

2. **Shake the jug thoroughly and distribute water in jars or beakers, one to each group of students. Each group should record its observations of the wastewater** (color, smell, pH, oil—put a drop on brown paper and see if an oil smear forms). STUDENTS SHOULD NEVER TASTE THE WATER.

3. **Tell students their mission is to try to clean this water. Show students the materials that can be used and instruct students on necessary safety procedures.** THEY SHOULD NOT USE MORE THAN ABOUT HALF A TEASPOON (2 ML) OF THE BLEACH, ALUM, OR BAKING SODA. THEY SHOULD WEAR SAFETY GOGGLES AT ALL TIMES WHEN CONDUCTING THE TESTS AND WASH THEIR HANDS IMMEDIATELY AFTER COMING IN CONTACT WITH ANY MATERIALS.

4. **The groups should write down the procedures they plan to use to clean the water.** Encourage them to use a series of steps, so they can evaluate each step separately. Check the proposed cleaning actions before they begin. Advise them to change their strategy if any methods appear to be dangerous.

SELECTED LIST OF NONTOXIC CLEANING SUBSTANCES

Cleaning agent	Alternative
Room deodorizer	Baking soda
Drain cleaner	Boiling water, vinegar and baking soda, plunger
Window cleaner	Vinegar wiped with newspaper
Scouring powder	Baking soda and vinegar
Tarnish remover	Salt, baking soda, and a piece of aluminum foil in warm water

5. **Have students record their procedure in a table similar to the one below.**

6. **After they have attempted to clean their water, have students evaluate the results.** The groups can switch water samples to compare results. Evaluation strategies include color, smell, pH, and presence of oil. What are some contaminants they could not remove?

7. **Describe the general cleaning processes used in a treatment plant. Have students compare their procedures with what occurs in treatment plants.**

8. **Inform students of the materials that may remain even after treatment. Discuss reasons why treatment plants that can remove these contaminants are not being built.** (Reasons could include money, available resources, time, space, or practicality.)

Part II

Introduce students to a few of the alternative household cleaning materials they can use. (See table.) Encourage students to contact the department of natural resources, the health department, and environmental groups to research additional options. Have students test and use some of these methods at home and report the results to the class.

▼ *Wrap Up and Action*

Have students draw a diagram summarizing various ways wastewater is treated. Which of these methods are similar to natural processes in the water cycle? Compare students' diagrams to their descriptions of wastewater treatment from the *Warm Up*. Ask students to design a brochure describing alternatives to household cleaning agents. These can be distributed to friends and family.

CLEANING STRATEGY USED	DESCRIPTION OF WATER	COMMENTS ABOUT EFFECTIVENESS

Assessment

Have students:

- implement a variety of strategies to remove waste materials from water (***Part I***, steps 4-5).
- evaluate the effectiveness of their water treatment strategies (***Part I***, step 6).
- compare how water is cleaned in the water cycle to how it is cleaned in a wastewater treatment plant (***Warm Up*** and ***Wrap Up***).
- design a brochure highlighting alternative household cleaning agents (***Wrap Up***).

Upon completing the activity, for further assessment have students:

- discuss, "Does clear water = clean water?"

Extensions

Excess organic waste promotes the growth of microorganisms and the consumption of oxygen. To demonstrate this, mix 1/2 cup (120 ml) milk (symbolizing organic waste) in 1 cup (240 ml) of warm water. Add 10 to 12 drops of methylene blue (to indicate the presence of oxygen), and 2 tablespoons (3-5 g) of yeast (microorganisms). As the yeast consumes the milk (or organic waste), oxygen is used up. This is shown when the methylene blue color disappears. (This should occur in about 15 minutes.) Absence of oxygen affects the health of other aquatic organisms.

Visit a water treatment plant and a wastewater treatment plant or have representatives from these agencies speak to the class.

Students may be interested in testing their water for organic sediments and heavy metals. Often state departments of public health or natural resources and university laboratories can provide testing facilities. Sometimes a fee is charged. Some drugstores or school supply companies sell home water testing kits. (Lab-Aid sells a kit called "Qualitative Analysis of Water"; other examples include Nordic Ware Water Test Kit and Aqua-Pure Home Water Test Kit CW-TS; test kits can also be purchased at pet stores).

Resources

About Wastewater Treatment. 1
To order, contact: Channing L. B
Co., Inc., South Deerfield, MA 0
or telephone (800) 628-7733, and
request booklet number 45054.

Cole, Joanna. 1986. *The Magic
School Bus at the Waterworks.* New
York, N.Y.: Scholastic, Inc.

*Household Hazardous Waste: Wha
Should & Shouldn't Do.* 1987. Bro
chure. Contact: Water Environm
Federation, 601 Wythe Street, Al
andria, VA 22314-1994.
(703) 684-2400.

*Nature's Way: How Wastewater
Treatment Works for You.* 1985.
Brochure. Contact: Water Enviro
ment Federation, 601 Wythe Stre
Alexandria, VA 22314-1994.
(703) 684-2400.

Video: *The Murky Water Caper.* 1
Distributed by: The Video Proje
5332 College Ave., Suite 1E, Oak
CA 94618. (510) 655-9050.

Notes ▼

SAFETY ALERT

When preparing for the "Sparkling Water" activity, make certain that the alum to be used—which will be mixed with bleach—is PURE ALUM. Alum purchased at some pharmacies is ammoniated. Mixing ammonia with bleach creates a serious health hazard.

Choices and Preferences, Water Index

■ **Grade Level:**
Middle School, High School

■ **Subject Areas:**
Mathematics, Environmental Science, Government

■ **Duration:**
Preparation time: 30 minutes
Activity time: 50 minutes

■ **Setting:** Classroom

■ **Skills:**
Organizing (graphing); Analyzing (comparing and contrasting); Interpreting (drawing conclusions)

■ **Charting the Course**
Basic math skills (addition and division) and an understanding of graphing will be needed to complete this activity. Students learn about the interdependence of various water users in "Water Works." The water index developed in this activity can be used to help students make decisions in several other activities ("Dilemma Derby," "Perspectives," "Water Bill of Rights"). "Hot Water," in which students conduct a debate, can follow this activity.

■ **Vocabulary**
attitudes, values

Water is for all water users, isn't it?

Summary

Students rank and compare different uses of water. The class develops a *water index*, an indication of the group's feelings and values about water and its uses.

Objectives

Students will:

- analyze how people perceive the value of various water uses differently.

Materials

- *Copies of* ***Major Water Use Chart***
- *Copies of* ***Student Ranking Line Graph***
- *Ruler*
- *Colored pencils* (red, blue, green)
- *Calculators* (optional)

Making Connections

People prioritize many things in their lives. Organizing a day, planning a budget, and deciding upon a career involve ranking skills. Students are often asked who their favorite musician or teacher is. In response, they may rank musicians or teachers in order of preference. Students should understand that their list of favorites may differ from another person's. Involving students in learning how their peers rank water resource uses will help them appreciate how differing opinions influence water resource management strategies.

Background

Water resources are used throughout society. Industry uses water to process materials; agriculture needs water to irrigate crops; residential areas require water for drinking, cleaning, and cooking. In many places, all water users have all the water they need. What happens when supplies are limited? Or when a particular water use decreases water quality? Is one water use the *most* important?

How people rate the importance of diverse water uses will vary based on their knowledge and experience. Often, values regarding water use are determined by geographical area, economy, community, culture, and/or family. For example, people from an agricultural region might rank water use differently than people from a region whose economy is based on recreation or industrial production. As individuals acknowledge the diversity of values and opinions surrounding water use, the need to provide water of sufficient quality and quantity to all water users becomes apparent.

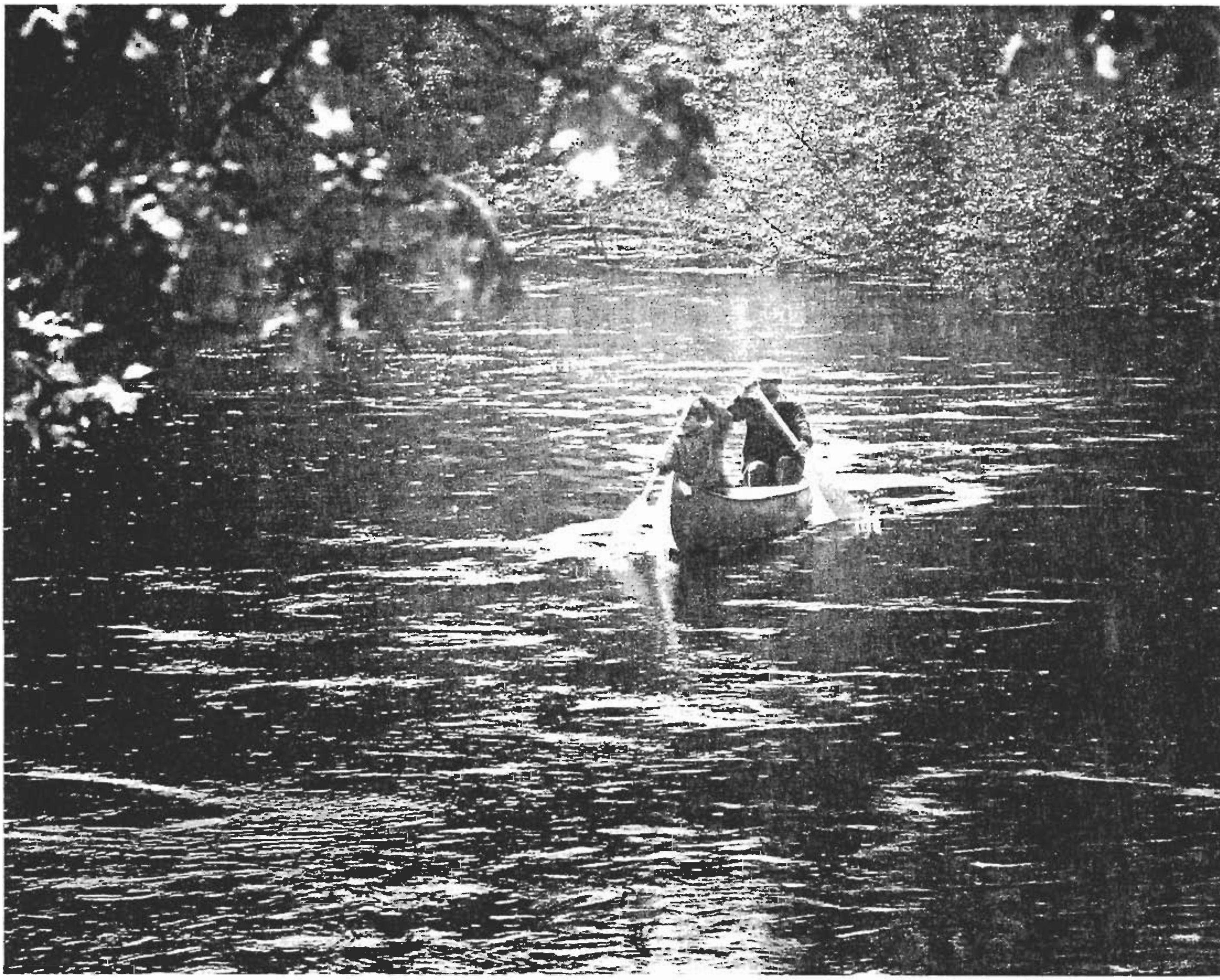
An index is a reference tool used to organize concepts or topics. A water index lists water use categories arranged in order of preference or importance. This index can be used to help determine how and why a community or class values certain water uses. If indexes are produced at different times, recent indexes can be compared to earlier versions to see if preferences have changed over time.

Procedure

▼ *Warm Up*

Have the class generate a list of major water uses. Help them fit the uses into the ten categories listed in the *Major Water Use Chart*. Challenge them to relate each water category to their own lives (e.g., transportation: they use products that are shipped over water; recreation: they go sailing; industry: they play computer games).

Present the following hypothetical situation: A meeting has been called



COURTESY: NATIONAL PARK SERVICE, U.S. DEPARTMENT OF INTERIOR, RICHARD FROAR.

where representatives from agriculture, industry, recreation, energy, fish and wildlife, transportation, municipalities, and other major water use groups have assembled to ask you and your classmates one question: Which one of the water use groups is the most important and why? Your class will likely come to the conclusion that all water users are important. However, in reality, water managers and policymakers at all levels must make important decisions about allocating water.

The Activity

1. **Give each student a copy of the *Major Water Use Chart* and have them rank the items in priority order.** "1" is the least important use, while "10" indicates top priority use.

2. **After students have completed their ranking, have them graph their scores on the *Student Ranking Line Graph*.**

3. **Have students form small groups. Ask them to average the group's rankings for each use category.** For example, if one student in a group of five students ranked energy consumption as 10, a second student gave it a 7 ranking, the third a 3, the fourth a 10, and the fifth a 5, the total of their scores would be 35. Divide 35 by the number of students in the group (5), and the result is an average of 7. Remind students to check their work.

4. **Have each student plot his or her group's averaged rankings on the graph.** How does the small-

group average compare with an individual's ranking? How do students feel if their individual top priority is ranked lower by the group?

5. **Tell students to average all the group rankings to find the class average for each category. Have students plot the class results on their graphs. Do students think the average provides an accurate representation of the choices and preferences of the class regarding water use priorities?**

6. **Have the entire class list the designated uses in the order they were rated. The highest rating first, the lowest last. This is the water index for the class.**

▼ *Wrap Up and Action*

Have students compare and contrast the individual, small-group, and class rankings. Why do different groups of people feel so strongly about the importance of water? Ask students what factors might cause them to rank the list in a different order. Review with students the hypothetical situation in the ***Warm Up***. Will the outcome of the class ranking satisfy representatives from the other major water use groups? When decisions are made affecting large groups of people, is it possible to satisfy all individuals involved?

Have students share the class results with their families. Do all family members agree with the class, with each other, with their student family member? Students may contact a school in another geographic region, forward the activity, and exchange data. How do students account for the similarities and differences?

Assessment

Have students:

- rank major categories of water uses (step 1).
- graph scores and establish a class water index (steps 1-6).
- explain why one individual's ranking may differ from other students (step 4 and ***Wrap Up***).
- interpret the graphs and water index to conclude how the class values water uses (step 6 and ***Wrap Up***).

Upon completing the activity, for further assessment have students:

- suggest ways this index could be used to set water management policy within their community.

Extensions

Have students use alternate means of averaging results. They may want to find the median or mode for each ranking. The median is the middle number in a set of numbers arranged in order of magnitude. For example, if the rankings for wildlife were 3, 4, 6, 8, 8, the median is 6. In an even set of numbers the median is the average of the two middle numbers. The mode is the number that is used most frequently in the group. In the above example, the mode is 8.

Create a frequency chart by plotting the number of times each category received a ranking of 10. For example, twenty students in the class ranked energy as a 10. Three students ranked aesthetics as a 10, while six students ranked fish and wildlife 10, etc. Present the results in graph form listing the item that received the most 10s first, the category with the second most 10s next, and so forth.

K-2 Option

With fewer choices to prioritize, young children can make a water index, too. Begin the activity by orienting students to the process of how choices are made. Present students with the following scenario. Which is **most important** for an animal, such as a pet dog or cat—water, a toy, a book, or a brush? Arranging the items in order of importance, some students may list water, brush, toy, book. Another group may select water, toy, brush, book. Discuss the reasons for their decisions.

Inform students that they can use the same criterion (degree of importance) to prioritize different uses of water. Have students list uses of water. Help them organize their suggestions into the four water use categories that are pictured (*Water Use Categories*).

Distribute copies of *Which Water Use is Most Important*. Instruct students to cut out the pictures and glue them in order of importance in the priority boxes. Discuss similarities and differences among students' arrangements and remind them that all arrangements have merit.

Resources

🍎 Hammer, Trudy J. 1985. *Water Resources*. New York, N.Y.: Watts.

Miller, G. Tyler, Jr. 1990. *Resource Conservation and Management*. Belmont, Calif.: Wadsworth Publishing Company.

Polesetsky, Matthew, ed. 1991. *Global Resources: Opposing Viewpoints*. San Diego, Calif.: Greenhaven Press, Inc.

🍎 Pringle, Laurence. 1982. *Water: The Next Great Resource Battle*. New York, N.Y.: Macmillan.

Whose Problem Is It?

■ **Grade Level:**
Middle School, High School

■ **Subject Areas:**
Government, Environmental Science

■ **Duration:**
Preparation time: 20 minutes
Activity time: 50 minutes

■ **Setting:** Classroom

■ **Skills:**
Gathering information (listening and collecting); Organizing (classifying); Analyzing (comparing, discussing, and contrasting); Interpreting (defining problems, generalizing, drawing conclusions)

■ **Charting the Course**
This activity could be conducted at the beginning of a unit to assess concerns or at the end of a unit to evaluate changes in student perceptions of water-related issues. The activity "Perspectives" complements this activity. Conduct "Idea Pools" prior to this activity to access students perceptions of water-related problems and "What's Happening" and "Water Actions" can follow if students want to further investigate or analyze an issue.

■ **Vocabulary**
water-related issue

Why should the world care about a leaky faucet in your home? Why should you care about a drought in central Africa?

Summary
Students analyze the scope and duration of a variety of water-related issues to understand the relationship between local and global issues.

Objectives
Students will:
- analyze how water issues affect individuals as well as world populations, and how these issues can have short- and/or long-term implications.
- illustrate the scope and duration of water-related issues.

Materials
- *News reports on water-related issues* (can be collected by students)
- *Copies of **Water Issue Analysis Chart***
- *Chalkboard and chalk, or butcher paper and markers, or overhead transparency and markers*

Making Connections
Too often people become so involved in everyday problems that they forget to pay attention to issues that are of a statewide, national, or international scope. While it is important for young people to focus inward and learn about themselves, they should also be aware of the community and world around them. Analyzing water issues of concern to students helps them understand that local issues have global implications and global issues affect individuals.

Background
Ensuring that human activities sustain, rather than damage, water resources involves ecological and consequential thinking. That is, we need to understand the processes by which balanced ecosystems are maintained and to develop long-term thinking and our planning skills. Employing these understandings and skills enables us to predict how actions might affect water resources in the future. Students may develop these qualities by considering how the scope and duration of water-related problems can simultaneously affect the individual, the community, and the world.

The scope of water-related problems ranges from local to global. Local problems usually involve a small number of people and take place in a limited area. However, if left unchecked, local issues may affect other communities. For example, if individuals in one town carry a waterborne disease, the bacteria could multiply and spread to other towns. A drought in one part of the world may raise prices of certain foods at your grocery store.

Global problems affect the lives of individuals. For example, many scientists predict that if changes in global climate increase world temperatures, sea levels will rise. This would bring a global problem to the direct attention of individuals living in coastal areas.

The duration of water-related concerns may be short-term (e.g., within a week's time), long-term (e.g., over 500 years from now) or both. A leaky roof creates a short-term problem if fixed within a reasonable amount of time. Toxic wastes dumped into oceans will remain an issue for humans many years into the future. A hurricane may pass through a town in a few hours, but it may take several years for people to recover from the damage to property and a lifetime to mourn the loss of life.

People are more likely to act on issues that affect them directly. The challenge

for educators is to help people appreciate how they can be personally affected by global problems and how individual actions can help solve not only local, short-term problems but also broad-scale concerns.

Individuals resolving local problems (cleaning trash out of a river, landscaping a hillside to prevent erosion, etc.) contribute to the well-being of the planet. Individuals can also act directly on global issues (educating others about environmentally responsible behavior, lobbying a government official about the nation's water quality laws, etc.). Local actions may produce immediate results, but an individual working to resolve global issues may not see the result of his or her efforts for many years, if at all.

Procedure

▼ *Warm Up*

Ask students to think of a problem they face. When posing the following questions, have students raise their hands to indicate a positive response: Does the problem affect their lives directly? Will it concern them during the upcoming week? Does the problem concern their family? Will it be an issue a year from now? Does it concern the community? The nation? The world? Will it still be on their minds in five years? Most students will raise their hands for the first questions, fewer for the last.

▼ *The Activity*

1. **Have the class brainstorm a list of current issues related to water.** (This can be supplemented by news articles collected by students.) A current-events bulletin board or wall could be designed in the room.

2. **Have students, working in groups, choose a water-related issue. Ask them to discuss the following questions:**
   - What caused the problem?
   - Who is affected by the problem (a few individuals, an entire town, the population of a country, etc.)?
   - How long has the problem persisted?
   - Can the problem be resolved in the near future or will it take a long time for a solution to be found?
   - Will the solution be costly?
   - How realistic is the solution? (For example: "Air pollution could be reduced if everyone stopped driving cars." Is this practical?)

3. **Provide each group with the *Water Issue Analysis Chart*, or have them draw the chart on butcher paper or an overhead transparency.**

4. **Ask students to decide in which box of the chart the issue belongs.** Decisions will be based upon the issue's scope (who is affected: individual, community, state, etc.) and duration (how long the problem will affect those involved: weeks, months, years, etc.). For example, students may conclude that a leaky faucet in a house will affect the *individual/family* in the next *week*—until the faucet is fixed. The issue of acid rain affects several countries and may take many years to correct; therefore, students may place it at the intersection of *international* and *over 100 years*.

5. **Discuss why students categorized issues as they did.** Was there any debate among the students about the scope and duration? Did students find the task easy or difficult? Challenge students to see that a single issue may vary in scope and duration. (For example, what if the leaky faucet is not fixed? What about the individual property owner whose trees are affected by acid rain?)

▼ *Wrap Up*

Have the groups share results with other groups and transfer their conclusions to a master copy of the chart posted on the board, wall, or overhead. Ask the groups to discuss similarities and differences among findings. Is there a correlation between who is affected and which issues get the most attention in the media? Do global or local issues get mentioned more frequently in the media?

Ask students to rank 10 of the water-related concerns from most to least important. What criteria did they use? Did they consider scope and duration? Which of the issues do students think affect them the most? Why? Students can review periodicals and news reports to learn how the media address these issues.

Have students draw pictures or cut photographs and articles from newspapers to create a collage for each of the issues. The collage should reflect who is affected by the issue (scope). A time line can be incorporated into the collage, showing when the problem originated and how long it likely will persist. Student work can be posted in the school hallway or sent to local or national government officials.

Assessment

Have students:

- analyze the scope and duration of water-related issues by using the *Water Issue Analysis Chart* (step 4).
- create a collage and coordinate it with a time line to show how water-related local issues can have global implications and how world-wide issues can affect the individual (***Wrap Up***).

Extensions

Divide students into groups and have students pretend to be members of a think tank or conservation group focusing on particular issues. Groups can study issues that affect different levels of society. What are possible solutions? How would students persuade people to participate in resolving these problems? Will local, state, and global issues require different approaches?

Ask students to imagine they work for an advertising agency developing a campaign to motivate people to become involved in local or global water issues. Different groups can be assigned different types of issues. For example, one issue could involve a toxic waste site near a stream within an inner city; another could focus on water sanitation in a developing country, and a third on preserving wetlands. Groups can compare strategies they used to involve individuals for each type of issue. Have students use the results of the advertising campaign activity to publish a brochure for the school or community.

Considering geographic and cultural differences, students may investigate the unique perspectives and approaches of other countries in avoiding and solving water issues. If students have a sister school in another country, they may contact the school to learn how water resources are managed and protected.

Resources

Hungerford, Harold R., et al. 1992. *Investigating and Evaluating Environmental Issues and Actions Skill Development Modules*. Champaign, Ill.: Stipes Publishing Co.

Notes ▼

Water Issue Analysis Chart

Name: ______________________ Date: ______________

Issue: ______________________

DURATION

SCOPE	1 WEEK	SEVERAL MONTHS	1 YEAR	OVER 5 YEARS	OVER 10 YEARS	OVER 50 YEARS	OVER 100 YEARS	OVER 500 YEARS
Individual/ family								
Community								
Statewide								
National								
International								
Global								

Explanation:

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COPY

Water in Motion

- **Grade Level:**
Upper Elementary
- **Subject Areas:**
Fine Arts, Physical Science, History
- **Duration:**
Preparation time:
Part I: 30 minutes
Part II: 30 minutes
Part III: 10 minutes
Activity time:
Part I: 30 minutes
Part II: 30 minutes
Part III: two 50-minute periods
- **Setting:**
Classroom or outdoors (activity can be messy)
- **Skills:**
Gathering information (observing); Applying (designing); Presenting
- **Charting the Course**
The sounds of water in art are also incorporated into the activity "The Rainstick." The use of flowing water to produce energy is presented in "Energetic Water," which is a related activity.
- **Vocabulary**
gravity, water pressure

Why do people pull off the highway to watch a cascading waterfall, or pause along a trail to listen to a stream?

Summary

Students create artwork to help them appreciate the movement and sound of water in their environment.

Objectives

Students will:

- recognize reasons why people find the sound and movement of water pleasing.
- demonstrate how wind, pressure, and gravity move water.
- design artwork that incorporates the movement and sounds of water.

Materials

- *Rectangular clear baking pan*
- *Blue-colored water*
- *Battery-operated or electric fan*
- *Aluminum pie plate with holes pierced through bottom*
- *Cardboard*
- *Aluminum foil*
- *Tape*
- *Photograph of fountain* (provided)
- *Sand*
- *Plastic jar*
- *Flexible tubing* (about 3 yards [1 m] long)
- *Wood glue or duct tape*
- *Student-supplied building materials such as scraps of wood, aluminum foil, clay, tubing, jars with lids, rocks, hammer, nails, waterproof glue, etc.*

Making Connections

Water's movement in natural settings—crashing waves, cascading waterfalls, and rolling rivers—influences many forms of artistic expression found in cities. Fountains and water sculptures imitate the aesthetic characteristics of water in nature. By recognizing this relationship, students identify not only their physiological but also their emotional need for the soothing effects of water's movement and sound.

Background

All around the world, water is in motion. Gravity, the sun's energy, and Earth's rotation cause rivers to rush downstream or plunge over ledges to create spectacular waterfalls; they induce lakes and ponds to swirl below their surfaces, and draw the ocean waves to shore. People travel to Niagara Falls, Old Faithful Geyser, or Maui to enjoy the beauty and power of water in motion.

Gravity causes all free-running water to flow downhill. Falling rain is also influenced by this force. Raindrops fall from clouds when water vapor cools and condenses into droplets that are too heavy to be suspended by air molecules.

Wind also contributes to the movement of water. Because Earth's surface is made up of a variety of materials, it heats unevenly. The heat from the surface warms the air above it. Warmer air rises and is replaced by denser, colder air, creating wind. When wind blows over water, it produces waves.

Sounds are generated by the motion of water; these sounds can either alarm us (waves crashing or thundering) or soothe and comfort us (brooks babbling, rainfall softly pattering).

In the natural world, water not only sustains plants and animals, but also entertains and inspires people. Many architects and landscape designers have recognized the pleasing qualities of water in nature and have re-created them in steel and stone in cities. Fountains and water sculptures mimic the sights and sounds of waterfalls and bubbling creeks.

Fountains have been built for thousands of years. While many modern fountains are activated by pumps, earlier designs utilized water pressure. The source of the water was elevated above the level of the fountain, and gravity and the weight of water upon itself created the pressure. Traditionally, artists used naturally flowing water for their fountains. Today, many fountains, such as those designed for libraries, malls, and hotels, use water that is recycled by generators.

Procedure

▼ *Warm Up*

Ask students why people like to visit waterfalls, rivers, and beaches. Have students list the sounds these water bodies produce. Do they find these sounds pleasing or not? Ask students to describe what causes water to move and the sounds that are created.

▼ *The Activity*

Part I

1. **Fill a baking pan one-third full of blue-colored water and proceed with the following activities.**

- Place a battery-operated fan in front of the pan. (If using an electric fan, caution students about the hazard of water and electricity.) Ask students to predict what will happen to the water when you turn on the fan. Start the fan and have the students record their observations. Ask them to identify the energy source used to create these waves. (The first response is wind power; ultimately, however, the energy comes from the sun.)
- Hold the aluminum pie plate with holes punched in the bottom over the pan of water and pour a small amount of water into the pie plate. Ask students what this demonstration simulates. Have them identify the force of nature that pulls atmospheric water down to Earth.
- Fold a piece of cardboard lengthwise. Wrinkle a sheet of aluminum foil and tape it to the cardboard. Hold the board almost vertically over the pan and slowly pour water over the surface of the aluminum foil. Ask students to describe the sounds when the water flows over the aluminum foil and falls into the pan of water.

2. **Ask students where they might find the sounds created by moving water in a city building or a park. Show students pictures of fountains and discuss why people are attracted to fountains and why fountains are built in many public places.**

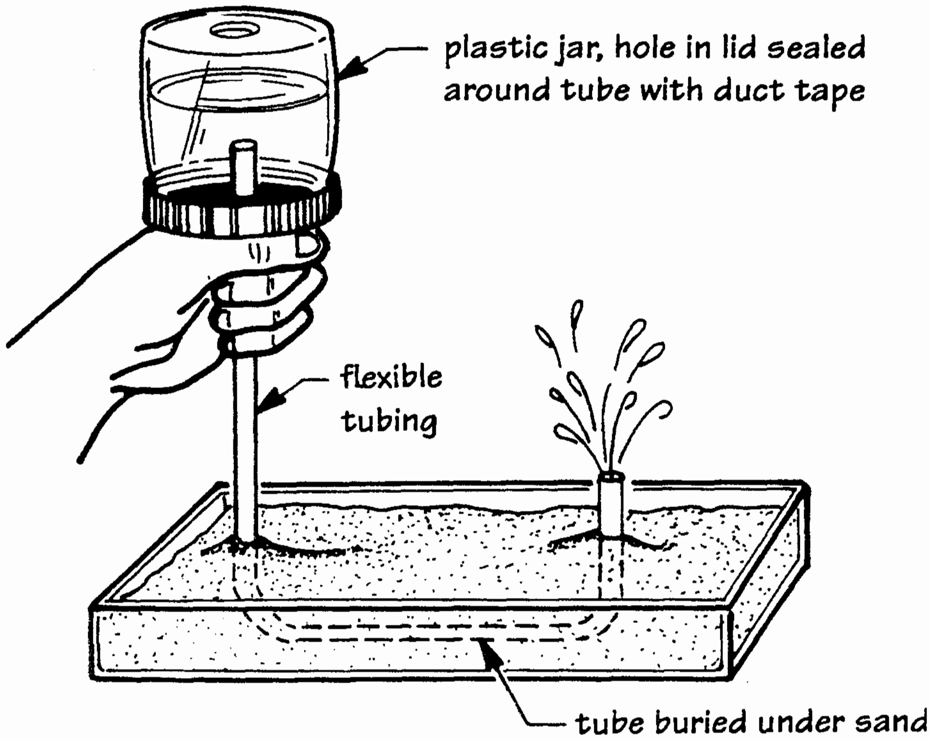
Part II

1. **Demonstrate how to mimic a fountain.** Fill a pan with sand. Cut a hole in the lid of a plastic jar and thread one end of a flexible tube through the hole. Seal the spaces around the tube with wood glue or duct tape. Put the lid on the jar. Bury the other end of the tube under the sand leaving the end pointing upward above the surface. (See diagram.) Lift the jar above the level of the pan and pour water into the hole in the base of the jar.

2. **Have students observe water flowing upward and explain that this is the basic structure used by artists to create fountains. Have them identify what causes the water to flow upward, against the pull of gravity.**

Part III

1. **Divide the students into groups and tell them they are architects or landscape designers. Challenge them to locate various building**



Fountain at Missouri Botanical Garden, St. Louis, MO.
FRANK OBERLE

materials to create their own functional design that incorporates flowing water. Student designs could include water sounds, sights, and motions.

2. **Have each group test and demonstrate their creation by pouring water through, on, or over it.**

▼ *Wrap Up and Action*

Have students review and interpret the artwork created by other groups. How did the artists create water movement? Do they think the artists were trying to elicit a feeling or thought with their designs? Do the structures have symbolic meaning?

Have students organize an art show to exhibit their work. This display should include information about the artists and reviews or interpretations of their designs. Students can act as guides, providing viewers with information and background about the designs.

Assessment

Have students:

- describe how water moves in nature (*Part I*, step 1).
- design art forms that incorporate moving water (*Part III*, step 1).
- list reasons why people find the sound of moving water in natural and human-made settings appealing (*Part I*, step 2 and *Wrap Up*).
- critique water designs (*Part III*, step 2 and *Wrap Up*).

Extensions

Water has been an integral part of architecture since the time of ancient Greece. Have students examine art and architecture books to find examples of fountains and other designs that incorporate water (e.g., water clocks, water drums). Students may research and model a particular design.

If a kiln is available, students may want to create a clay sculpture that incorporates rainfall. This functional design could be placed in the school yard or nature center.

Have students discuss how fountains may be designed to create a particular atmosphere to influence people's behavior. For example, fountains have been constructed in libraries where the sound of flowing water is conducive to quiet activities—reading and studying. Conversely fountains in Las Vegas create exci ment, and in attracting people ma contribute to the economy of the c

K-2 Option

CREATE A WATER TABLE! Set a "water table" or center in the ro so students can create a variety of water movement structures and learn math (e.g., volume) and physical science (e.g., density) concepts as well. Include the follo ing items at the water table: large basins, measuring cups and spoor squeeze bottles, bowls, straws, funnels, sieves, sprinkling cans, sponges, blocks of wood, plastic a metal, tubes, etc. Focus students' attention by giving them task carc (See *Water Task Cards.)* When plac the water table, consider students safety, freedom of movement, accessibility to running water, anc ease of clean up. Encourage stude to wear raincoats or plastic aprons when working at the table. Have students record their observations and conclusions by writing or drawing in a "Water Log" or journ and presenting their work to the class.

Resources

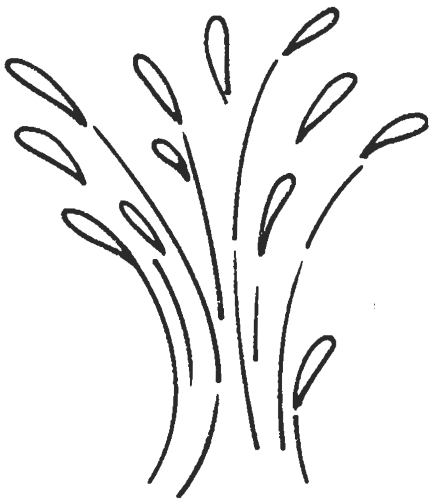
Campbell, C. S. 1978. *Water in Landscape Architecture*. New York, N.Y.: Van Nostrand Reinhold.

Martin, Bill, Jr., and John Archambault. 1988. *Listen to the Ra* New York, N.Y.: Harry Holt & Company.

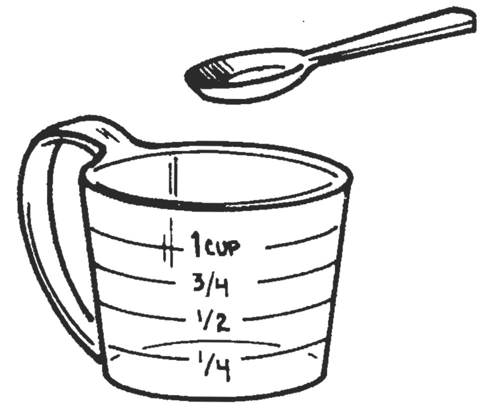
Praegor, Frederick A. 1958. *The Praegor Picture Encyclopedia of Art*. New York, N.Y.: Praeger Publishe

Robb, David M., and June J. Garrison. 1963. *Art in the Western World*. 4th ed. New York, N.Y.: Harper & Row.

Water Task Cards

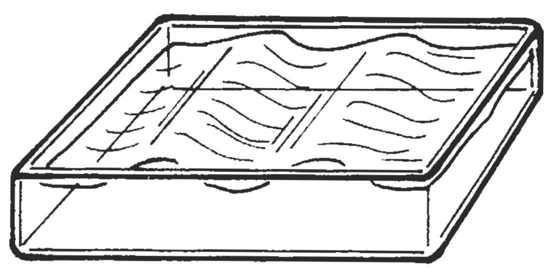


Can you make water squirt upward?

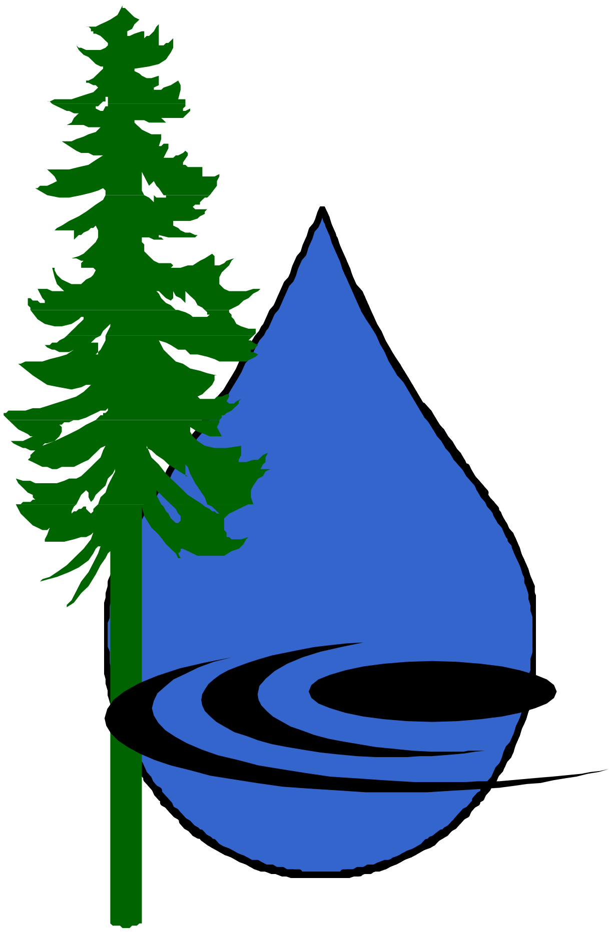


How many spoons of water fill a cup?

Can you make a waterfall?



Can you create big and small waves?



Discover a Watershed

Seeing Watersheds

If you look for watersheds you will find them.

Grade Level:
4–12

Subject Areas:
Natural Science, Geography

Duration:
Preparation: 15 minutes

Activity time: 45 minutes

Setting:
Classroom

Skills:
Map reading, Following instructions

Vocabulary:
basin, confluence, delineate, drainage basin, drainage divide, headwaters, main stem, mouth, tributary, watershed

Summary

Seeing a watershed on a map is easy after you learn how to see the parts: main stem, tributaries, headwaters, mouth, and drainage divides.

Objectives

Students will:

- locate the main stem, tributaries, and headwaters of a watershed.
- outline the boundary of the watershed.
- apply this skill to a more detailed map.

Materials

- *Copies of **Seeing Watersheds** Student Copy Pages One and Two* (one of each per student)
- *Blue, red, green, orange, and purple markers*

Background

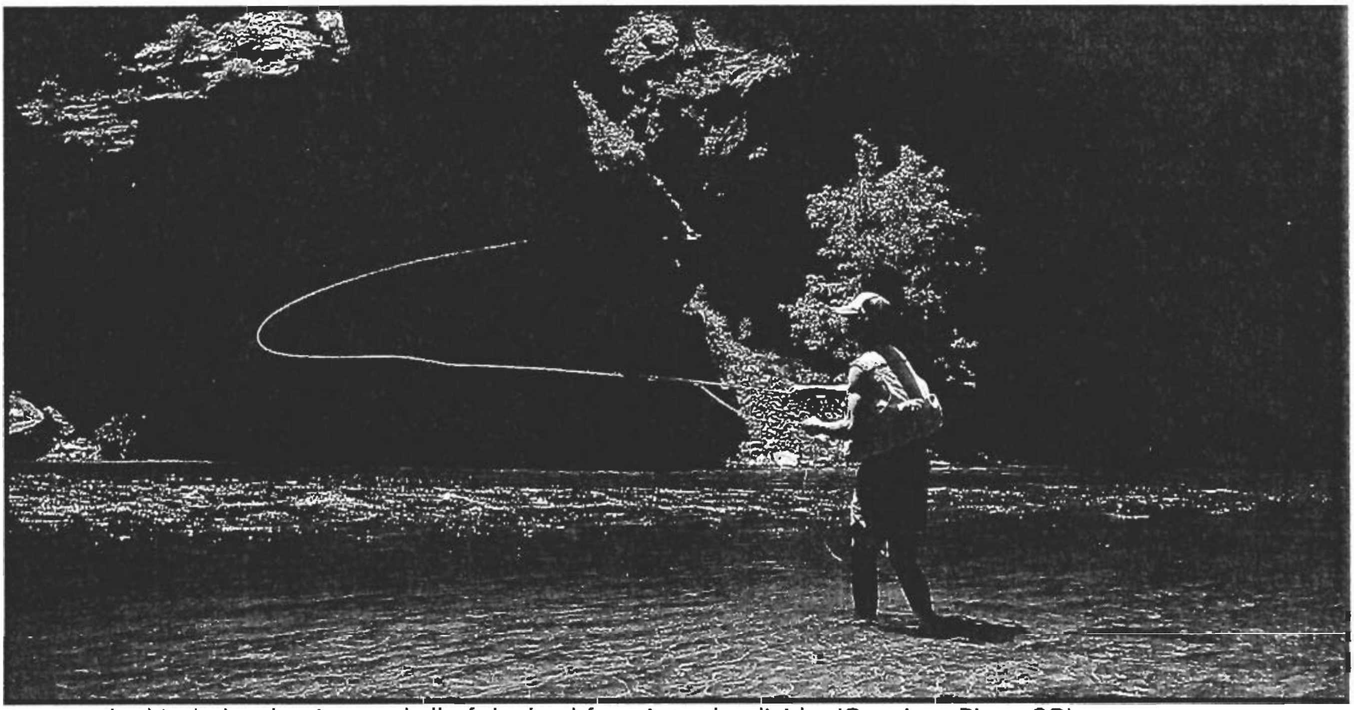
Glance at a national map of Canada, the United States, or Mexico. Can you see the watersheds? Most people couldn't show where the boundaries of their watershed are. In fact, in a recent national survey, only 20% of respondents were able to select the correct definition of a watershed from a list of possible answers. One reason the concept of a watershed is so difficult to understand is we seldom actually see our watershed's boundary—we see streams, lakes, and rivers, but have difficulty seeing the whole. "Seeing Watersheds" provides a simple method of delineating a river's watershed on a map that can be used for any watershed of any size, whether it's the huge Mississippi River Basin, the Everglades, or your local subbasin.

Seeing watersheds on a map is as easy as tracing a line. You will need a map that shows rivers and smaller tributaries (see illustration). It begins with knowing the name of the main river (main stem) in the watershed. If you know the name of the main stem, you know the name of the watershed (and vice versa). To learn how to see the watershed on any map, you will begin with tracing the pattern of the main stem and its tributaries on a simple line drawing. This starts the process of seeing the watershed.

Procedure

Warm Up

Review the definition of a watershed with the class, if necessary. Ask the students if anyone knows the name of the watershed the



A watershed includes the river and all of the land from it to the divide. (Gunnison River, CO)

school is located in. Ask if they can name several features of the watershed such as all of the states it covers, the highest and lowest points, several cities, any tribal lands, and any national parks or forests. Tell the group that the only way to answer these questions and others about a watershed is to first know its boundary.

Show students a map of your state or province, the United States, Canada, or Mexico. Ask if they can see the watershed boundaries. Brainstorm methods to find the boundary of a watershed (possibilities could be to look at the map *Selected Rivers and Watersheds of North America*, look up your watershed online, call a water resources office and ask for a map, walk along the rivers until you come to the headwaters, fly over in a plane, etc.)

Show the class the map again. Ask why it might be important to know the boundary of a watershed. There could be a wide range of ideas such as learning who or what is affecting the water supply, how much water is available to different towns, which water users are placing demands on the water quality or quantity, what the water rights are, or predicting future scenarios.

The Activity

1. **Tell the class you are going to teach them how to see watersheds on any map that shows rivers.** For this exercise they will start with a large watershed, The Missouri River Basin. Distribute a copy of the ***Seeing Watersheds*** *Student Copy Pages* to each student, and make sure each student has a set of markers (blue, red, green, orange, and purple).
2. **Begin with *Seeing Watersheds Student Copy Page One*.** Instruct the students to use the blue marker to trace the main channel (main stem) of the Missouri River from its mouth at St. Louis (the point where the Missouri flows into the Mississippi River) all the way to its headwaters at Three Forks, Montana (the confluence of the Jefferson, Gallatin, and Madison Rivers).
3. **Tell the class to use the red marker to trace the tributaries of the Missouri River.** To do this, they can start at St. Louis

again, and each time they encounter a river connecting to the Missouri they should follow that river from its mouth (where it flows into the Missouri River) to its headwaters (where it begins, as far away from the Missouri River as they can follow the tributary).

4. **With a green marker, repeat the process for any smaller tributaries flowing into the ones marked in step 3.**
5. **Now it's time to find the drainage divides, the next step to locating the watershed boundary.** Remember that streams flow from higher elevations to lower ones. Thus, each tributary or stream actually begins at some point on the land above the headwaters, usually a hill, mountain, or some other high point dividing this watershed from the one(s) next to it. Find a spot above the top of each river and mark it with an orange dot to indicate the divide.
6. **Complete the process of seeing the watershed by connecting the dots with the purple marker.** Start at a point near the mouth of the Missouri River and move in a clockwise fashion around the main stem. Continue connecting the dots all the way around until the purple line meets itself back at the mouth of the river (the confluence with the Mississippi River).
7. **Repeat steps 2-6 for the three fictional watersheds illustrated on *Seeing Watersheds Student Copy Page Two.***

Wrap Up

Have the students hang their watersheds (both copies) up around the classroom. Are they all the same? Where did difficulties arise, if any? Do they think they can duplicate the process for another river or watershed? Why or why not?

Assessment

Have students:

- identify the main stem and tributaries of the Missouri River (steps 2-4).
- show the drainage divides of the Missouri River Basin (steps 5-6).
- see multiple watershed divides on a map using their knowledge of the features of a watershed (step 7).

Extensions

Find a large, detailed map of the United States or of North America and challenge the students to delineate the Missouri River Basin again.

Ask the students to see the smaller watersheds within the Missouri River Basin, follow the same methods of marking and outlining them, and be prepared to discuss the rationale behind the boundaries they have marked.

Resources

EPA. Mississippi River Basin: Subbasin, Missouri. Retrieved o August 3, 2002, from the Web site: http: //www.epa.gov/msbas missouri.htm

USGS. Missouri River Basin Geography and Natural Feature Retrieved on August 6, 2002, from the Web site: http://aa179.cr.usgs.gov/basin/ dynamap.html

e-Links

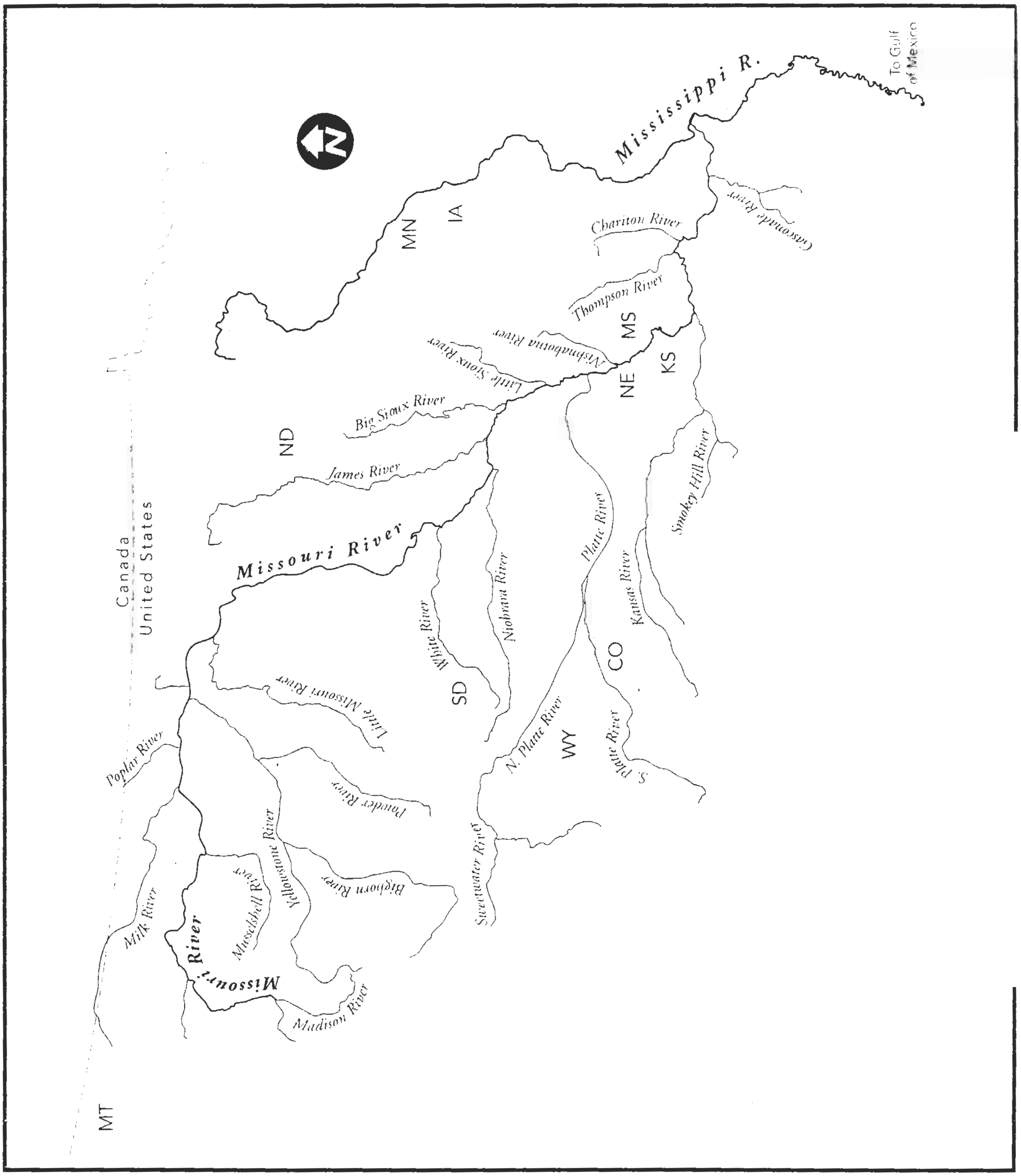
Maps
www.epa.gov/surf
www.50states.com
www.geographynetwork.com
www.lib.utexas.edu/maps/united_states.html

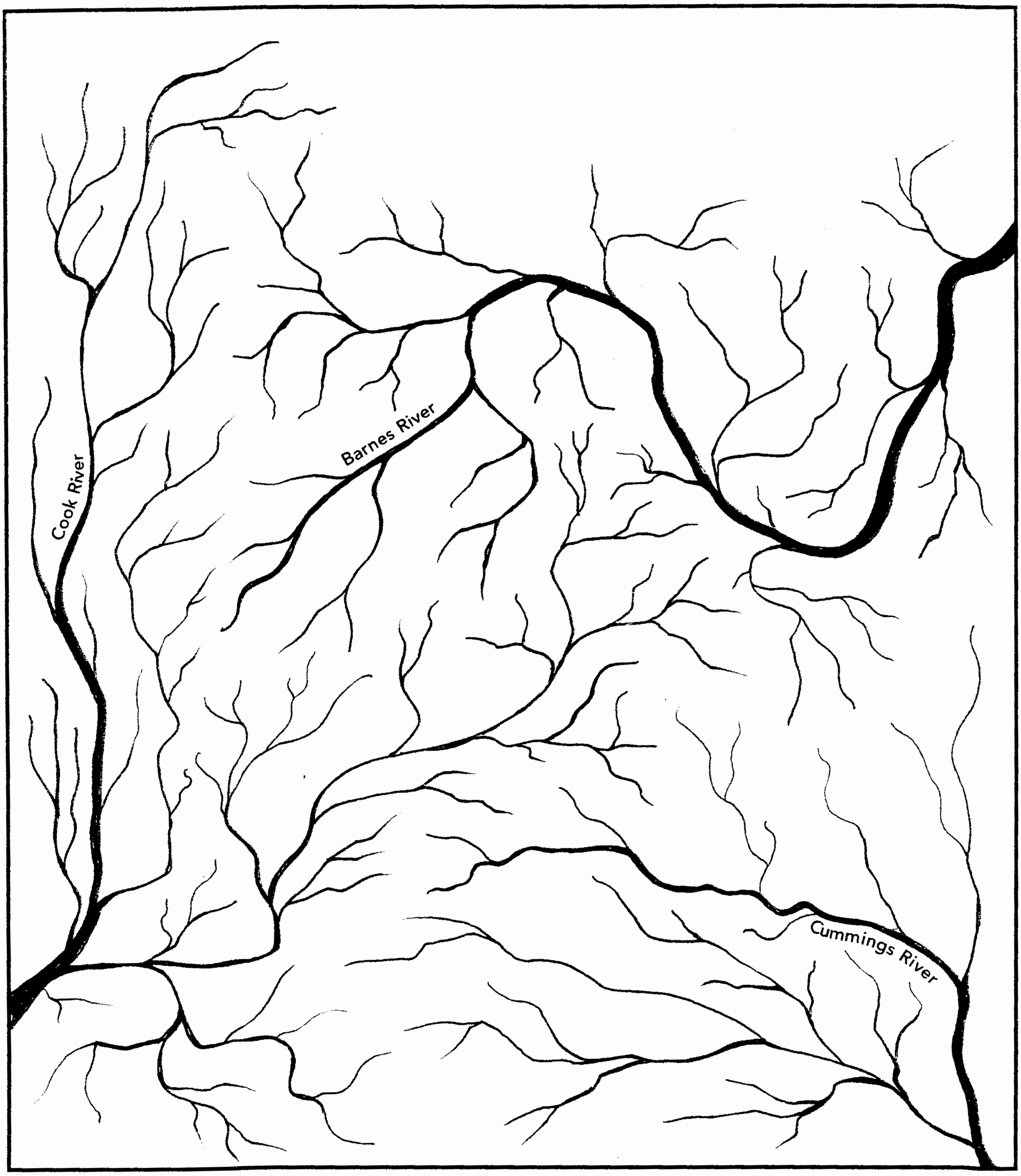
Mexican Institute of Water Technology
www.imta.mx

Mexico National Water Commission
www.can.gob.mx

Rivers of Canada
www.aquatic.uoguelph.ca/rivers cnrvintr.htm

Watershed Council Data Management Assistance "Scienc in Your Watershed."
http://water.usgs.gov/wsc/wsc_dswb.htm


Mississippi R.
To Gulf of Mexico
MN
IA
Chariton River
Gasconade River
Thompson River
MS
Nishnabotna River
Little Sioux River
KS
NE
Big Sioux River
ND
James River
Smokey Hill River
Platte River
Missouri River
Canada
United States
Niobrara River
Kansas River
White River
CO
SD
Little Missouri River
N. Platte River
WY
S. Platte River
Poplar River
Powder River
Yellowstone River
Sweetwater River
Bighorn River
Musselshell River
Milk River
Missouri River
Madison River
MT


Cook River
Barnes River
Cummings River

River Talk

What do a watershed and an orchestra have in common?

Grade Level:
6–12

Subject Areas:
Language, Logic

Duration:
Preparation:
15 minutes

Activity time:
120 minutes

Setting:
Classroom

Skills:
Analyze, Define, Deduce, Explain

Vocabulary:
precipitation, condensation, evaporation, runoff, ground water, transpiration, drought, floodplain, tributary, drainage basin, reservoir, headwaters, mouth, main stem, aquifer, ecosystem, watershed, riparian, recharge, hydrologist, watercourse, sub-basin, catchment, arid, dam

Summary

Students study the relationship between a pair of watershed words and choose another pair that demonstrates the same type of analogy.

Objectives

Students will:

- learn watershed terms.
- understand the physical properties or relationships of the watershed vocabulary.
- increase their ability to use analogies to explain the world around them.

Materials

- *Transparency of watershed diagram*
- *Overhead projector*
- *Copies of watershed diagram* (one per student)
- *Copies of **River Talk Student Copy Page**, either for grades 6-8 or 10-12* (one per student)
- *Paper and pens or pencils*
- *Dictionary and/or Internet access*
- *Optional: glossary from this guide for teacher's reference*

Background

Although we are all different from one another in appearance, temperament and health, we are (more or less) made up of the same parts: eyes, ears, heart, lungs, and so Like us, each watershed is uni yet there are components they share. Understanding the com parts of each basin provides a foundation for understanding dynamic whole of a watershed just like learning anatomy is th first step to understanding the complexities of the body.

The use of analogies, like the c above comparing a watershed t the human body, helps us und stand something new by relatin to something known. Analogy Greek in origin, and means pro portion, or equality of ratios. A definition of analogy is as follo

1. a similarity or likeness betw things in some circumstanc or effects, when the things a otherwise entirely different.
2. an explanation of something comparing it point to point with something else.

You can also explain analogy by looking at the root it shares wit analysis. Analysis means to sepa rate or break up any whole into parts so as to find out their natu proportion, function, or relation ship.

Analogies generally fall into seve basic types:


MICHAEL COLLIER

We create many analogies from our observations of nature, such as these Sandhill Cranes on the Platte River in Nebraska.

1. synonyms. A word having the same or nearly the same meaning as another word, such as hat: cap.
2. antonyms. A word having the opposite or nearly the opposite meaning as another word, such as rich: poor.
3. type of. A word that is a sub-set or category of another word, such as trout: fish.
4. is caused by. An analogy in which one word is caused by (or could be caused by) the other word, such as fire: spark.
5. is where. An analogy in which one word's meaning is found in the location of another word's meaning, such as theater: movie.
6. without. An analogy where one word means the lack of the other word, such as broke: money.
7. is used to. An analogy where one word "is used to" perform the other word, such as dumpster: trash, or spoon: stir.

(Portions of this information are from http://freesat1prep.com/.) In this activity, students will learn the names and roles of different parts of a watershed by solving analogies that compare the processes of a watershed to everyday situations.

Procedure

Warm Up

Put the transparency of the watershed diagram on the overhead projector. Tell the class that a watershed is made of many parts. Ask if they can identify any of the parts. (If they answer correctly, write it in place and ask if they can give a definition for the part they labeled.) Tell them one of the easiest ways to understand a system as large and complex as a watershed is to break it down into parts, learn the name and definition of each part, and examine the role the part plays in the larger system. Tell the class they are going to learn the names and definitions of parts of a watershed, and then use analogies to examine the function of the different parts. Explain the term analogy. Offer an example, such as "pop: soda / sick: ill." Ask the students to define the relationship between the two pairs of words. (Pop is a type of soda won't work because sick isn't a type of ill. The answer is pop is synonymous with soda and sick is synonymous with ill.) Or another one: "president: country / _____ : school." (Principal.) Again, wait for the class to figure out the relationship, not just a word to fill in the blank. You might try several different words in the blank to help them use logic to figure out the connections, such as why "principal" is more correct than "teacher" (only one president to a country, although many leaders; only one principal to a school, although many teachers).

The Activity

1. **Distribute a copy of *River Talk Student Copy Page* and a copy of *River Talk Watershed Diagram* to each student.** You can choose whether you would like them to work in pairs or alone. Each student should complete her or his own copy sheet.
2. **Have the class discuss strategies to complete the exercise.** Write the suggestions on the board for all to share. One good idea is to skim all of the words first, thus gaining an overview of the vocabulary. Another would be to look up all of the definitions first, or, if working in pairs, divide the list and each look up half the words (and then share their answers). Trying out one or

two definitions of the relationship between the known pair is a good way to start, but tell students not to linger over the exact definition because they may figure it out as they go.

3. **Tell the students to write out the definition of each watershed word on their own paper (but they don't have to write the definition for the non-watershed words unless it helps them).** Ask them to complete as many analogies as they can. (The definitions are in most standard hard copy or online dictionaries, or can be looked up at several different water glossary Web sites. See the links at the end of this section.)
4. **Ask the class to label their watershed diagram when they are finished with the analogies.**

Wrap Up

Ask the students to describe which methods worked and which ones didn't work when they tried to solve the analogies. Make two lists on the board, one for successful methods and one for unsuccessful methods (remember, not everyone will agree about these).
Review the answers to the analogies. It is likely that there will be several words that could be argued as solutions to an analogy, and this is good. It will create opportunities for the students to discuss the meanings of the words, the characteristics of a watershed, and the way analogies work.

Put the transparency back up. Ask the class to name and define each part of the watershed, and to explain the role each part plays in the whole system. Conclude the activity by asking them to write a definition of a watershed. Tell the students to include observations about what would happen to the whole if any part was missing.

Assessment

Have students:

- analyze the parts of a watershed (*Warm Up*, step 3, and *Wrap Up*).
- define each part of a watershed (step 3).
- deduce the relationship between the parts of a watershed (step 3).
- explain the system of a watershed (*Wrap Up*).

Extensions

Have a spelling bee with the River Talk vocabulary.

Create a game show. Divide the class into four teams. Each round, you name a word, and the first team to respond has to define the watershed word, place it on the diagram, and use it (correctly!) in a meaningful sentence.

Assign one of the River Talk vocabulary words to each student, and tell him or her to bring in an example of the word in use. They could look for newspaper articles mentioning the word, Web sites, etc.

Resources

Horton, Gary A. *Dictionary: Technical Water, Water Qualit Environmental, and Water-rela Terms.* Nevada Division of W Planning. Retrieved July 2, 2(from the World Wide Web: www.state.nv.us/CNR/NDW Dict-1/wwords-g

Random House. *Unabridged Dictionary, 2nd edition.* 1993. York.

Reckner, Ann. What's an Ana Retrieved June 21, 2002, fron World Wide Web: www.info-please.com/spot/analogy.html

SAT Verbal Analogy Types. Retrieved June 21, 2002, from World Wide Web: http://freesat1prep.com/

e-Links

Know Your Watershed's Wate Glossary
http://www.ctic.purdue.edu/K /glossary/glossary.html

Natural Resources of Canada General Glossary
http://atlas.gc.ca/site/english/index.html#

River of Words,
an Annual Art and Poetry Contest about Watersheds
http://www.riverofwords.org/

River Talk Answer Key

1. inhalation: exhalation / precipitation: transpiration
2. ranch: barn / riparian: river
3. condensation: evaporation / headwaters: mouth
4. tributary: main stem / branches: tree
5. drought: precipitation / hunger: food
6. dam: river / stoplight: traffic
7. aquifer: water / refrigerator: food
8. ecosystem: watershed / musicians: orchestra
9. hydrologist: water / doctor: medicine
10. humid: arid / wet: dry
11. subbasin: basin / team: league
12. recharge: ground water / deposits: bank account
13. dam: reservoir / plug: bath
14. watercourse: water / highway: traffic
15. catchment: water / glove: baseball

River Talk Analogies of a Watershed

Grades 6-8

Write down the definition of each of the watershed words.
Then use your logic to figure out the relationship between the first pair of words, and apply that same relationship to fill in the blank in the second pair of words.

Vocabulary:

aquifer, arid, catchment, condensation, dam, drainage basin, drought, ecosystem, evaporation, floodplain, ground water, headwaters, hydrologist, main stem, mouth, precipitation, recharge, reservoir, riparian, runoff, subbasin, transpiration, tributary, watercourse, watershed

1. inhalation: exhalation / precipitation: ____________________ (hint: leads to)
2. ranch: barn / ___________ : river or body of water (hint: dwells next to)
3. condensation: _______________ / headwaters: mouth (hint: is the opposite of)
4. tributary: _________ / branches: tree (hint: connects to)
5. drought: _________ / hunger: food (hint: is a lack of)
6. dam: ___________ / stoplight: traffic (hint: regulates)
7. aquifer: ____________ / refrigerator: food (hint: stores)
8. ecosystem: watershed / musicians: ________________ (hint: makes up)
9. ____________: water / doctor: medicine (hint: one who studies)
10. humid: ___________ / wet: dry (hint: is the opposite of)
11. subbasin: __________ / team: league (hint: is part of)
12. recharge: ___________ / deposits: bank account (hint: adds to)
13. dam: __________ / plug: bath (hint: holds back)
14. watercourse: ___________ / highway: traffic (hint: is where)
15. catchment: _______ / glove: baseball (hint: is used for)

River Talk Analogies of a Watershed

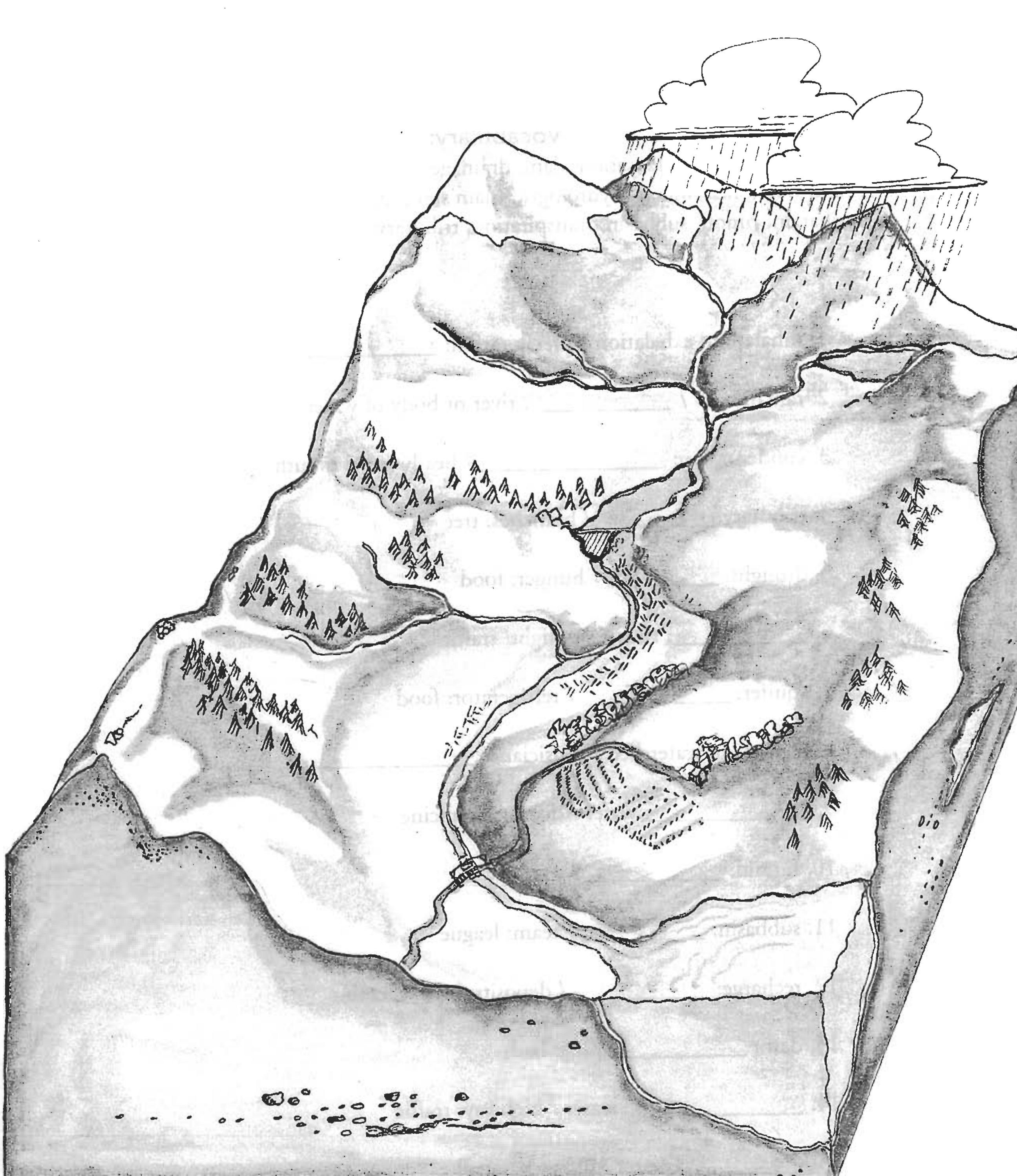
Grades 10 -12

Write down the definition of each of the watershed words.
Then use your logic to figure out the relationship between the first pair of words, and apply that same relationship to fill in the blank in the second pair of words.

Vocabulary:

aquifer, arid, catchment, condensation, dam, drainage basin, drought, ecosystem, evaporation, floodplain, ground water, headwaters, hydrologist, main stem, mouth, precipitation, recharge, reservoir, riparian, runoff, subbasin, transpiration, tributary, watercourse, watershed

1. inhalation: exhalation / precipitation: ____________________
2. ranch: barn / ___________ : river or body of water
3. condensation: _______________ / headwaters: mouth
4. tributary: _________ / branches: tree
5. drought: _________ / hunger: food
6. ___________: river / stoplight: traffic
7. aquifer: ____________ / refrigerator: food
8. ecosystem: watershed / musicians: ________________
9. _____________: water / doctor: medicine
10. humid: ___________ / wet: dry
11. subbasin: __________ / team: league
12. recharge: ___________ / deposits: bank account
13. dam: __________ / plug: bath
14. ______________: water / highway: traffic
15. __________: water / glove: baseball



Sum of the Parts

Imagine you have just inherited valuable riverfront property with a new house and a resort on it. On the day you move in, you discover the beach polluted with oil and littered with construction materials and animal waste! Where did all this stuff come from?

Grade Level:
Upper Elementary, Middle School

Subject Areas:
Environmental Science, Government

Duration:
Preparation time:
50 minutes

Activity time:
50 minutes

Setting:
Classroom

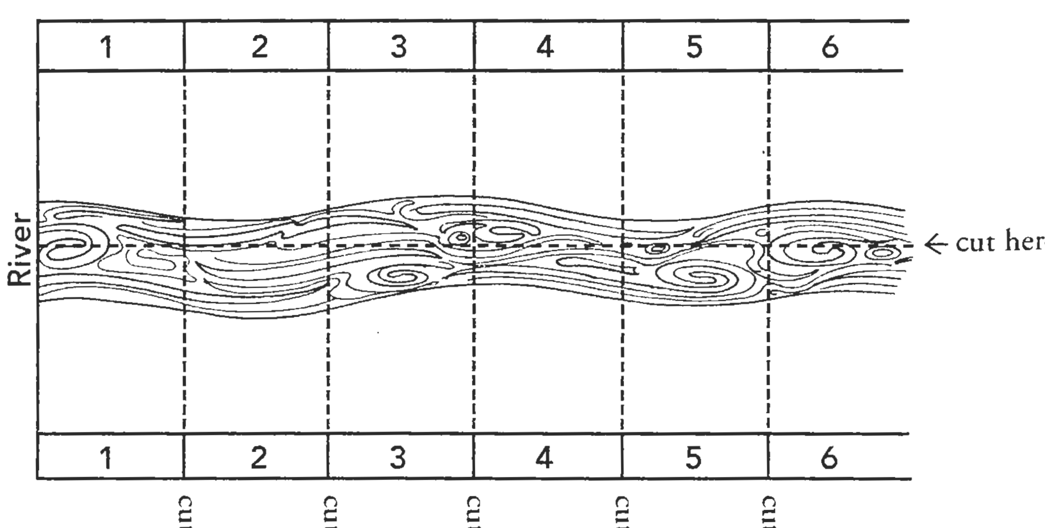
Skills:
Gathering information, Organize, Analyze, Interpret, Apply

Vocabulary:
point source pollution, nonpoint source pollution, Best Management Practices

Summary
Students demonstrate how everyone contributes to the pollution of a river as it flows through a watershed and recognize that everyone's "contribution" can be reduced.

Objectives
Students will:
- distinguish between point and nonpoint source pollution.
- recognize that everyone contributes to and is responsible for a river or lake's water quality.
- identify Best Management Practices to reduce pollution.

Materials
- *Large piece of poster board or newsprint* (Using blue marker, draw and color a river on poster board, as shown below. Divide the stream in half down the middle and crosswise into sections. Each section should include a bit of river and blank space to allow room for students' drawings. The number of sections should correspond with the number of students or groups of students working together. Number the sections on one side of the river in sequential order, placing numbers in upper left-hand corners and repeat for the other side. Cut out the sections of stream. For durability, sections can be laminated.)
- *Drawing pens and pencils*
- *Items from students' desks* (e.g., pencil, paper clip, book)



Background

The quality of water in a river (or lake) is, to a large extent, a reflection of land uses and natural factors found in its watershed. If soil near a river or lake naturally erodes, chances are the river has sediment and turbidity problems. If the land has stable vegetative cover, erosion is kept in check. When humans settle and develop land, water quality is affected. Breaking sod, cutting forests, building cities, mining, and other land uses make an impact upon water quality.

Everyone bears responsibility for the health of a watershed and the water systems (rivers, lakes, wetlands, etc.) within a drainage basin. Individual actions, both negative and positive, add up. Understanding a river or lake's water quality and quantity involves investigating the condition of the contributing watershed. If the watershed is polluted, the river will likely be polluted.

Watershed investigations are usually conducted for many reasons. Some investigations monitor changes in river and stream flows over time, to protect fisheries, to regulate floods, or to meet seasonal demands. Other studies determine the best method of protecting a river or lake from pollutants. One aim of a researcher might be to determine which areas of a watershed contribute the highest percentage of contaminants. This information is vital to policy makers and water managers when determining how best to spend money for improvements. For example, most lake improvement projects address problems in the watershed as well as those of the lake. It would prove fruitless to spend thousands (or even millions) of dollars to clean up a lake, if problems in the watershed will only pollute the lake again.

When watershed managers investigate land use practices that might affect the quality of water, they are concerned with two general sources of pollutants: point and nonpoint.

Point source pollutions involves pollutants that are discharged from, and be traced back to, and identifiable point or source, such as a factory's discharge pipe or a sewage ditch. Nonpoint source pollution (NPS) occurs when the source of a contaminant is unidentifiable; that is, the pollutant can come from on of many places. Examples of nonpoint source pollution include runoff from agricultural fields containing fertilizers and pesticides, motor oiling filtering from urban areas, and sediments from eroded stream banks.

Surface runoff and ground water can transport both point and nonpoint source pollutants since point source pollutants are identifiable, they are easier to moni

The protection of surface an ground water resources from NPS pollution present an en mous challenge because of th widespread and diverse natu the problem. Land and wate managers rely on methods ca Best Management Practices, BMPs, to describe land use measures designed to reduce eliminate NPS pollution pro lems. A list of nonpoint sour pollution sources and sugges BMPs can be found in the si bar on the previous page.

Procedure

Warm Up

Determine students' knowled about watersheds by asking th to name several major North American rivers (e.g., Mississi Columbia, Missouri, Hudson and Rio Grande). Where do t rivers originate (where are the headwaters) and end? How m states does each cross or touc

Discuss some of the predomi types of land uses found alon one river as it flows through a gle state. Do students think th practices could affect the rive What do students think the a tude of downstream state residents might be about the wat received from their upstream neighbors?

Major Sources of NPS Pollution and BMPs

Sources	Best Management Practices
Roads and Streets	• Dispose of paints, solvents, and petroleum products at approved disposal sites, not in storm drains or street gutters
	• Fix automobile oil and fuel leads
	• Stop oil dumping on rural roads
	• Dispose of paints, solvents, and petroleum products at approved disposal sites, not in storm drains or street gutters
	• Fix automobile oil and fuel leads
	• Stop oil dumping on rural roads
	• Use nonchemical deicers (sand and ash) on roads, sidewalks, and driveways
	• Construct a sediment catch basin to collect storm water runoff
	• Reduce road construction runoff by building terraces and catch basins, and by planting cover crops
Agriculture	• Read and follow all labels and ask for application directions before using chemicals, fertilizers, and pesticides
	• Use conservation tillage
	• Use contour farming
	• Use strip cropping
	• Leave filter strips and field borders along wetlands and streams
	• Use a cover crop to protects exposed soil
	• Rotate crops
	• Plant shelter belts and windbreaks
	• Institute pasture management
	• Terrace areas prone to erosion
	• Construct livestock waste collection and treatment ponds for confined livestock
	• Use grassed waterways
	• Seal abandoned or waste disposal wells
	• Fence waterways to reduce riparian zone impact by livestock
Logging	• Monitor water entering and leaving cut areas
	• Prevent sediments form reaching streams and lakes by building ter races, catch basis, and natural filters
	• Leave a vegetative buffer zone in riparian areas
	• Maintain and restore effective watersheds
	• Implement a plant to reduce erosion from roads
Mining	• Monitor all water entering and leaving mine sites
	• Intercept and reroute uncontaminated water away from contaminated areas (keep clean water clean!)
	• Construct catch basins and terraces, and plant cover crops, to catch sediment and prevent erosion
	• Catch and treat contaminated water (clean contaminated water!)
	• Stabilize stream channels
	• Stabilize mining waste areas to prevent release of materials to streams
	• Maintain buffer strips along streams
Construction	• Implement a sediment control plan
	• Plant ground cover to reduce erosion
	• Dispose of solvent paint and other wastes at approved disposal sites
	• Build temporary, small dikes to slow and catch runoff
	• Build sediment catch basins to collect construction runoff
	• Build earth bergs and filter runoff before water enters steam
Residential	• Use non chemical deicers (sand and ash) on residential driveways and sidewalks
	• Read labels prior to using pesticides and fertilizers
	• Consider xeriscaping
	• Use nonchchemical fertilizers (compost) on gardens
	• Dispose of household hazardous waste at approved disposal sites
	• Maintain septic tanks if sewers are not available

Activity

1. **Inform students that they have just inherited a piece of riverfront property and a million dollars.** Have them list ways they could use the land and the money.
2. **Pass out "pieces" of property and drawing pens and pencils.** Explain that the blue is water and the blank space is land they own. They have one million dollars to develop their land as they wish. They can farm or ranch; build resorts, homes, factories, or parks; plant forests, log, mine —whatever they like.
3. **When students have completed their drawings, ask them to look in the upper left corner of their property for a number.** Explain that each piece is actually a part of a puzzle. Starting with number one, have students assemble their pieces. They will construct the stream pathway and adjacent land area in proper order. (The ones should face each other, with the twos next to them, and so forth.)
4. **Have students describe how they developed their land and how they used water.** They should identify any of their actions that polluted or added materials to the waterway. Have students represent each of their contributions to the river with an item from their desks (e.g., book, piece of paper, pen, pencil).
5. **Tell students to take their item(s) and line up in the same order as their pieces of river front property.** They are going to pass their pollution pieces downstream. Have them announce what kind of pollutant they are holding before they pass it on. The ones will pass their item(s) to the twos, the twos will pass everything to the threes, and so on, until the last students are holding all the items.

Wrap Up

After all the items have reached the final students, discuss the activity. How did those students toward the middle or at the end of the river feel? What about their property use plans? Could a student downstream be affected by the actions of a student upstream? Could upstream users alter the water quality of those downstream?

Tell students to reclaim their items. Explain that the items easily identifiable as their own simulate point source pollution. Other items (e.g., pencils, paper clips, notebook paper) may be more difficult to claim, because these kinds of pollutants originated from multiple sources. Tell students these represent nonpoint source pollution.
As a follow-up, have each student write one paragraph detailing ways to reduce the amount of pollution he or she contributed. (Share the *Major Sources of NPS Pollution and*

BMPs from **Background**.)
Students can research the regulations governing waterfront property in their communities. If they believe their waterways are poorly treated, they may want to write letters to local government officials supporting environmentally sound land use legislation.

Assessment

Have students:

- express their opinions about individual contributions to total water quality (***Wrap Up***).
- write a paragraph identifying what they can do to protect water quality (***Wrap Up***).
- discriminate between point and nonpoint source pollutants (***Wrap Up***).

Upon completing the activity, for further assessment have students:

- design a community that uses Best Management Practices that allow for a minimum contribution of pollutants.

Extensions

Instead of a river, have students represent a lake system. One student represents a lake. A group of students encircle the student presenting the lake; they are houses around the lake. Other students, standing in lines extending from the lake, can be streams flowing to the lake. Students pass their item(s) downstream and into the lake until all the items are held by the person in the middle who represents the lake.

Have students adapt the activity to represent a river system that includes tributaries flowing into a main channel.

Complete the main activity using real water users within the watershed where students live. Or assign roles (farmers, suburban dwellers, etc.) to students and have them develop their own land accordingly. How would they manage their land to protect water resources?

Resources

Braus, Judy, ed. 1990. *NatureScope: Pollution, Problems and Solutions.* Washington, D.C.: National Wildlife Federation.

Collier, James Lincoln. 1986. *When the Stars Begin to Fall.* New York, NY: Delacorte.

Gay, Kathlyn. 1990. *Water Pollution.* New York, NY: Watts.

Greene, Carol. 1991. *Caring for Our Water.* Hillside, NJ: Enslow.

Miller, G. Tyler, Jr. 1990. *Resource Conservation and Management.* Belmont, CA: Wadsworth Publishing Company.

Myers, Carl F., and Hal Wise. 1989. Non-Point Sources of Water Pollution: A New Law for an Old Problem. *Western Wildlands* (Winter).

e-Links

EPA (Environmental Protection Agency) Kid's Page
http://www.epa.gov/kids/water.htm

Foreign Policy and Marine Pollution 1995 Speech
http://dosfan.lib.uic.edu/ERC/environment/releases/950525.html

Gulf of Mexico Kid's Page (US EPA)
http://www.epa.gov/gmpo/edresources/kids.html

National Agricultural Library, Agricultural Research Service, U. S. Department of Agriculture
Información en Español Sobre Agua
http://www.nal.usda.gov/wqic/Spanish.html

Project WILD

How Many Bears Can Live in This Forest?

Objectives

Students will (1) define a limiting factor, and (2) describe how limiting factors affect animal populations.

Method

Students become "bears" to look for one or more components of habitat during this physically involved activity.

Materials

Five colors of construction paper (a couple of sheets each of red, yellow, green, blue, and orange) or an equal amount of light poster board or colored tokens; one black felt pen; envelopes (one per student); pencils; one blindfold; five sheets green construction paper (for extension)

Grade Level: 5–8

Subject Areas: Science, Environmental Education, Mathematics

Duration: one 20- to 45-minute session or longer

Group Size: 10 to 45

Setting: outdoors

Conceptual Framework Topic Reference: WPIIA2b, WPIIA2b1, WPIIA2b2

Key Terms: limiting factors, habitat, shelter, cover

Appendices: Simulations, Ecosystem

Background

Black bears are the focus of this activity that illustrates the importance of suitable habitat for wildlife. The activity demonstrates the consequences for a population of bears if one or more habitat components is relatively scarce. When any element or factor in a habitat is inappropriate or exceeds the tolerance range for an animal or population, it directly affects the well-being of the animal(s) and may result in death or population reduction. This factor "limits" the animal or population. Limiting factors may include habitat components such as food, water, shelter, and appropriate space, as well as life history parameters such as disease, predation, and climatic conditions. Limiting factors also may be related to human activity such as development, pollution, and hunting. Populations tend to increase in size until limited by one or more of these factors.

Black bear habitat limits black bear populations, especially through the influences of shelter, food supply, and the social tolerances or territoriality of the animal. Shelter or cover is a prime factor. Black bears need cover—for feeding, hiding, bedding, traveling, raising cubs, and denning. With limits of space, adult bears will kill young bears or run them out of the area. These young bears must keep moving around either until they die or until they find an area vacated by the death of an adult.

When food supplies are reduced by factors such as climatic fluctuations, competition becomes more intense. Some adult bears might temporarily move to seldom-used areas of their home range, sometimes many miles away. They must live on what food is available in the area. These individuals may become thin and in poor

continued

Number of Cards to Make

Paper Color	Label	Represents	Number of Students in Group						
			10–15	16–20	21–25	26–30	31–35	36–40	41–45
Orange	N-20	Nuts, 20 lbs.	2	3	3	4	5	6	7
Orange	N-10	Nuts, 10 lbs.	8	13	17	21	25	29	33
Blue	B-20	Berries, 20 lbs.	2	3	3	4	5	6	7
Blue	B-10	Berries, 10 lbs.	8	13	17	21	25	29	33
Yellow	I-12	Insects, 12 lbs.	2	3	3	4	5	6	7
Yellow	I-6	Insects, 6 lbs.	8	13	17	21	25	29	33
Red	M-8	Meat, 8 lbs	2	3	3	4	5	6	7
Red	M-4	Meat, 4 lbs.	8	13	17	21	25	29	33
Green	P-20	Plants, 20 lbs.	2	3	3	4	5	6	7
Green	P-10	Plants, 10 lbs.	8	13	17	21	25	29	33

condition for winter hibernation or, in the case of young bears, be forced from the area by more aggressive adults.

All possible conditions are not covered by the design of the activity. However, by this simple illustration it is possible for students to grasp quickly the essential nature of the concept of "limiting factors"—habitat components that affect the survival of an animal or restrict the numbers or range of an animal population.

Procedure

1. Make a set of 2″ × 2″ cards from the colored construction paper. Use the chart on this page to determine how many cards of each color to make and what to write on each one.

   As shown in the chart, the color of the card determines the type of food it represents:

   orange—nuts (acorns, pecans, walnuts, hickory nuts)

   blue—berries and fruit (blackberries, elderberries, raspberries, wild cherries)

   yellow—insects (grub worms, larvae, ants, termites)

   red—meat (mice, rodents, peccaries, beaver, muskrats, young deer)

   green—plants (leaves, grasses, herbs)

   The number on each card represents the number of pounds of food. For example, a card with the label M-4 represents 4 pounds of meat.

2. The following estimates of total pounds of food needed for one bear for 10 days are used for this activity:

Nuts	20 pounds	(25%)
Berries and fruit	20 pounds	(25%)
Insects	12 pounds	(15%)
Meat	8 pounds	(10%)
Plants	20 pounds	(25%)
	80 pounds	(100%)

NOTE: These figures represent the food of a typical black bear in Arizona. The components of an actual bear's diet will vary between areas, seasons, and years. For example, a bear in the state of Alaska would likely eat more meat (fish) and fewer nuts than a bear in Arizona. One similarity among black bears everywhere is that the majority of their diet is normally made up of vegetable material.

If the teacher follows the table when making the food cards, there should be less than 80 pounds of food per student, so there is actually not enough food in the area for all the "bears" to survive.

3. It is also possible to include water as a habitat component by making additional squares from light blue paper. To calculate how many water cards to make, multiply the number of students by 1.25 (round to the nearest whole number). For example, for a group of 20 students, make $20 \times 1.25 = 25$ water cards. Divide the water squares into five equal piles (or roughly equal), and mark each group with one of the following letters: R, L, ST, SP, and M. These letters represent all the places where a bear could find water: rivers, lakes, streams, springs, and marshes.

4. In a fairly large open area (e.g., 50′ × 50′), scatter the colored pieces of paper.

5. Do not tell the students what the colors, initials, and numbers on the pieces of paper represent. Tell them only that the pieces of paper represent various kinds of bear food. Since bears are omnivores—they like a wide assortment of food—and the students should gather different colored squares to represent a variety of food.

6. Have the students write their names on an envelope, which will represent each student's "den site" and should be left on the ground (perhaps anchored with a rock) at the starting line on the perimeter of the field area.

7. Have the students line up on the starting line, leaving their envelopes between their feet on the ground. Give them the following instructions: "You are now black bears. All bears are not alike, just as you and I are not exactly alike. Among you is a young male bear who has not yet found his own territory. Last week he met up with a larger male bear in the big bear's territory and before he could get away, he was hurt. He has a broken leg. (Assign one student as the injured bear and tell him or her to "hunt" by hopping on one leg.) Another bear is a young female who investigated a porcupine too closely and was blinded by the quills. (Assign one student as the blind bear; he or she must hunt blindfolded.) The third special bear is a mother bear with two fairly small cubs. She must gather twice as much food as the other bears. (Assign one student as the mother bear.)

8. Students must walk into the "forest." Bears do not run down their food; they gather it. When students find a colored square, they should pick it up (one at a time) and return it to their "den" before picking up another colored square. (Bears would not actually return to their den to eat; they would eat food as they find it.)

9. When all the colored squares have been picked up, the food gathering is over. Have students pick up their den envelopes containing the food they gathered and return to class.

10. Explain what the colors and numbers represent. Each color is a kind of food and the numbers represent pounds of food eaten. Ask students to add up the total number of pounds of food they gathered—whether it is nuts, meat, insects, berries, or plant material. Have students write the total weight on the outside of their envelopes.

11. Using a chalkboard, list "blind," "injured," and "mother." Ask the blind bear how much food she acquired. Write the amount after the word "blind." Ask the injured bear and the mother bear how much they acquired and record the information. Ask the other students how much food they found and record each response on the chalkboard. Tell the students each bear needs 80 pounds to survive. Which bears survived? Is there enough to feed all the bears? How many pounds did the blind bear collect? Will she survive? What about the mother bear? Did she get twice the amount needed to survive? What will happen to her cubs? Will she feed her cubs first or herself? Why? What would happen to her if she fed the cubs? What if she ate first? If the cubs die, can she have more cubs in the future, and perhaps richer, years? (The mother bear will eat first and

continued

the cubs will get whatever, if any, is left. The mother must survive; she is the hope for a continued bear population. She can have more cubs in her life; only one needs to survive for the population to remain static.)

12. If the water squares are included, each student should have picked up at least one square representing a water source or that bear will not survive. Water can be a limiting factor and is an essential component of habitat.

13. Ask students to record how many pounds of each of the five categories of food they gathered. Next, ask each student to convert those numbers into percentages of the total poundage of food each gathered. Provide the students with the background information about black bears so that they can compare their percentages with the typical percentages eaten by black bears in Arizona. Ask students to guess how healthy their bears would be. How do the bears' requirements for a diet seem to compare with the needs of humans for a balanced and nutritious diet?

14. Ask the students to arrive at a class total for all the pounds of food they gathered as bears. Divide the total by the 80 pounds needed by an individual bear (approximately) in order to survive in a 10-day period. How many bears could the habitat support? Why then did only ____ bears survive when your class did this activity? Is that realistic? What percentage of the bears survived? What percentage would have survived had the food been evenly divided? In each case, what percentage would not survive?

15. Ask the students to determine the amount of food tokens that must be added to support all of the bears in this activity. If sufficient food were available for all of the bears, would the population likely increase the following year? Have the students support their answers. Other than food, what factors, natural or human-related, might also limit the growth of the bear population? How would each of these factors affect the bear population? Could the bear population increase indefinitely if unlimited food were available? Why or why not?

16. Drawing on their discussion, ask the students to try to define the term "limiting factor." Have them suggest examples of limiting factors, cultural and natural, that would be likely to actually influence the survival of other animals and their populations.

Extensions

1. Cut paper or poster board into 2″× 2″ squares. Make five squares per student. For example, with a class of 30 students, you would make 150 squares. Divide all the squares into five equal piles and mark the cards in each pile with one of the following letters: B, T, D, H, and F. These represent B = bedding sites, T = travel ways, D = dens, H = hiding cover, and F = feeding sites. For this activity, these terms are defined as follows:

   bedding sites: Black bears are usually active in early morning and late evening, and bedded most of the rest of the day and night. Bedding sites are usually in areas of dense vegetation, steep topography, or large trees where the bears feel secure.

   travel ways: Bears require corridors of cover (made up of thick vegetation or steep topography) to enable them to travel between areas of food, water, and shelter within their home range.

   dens: Black bears use dens as shelter for hibernation from November to April in each year. Bears have been found denning in hollow logs, caves, holes dug into hillsides, under buildings on top of the ground, and even in culvert pipes. Bears often prepare and may use more than one den; they may change dens during the winter because of disturbance or a leaky den. Bears seldom re-use dens from year to year.

   hiding cover: Black bears evolved as animals that escape danger from predators and other bears by hiding in thick cover.

feeding sites: Bears often will use areas with less cover than hiding areas or bedding sites for feeding. Feeding sites are, however, often found close to thick hiding cover to allow the bear to quickly escape danger, if necessary.

NOTE: This information is based on actual research data from a study in Arizona. These components of shelter may vary slightly in different parts of North America.

2. In a fairly large open area (e.g., 50′ × 50′), scatter the colored pieces of paper.
3. Have the students line up along one side of the area. Tell them that they are to become "bears" for this activity. Review the concept of habitat—that a bear would need shelter, food, water, and space in a suitable arrangement in order to survive. Do not tell the students what the letters on the squares of paper represent. Tell them only that the squares represent one element or component of bear habitat.
4. Direct the students to move as individual "bears" into the area. Each bear must pick up as many of the components of habitat as possible. Some competitive activity is acceptable as long as it is under control. Bears are territorial. Remember that if bears fight, which they seldom do, they can become injured and unable to successfully meet their needs for survival.
5. When the students have picked up all of the squares of paper in the area, have them return to the classroom or be seated in any comfortable area. Ask the students to separate their squares of paper into piles according to the letter on each. Using a chalkboard or large pad for a visual reference, ask the students to predict what the letters on the green cards represent—giving them the clue that each is an element of cover or shelter for a black bear. What kinds of shelter would a bear need? What do those initials represent? Record how many bears acquired at least one of each kind of shelter. How many got only four kinds? Three? Two? How many got only one kind of shelter? For this activity, only those bears with at least one of each kind of necessary shelter can survive through 1 year.
6. Shelter is a very important part of a bear's habitat. A bear needs shelter in which to search for food and water. Bears also need shelter for traveling through their home range as well as shelter for bedding, hiding, and denning. Ask students why a den is important. (The bear could live from April through October but would not have a secure place to hibernate and might not survive the winter.) Ask the students what would happen if a bear did not have travel ways? (Without travel ways, home ranges become fragmented and bears are not able to reach needed food, water, or other shelter. Without suitable habitat, bears move into marginal habitats and get into trouble with people.)
7. In this activity, how many bears survived? What was a limiting factor for this population of bears? (Shelter.) What other things could possibly become limiting factors? (Water and space—or territory—are two examples.) Could food be a limiting factor for bears? (Yes, however bears are omnivores and can use many sources of food.)
8. Ask the students to summarize what they have learned about the importance of suitable habitat for bears' survival. How are the bears' habitat needs similar to and different from the needs of other animals?

Evaluation

1. Define limiting factor.
   a. Describe some of the factors that may limit the survival of an animal.
   b. What might be the consequences to the individual animal and to its population if one of these limiting factors were no longer limiting?

Wildlife Is Everywhere!

Objectives

Students will (1) compare human and wildlife habitat, and (2) generalize that wildlife is present around the world.

Method

Students search their surroundings for evidence of wildlife.

Materials

None

Background

Many people think of wildlife as the large animals of Africa, such as the lion and elephant, or the large animals of the North American forests, such as the grizzly bear and elk. However, wildlife includes all animals that have not been domesticated by people.

What may be surprising is that wildlife includes the smallest animal organisms—even those that can be seen only through a microscope. Spiders, insects, reptiles, amphibians, and most species of fish, birds, and mammals may be considered wildlife. Even when animals are silent or not visible, they exist somewhere around us. Thousands of organisms live in and on human skin, hair, and bodies. In fact, the organisms that inhabit human bodies play a part in human survival. Some form of animal life is always near.

By investigating microenvironments or microhabitats, students will be able to generalize that wildlife exists in every country on the planet.

Grade Level: K–4

Subject Areas: Science, Language Arts, Environmental Education

Duration: one 30- to 45-minute session

Group Size: any

Setting: indoors and outdoors

Conceptual Framework Topic Reference: HNIA, HNIB1, HNIB2

Key Vocabulary: wildlife, wild, domesticated, environment, evidence

Appendices: Field Ethics, Observations and Inferences, Early Childhood

Procedure

NOTE: Ask students to observe, but not touch or disturb, any animals they may see.

1. Invite the students to explore the room looking for signs of wildlife. Even in the cleanest rooms, some signs of life can be found. It might be a spider web, dead insects near lights, or insect holes along baseboards and behind books. After the search and a discussion with the students about what they might have found, introduce the idea that people and other animals share the same environment. Sometimes people do not even notice that they are sharing the environment with other living things.

2. Take the search for animals outside. Divide the students into pairs, and give each pair five minutes to find an animal or some sign that an animal has been there. Look for indirect evidence such as tracks, webs, droppings, feathers, and nests (be sure not to harm or seriously disturb any evidence that is found). Afterward, sit down and discuss what everyone found.

continued

3. Discuss with the students what they have learned. Emphasize that the experience shows that people and wildlife share the same environment. Ask the students to predict where different kinds of animals are found all over the Earth—in the deserts, oceans, mountains, and cities. They may draw from their own experiences and talk about places they have been and have seen animals.

Extensions

1. Observe wildlife in yards, kitchens, neighborhoods, and city parks.
2. Search magazines and books for pictures of wildlife from all over the planet.
3. Invent names and descriptions for the wildlife found during wildlife searches. Students can observe the animals, write descriptions, and then check their invented names and descriptions against the scientific names and information found in reference materials.
4. Using state maps, look up towns, cities, and counties named after wild animals.

Aquatic Extension

Survey your school grounds or neighb for any aquatic wildlife habitats. Chec sprinkler systems, and, if possible, stre beaches, and ponds. Look for evidenc or indirect—of any wildlife that lives these water-related areas. Tell or show what you find, taking care not to dam wildlife or its habitat.

Evaluation

1. In which of the following places w animals be living: in a forest; in a h desert; in a lake; at the top of a mo at the North Pole; in New York Ci kinds of animals would be found i places? Name areas on Earth wher would not be found.
2. What evidence did the class have (the five senses) that showed that w lives in any location where this act was conducted?
3. Draw a picture of a place and incl many different animal species as p would be found living there. Expla picture to a friend or adult.
4. Identify and describe three things could do to increase the numbers of wildlife living in an area that ha evidence of wildlife.

What's for Dinner?

Objective

Students will generalize that all animals, including people, depend on plants as a food source, either directly or indirectly.

Method

Students list and analyze the sources of foods.

Materials

Writing materials, chalk board; OPTIONAL: poster board and drawing materials

Background

NOTE: The concepts in this activity are reinforced using pictures and verbal language skills and may be used effectively with English language learners.

Food webs are just one of nature's many cycles. In a food web, omnivores, herbivores, and carnivores comprise the organisms in an ecological community that ensures the continuation of food energy from one organism to another. These webs are made up of individual food chains.

Grade Level: 5–8

Subject Areas: Science, Language Arts, Environmental Education

Duration: one 20-minute session or longer

Group Size: any

Setting: indoors

Conceptual Framework Topic Reference: IDIA, IDIB, IDIIB2

Key Terms: food chain, plants, animals

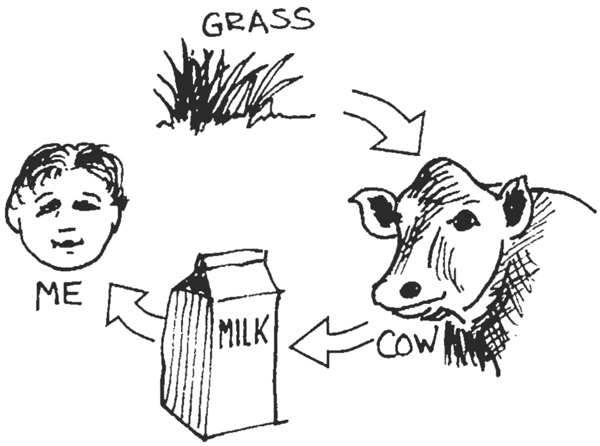
Appendices: Using Local Resources

In a grazing web, materials typically pass from plants to herbivores (plant eaters) to carnivores (flesh eaters). The food web can be viewed not only as a network of chains but also as a series of trophic (nutritional) levels. Green plants (primary producers of food) belong to the first level. Herbivores (consumers of green plants) belong to the second trophic level. Carnivores (predators feeding upon the herbivores) belong to the third. Omnivores (consumers of both plants and animals) belong to the second and third. Secondary carnivores (predators that feed on predators) belong to the fourth trophic level.

Animals, including people, either consume plants directly or depend on other species that, in turn, depend on plants.

Procedure

1. Ask students to make a list of everything that they had for dinner on a particular evening, or ask them to invent a dinner menu of their choice.
2. Ask the students to work alone or in groups to analyze where their food comes from. Every item from their dinner menu should be traced back to a plant. As each item on a menu is examined, ask the students to create a flow diagram or chain that shows the major sources of each food—from the product they eat all the way back to the plant origin (e.g., milk, cow, grass). Some chains will be short while others will be long. Sometimes the students may not be sure what particular animals eat for food, so they will want do some research.



3. Discuss with the students some of the things they learned from this activity. After the students have described things they have learned, encourage them to make two generalizations about plants and animals. These generalizations may include that all animals, including people and wildlife, need food; all animals, including people and wildlife, depend on plants for food.

Extensions

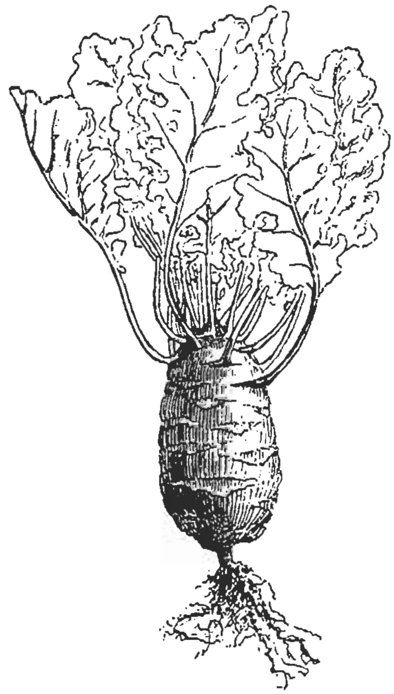
1. Make posters of the menus created at the beginning of this activity, showing the food chains involved in each. Add soil, water, sun, and air, because those are necessary to plants, people, and all animals.
2. Create a master list of all the plants that were identified during the activity. Are there some plants that we are more dependent on than others? Ask students to research people who live in other parts of the world and to develop a list of plants on which they depend.
3. Did you know that everything you ate for breakfast (lunch, dinner, or a snack) started somewhere with a rock? Trace plants to soil and soil to its parent matter, which includes rocks.

Aquatic Extensions

1. See the Project WILD Aquatic activity "Water We Eating?"
2. Create at least two food chains that involve people, aquatic wildlife, and plants.

Evaluation

1. Construct at least three food chains using the following organisms: people, rabbits, grass, lettuce, mountain lions, robins, earthworms, hawks, mice, insects, wheat, cows, corn, pigs, deer, and acorns.
2. Which of these animals do not need food: horse, snake, frog, person, robin?
3. All of the food eaten by animals must first come from ______________________? (Although the objective of this activity stressed that animals rely on plants, please accept any reasonable response, such as soil or sunlight, if the students reasonably explain their theory.)



Birds of Prey

Objectives

Students will (1) interpret a graph of animal populations, noting changes over time; (2) hypothesize the relationship among temperature, ground squirrel behavior, and falcon populations; and (3) describe the importance of interdependence to the functioning of an ecosystem.

Method

Students interpret data on wildlife populations, generate hypotheses related to the data, and research potential explanations.

Materials

Graphs A–E (found in the Procedure section) enlarged for classroom use; OPTIONAL: photographs of predator and prey species

Grade Level: 9–12

Subject Areas: Mathematics, Science, Environmental Education

Duration: one or two 45-minute sessions

Group Size: large group, with small groups working with data and discussing

Setting: indoors

Conceptual Framework Topic Reference: IDIIB2, IDIIC

Key Terms: aestivation, population, hypothesis, prediction, interdependence, ecological systems

Appendices: Observations and Inferences

Background

In the Birds of Prey Natural Area in southwestern Idaho, a large number of prairie falcons nest in late spring and early summer each year. The falcons mainly live off a large population of Townsend ground squirrels that live in the surrounding flatlands. Throughout the breeding season, the population of falcons increases as more and more birds move into the area to nest, until all available nesting sites are taken. Because the Townsend ground squirrels serve as the food base for the falcons, continued activity and availability of this prey base is crucial for the support of the nesting falcons. As the summer progresses, the daytime temperatures in the area increase to a point (around July 4) where it is too hot for the ground squirrels, and they go underground and undergo a form of summer sleep called "aestivation" or summer hibernation. Without available prey, the falcons and their new offspring must either leave or die. Within a day of the ground squirrels' aestivation, nearly all falcons capable of flight move out of the area in search of other food (other ground squirrel species and rodents). Most move to higher, cooler elevations where other species of ground squirrels (such as Columbian ground squirrels) remain active. This sudden seeming "loss" of falcons from the Birds of Prey natural area is directly tied to the important environmental factor of temperature.

The major purpose of this activity is for students to recognize that life forms and environmental factors interact in natural ecosystems to keep wildlife populations in long-term dynamic equilibrium with each other and their habitats.

continued

Procedure

1. Set the stage by giving students the following background information:

   The Birds of Prey Natural Area in Idaho hosts the largest concentration of nesting prairie falcons in the world each spring and summer. The birds nest along the cliffs above the Snake River and use the huge Townsend ground squirrel population for food. This prey species lives on the flat land above the canyon. Each year, the populations of these two species change from April through July.

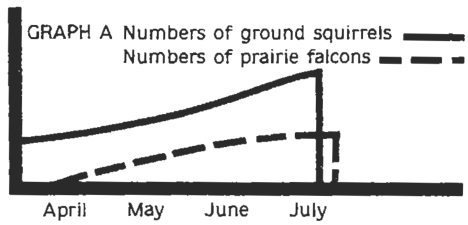
2. Show the students Graph A. Have them look at the graph to see what happens to the populations of predator and prey. Then have them answer the following questions:
   - What do you observe happening?
   - What do you notice about the Townsend ground squirrel population in April, May, and June?
   - What do you notice about the ground squirrel population in July?
   - What do you think caused this drop in population? What might have happened to the squirrels?
   - What do you notice about the falcon population in April and May?
   - What do you notice happening to the falcon population in July? What do you think caused this population decline?
   - What might have caused the change?
   - How do these populations seem to be related?

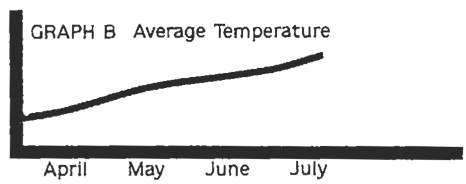
   Ask the students to speculate, offer hypotheses, and develop questions to assist with finding a solution to this dilemma.

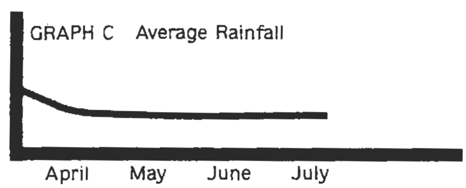
3. Show the students Graphs B, C, D, and E. Using the information provided on these graphs, encourage the students to discuss their ideas and hypotheses.

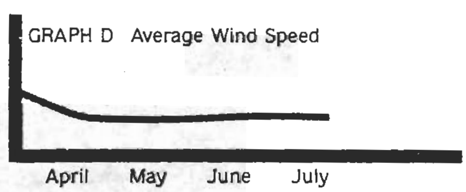
4. Ask the students to share those ideas that seem to be most reasonable given the information presented in the graphs.

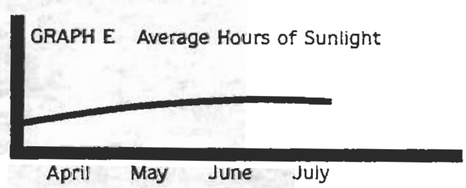
5. Summarize the activity by
   - Closed inquiry approach—Review the sequence of events. Discuss the role of temperature in triggering aestivation. Ask the students to predict what the falcons might do if their food source "disappeared." Where might they find the falcons after they leave the area? Where would they go to obtain food? What kind of prey species might they use? Have the students suggest other physical factors that influence or limit wildlife activity. Have the students also propose some ways these same factors influence or limit human activity.











or by

- Open inquiry approach—Do not provide the above information, but allow student teams to research information on the squirrels and falcons.

6. Extend the discussion to the concept of interdependence in ecological systems. What was interdependent in this situation? Encourage the students to think of other examples of interdependence. Can they think of any ecosystems that are not composed of interdependent parts? Generalize that all ecosystems are made up of interdependent parts.

Extensions

1. The prey ordinarily used by the falcons at the natural area—the Townsend ground squirrel—is distributed throughout much of the plains area above the river, which is also potentially good agricultural land. Given this information, the activity could be extended to an investigation into competitive uses for the land occupied by the prey base, the legislation behind the establishment of the natural area, related controversies, or all three.
2. Investigate the process by which such natural areas are set aside, the agencies involved, and related issues.
3. Describe the usefulness of mathematical data in interpreting relationships between organisms in ecosystems; use the Birds of Prey Natural Area as an example.

Evaluation

1. Using Graph A as a reference, describe for each month between April and July:
   a. the relative population levels of squirrels and falcons,
   b. the behavior of the squirrels and falcons, and
   c. the role of temperature on a and b above.

Explain the importance of interdependence to an ecosystem.

Additional Resources

www.seaworld.org/birds/bird.html

www.ticcamp.com/kidspage/s4/j/hannah

www.raptor.cvm.umn.edu/raptor/rfacts/rfacts.html

Arctic Survival

Objectives

Students will (1) describe how the available resources, including wildlife and habitat, affect the economy and culture of an area; (2) list natural resources; and (3) describe the difference between a nonrenewable and a renewable resource.

Method

Through a simulation, students will become hunters, gatherers, and traders in an attempt to gain food, water, shelter, and heat.

Materials

Tokens on page 239 made from multicolored construction paper, masking tape, an envelope for each student, four copies of Token Tally Data Sheet on page 242 for each group; OPTIONAL: a transparency of Token Tally Data Sheet to record class results

Grade Level: 9–12

Subject Areas: Social Studies, Science, Environmental Education

Duration: minimum two 45-minute sessions

Group Size: any

Setting: indoors

Conceptual Framework Topic References: ECIA, ECIA1, ECIA2, ECIB1, ECIC, ECID

Key Terms: renewable resources, non-renewable resources

Appendices: none

Background

One of the factors that drives the world's economy is the consumption of natural resources. A natural resource is anything that comes directly or indirectly from the earth. Natural resources include water, air, minerals, soil, fossil fuels, plants, and aquatic as well as terrestrial animals. This list includes homes, food, water, and income. In an analysis of the jobs of the world, it was found that many jobs are connected to the use of natural resources.

Economics is first about survival and then about power. If a country is aggressive in the sale, manufacture, or resale of natural resources, that country can provide jobs for its people who in turn can buy more natural resources to provide food, water, and shelter for themselves and their families. If the country is lacking natural resources but is able to buy them and resell them for a large profit, it will increase its opportunities for wealth and power. If a country has few natural resources and is unable to use them as a source of income, it may find itself unable to join the trade of international natural resources, making the economy depressed and with very little power.

Economic trends, as well as the increase of human populations and mobility, have important influences on wildlife and its habitat. During times when the value of money is high, people may find themselves buying more things made of natural resources. They may buy more fresh salmon, caviar, or lobster. They also may buy and develop more property, destroying natural habitats. Increases in wealth also allow greater mobility. As people move away from cities, rural areas become developed, too.

Natural resources fall into one of two categories: renewable or nonrenewable resources. Renewable natural resources are living things with the capacity for regeneration. Trees and wildlife are examples of renewable natural resources. However, renewable resources have limits. For example, although animals have the capacity for regeneration by mating and bearing offspring, they cannot survive if their habitat is destroyed or if environmental or human-caused pressures are too great. Nonrenewable resources are non-living things. Minerals and fossils are examples. Although such resources may be replenished over geologic time by natural processes, the time span covers millions of years. Although the better choice when using natural resources might be renewable sources, this choice may not be an option because of economic reasons or because it is consumed too quickly. For instance, although wood is a renewable resource and a good choice for heat, it may be too costly or labor intensive to use. Therefore, another choice may be natural gas, an easily accessible, low-labor, nonrenewable resource. People may sometimes choose nonrenewable resources over renewable ones as an investment. Generally speaking, nonrenewable resources are more scarce and, therefore, may be considered more valuable. An investor, for example, may choose to spend money on an oil company rather then investing in a corn farm.

The benefits and liabilities of appropriate uses of renewable and nonrenewable natural resources are difficult and complex and may raise social, economic, ethical and political—as well as biological—questions. Even the concept that wildlife and other animals are renewable resources raises ethical objections from some people.

The purpose of this activity is to illustrate how the economy of an area can affect and be affected by natural resources, including wildlife.

Procedure

Overview

In this activity, students will represent a group that has been lost in the Arctic in the fall. As they find food, water, shelter, and heat in order to survive the harsh conditions, economic principles unfold related to the availability of resources. The simulation will last several rounds. A new component will be added in each round. In the first round, students simply collect food, water, shelter, and heat; then students examine whether they survived. Next the student groups may trade to pool their resources and to increase their chances of survival. In the next round, a stress alters the available resources, affecting the economic dynamics. In the last round, the limitations of nonrenewable resources come into play as well.

Before the Activity

1. Divide the room into three sections with masking tape. Those sections represent the three boundaries of Groups A, B, and C. See Diagram A: Room Set Up on page 241.
2. Using construction paper, make the tokens indicated on page 239. Tokens should be about 2″ across or large enough to find and grasp easily, but small enough to fit in the envelopes. Spread out the food, water, shelter, and heat tokens listed on page 239 (for Rounds 1 and 2) for each group in that group's section. Place tokens at the far end of each section.

The Activity

1. Explain to the students that the class represents a hunting club that has gone on an Arctic hunting trip in early fall. After a 4-day snowstorm, the club members have been separated into three groups, each lost within the same wilderness area. Each group must determine how to survive, finding food, water, shelter, and heat (it is getting very cold). Because the club planned on being gone for just a couple of days and because

continued

some equipment was lost or damaged in the storm, club members have only a small snow shovel, ax, rope, ammunition, rifles, hooks, string, matches, flint, knife, light-weight sleeping bags, some water bottles, and one backpack.

2. Divide the class into three groups. Place each group at one end of the section designated for that group. (The students should be standing at one end of their section, and their group's tokens should have been distributed at the other end.)

3. Give group members a Token Tally Data Sheet, and have them put their names and the round number in the appropriate blanks at the top of the form. Tell the students their group must collect enough food, water, shelter, and heat points to sustain their group for 2 weeks. This means they must earn 300 points each of food, water, shelter, and heat each round. Note that these point values and totals are shown on the Token Tally Data Sheets. Show students the different token shapes, and explain what each token represents.

4. Give group members a scenario card describing the habitat and resources in their section of the wilderness area. Ask the group members what types of animals they would expect to find in their section. What type of heat and shelter materials might be available?

NOTE: For more complete responses, have students research Arctic habitats before conducting the activity.

5. Give students the envelopes, and have them put their names and group numbers on the envelopes. Have them place their envelopes in a pile with those of their group members on a desk in the front of the room (away from the distributed tokens).

6. Round 1A: Basic Scenario
   a. Explain that each group will have three minutes to collect its tokens. Group members may work as individuals or as a team, but they must stay within their marked area. The envelopes must stay on the desk.
   b. Students must walk and collect tokens one at a time. Each one must be taken separately to the desk and placed in the envelope before another token can be gathered.
   c. Have students collect tokens for exactly three minutes. Make sure they collect one token at a time and put it in the envelope. At the end of the round, have each group add up its total number of points to determine if the group survived. Record the number of points on the Token Tally Data Sheets. Display the results (on the board or on a transparency) from each group for each category (food, water, shelter, heat) so the groups can compare their point totals and their available resources.
   d. Discuss which groups survived. (None will.) Ask each group to tell which resources it was missing and which were sufficient. Which resources did each group have in excess? Did any of the other groups have excess materials their group could have used?
   e. Collect all of the tokens for Round 1B. Keep Group A tokens together, Group B tokens together, and Group C tokens together. Do not mix group tokens.

7. Round 1B: Scenario with Trading Added
   a. Spread the food, water, shelter, and heat tokens as before. Have the students break into their respective groups. Give the students another Token Tally Data Sheet, and have them fill in their names and the round number.

b. Because no one "survived," the class will repeat Round 1, but this time the three groups will hear the gunfire from the other hunting parties and will manage to make contact with each other during the second week. They agree to meet to trade resources. They do not join but remain in one area in order to avail themselves of the varied resources, which are too far apart to access from one point. To simulate this scenario, the three groups will gather resources for two minutes but then they may cross boundaries and exchange some resources for an additional two to three minutes if they think doing so will increase their probability for survival. (Students may not take resources directly from another section.) Before beginning the round, give the groups a few minutes to develop a strategy or plan to gather resources and to trade with other groups.

NOTE: Late in this round, the students may begin to organize their trading into an informal stock market. If such activity becomes apparent, call attention to it as soon as the round ends.

c. At the end of the round, again ask each group to tally its points and record them on its Token Tally Data Sheet. Display the class results as before.

d. Which groups survived this round? (All may have.) Compare resources after trading. What does each group lack? Does another group have resources that still might have been traded? How has mobility affected the resources for each group? Was it a waste of valuable time or was it worthwhile because crucial resources were obtained?

e. Does any group still have excess items after trading? (If all groups have traded to the maximum extent, one group should have 50 extra food points.) If the survival needs of the group have been met, how could these items be used culturally (i.e., for clothing, decorations, art, religious ceremonies)? How can the availability of natural resources influence the culture of a community?

f. Collect the tokens for Round 2.

8. Round 2: Alteration of Renewable Resources

a. Spread the food, water, shelter, and heat tokens as before. Have the students break into their respective groups. Hand out another set of Token Tally Data Sheets, and let the students fill in their names and the round number at the top of the form.

b. In this round, explain to the students that Group B has harvested all of the bears from the area. (Remove all white food tokens from the Group B section.) At the same time, a herd of caribou migrated into Area C. (Add two black food tokens to Area C.)

c. Play the round as in 1B with the students gathering, trading, and tallying their points. Ask the students which groups survived Round 2. What was each group lacking? What did each group have in excess? How can the excess resources be used culturally?

d. How did the transfer of food resources from Group B (which lost bears) to Group C (which gained caribou) affect these two groups? (Group B still has adequate food, but now it does not have enough excess to trade for needed shelter

continued

with Group C. Group C has excess shelter available for trading, but now has adequate food and no longer requires an exchange with Group B, which previously supplied its food. Group A has no excess of either item.) At this time, Group C may ask to donate the extra shelter points to Group B to ensure its survival. If the class does not think of this alternative, you can bring it up in preparation for Round 3 when the food resources return to normal. (You also may want to discuss the role of charity organizations in society and the long-term economic strategy implied.) Ask students what the consequences might be to the other groups if Group B does not survive (and if the resources in this wilderness are so widely distributed that the other two groups cannot successfully gather from their own areas and also that of Group B).

e. Collect the tokens for Round 3.

9. Round 3: Loss of Nonrenewable Resources

a. Spread the food, water, shelter, and heat tokens as before. Have the students break into their respective groups. Again, distribute Token Tally Data Sheets, and have the students fill out the tops of the forms.

b. Tell the students that in this round some of the bears have returned and the caribou have moved on. (Remove all but the one black food token from the Group C section, and replace two white food tokens in the Group B section.). Tell the class that, unfortunately, Group A has used up its oil supply. (Remove all black heat tokens from the Group A section.)

c. Have the students differentiate between renewable and nonrenewable resources. Which type are the bears and caribou? Which type is the oil? The wood? Have the students quickly classify each of the other items. Ask the students to predict the effect the loss of the oil will have on Group A. (Group A will have enough heat from its wood, but will have nothing to trade for the other items it needs.)

d. Play the round as before with the students gathering, trading, and tallying their points. Ask the students which groups survived Round 3. What was lacking by each group? How is the effect of a loss of a nonrenewable resource different from the loss of a renewable resource? What might happen if Group B built a dam in its stream and used the power to mill its logs for more firewood? How would trade be affected? Who would benefit? Who would be hurt?

Extensions

1. Research the natural resources obtained in your area for commercial use. Determine how their value came to be.
2. Compare renewable and nonrenewable natural resources, and determine which group has more value in the world market. Describe why.
3. Research some wildlife species whose products are sold commercially.

Evaluation

1. Ask the students to design a fourth round that would simulate another scenario. They could develop the dam/mill idea from Round 3 or perhaps create another scenario such as what would happen if a forest fire destroyed the trees in the Group C area. Have them predict the results of the new round for each group.
2. Have the students research natural resources found in one country on each of the populated continents. What resources do each of these countries have that is either unique or in unique abundance? What resources does each lack? To what extent does it trade with other countries? Evaluate and explain the success or failure of each country in terms of the extent to which it maximizes its resources.

Total Tokens

EDUCATOR: Make the following tokens. Note the different shapes for each type. You may find that using small objects such as buttons or beans may be less labor intensive.

Animal Tokens

Animal	Renewable or Nonrenewable	Color Squares	Amount to Make	Value
Ptarmigan	Renewable	Orange	16	1
Rabbit	Renewable	Blue	12	2
Fish	Renewable	Red	30	4
Beaver	Renewable	Yellow	5	50
Duck	Renewable	Green	40	1
Bear	Renewable	White	3	50
Caribou	Renewable	Black	3	100
Moose	Renewable	Brown	2	200

Water Tokens

Water Source	Renewable or Nonrenewable	Color Circles	Amount to Make	Value
River	Renewable	Blue	20	25
Stream	Renewable	Green	12	25
Pond	Renewable	Brown	10	10

Shelter Tokens

Shelter Resource	Renewable or Nonrenewable	Color Triangles	Amount to Make	Value
Wood	Renewable	Brown	27	25
Stone	Nonrenewable	Gray	16	10
Earth	Nonrenewable	Black	13	5

Heat Tokens

Heat Source	Renewable or Nonrenewable	Color Rectangles	Amount to Make	Value
Oil	Nonrenewable	Black	25	20
Wood	Renewable	Brown	70	10

continued

Distribution of Tokens Per Group

Group A: pond, willows (shrubs), small animals, seeping oil

Item	Amount
Animals	16 orange, 12 blue, 10 red, 5 yellow, 20 green
Water	10 brown
Shelter	6 brown, 1 gray, 8 black
Heat	20 black, 40 brown

Group B: river, open area, large game, rocky

Item	Amount
Animals	2 brown, 20 red, 20 green, 3 white
Water	20 blue
Shelter	7 gray, 1 brown, 1 black
Heat	10 brown

Group C: stream, spruce forest, little game

Item	Amount
Animals	1 black
Water	12 green
Shelter	4 black, 20 brown, 8 gray
Heat	20 brown

ANSWER KEY

Total *Possible* Points for Each Group and Category in Round 1A Only
(None will survive.)

Category	Group A	Group B	Group C
Food	350	650	100
Water	100	500	300
Shelter	200	100	600
Heat	800	100	200

DIAGRAM A
Room Setup

(Front Desk)

Envelopes for
A B C

Group A	**Group B**	**Group C**
Tokens for Group A distributed here	**Tokens for Group B distributed here**	**Tokens for Group C distributed here**

Group Scenario Description Cards

Group A is lost near a murky pond surrounded by many small willow shrubs that are suitable for kindling. They have a lot of small animals to hunt, but with the number of mammals in the area, the water could be full of micro-organisms and must be carefully filtered to keep everyone healthy. Oil can be found seeping from the ground in small puddles.

Group B is lost in an open area protected from prevailing winds by a large, rocky knoll. It has a clear river flowing through it and patches of snow from the previous winter. Larger animals can be found migrating through this area.

Group C is lost in a spruce forest. There are large animals in the area. A small stream flows through it.

continued

Token Tally
Data Sheet

Name: ______________________________ Round: __________

Animal Tokens

Animal	Color Squares	Value	Number Found	Points
Ptarmigan	Orange	1		
Rabbit	Blue	2		
Fish	Red	4		
Beaver	Yellow	50		
Duck	Green	1		
Bear	White	50		
Caribou	Black	100		
Moose	Brown	200		

Total Animal Points = __________
300 needed for survival

Water Tokens

Water Source	Color Circles	Value	Number Found	Points
River	Blue	25		
Stream	Green	25		
Pond	Brown	10		

Total Water Points = __________
300 needed for survival

Shelter Tokens

Shelter Resource	Color Triangles	Value	Number Found	Points
Wood	Brown	25		
Stone	Gray	10		
Earth	Black	5		

Total Shelter Points = __________
300 needed for survival

Heat Tokens

Heat Source	Color Rectangles	Value	Number Found	Points
Oil	Black	20		
Wood	Brown	10		

Total Heat Points = __________
300 needed for survival

DIAGRAM A
Room Setup

(Front Desk)

Envelopes for

A B C

Group A	Group B	Group C
Tokens for Group A distributed here	Tokens for Group B distributed here	Tokens for Group C distributed here

Group Scenario Description Cards

Group A is lost near a murky pond surrounded by many small willow shrubs that are suitable for kindling. They have a lot of small animals to hunt, but with the number of mammals in the area, the water could be full of micro-organisms and must be carefully filtered to keep everyone healthy. Oil can be found seeping from the ground in small puddles.

Group B is lost in an open area protected from prevailing winds by a large, rocky knoll. It has a clear river flowing through it and patches of snow from the previous winter. Larger animals can be found migrating through this area.

Group C is lost in a spruce forest. There are large animals in the area. A small stream flows through it.

continued

Token Tally
Data Sheet

Name: ______________________ Round: __________

Animal Tokens

Animal	Color Squares	Value	Number Found	Points
Ptarmigan	Orange	1		
Rabbit	Blue	2		
Fish	Red	4		
Beaver	Yellow	50		
Duck	Green	1		
Bear	White	50		
Caribou	Black	100		
Moose	Brown	200		

Total Animal Points = __________
300 needed for survival

Water Tokens

Water Source	Color Circles	Value	Number Found	Points
River	Blue	25		
Stream	Green	25		
Pond	Brown	10		

Total Water Points = __________
300 needed for survival

Shelter Tokens

Shelter Resource	Color Triangles	Value	Number Found	Points
Wood	Brown	25		
Stone	Gray	10		
Earth	Black	5		

Total Shelter Points = __________
300 needed for survival

Heat Tokens

Heat Source	Color Rectangles	Value	Number Found	Points
Oil	Black	20		
Wood	Brown	10		

Total Heat Points = __________
300 needed for survival

Know Your Legislation: What's in It for Wildlife?

Objectives

Students will (1) describe the legislative process in which a bill becomes law, (2) identify points when private citizens can have an effect on the legislative process, and (3) evaluate the effectiveness of the legislative process from the perspective of the students' personal experience.

Method

Students actively participate in the legislative process.

Materials

A copy of a bill being considered in a state legislature, butcher or poster paper, marking pens, writing materials

Grade Level: 9–12

Subject Areas: Social Studies, Environmental Education, Language Arts

Duration: five 30- to 45-minute sessions to start the project, 45 minutes every 2 weeks, 15-minute updates each week

Group Size: any

Setting: indoors

Conceptual Framework Topic Reference: PLIA, PLIB1, PLIB3, PLIC

Key Terms: legislation, legislature, bill, law

Appendices: Taking Action, Agencies and Organizations, Using Local Resources

Background

See the Project WILD activity "Wild Bill's Fate."

Students can learn about the political process by becoming involved at a "grass-roots" level. Voting, letter-writing, and lobbying are among the direct ways used by adults to communicate their opinions to their governmental representatives. Young people can prepare themselves for their voting rights and responsibilities by monitoring the legislative process—specifically following a bill of interest to them in its course toward becoming a law. This activity is best done over a one- to two-month or longer period. The students should select a local wildlife or other environmental issue of interest to them with related legislation pending. Be sure that the students tackle a piece of legislation that is worth the effort.

Real-life—rather than simulated—experiences are important in learning such concepts and skills. Although role-play and simulation activities can be useful, they do not show students that they can influence policy making. Instructional benefits to students from this activity will vary depending on their own interest and abilities, their access to governing groups, and the amount of time available to work on this project.

The major purpose of this activity is to give students real-life experience in studying and participating in the legislative process. They are given an opportunity to have an impact on issues of concern to them.

HELPFUL HINTS from a classroom teacher who has successfully done this activity with students:

1. By contacting legislators, students will make an impact. Four or five letters on a legislator's desk receive attention.
2. Students will really learn how a bill progresses—important knowledge in a democracy where citizens have rights and responsibilities.
3. This process might actually assist in passing or defeating a bill—and make an impact for the good of wildlife and the environment that will last a long time.
4. This process might not get the bill through or defeat it. Most pieces of legislation take three to five years to go through the legislature. It typically takes that long for a bill to receive serious attention and for the legislators to acquire sufficient information to consider its importance. If the outcome is not what you wanted, don't be discouraged. Ask students to join forces with next year's class in the same project. Their impact may not bring about the passage or defeat of a bill in one year, but it will hasten the process.
5. Appropriations bills that require allocation of money are much harder to get passed.

Procedure

Day One

1. Ask your students if they know of any laws that affect wildlife and the environment. They may be able to give a few examples. Initiate a discussion about how such laws came to be. Where do they come from, and how are they passed into law?
2. Ask for students to volunteer to contact local people about any legislation presently being considered that would affect wildlife or other aspects of the environment. One student could call the state wildlife agency and ask to speak to someone responsible for information about proposed legislation. Another could call a federal agency with responsibilities affecting wildlife. Another student could call a private organization—like a local chapter, affiliate, or representative of the Pheasants Forum, Defenders of Wildlife, Sierra Club, National Audubon Society, The Nature Conservancy, National Wildlife Federation, The Wildlife Society, or the Izaak Walton League—for information about proposed legislation they might be concerned in and working on. Industry can also provide valuable information. For example, the government affairs office of a large corporation might be able to assist. Check with the students before they make their calls or send letters. Stress that they make their requests clearly, concisely, and courteously. Make sure students research the mission and goals of the agency or organization they contact because this research will influence the group's perspective of the proposed legislation. Ask the students to be prepared to report back within two weeks about what they have learned. If possible, by that time the students should have copies of proposed legislation for review by other members of the class.

Day Two

3. Ask the students who contacted local people about proposed legislation to report to the rest of the class. After hearing the reports, ask the entire class to decide what one piece of proposed legislation they are most interested in finding out more about by following its route through the legislature to possible passage.

continued

Day Three and On

4. Once the students have selected the legislation they are interested in following, these are the next main steps:
   - Know your legislation. Give each student a copy of the proposed legislation. Divide the class into committees. Ask each committee to take a section of the legislation, read it, interpret it to the best of their ability, and report back to the whole class. Ask each committee to outline its reports visually and verbally on a large piece of butcher paper for presentation in front of the class.
   - Write the position paper. Ask the students to decide which areas of the legislation they wish to support or oppose with specific positions. Again, ask the students to work in committees to do research, bringing back information and expert opinions to substantiate their positions. All the information and concerns then should be compiled into a class position paper they will use to present their points of view to the legislators and allied groups.
   - Get in touch with your federal representative or senator. Next, ask each student to write a letter to his or her state legislator. At least one copy of the students' position paper should be included with their letters. Be sure to check the letters for grammar and spelling errors—they have to be perfect!
   - Establish a legislature contact person. Ask the class to appoint a student "Eagle-Eye" to be the contact person with the local legislator's office. If possible, the student should introduce himself or herself in person or by phone to the legislator or aide and should express the class's wish to keep track of this bill. It is the responsibility of the student "Eagle-Eye" to do as follows:
     - Contact the legislator's office twice a week to determine where the bill is in the process and whether it has picked up any amendments.
     - Keep a flow chart on the progress of the bill. This flow chart can be placed on a large piece of butcher paper on a bulletin board for the class to follow.
   - Establish an organization contact person. The class already may have identified allied groups that might have an interest in this bill (e.g., when students volunteered at the beginning of the project to contact people for information about proposed legislation). Ask the students to appoint one class member to each group identified. It will be the responsibility of the student liaisons to contact, in person, the president or legislative chairperson of the local allied group for which they are the contact. Explain this class project, and give students a copy of the position paper. Student liaisons are to keep their allied groups informed, and—when the legislation reaches a critical point—student liaisons will contact the allied group leader, asking that the groups contact their general membership to write or call their local legislators about the bill. Keep a list of who is contacted.
   - Identify a student whip. Ask the class to appoint another student to find out to what committees this bill will probably be assigned to. Wildlife bills usually go to the Natural Resource Committee and to the Appropriations or Ways and Means Committee if they cost money. The student whip should get a list of committee members and their districts from the legislature's Information Desk. Ask the student whip to list and display the names of these committee members and their districts. The student whip also should keep in constant contact with the student liaison in case the bill is relegated to some other committee unexpectedly.

- Student "Watchdog." Each committee member on the student whip's list should be assigned to a student Watchdog. Each Watchdog is to write his or her committee member a letter stating the class's position, including a copy of the position paper. Keep track of who is contacted, when, and how. It is the responsibility of each student Watchdog to call his or her respective legislator's office a couple of days before the bill goes into that committee to reaffirm the position of the students. Again, stress courtesy and clarity on the part of the students in making these calls. Student Watchdogs can also encourage relatives and friends who live in their committee member's district to write or call the legislator and to voice their opinions. Student Watchdogs should also work with student liaisons to contact the allied group leaders who live in their legislator's district.
- Make final efforts. When the bill is about to go into full committee or before the full House or Senate, it is time for the students, their friends, relatives, and allied groups to write or call (get the toll-free number for them) the legislators who will be making the decisions—making one last effort to make their views known.
- Get the results. The bill may or may not pass. In either case, the students have acquired valuable information and developed first-hand skills in working within the established political processes affecting wildlife and the environment.

Extensions and Variations

1. Draft your own proposed legislation, and debate it in a mock classroom legislature. Submit it for consideration to your state legislator or the appropriate committee.
2. Distinguish between laws and regulations. Regulations may have the same powers and penalties as laws, or may not. Look at similarities and differences. Obtain copies of state wildlife laws and regulations. They are normally free from the state wildlife agency.

Aquatic Extensions

Choose a piece of legislation related to aquatic species or aquatic habitats.

Evaluation

1. List five stages in the passage of a bill where citizens can influence the outcome. List the stages in order. Assume the bill begins in a House of Representatives. Briefly describe how citizens can have input.
2. What are three good places to go for information about legislation affecting wildlife, natural resources, and the environment?
3. How can a citizen find out the status of a bill that is being considered for legislation?
4. What impact does the legislative process have on people's perceptions and actions that affect wildlife and its habitat? Using your experience, what suggestions, if any, would you like to make that will improve the effectiveness of the legislative process? What are its strongest, most-valuable features? What are its weakest, most-negative features? What is your assessment of its overall importance?
5. What advice would you offer other students who want to influence the passage or defeat of legislation?

continued

Action Flow Chart for "Know Your Legislation" Activity

Study legislation.

Write position paper.

Send letters and one position paper to your state legislator.

Establish contact with legislator's office, and keep up-to-date flow chart on bill—especially noting movement into committees or amendments.

Identify allied groups.
Assign a student liaison to contact each group.

Find out to what committees this bill will go.
Student whip is responsible for identifying committee members.

Each committee member is sent a letter and position paper.

Friends, relatives, and allied groups in town of committee members are educated and ready to act.

Bill is going before committees or full House or Senate.
Contacts write or phone the legislators who will be voting.

IT PASSED.

IT DIDN'T PASS.

Animal Poetry

Objectives

Students will recognize and experience the inspirational value of wildlife.

Method

Students go outside to imagine themselves as animals and then write poems.

Materials

Writing materials: pens, pencils, paper

Background

Poetry is a form of imaginative literary expression that makes its effect by the sound and imagery of its language.

Poetry is one of the most ancient and widespread of the arts. Originally fused with music in song, poetry eventually gained an independent existence. Where poetry exists apart from music, it has substituted its own purely linguistic rhythms for musical rhythms. This rhythmic use of language most easily distinguishes poetry from imaginative prose.

Grade Level: 5–8

Subject Areas: Language Arts

Duration: one 45-minute session

Group Size: any

Setting: indoors and outdoors

Conceptual Framework Topic Reference: AAIA

Key Terms: poetry, imagine

Appendices: Outdoors, Field Ethics

Meter, the highly regular part of verse rhythm, depends, in some languages, on the different stresses on adjacent syllables and monosyllabic words. In some languages, poetic rhythm depends more on line length than on differences between syllables. Line length is determined by the total number of syllables in a line, by the number of stressed syllables in a line, or by some combination of number and stress.

Poetry may be divided into a number of types, including lyric; narrative such as epics, ballads, metrical romance, and verse tales; and dramatic (poetry as direct speech in specified circumstances). This activity develops the use of several forms of poetry: the Japanese Haiku, the Cinquain, and the Diamante.

Procedure

1. Locate a setting on the school grounds, in a park, wooded area, or other natural environment. Ask the students to choose a wild or domesticated animal for their poem. Ask them to close their eyes for a few minutes and imagine they are the animal, living in its natural environment. With students' eyes closed, educators can guide the students, imagining process with a few words or simply leave this process to the students' own imagination.

2. For five minutes, have the students "become" that animal. Imagine how long it lives, where it travels, and how other plants and animals look from its perspective. Afterward, ask the students to write a short poem about their animal. Poems can be free verse or rhyming. Cinquain and haiku are interesting forms of poetry and are explained in the Optional section below. Another form of poetry is a group poem. Everyone thinks of one animal. Each person contributes one word. One or more students can combine the words together to form the poem while the others discuss their experiences in "becoming" an animal.

   OPTIONAL: Here are a few examples of other poetic forms that can be practiced.

   Haiku Haiku, a Japanese lyric verse form having three unrhymed lines of five, seven, and five syllables, traditionally invoking an aspect of nature or the seasons. Traditionally and ideally, a haiku presents a pair of contrasting images: one suggestive of time and place, the other a vivid but fleeting observation. Working together, they evoke mood and emotion. The emphasis is syllabic, not rhyming. For example,

   The hawk soared over
   Spirit bird in my living
   Guide to harmony.

   The haiku evolved from the earlier linked-verse form, known as the renga, and was used extensively by Zen Buddhist monks in the 15th and 16th centuries. In the next 200 years, the verse form achieved its greatest popularity and success.

   Cinquain The word cinquain is derived from the French and Spanish words for five. The cinquain is a poetic form originated by the United States poet, Adelaide Crapsey (1878–1914), comprising five unrhyming lines of, respectively, two, four, six, eight, and two syllables. Each line has a mandatory purpose and number of syllables or words. These are (1) the title in two syllables (or words), (2) a description of the title in four syllables (or words), (3) a description of action in six syllables (or words), (4) a description of a feeling in eight syllables (or words), and (5) another word for the title in two syllables (or words). Here are two examples, the first using syllables and the second using words:

   Panther
   Vital, quiet
   Moving swiftly to live
   Endangered by human patterns
   Near lost

   Sea Otter
   Mammal of living waters
   Swimming, sleeping, eating, diving, basking, playing,
   Sensitive indicator of the quality of continuing life
   Still here

   Diamante A diamante is a poem shaped in the form of a diamond. It can be used to show that words are related through shades of meaning from one extreme to an opposite extreme, following a pattern of parts of speech like this:

   noun
   adjective adjective
   participle participle participle
   noun noun noun noun
   participle participle participle
   adjective adjective
   noun

continued

For example,

egg
light bright
living stretching growing
bird beak wing flight
soaring seeing seeking
feathered fluid
raven

3. The completed poems can be typed or printed neatly and then displayed with a photograph or with black-and-white pen and ink drawing of the animal. For example,

The Goat, "Mazama"
Rhime ice coats my nostrils
The gale rages from peak to crag
Warm, white wool shaggily hugging my body...
Cautiously I move on rock
Barely noticing the fear
Of the valley below.
The eagle—the feel of snow—
This is my home.

Hal Neace, Teacher
Seldovia, Alaska

Excerpted and adapted with permission from Project Learning Tree (American Forest Foundation, Washington, DC).

Aquatic Extensions

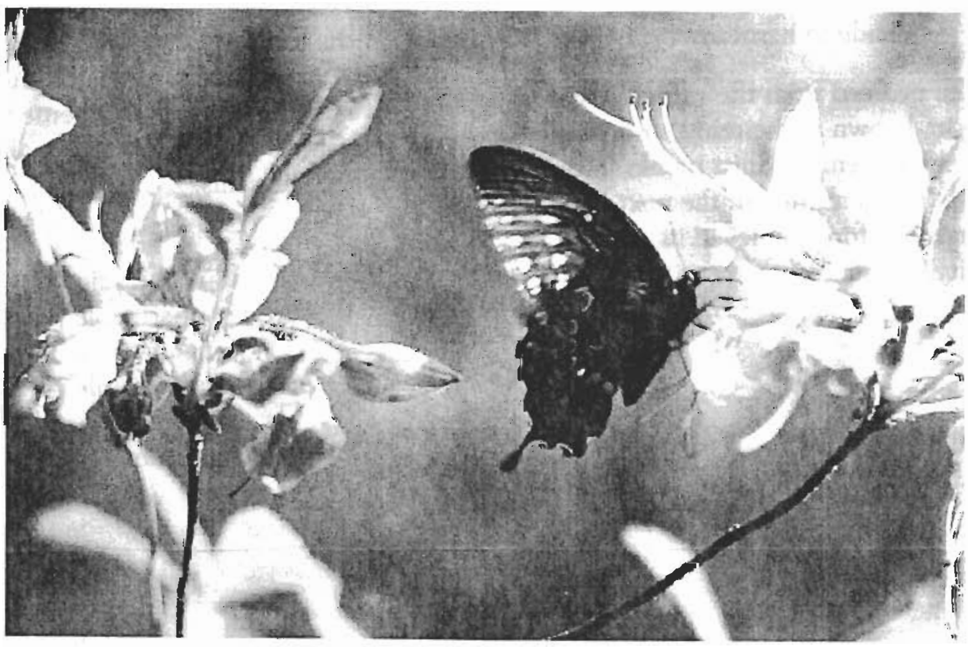
1. See the Project WILD Aquatic Education activity "Aqua Words."
2. Create a poem in the shape of an aquatic animal. After drawing an outline of the animal, place words of the poem in order around the shape of the animal. Use words that describe the characteristics of this aquatic animal (e.g., where it lives, what it eats, how it moves, and other interesting facts).

Evaluation

1. Why do you think some people say that they would not want to live in a world without wildlife? Are you one of those people? Why or why not? Would you prefer to choose the types of wildlife you would like to live with? If so, which types would you want to live with and why?
2. Find an inspirational photograph, painting or other image that features wildlife. How does the artist portray wildlife in a way that you find inspiring?

Additional Resources

www.riverofwords.org



Drawing on Nature

Objective

Students will generalize that wildlife and other animals are an important inspiration for art and science.

Method

Students use techniques of observation and visualization to record wildlife by drawing.

Materials

Drawing materials

Background

Some significant breakthroughs have been made in recent years with respect to teaching drawing to young people and adults. Betty Edward's *Drawing on the Right Side of the Brain* and Robert McKim's *Experiences in Visual Thinking* are classics in this area, filled with actual instructional activities for use alone or with others.

Much of our understanding of science comes from interpreting visual images. The language of science is precise. The images that accompany scientific writing can enhance our knowledge of a subject and can add more precision to our perception. Drawings that accompany field notes offer researchers several paths through which to interpret their experiences. The subject is the same, but the information is different. Incorporating drawing into research improves one's observation skills. Good science requires keen observation skills.

Wildlife has been an inspiration for artwork of varying kinds throughout human history. Skills for observation of wildlife are also important to the poet and the scientist.

The major purpose of this activity is for students to recognize the value of wildlife as an inspiration for art and science, as well as to develop personal skills.

Grade Level: 5–8

Subject Areas: Environmental Education, Language Arts, Expressive Arts

Duration: one 45-minute session

Group Size: any; individual student project

Setting: outdoors

Conceptual Framework Topic Reference: AAIA, AAIB

Key Terms: observation, visualization, inspiration, art, science

Appendices: Outdoors, Field Ethics

Procedure

1. This activity is best done in an outdoor setting and requires students to be able to observe an animal, preferably wildlife.
2. Provide each student with drawing materials.
3. Take the students to a park, a wooded area, a natural desert, an area of the school grounds, or a place where they can see animals. If sites are limited, the wildlife may be a line of ants, a cricket, or a grasshopper. If you can't find animals outside in a natural setting, perhaps the group could visit a zoo or an aquarium.

continued

4. Give the students the following instructions:
   - Find an animal. Watch the animal as closely as you can. Look at its color, form, and body shape as if it were an outline against the sky.
   - Close your eyes and try to reconstruct the animal in your mind. See its color, body shape, etc., again in your mind. Remember—this time your eyes are closed.
   - If, when you open your eyes, that animal is gone—find another animal and start over. Find an animal. Watch the animal as closely as you can, etc.
   - After you've watched it very closely while paying particular attention to the shape of its body as if it were against the sky in an outline, close your eyes again and see the animal in your mind as clearly as you can.
   - Using a pencil, try to draw the body shape of the animal. Draw the outline of the animal as you would see it if it were surrounded by sky. Draw that outline of the animal's body on your sketching paper. Sometimes it helps to look at the animal—and not at the paper—when you are drawing the animal's outline.
   - Now that you have the body outlined, concentrate more on filling in some of the body parts than on filling in details.
   - Now fill in some of the details of the animal's surroundings—first closing your eyes to see the shape clearly before you outline it on your paper. You might outline the limb of a tree for a bird or the horizon line for an ant.
   - Now fill in as many details as you like. Your drawings may remain a pencil sketch, or you may use a felt-tip black pen for a pencil-and-ink impression, or you could use chalks or crayons to add color.

NOTE: Try to be supportive and encouraging to each of the students in this process without being too evaluative and judgmental. Several of the students who have never been able to draw anything with any feeling of success will experience some real delight with this activity. All of the students should be able to come up with something on paper they can be proud of. Encourage the students to keep using this technique for things such as keeping a journal of words and images.

5. Once their work is completed, talk with the students about what happened while they were working on their projects—what they saw, how they felt, etc. Talk with them also about the importance of wildlife and all of nature as a source of inspiration for varying forms of art and science.

Aquatic Extensions

1. Use these techniques for enhancing observations of aquatic wildlife and habitat. Include drawings of aquatic organisms in your own "Field Guide to Our School's Aquatic Wildlife" or "Field Guide to Our Community's Aquatic Wildlife."
2. If you have an aquarium or if you can visit one, use these visual techniques to record your observations.
3. At an aquarium, choose one feature of aquatic organisms to investigate. Make drawings of this feature in several different organisms. For example, try features used for locomotion in animals that live underwater.

Evaluation

Groups of people were discussing endangered plants and animals—that is, those that are very close to becoming extinct. Some of the people felt that plants and animals need to be preserved and protected because of the value they may have for medicine, food, and clothing or that they are a necessary part of our ecosystem. Other people said that plants and animals are not needed and that they would not worry about losing these species. Suppose you are an artist in the group and you want to express your opinion about whether or not plants and animals should be preserved. What would you say?

Too Close for Comfort

Objectives

Students will (1) describe possible negative consequences for people and wildlife under conditions of crowding, and (2) identify ways people can behave in order to reduce negative consequences of crowding for wildlife.

Method

Students experiment with physical distance and levels of comfort in humans, estimate appropriate distances between humans and wildlife under various conditions, hypothesize about indicators of animal discomfort, and summarize reasons to avoid animal discomfort through crowding.

Materials

None

Background

Sometimes wildlife seems to want to say, "Don't get too close!" From a tree branch, a bird watches a person approaching; when the person gets too close, the bird takes flight.

Grade Level: K–4

Subject Areas: Science, Environmental Education

Duration: 10- to 30-minute session

Group Size: any

Setting: indoors

Conceptual Framework Topic Reference: HIIA

Key Terms: crowding, disturbance, safety, behavior

Appendices: Simulations, Field Ethics

Animals are often threatened when crowded by humans, even though the humans may m no harm and may merely want to observe th animal. Animals may display their discomfor by fleeing, grinding their teeth, coiling, hissir stomping their feet, snarling, coughing, or wolfing. Flight is the usual way animals show stress. Noises may come when an animal is r or threatening to attack.

Wildlife photographers have learned that wh the wildlife they are photographing begins t act strangely, they probably have gotten too close. Animals may run away if you are insid a certain distance. At a closer distance, they charge or in other ways respond aggressively the threat of human presence.

One way of understanding the way wildlife is to recognize that many animals have certa distances that they keep from their own kin Wolves may demand large areas of range tha no other wolf outside of their own pack (far may enter. Studies show that certain kinds o finches always leave a certain distance betwe themselves when they perch on a telephone wire or fence line.

When crowding occurs, many animals react bizarre, aggressive, or disordered behavior, an they may develop skin diseases like mange. T may adjust to the crowded conditions, over time, by ceasing reproduction.

In the United States, great blue heron rooker (colonies of nesting sites) have been disturbe by the mere presence of people. Rookeries a the birds' breeding grounds. Herons live mos of the year alone; when they come together breed, disturbances by humans during courtship and nesting can cause stress. Under circumstances of stress, they may not breed, may lay fewer eggs, or may abandon the rookery, leaving eggs or young birds to perish. The U.S. Fish and Wildlife Service recommends that nesting sites should be observed by humans at a distance of at least 660 feet (200 meters) to minimize disruption of the colony.

The purpose of this activity is for students to recognize the possible negative consequences for people and wildlife as a result of conditions caused by crowding. You may want to gather additional information from state or federal agencies concerning specific animals in your area.

Procedure

1. Introduce the concept of discomfort from crowding by asking one student to stand in front of the class. Approach the student slowly, asking the student to tell you when your closeness begins to make him or her feel uncomfortable. Ask the class whether they allow strangers to approach them as close as they do their friends or family. How do they feel in the middle of strangers on a crowded bus or elevator? Discuss what physical reactions they have in crowded conditions, such as avoiding eye contact, nervousness, sweaty palms, and so on.
2. Introduce the idea that animals in the wild might also be uncomfortable when approached by strangers. Talk about why they might be uncomfortable (e.g., fear of predation, need to protect young). Discuss what other conditions might increase or decrease wariness such as whether it can fly away, climb quickly, run fast, or swim fast; what the animal's size is; whether the animal is alone or with a group; and whether it is on a nest or has young.
3. Have the students make a list of animals they are likely to encounter and then estimate what distance should be maintained from each animal species, both for reasons of personal safety and for the comfort and safety of the animal. Emphasize that these are just estimates. As a rule, it is better to stay farther away than might be necessary than to get too close.
4. Have the students hypothesize about animal behaviors that might indicate discomfort, such as foot stomping, teeth grinding, raising up on hind feet, nervously looking around, and eventually flying away. OPTIONAL: Students can mime or portray such situations and have other students guess which animal they are and in what situation.
5. Discuss the ways in which wildlife harassment might occur unintentionally, such as getting too close when photographing, hiking near a nesting site, and using loud vehicles near newborn animals or in places where animals are unaccustomed to humans. Explain the possibility that there are certain times of the year when some animals are more sensitive to intrusion, such as during their mating season and during severe climatic conditions such as heavy winters or drought. How can communities minimize disturbances to wildlife? What can individual people do? Summarize reasons it is important to wildlife for people to minimize such disturbances.

Extensions

1. Have the students draw life-size outlines of some of the animals and display them on an outside wall of a building. Break into small groups; have each group establish a distance from each species that the group feels would be far enough for the animal not to be threatened by the presence of a person. Using measuring tapes, each group should measure the established "comfort zone" for each species under different conditions—and then present those suggested distances. Verify the accuracy of these distances by contacting a wildlife resource person. Discuss whether a general rule is apparent about the relationship of the size of the comfort zone to conditions such as size of the animal,

continued

presence of young, ability to flee, single animal or group of animals, and so forth.

2. Why is it important to minimize such disturbances for domesticated animals, like pets, dairy cows, and so on?
3. Why is it important to minimize such disturbances for people? What actions can be taken to do so? With what consequences? With what benefits?

Aquatic Extensions

Because water is one of the essential components of a habitat, areas where water is available in the natural environment frequently are visited by many species of wildlife. Some live in or near the water. Others come to the water as needed. As a result, ponds, lakeshores, river banks, ocean beaches, streams, reservoirs, canals, irrigation ditches, and even city fountains can sometimes be places where people come "too close for comfort" when it comes to wildlife. Think of three examples of situations where people can come too close for comfort in aquatic habitats, with possible negative consequences for wildlife. Think of three examples of people and wildlife being able to successfully coexist near and in water.

Evaluation

1. Identify three examples of wildlife behavior that would indicate a human is too close.
2. Describe negative results of crowding for humans. Describe negative results of crowding for animals.
3. Identify several special conditions or times of year when wildlife are more sensitive to intrusion.
4. Use data from state or federal agencies to have students mark off the actual distance recommended for humans to stay away from particular animals. For example, visitors to Yellowstone National Park are to stay at least 25 meters from large animals.

Ethi-Thinking

Objectives

Students will (1) generate a list of activities that are harmful to wildlife and the environment, (2) discuss reasons these activities are inappropriate, and (3) recommend alternate activities that are not harmful.

Method

Students list activities that might be harmful to wild plants and animals and use photos or drawings to picture, discuss, interpret, and evaluate these activities.

Materials

Art supplies (crayons, construction paper, magazines for photos) to make discussion cards

Background

NOTE: This activity can be used as an introduction to the Project WILD activity "Playing Lightly on the Earth."

Grade Level: K–4

Subject Areas: Environmental Education, Language Arts

Duration: one or two 20- to 40-minute sessions

Group Size: any

Setting: indoors

Conceptual Framework Topic Reference: HIIB, HIIIA, HIIIB

Key Terms: harm, wildlife

Appendices: Simulated Field Trips, Early Childhood

The major purpose of this activity is for students to discriminate between outdoor activities that are harmful to wildlife and the environment and those that are not.

Procedure

1. Ask the students to make a list of human activities that seem harmful to wild plants and animals. Ask them to think about things they've seen or know about that might be harmful. Some things could be these:
   - Pick up baby wild animals in the environment (birds, fawns, etc.).
   - Carve initials in trees.
   - Drive vehicles (cars, motorcycles) over fragile environments.
   - Remove plants from the environment, such as digging up cactus.
   - Destroy bird nests.
   - Illegally kill, collect, harass, or possess wildlife.
2. Have the students use photos or drawings to make cards showing these activities and describing what is happening. (Or the educator can prepare cards in advance, laminate them, and use them again.) Or students can dramatize the situation in skits, "commercials," songs, poems, and so on.
3. Collect the cards. Divide the group into teams of four students. Distribute one card to each group, and ask them to discuss (or present the skits, poems, and so on):
   - What is happening?
   - Does it harm wildlife? How?
   - Does it seem to be appropriate or inappropriate behavior? Why?

continued

- Is the person having fun?
- What else could people do that would satisfy their needs and interests without harming wildlife or the environment?

4. Ask each group to report to everyone else about (a) the students' feelings concerning what is happening in the outdoor activity shown in the picture and (b) a recommendation for an alternative activity the people could do that would not be harmful.

Extensions

1. Choose something you or your family owns such as a car, television, or refrigerator. Imagine you are that object, and explore how you—from invention to garbage dump—affect wildlife!
2. Distinguish between actions that are harmful to individual plants and animals and those that are harmful to large numbers of plants and animals. In what situations, if any, does it seem appropriate to harm a single animal or plant? In what situations, if any, does it seem appropriate to harm large numbers of animals or plants? In what situations, if any, does it seem inappropriate to harm a single animal or plant? In what situations, if any, does it seem inappropriate to harm large numbers of animals or plants? (Remember the definitions of wildlife and domesticated animals. Don't forget that wildlife includes but is not limited to insects, spiders, birds, reptiles, fish, amphibians, and mammals.)
3. Sometimes it is difficult to decide what is harmful and what is not. Usually if something is against the law, it is harmful in some way. Sometimes actions may be legal or there simply may be "no law against it." People will differ in their judgment as to whether the actions are harmful or not. Sometimes we may recognize that some of our actions are harmful in some ways—such as some of our choices for housing, transportation, and consumer products in our daily lives—and we still take those actions because of our perceptions of the importance of our wants and needs. One way to examine wants and needs is to categorize them according to "Luxury," "Useful But Not Necessary," and "Necessary for Survival." Think about personal ethics. What are ethics? How do we each make responsible decisions in our daily lives? (See the Project WILD activity "Enviro-Ethics" for an activity aimed at identifying a "Personal Code of Environmental Ethics.")

Aquatic Extensions

1. Generate a list of activities that are sometimes or always harmful to aquatic species of wildlife and aquatic habitats. Discuss the ways these activities are harmful. Discuss ways such harmful activities can be prevented.
2. Identify at least five examples of things people can do in aquatic environments that will not damage to populations of aquatic animals or the long-term health of aquatic habitats.

Evaluation

1. Identify five things people do that harm wildlife and wildlife habitat.
2. For each thing listed, describe what you can do about it.
3. Identify five things that people do that help wildlife.
4. Choose 10 photographs of people completing various actions or tasks. Examine each photograph and evaluate the potential environmental effects from the activities of the people portrayed. Explain the reasoning for your evaluations. What are the positive and negative effects of their actions?

Back from the Brink

Objectives

Students will (1) explain the reasons for the decline of certain wildlife species and describe methods used in species recovery, (2) describe the effects of the decline and recovery of wildlife on people and the environment, (3) analyze issues surrounding the decline and recovery of wildlife species and examine strategies to resolve those issues, and (4) describe the importance of an environmentally literate citizen base to the success of the recovery project.

Method

Students are given background information on the recovery of wildlife species, and they are asked to analyze the issues and make recommendations for their resolution.

Materials

Paper; pencils; copies of the background information for the North American alligator, black-footed ferret, and the gray wolf on pages 358 through 361; Issue Analysis Sheet on pages 362 to 363; chalkboard or other large surface; access to research materials or state wildlife agency web sites, if possible

Grade Level: 9–12

Subject Areas: Science, Language Arts, Social Studies, Environmental Education

Duration: three 45-minute sessions

Class Size: any

Setting: indoors

Conceptual Framework Topic Reference: ITIVA, ITIVB, ITIVC, ITVA, ITVB

Key Terms: reintroduction, recovery

Appendices: none

Background

The Endangered Species Act of 1973 requires the U.S. Fish and Wildlife Service to protect federally endangered and threatened species and to develop recovery plans for them. Some of these species are extirpated, or missing from their native range, although they are not extinct. In developing and implementing a recovery plan, you must consider many environmental and societal variables. If recovery of a species is successful, you must consider where reintroduction should occur and how it should be implemented. Biological considerations include researching the habitat (food, water, shelter, and space) needs of each species.

Biologists must take into account many factors. How will introduced species affect the other inhabitants in the ecosystem? Where will individuals of the species being introduced come from? Is there enough genetic diversity for long-term population sustainability? Why did the species decline in the first place? Have there been changes, events, or regulations that will now enable the species to recover?

Today, individuals involved in reintroduction plans consider a species' carrying capacity and society's tolerance for living with the species. How does the species affect people? Historically, how have people viewed and valued the species? If that species is an animal, are they afraid of it? Is the animal considered "cute" or "mean?" Do

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people have an understanding of the natural history of the animal? Is there a perception that the recovery of the species will have an impact on the safety of people? Can the species affect their livelihood or limit resources for people on a local, state, or national level? For some species, few conflicts will occur. In other situations, the recovery of a species may raise many concerns and issues.

Recovery plans address different options. Recovery plans may, or may not, include strategies for the reintroduction of the species to native habitats. Important to the selection of a particular option is the classification of the species under the Endangered Species Act. Some species may be classified as an "experimental population." Experimental populations and their associated habitats are subject to fewer regulations and protections. Management of these populations is more flexible and can include a variety of options not permitted in populations designated as "endangered." Various possible scenarios are considered, as the plan examines the effects on the species, the ecosystem, other species, and people. Cost-effectiveness for the different options is examined as well. Before selecting the final option, individuals, groups, and organizations can voice their support or their concerns in public hearings.

The purpose of this activity is for students to analyze the complex human and environmental issues that are involved when a species is reintroduced to an area. It is important that the agencies and groups involved in developing the recovery plan acknowledge and address those concerns, because the long-term recovery of a wildlife species ultimately depends on the conservation measures developed and supported by people.

Procedure

1. Divide the class into groups. Assign each group one of the animals featured on pages 358 through 361, and provide them with the Issue Analysis Sheet on page 362 and 363.
2. Ask students to read the wildlife background information sheet for their animal and review the Issue Analysis Sheet. Have them conduct further research on their animal.
3. Ask the groups to discuss their species and their recovery. Then have the students complete the Issue Analysis Sheet. The sheet will ask students to address the species' preferred habitat; its food; what contributed to the loss or decline of the species; what has helped the recovery of the species; historical range; current range or status of the species (if available); existing or potential issues involved in the species' recovery; the interest groups, agencies, and people involved in the issue surrounding their species; and the steps that have been taken to help resolve these issues.
4. Have students discuss their responses and suggest additional options that might be considered to resolve these conflicts.
5. Ask students to prepare a media brief about their animal. It can be a short "infomercial," formal presentation, brochure, article, or web page. Have the students emphasize the issues and conflicts involved in the animal's recovery. Include the different options or steps they suggest be taken to help mitigate the conflict.
6. Have the groups poll the class for recommendations the students think would best resolve the issues.
7. Using the information provided in the background information sheet and presentations, ask students to construct a class chart summarizing the following: name of the animal, method of recovery, why recovery was able to occur, potential or existing issues or conflicts associated with recovery of the species, the people or groups involved in these conflicts, and the most common strategies selected for helping to resolve the issues or conflicts. Compare and contrast among the species using the following questions to help guide the discussion.

- What changes or events had to occur before species recovery projects could begin?
- How did the loss of the species affect people? The environment? Are the loss and/or recovery important? Why?
- What issues or potential conflicts are involved in the recovery of each animal? Who are the different "players" involved in these issues or conflicts? Are any of the issues or conflicts similar among the species?
- How has public perception of the species influenced decisions related to the issues?
- Are there reoccurring strategies in resolving conflicts associated with these species?
- How important is it that local individuals and groups understand the natural history of the species and its role in the ecosystem? Why?

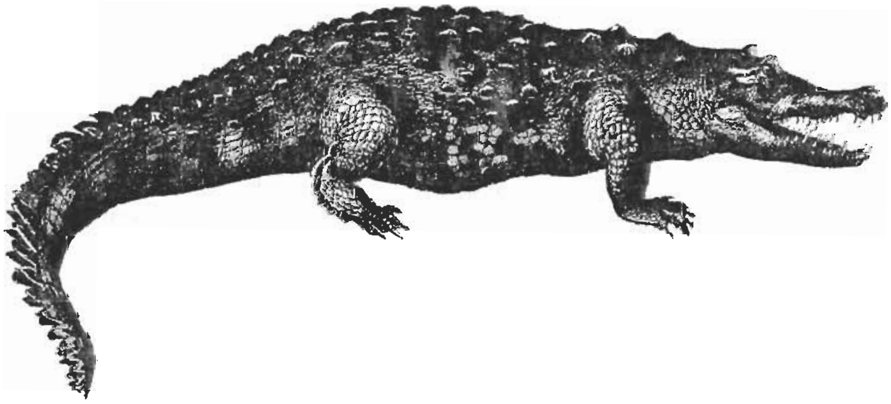
8. After the class discussion, have the students return to their groups and finalize their recommendations or strategies to help resolve the issues surrounding their species.
9. Have students present the final strategies that will be used.

Extensions

1. Ask students to choose one of the species in this activity and to research what is being done to resolve issues and conflicts surrounding the recovery of the species.
2. Research rare or declining wildlife species found in your state. Develop a plan to bring about recovery for one of those species. How could it be determined if recovery might be feasible? What method could be used? What would justify the recovery of this species? How could local citizens be involved and help to resolve concerns?
3. In groups, have students construct a personnel chart that includes all job categories that might be needed in the recovery of their animal. Describe the role of each position and indicate possible employers.

Evaluation

1. Identify a wildlife species that is or has the potential to be involved in an issue or conflict on a local, state, or international level. Ask students to identify potential problems, conflicts, or issues. What strategies would they use to help prevent conflicts from arising in the first place? How would they resolve conflicts if they did occur? Ask the students to choose a wildlife species from the activity and to create a position statement portraying their views on the issues involved in that species' recovery.
2. Ask students to choose a wildlife species from the activity and to create a bumper sticker portraying their views on the issues involved in the species' recovery.



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North American Alligator *(Alligator mississippiensis)*

The North American alligator, a member of the crocodile family, can be found in marshes, swamps, shallow lakes, ponds, and waterways in the southeastern United States—from Texas to Florida and as far north as the Carolinas and southern Arkansas. As adults, these large reptiles can weigh more than 500 pounds and measure 8 to 13 feet or more in length.

North American alligators are predators and eat a wide variety of foods including fish, turtles, snakes, birds, and small mammals. The North American alligator has existed for more than 180 million years. It is well adapted to life in the wet areas of the south. Alligators are exothermic. They have no internal method to control body temperature and rely on water to keep their body temperatures lowered in the hot summers. The North American alligator helps retain water in its habitat by creating holes that retain water in times of drought. These "gator holes" help supply water for wetland plants and wildlife.

During the early colonization of the southeastern United States, alligator populations remained fairly stable throughout most of their range. However, at the end of the 19th century, it became fashionable to use alligator hide in boots, wallets, purses, belts, and other fashion items. Market hunters began to take alligators in large numbers to use their skins in the fashion industry. In the 1920s, 200,000 alligators were killed each year in Florida alone.

During the 1920s, thousands of acres of wetlands also were being drained to provide more land for agriculture and development, and to limit mosquito populations. With the combined pressures of habitat loss and market hunting, alligator populations began to plummet. By the 1950s, the American alligator was on the verge of extinction.

Between the 1940s and the 1960s, the southeastern states began protecting their remaining alligator populations. In 1967, the North American alligator was placed on the federal endangered species list, which provided it complete protection. It remained on the list under the Endangered Species Act of 1973. This act emphasizes protection and recovery of endangered species and helps provide funding for research and recovery projects. An amendment to the Lacey Act and CITES II (Convention on International Trade in Endangered Species of Wild Fauna and Flora) also protects the alligator by regulating interstate and international commerce in alligator products. (A South American alligator, not found in the wild in North America, is not endangered and never has been. Those alligators are sometimes sold in pet stores.) As a result of such efforts, the North American alligator has made a complete recovery. Effective management, habitat protection and restoration, law enforcement, and, in some states, reintroduction and restocking have enabled alligator populations to grow dramatically in recent years. In 1987, the American alligator was reclassified from "endangered" to "threatened."

While North American alligator populations continue to grow in the southeastern United States, the human population and associated development is also increasing. Because many people want to live along water, waterfront property has become a prime area for housing developments. People share these waterways with alligators while fishing, boating, swimming, and so forth. Greater contact has led to increased conflict between people and alligators, and most conflicts are due to alligators being in places where people do not want them. Although these reptiles typically stay away from people, people and alligator incidents can result when alligators lose their fear of people because someone has been feeding them. Alligators are large predators and have also been known to prey on household pets.

To help manage alligator populations, some states now allow closely monitored hunting and trapping. Alligator hide and meat are valued commodities. To help meet this need, alligator farming has become a thriving business. Some states have allowed the limited collection of eggs and hatchlings by licensed alligator farms and have allowed limited hunting by private individuals.

North American alligators remain protected on state, federal, and international levels to help ensure their continued survival.

Black-Footed Ferret *(Mustela nigripes)*

The black-footed ferret is the only ferret native to North America. These long, slender mammals were once found throughout the Great Plains, ranging from southwestern Canada to northern Mexico. Scientists do not think they were ever very abundant. The black-footed ferret is considered the rarest wild mammal in North America.

Black-footed ferrets are members of the mustelid family, along with weasels, otters, minks, badgers, and wolverines. Although they occasionally eat rabbits, mice, and other small mammals, black-footed ferrets feed almost exclusively on prairie dogs—in fact, prairie dogs make up more than 90 percent of a ferret's diet.

Prairie dogs are burrowing rodents that live in large groups often referred to as "towns." At one time, there may have been as many as 5 billion prairie dogs sharing the prairie with ferrets and other wildlife. It is no coincidence that the ranges of these two animal species overlap. Not only do black-footed ferrets rely on prairie dogs as their main food, but they also live and raise their young in the burrows of prairie dogs.

Prairie dog towns provide food and shelter for many other animals as well. Prairie dogs are the prey of other predators such as coyotes and red-tailed hawks. Burrowing owls use prairie dog holes for nest sites, and many species of snakes, lizards, and amphibians use the burrows for shelter and hibernation.

Prairie dog towns provide recreational opportunities for wildlife watchers, photographers, and hunters. Although valued or tolerated by many people, others consider prairie dogs as nuisances. Besides eating agricultural crops, they eat the prairie grasses that are also eaten by livestock. Most of the land that could be developed in some areas is inhabited by prairie dogs. In addition, prairie dogs can contact sylvatic plague, which, when transmitted to humans, is called bubonic plague.

Since the late 1880s, many methods have been used to control and eradicate prairie dog communities. At the same time, the majority of their habitat (more than 98 percent) has been lost to development. Poisoning, trapping, shooting, and other control measures; habitat loss; and disease have led to a decline in prairie dog populations. This loss of habitat and their major food supply, in conjunction with disease, caused black-footed ferret populations to plummet as well.

In 1967, the black-footed ferret was placed on the federal endangered species list. By 1980, black-footed ferrets were thought to be extinct. Then in 1981, a population of black-footed ferrets was discovered in a prairie dog colony in Wyoming. Biologists began to study these animals to determine what could be done to protect this colony. By 1985, the colony had expanded to 129 animals. Unfortunately, an outbreak of canine distemper almost wiped out the colony. By 1987, the 18 remaining black-footed ferrets were taken into captivity as a last ditch effort to save the species.

In 1988, the U.S. Fish and Wildlife Service adopted the Black-Footed Ferret Recovery Plan. State and federal wildlife agencies in cooperation with several zoos began a captive-breeding program to try to increase the number of black-footed ferrets. The goal of the program is to reintroduce these ferrets into the wild. Overall, the captive-breeding program has been a success. The first project to reintroduce black-footed ferrets into the wild took place in 1991 in a prairie dog colony in southern Wyoming. Since then, small numbers of ferrets have been reintroduced into Montana, Arizona, Utah, and South Dakota. On-site breeding programs have also begun in Arizona, Colorado, and Utah. In 1998, more than 100 black-footed ferrets were born in the wild, and more than 400 were born as part of the captive-breeding program.

Many challenges remain in this reintroduction effort. Little was known about black-footed ferrets, especially about how to raise them in captivity while maintaining their abilities to survive in the wild. Land-use conflicts among farmers, ranchers, and prairie dogs continue to exist, on public as well as private lands. Today, where some prairie dog species continue to be legally classified as "pests," poisoning and other measures are being used to control nuisance colonies. Urban development continues to affect the land used by both prairie dogs and black-footed ferrets. To help address some of the issues associated with the recovery project, the reintroduced black-ferret populations have been designated as "experimental nonessential" populations under the Endangered Species Act.

As land-use practices change and more prairie dog communities are eradicated, the final challenge may be to maintain enough suitable habitat and prairie dog communities for black-footed ferrets to survive in the wild.

continued

Gray Wolf *(Canis lupus)*

The gray wolf is a highly social animal, and lives in packs of two to more than a dozen animals. Within the pack there is a definite hierarchy of dominant and subordinate individuals. Typically, only the alpha (lead or highest ranking) male and female mate, which helps limit the size of the pack and the number of newborn pups. The alpha pair, along with its offspring, forms the pack. Wolves hunt in packs and will share their food with pups and other adults in their pack. This arrangement is rare in the animal world.

Gray wolves can survive in many habitats where food is plentiful. They usually live in isolated forested habitats interspersed with grassy areas where their prey—deer, elk, moose, and other ungulates—graze. Wolves are large animals and can weigh up to 175 pounds and measure up to 6 1/2 feet in length, but most wolves are about half this size. Although named the "gray" wolf, the color of these mammals varies in shade from black to white to gray.

The gray wolf once was found throughout North America from Canada to central Mexico. When European colonists began to settle in North America, they relied on many species such as deer and elk for food and clothing and for trade. They had very little knowledge about predators. Wolves, like other predators, were viewed with fear or as competitors for important food sources. Settlers were also concerned that wolves would attack their livestock or themselves. Consequently, as early as 1630, large bounties were paid to people to kill wolves. The Massachusetts Bay Colony paid an average month's salary for the head of a wolf.

As more people settled the land, the pressure on wildlife drastically increased. Between hunting and loss of habitat, many wildlife species, including elk, bison, and deer, were almost eliminated from parts of the country. The wolf was being pushed into an ever-decreasing range with a greatly reduced food supply. Conflicts between wolves and people grew. Programs, including those subsidized by the government, were established to eradicate the wolf. By 1897, the eastern timber wolf (*Canis lupus lycaon*), a subspecies of the gray wolf, was eradicated from the northeastern United States.

Wolves remained fairly common in the wild lands of the northwest through the early 1900s. However, continued habitat loss and eradication programs persisted. By 1950, wolves had been eliminated throughout the contiguous United States except for some remote wild areas in northern Minnesota. In 1967, the eastern timber wolf was included on the federal endangered species list. In 1973, the northern Rocky Mountain subspecies (*Canis lupis irremotus*) was listed as endangered. With a relatively large eastern timber wolf population surviving in parts of Minnesota, there was some confusion as to the legal status of the wolf in the United States. To clarify the situation, the U.S. Fish and Wildlife Service (USFWS) reclassified the Minnesota wolf as "threatened," and all other gray wolves south of Canada were listed as "endangered."

The Endangered Species Act of 1973 provides protection for endangered species and requires that plans be prepared for the recovery of these species. Over many years, federal and state agencies, as well as interested organizations, conducted studies, held public hearings, and conducted opinion polls to help assess which recovery strategies would have the best chance of success. In 1987, the USFWS approved the Rocky Mountain Wolf Recovery Plan that designated three official recovery areas in the northern Rocky Mountains. These areas were in northwestern Montana (including Glacier National Park and the Bob Marshall Wilderness); central Idaho (the Selway-Bitterroot and Frank Church River of No Return Wilderness Area); and the Yellowstone ecosystem (including Yellowstone National Park and surrounding areas in Montana, Idaho and Wyoming).

During the early 1980s, wolves naturally began to recolonize in northwestern Montana, dispersing south from Canada. By 1994, approximately 64 wolves were in Montana, forming five packs. As a result, plans for wolf reintroduction centered on central Idaho and Yellowstone National Park. In 1994, final plans were made for the reintroduction. And between 1995 and 1996, 66 wolves were brought to the United States from Canada. Thirty-one were reintroduced into Yellowstone National Park, and 35 were reintroduced into central Idaho.

The reintroduction of wolves into the northwest has been very controversial. Wildlife biologists, environmental organizations, and many individuals applaud the return of wolves as a step in restoring the natural balance in the ecosystem. Chambers of Commerce, shopkeepers, and entrepreneurs view the wolves as a way to attract tourists to the areas and increase profits.

In contrast, agriculture and some hunting and outfitting interests feel the introduction of wolves will affect their ability to make a living. Some are concerned that there will be timber harvest restrictions where wolves have been reintroduced. Some hunters are worried that wolves will reduce opportunities for big game hunting. Sheep and cattle ranchers fear wolves will prey on livestock, thereby affecting their livelihoods. Wolves can and sometimes do prey on livestock. However, not all wolves do, even those near livestock. Wolves that do prey on livestock tend to continue to do so and may teach their pups to do so as well. Some people have expressed safety concerns as they enjoy outdoor recreation in areas where there are wolves even though there are no documented attacks on humans in North America.

Before reintroducing wolves, the USFWS examined several options or alternatives: (1) reintroduce wolves with the wolves classified as "experimental populations", (2) take no action—allow wolves to naturally expand into Idaho and Yellowstone, (3) change laws and prevent wolf recovery, (4) establish legislation for states to implement wolf recovery with no federal oversight, and (5) reintroduce with wolves classified as endangered.

In an effort to address the concerns of local citizens, the reintroduced wolves in Yellowstone and central Idaho were designated "nonessential experimental" populations under the Endangered Species Act. This classification allows more involvement on the state level, broader flexibility in managing individual wolves and the pack, and the use of management options that would not be permitted if the populations were classified as endangered. Should the wolves pose a threat to livestock, pets, or property, problem or nuisance wolves can be relocated or, if necessary, killed by designated personnel. In addition, when the wolf is classified as an "experimental" population, private landowners can injure or kill a wolf if it is caught in the act of wounding or killing livestock on private land.

Amid all of the publicity, issues, and controversies, wolves are returning to North America. The gray wolf populations in Montana, Yellowstone National Park, and central Idaho continue to grow and the eastern timber wolf populations in Minnesota continue to thrive. In the early 1990s, red wolves,* a smaller wolf species, were reintroduced into selected wild areas in North Carolina, Florida, and Tennessee. And in 1998, several family groups of the Mexican wolf, a subspecies of the gray wolf, were released in the wilds along the Arizona–New Mexico border. Now, there are some environmental groups examining the possibilities of restoring wolves to areas in the northeastern United States and southwestern Colorado.

* Most scientists classify the red wolf as a distinct species of wolf. Others describe it as another subspecies of the gray wolf.

continued

Issue Analysis Sheet

Species____ Date______________________

Team Members:____

A. Natural History Information

Preferred habitat:

Food:

Historic range:

Current range:

Current status:

B. Decline and Recovery

Major reason(s) for the decline of this species:

Events, changes, or laws that occurred to enable recovery:

C. Issues/Conflicts

Identify and record existing or potential issues or conflicts associated with the recovery of this species. Then identify all potential interested groups, individuals, or organizations. Identify their views or opinions about the recovery of the species. Consider their reasons or motivations for these views.

Issue:

<u>Interest Groups</u> | <u>View or Opinion</u> | <u>Reasons/Motivation</u>

Issue:

<u>Interest Groups</u> | <u>View or Opinion</u> | <u>Reasons/Motivation</u>

Issue:

<u>Interest Groups</u> | <u>View or Opinion</u> | <u>Reasons/Motivation</u>

D. Issue or Conflict Resolution

1. What measures or strategies have been taken to resolve these issues? Do you agree with them? Why or why not?

Strategy	*Issue It Addresses*	*Agree Yes/No*	*Explain*

2. What are your recommendations to help resolve the issue or conflicts?

Recommended Strategy	*Issue It Addresses*

Bird Song Survey

Objective

Students will identify and describe the importance of bird counting as one means of inventorying wildlife populations.

Method

Students investigate an area and use bird-counting techniques.

Materials

Paper and pencil for note-taking, bird books as reference materials, drawing paper or magazine photos to illustrate final written project; OPTIONAL: binoculars, tapes of bird-call recordings, and battery-operated player

Grade Level: 9–12

Subject Areas: Environmental Education, Science

Duration: minimum of three 45-minute sessions, not including transportation to bird inventory site

Group Size: up to 30, with need to break into smaller groups for bird watching

Setting: outdoors

Conceptual Framework Topic Reference: WMIIIA, WMIIIB1

Key Terms: inventory, population, management, habitat

Appendices: Outdoors, Field Ethics, Animals in the Classroom

Background

People interested in wildlife and its habitat use many techniques to learn and assist in the management for conservation and protection of wildlife. Some techniques are used to acquire information and some to apply knowledge. Inventory is a technique that is used to acquire information about the number and kinds of wildlife in a given area.

This activity is designed to give students some experience in the use of inventory. Birds are the subject of study. The variety of species and the number of individual birds in an area are good indicators of the quality of that particular environment. Their presence indicates food, water, shelter, and space in an appropriate arrangement to suit their needs. Bird watching can be a valuable research tool, as well as an aesthetically pleasing activity that brings the student into touch with intangible values.

One means of identifying a bird species is by sight; another is by sound or song. Male birds of most species sing from conspicuous perches to mark territory, except during the nesting period. With practice, identification of many bird songs can be easily learned.

Procedure

NOTE: This can be an annual project or a one-time project during a single school year. Students who participate in a multiyear project can be contributing to a meaningful record of the natural history of their area.

1. Establish a suitable tract of land and an optimal season for conducting this activity. Check to find out in which time of year, in your area, there would be the greatest variety and number of birds. (Members of the National Audubon Society or the state nongame wildlife program may be able to assist with this information.) Find an area that is most likely to offer many habitats and thus is more likely to offer variety in birds as well. Transi-tion areas between differing ecosystems—like ponds, woods, and meadow areas—are apt to be good locations. Watering sites in desert areas and city sites with vegetation and water are other good locations. If the students are assisting in identifying the most suitable site, remind them of the basic habitat needs of animals, including birds: food, water, shelter, and space in an appropriate arrangement. They can use these components as working criteria.
2. Invite a member or members of a local bird club (e.g., affiliate chapter of the National Audubon Society) to instruct the class in field study techniques for bird watching. These people can help the class determine what bird species are common to the area, which are most easily identified or most difficult to spot, what precautions to take in order not to disturb the birds or other wildlife in the area to be studied, and so forth. As part of their preparation for their guests from the local bird club, ask students to bring in bird guides from home, school, local libraries, or natural history museums.
3. Try to obtain recordings of bird songs of selected species. Practice identifying the birds by their songs.
4. Now it is time to visit the site to apply the knowledge and skills the students have been working to acquire. Select a trail, path, or road to walk in the area that has an easily discernible starting and ending point. If possible, the students should walk the trail in the early morning, using techniques they were taught by the bird club members in making and recording their observations. Ideally, members of the bird club, parents, or other community members can come along to assist as well. OPTIONAL: Take along the recorded tapes of bird songs with a battery-operated recorder. This reference "in the field" is a big help in identification.
5. Repeat the inventory one or more times that morning to try to account for all breeding pairs. The number of singing males identified on each walk should be consistent.
6. Once back in class, have the students compile the results of their observations. Map the site and mark the locations of bird sightings (e.g., using colored dots for birds—with an explanatory key). Encourage the students to discuss their observations as well as the feelings they experienced in the process of watching the birds. Also talk about any difficulties they feel they might have experienced in getting an accurate count.
7. As an option—a small group of students might volunteer to compile all the findings in a written format, including magazine photos, sketches of the birds, or other items. This booklet could serve as the beginning of a year-to-year record of the inventory of birds in that location at that time of year, and it could be used by students conducting this project in subsequent years. As a new group of students repeats the inventory each year, the results could be graphed, showing year-to-year changes, if any. Trends could be analyzed, and so on. Additional information can be included in this report format, including a map of the area selected for the inventory with the trail and other notable landmarks identified.

continued

Extensions and Variations

1. In a single school year, conduct several counts throughout the migration period, checking to see what happens in the area selected. Take counts seasonally, noticing similarities and differences.
2. One or two singing male birds could be followed closely to determine the size of their respective territories. Be sure that students are following rather than chasing the bird. This variant could be a mapping and mathematics project, using geometry to calculate the area of the bird's territory. Map each location where the bird perches to sing his song, and try to determine where he comes into conflict with a neighboring, singing male.
3. Compare the class results with those of statistical count experts, if such research data are available.
4. Send for inventory techniques, counts, trends, and management implications for other species of animals from the state wildlife agency or other source. Make comparisons with class techniques and data.

CAUTION: Do not disturb the birds; make sure not to disrupt mating, nest-building, and nesting activities. Check with local authorities (e.g., the bird club members, state wildlife personnel) for precautions.

Evaluation

1. Summarize the findings from your study. Why is it important to be able to inventory wildlife populations?
2. Design a wildlife survey plan for conducting a butterfly inventory.
3. Use the Visual Vocabulary evaluation technique (see "Evaluating and Assessing Student Learning" in the Appendices) to either review or assess students on new concepts and terms introduced in this activity.

Wildlife Research

Objectives

Students will (1) identify reasons for research related to wildlife, (2) evaluate appropriate kinds of research related to wildlife, and (3) design and conduct a wildlife research project.

Method

Students evaluate types of research involving wildlife, apply their results to develop individual research proposals that meet criteria for appropriateness, and conduct research.

Materials

Writing materials; possible need for access to reference materials; observation tools such as video cameras, sketch books, and hand lenses

Grade Level: 9–12

Subject Areas: Environmental Education, Science

Duration: three to five 45-minute sessions, plus additional time for designing and writing

Group Size: any, whole class working individually or in small groups

Setting: indoors

Conceptual Framework Topic Reference: WMIII, WMIIIA, WMIIIA1

Key Terms: research, ethics

Appendices: Field Ethics, Outdoors, Using Local Resources, Animals in the Classroom

Background

Research, by definition, represents a quest for knowledge. It typically involves careful, systematic study and investigation. It does not necessarily involve intervention or experimentation; it may be entirely based on observation and other data-gathering techniques.

One area of scientific research involves the study of wildlife. Such research may be conducted in field or in laboratory settings. Research may involve wildlife directly, indirectly, or both. For example, it may focus directly on wildlife species, or indirectly on either habitats or societal factors such as attitudes, beliefs, and values.

Wildlife research may have a variety of purposes, including (1) to acquire knowledge specific to the animal under study (e.g., field research to identify food and cover needs, disease problems, and adaptability of transplanted bighorn sheep; and (2) to acquire knowledge specific to human activities that influence wildlife (e.g., potential impacts of a proposed land development on species of wildlife in an area).

Study of conditions affecting wildlife can be important to people as well as to the animals and for environments. However, there is controversy about what is ethical research involving animals. For example, questions of ethics may arise if research procedures involve activities that may harm or cause discomfort to individual animals in the process of acquiring information during the research.

The major purpose of this activity is for students to identify reasons for research related to wildlife and, through designing a possible research proposal, to consider what seem appropriate and inappropriate kinds of research and research practices.

Procedure

1. Brainstorm with your students a list of possible reasons to do research about or involving wildlife, directly or indirectly.
2. Discuss what seems to be reasonable, acceptable, and appropriate research and what does not.
3. Ask students to classify the kinds of research as acceptable or unacceptable, then to give their reasons for these classifications. Following this personal evaluation, ask them—as a group—to develop a set of criteria for acceptable and appropriate research.

OPTIONAL: Before they categorize and evaluate the various types of research, ask the students to do some library work to find additional information on the topic. A few students could be asked to place phone calls or write letters for additional information. For example, local agencies or organizations that might conduct research related to wildlife could be contacted to find out what kinds of research they conduct and what methods they use. Other agencies or organizations that oppose research involving wildlife could also be contacted for information. Review the questions the students will ask before they place their calls or send their letters to ensure the clarity of the request and to coordinate the inquiries, thus avoiding duplication of effort. If such contacts are made, ask the students to report back to the rest of the class.

4. Ask each student team to design and write a "Proposal to Conduct Research." The plan must follow good scientific methodology, take place on the school grounds or other approved site, and follow the class determined ethical guidelines developed in step 3. A proposal might be a behavioral study (e.g., students observe how house sparrows foraging for food respond to adjacent human activity). Their study might involve census work (e.g., how many ant colonies exist on the school site and what number of different species of ants is represented). The research project does not need to involve wildlife directly but, for example, could involve a survey of people's attitudes concerning wildlife. Such a research project could explore whether students think spiders serve any useful purpose on the school site. If the project directly involves wildlife, have the students become familiar with and incorporate the "Guidelines for Responsible Use of Animals in the Classroom" (see the Appendices) into their plan.
5. Evaluate each proposal to determine whether it follows good scientific procedures and to ensure that the plan is realistic. Students must be able to complete the research in the allotted time with the available resources.
6. After approval of the project, students conduct their research. They should compile their results and, if possible, draw conclusions. Their data may not support any conclusions; therefore, it is important for students to learn not to extend their conclusions beyond what their data support. Students can identify areas for further study and, if time permits, conduct some of those studies.

Evaluation

Suppose you are the director of a wildlife-research institute. You receive a letter from a fourth-grade student asking what your institute does and why it is important to the community. Write a letter in response.

Dropping in on Deer

Objectives

Students will (1) describe how habitat surveys provide important baseline information to guide management decisions; (2) apply field methodologies reflecting wildlife management practices developed through an understanding of species biology and ecosystem structure; and (3) explain the importance of scientific knowledge and technical skills in the conservation, limitation, preservation, and enhancement of wildlife and its habitat.

Method

Students estimate population density of deer in a given area by counting deer pellet groups.

Materials

Colored survey tape or wire survey flags, rope or string, stakes or dowel rods, measuring tape, compasses, clip boards and writing utensils, Pellet Group Counter Worksheets (one for each group of four students) on page 425; OPTIONAL: dry dog food nuggets

Grade Level: 9–12

Subject Areas: Environmental Education, Science, Mathematics

Duration: three sessions and one field trip

Group Size: groups of four students

Setting: outdoors

Conceptual Framework Topic References: WMIB, WMIII, WMIIIA, WMIIIA1, WMIIIB1

Key Terms: inventory, fecal pellets, scat, plot

Appendices: Field Ethics, Observations and Inferences

Background

One component of a wildlife biologist's job is to gather information about local animals and plants so that appropriate decisions can be made for their management. Deer populations are a concern in many areas where the numbers of deer are increasing. (For more information in issues related to deer populations, see the Project WILD activity "Deer Dilemma.") Assessing the size of the population is essential to any management strategy. How does a wildlife biologist know the size of the deer population in an area? Biologists use a variety of survey tools to gather information about the number of deer in a certain area at a certain time. This process is known as an inventory or census. "Density count" is another term biologists use to describe how many deer they find in a known area. One commonly used method of gathering these data is the aerial survey. A helicopter or airplane flies low over places where deer are known to reside, and the deer are counted and photographed. This technique is a "visual count," or direct accounting of what is seen on a given range.

Aerial surveys have limits in that deer may hide in the cover of trees and shrubs and may go uncounted. These surveys may be used for small areas, but they have limited application on a statewide scale. Consequently, other methods are also used to determine populations. Deer can be captured and released, a costly and time-consuming process. Deer killed through hunting can be monitored. Many states use computer models that estimate population size on the basis of known reproduction and mortality factors. One successful alternative is the strip census, or line transect, which provides a sample of what exists in a larger area. Pellet group (deer fecal material) counts are one example of a line transect.

Pellet group counts monitor population not by sighting the animal, but by tallying signs the deer leaves behind. This method gives an accurate accounting of animal use of an area of land. Because deer defecate frequently (approximately 12 times per day), pellet group counts are a useful way to evaluate the number of deer in a predetermined area—even if the deer themselves are not visible. How many deer are healthy for a given area depends on the quality of the habitat. If the habitat is over-browsed, then the number of deer that is indicated by the pellet count is too many. The biologist would keep records of pellet group counts for the over-populated area over time to monitor the progress of management strategies. In "Dropping in on Deer," students will conduct a pellet group count, assessing deer activity on a measured plot. They will use similar methods to those used by wildlife biologists.

The purpose of this activity is to demonstrate that management practices use ecosystem research methodologies. Surveys of wildlife populations and their habitat provide important baseline information that guides management decisions.

Pre-Field Trip Preparation

NOTE: If a deer habitat is not available, this survey technique can also be simulated using small piles of dry dog food nuggets in place of the deer pellet groups.

1. It is important to scout the area to be used in advance. Finding places to successfully survey for deer activity requires previewing the area and is time well spent.
2. Because the students are simulating actions of wildlife biologists, they need to understand what the biologist does and why. Be prepared to discuss this subject.
3. Students should be familiar with deer physiology and functions so they appreciate the pellet count activity as a real learning tool. Be sure the students understand that each deer will leave behind approximately 12 pellet groups per day.
4. Tool preparation can be done with or without the students. Begin by tying the rope or string to a dowel or stake. After that is complete, measure 11′ 9″ of rope, and cut it. One rope and stake is needed for every four students.

NOTE: A circle with a radius of 11′ 9″ has an area of 1/100 (or 0.01) of an acre.

5. Consider enlisting some parents or adult volunteers to join the class on the field trip. An ideal ratio is one adult for every eight students.
6. Set up a "test plot" before the field trip. Search for litter, insects, or tiny hidden treasures in place of the deer pellets. This activity can be conducted in many habitat types to practice finding pellets in tall grass, brush, and so on. The class will work much more quickly having practiced the survey in advance.

Procedure

1. Explain to the students that wildlife biologists use many survey methods to assess the size and health of the deer population. One method is the pellet group count. The results of the survey help biologists decide how to improve habitat for deer or how many permits to issue for hunting. When doing a deer study, wildlife biologists first must establish an area to be studied. The site is inspected for deer droppings. In some cases, the pellet groups are removed from the survey plots so that only "fresh" use of the site will be recorded. The biologist then returns later and counts the new pellet groups that have been deposited. This technique eliminates the need to guess the "age" of each pellet group, and the information is more accurate. In most cases, however, the biologist saves time by simply estimating the age of the pellet groups during the survey. Students will use this latter approach. Pellets will be observed and recorded only. No animal droppings will be touched or contacted in any way.
2. Review the following ground rules before the students begin their surveys.

continued

- Do not touch or pick up any deer pellets or other animal droppings.
- Avoid wandering over the plot and trampling evidence before the survey begins.
- Be careful in your observations, and record information for each pellet group before moving on.

3. Divide the class into groups of four students. Each group will investigate several circular plots for deer pellets. Discuss exactly what the students will be doing before they begin their surveys. Find some recent and old deer droppings. Show them to the students, noting the characteristics that distinguish the two types.

4. Set up and examine the plots.

   a. Have the students disperse over the study area and randomly select the center point of their first plot. The more random the selection, the more accurate the information will be. (If students select just the sites with the most pellet groups, the estimate will be higher than the actual number of deer in the area.) Number the plots. At the site, have students note the condition of foliage near the ground and up to approximately 6 feet high. Is vegetation plentiful or sparse?

   b. One group member should push the stake into the ground until it can stand securely on its own. If the stake will not stand on its own or if the ground is too hard, then that student should stand with the stake to keep it in place during plot measurements. The stake should stay put from this point on, because it is the center of the area to be studied. The student holding the stake also can record data as it is collected.

   c. Have one student stretch the rope out its entire length and mark the outermost point with a rock or something similar. This is the starting point of the transect. (See Diagram A.)

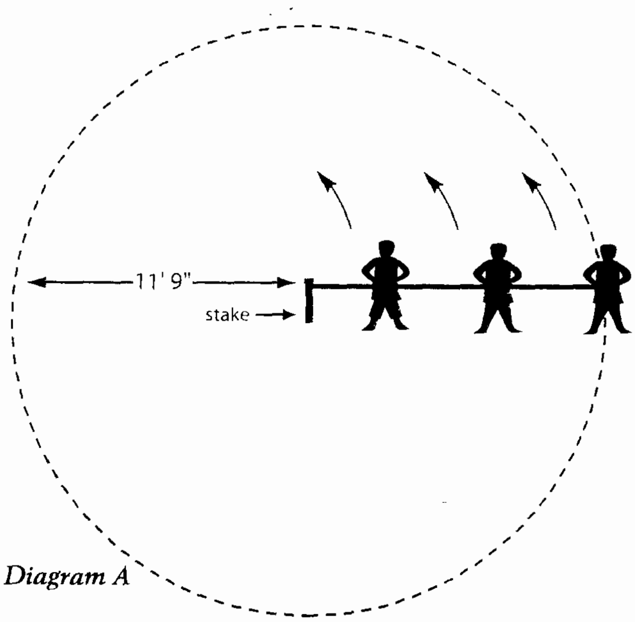


Diagram A

   d. Instruct the remaining students to position themselves evenly along the rope, all facing the same direction.

   e. Have the students walk slowly in a circle, keeping the rope taunt as they move the rope and search the ground for pellet groups.

   f. When a pellet group is encountered, have the students stop and examine it. As a rule, count a pellet group if at least half of the pellet group lies within the circle. If most of the pellets are beyond the end of the rope, the pellet group should not be counted as part of that plot. Determine if the pellets are recent (within a few months). If they are dry and cracked, they are not recent and should not be counted.

   g. On the Pellet Group Counter Worksheet, record each recent pellet group by placing a tally mark in the Number of Recent Pellet Groups per Plot column next to the plot number. The presence of old pellet groups should be noted in the right-most column of the worksheet. Also record in the far right column any evidence of other animals.

h. When the group completes the circle and students are back at the beginning marker, have the students total the number of recent pellet groups within the plot and record that number on the worksheet. Circle the total for each plot.

i. Move to a second randomly selected spot and repeat the process.

j. Depending on time, each group of students should attempt to complete 10 plots.

5. Calculate the findings. (This procedure can be done in the field or in the classroom.)

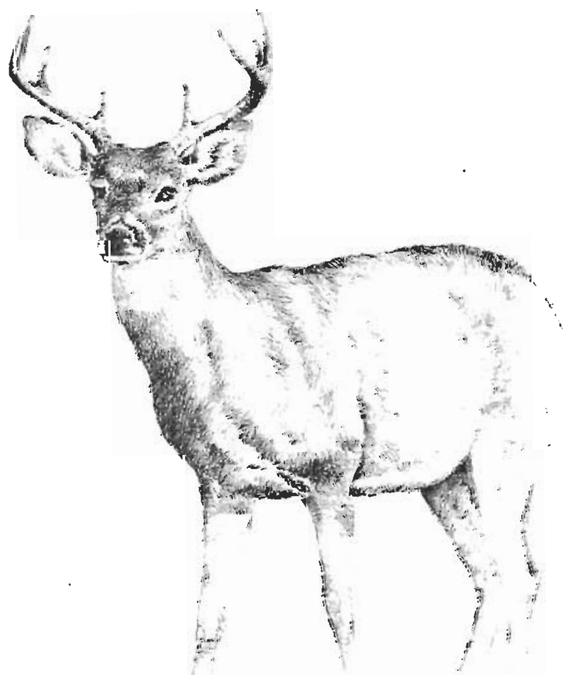
a. Have the students follow the procedures at the bottom of the Pellet Group Counter Worksheet to estimate the number of deer in the study area.

b. Compare the estimates from each group, and see how close their numbers are.

c. Total all the plots in the entire class, and determine a class estimate of the deer population.

6. Prepare to discuss the findings with the class as a whole.

- Did the students' estimate of the deer population make sense? If it didn't, discuss what might have affected the results.
- Would the results be different at a different time of year? Why or why not?
- Were there only groups of old pellets or only fresh ones? What does that mean?
- Were some plots or parts of plots filled with more pellet groups than others? What might that mean about the forage or terrain? The carrying capacity for deer in an area varies with the quality of the habitat. Keeping in mind the amount of near-ground vegetation, decide what the number of deer pellets tells you about the quality of the habitat at the site.
- Ask students how this information is useful in guiding wildlife management decisions.



continued

- What wildlife management decisions could they make based on the information they have?
- What additional information would they like to have? To determine if the number of deer is appropriate for the study area, students may want to conduct one or more of the extensions listed at the end of this activity.
- Why is it important for people who manage wildlife to have scientific knowledge and technical skills? What knowledge and skills do they need?

Extensions

1. Survey the same area over several years to build baseline data and monitor population trends.
2. Survey several types of habitats, and compare density of deer between areas.
3. Research statewide data from natural resource agencies, and compare findings to the data collected from this activity or from these extensions.

Evaluation

1. Have the students compile the findings from their groups and synthesize information in a report to the class. What are the wildlife management implications of the results?
2. Describe how habitat surveys provide important information to guide management decisions. Explain the importance of scientific knowledge and technical skills in the conservation, limitation, preservation, and enhancement of wildlife and its habitat.

Adapted from "Dropping in on Deer." Originally developed by Winston Dines for the Colorado Division of Wildlife.

What to Look for and What to Record

Recognizing deer droppings is not difficult in most settings. Deer defecate in clusters, usually all in one spot. Occasionally, the individual pellets get spread over a distance as the animal moves, but that is not common. Deer also leave droppings near places where they have been feeding. Unlike some animal species, they do not use their feces to mark their territory, nor do they always defecate in one location.

Students need to be aware that both fresh and older deer droppings may occur within their plot. Other types of scat (droppings) may be present as well. The only scat that can be confused with deer is that of elk and rabbit. Elk pellets resemble deer pellets in the clusters that occur, but the overall pellet size is larger. Rabbit droppings are found more randomly and widely scattered. Because rabbits produce one dropping at a time, clusters of pellets occur less often. The shape of rabbit pellets is spherical, and they are much lighter in color than deer pellets.

Condition of Droppings

RECENT (within 6 months)	dark brown to brown in color; shiny or smooth in texture; some speckles of plant fibers may be visible
OLD (more than 6 months)	exterior very dry and cracked; light brown to yellow in color; many plant fibers visible

Pellet Group Counter Worksheet

Directions: On each of your circle plots, look carefully at the ground for groups of deer pellets. Each time you notice one, inspect it and estimate its age. Record the number of recent pellet groups in each plot below. Then use the equations to estimate the population. Record other observations in the right-hand column, including old pellet groups and evidence of other animals.

Pellet Group Plot Number	**Number of Recent Pellets Groups per Plot**	**Other Observations** (other animal signs)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total		

Calculations:

A. $\frac{\text{total \# pellet groups}}{\text{\# total plots}} \times \frac{\text{100 plots}}{\text{acre}} =$ # pellet groups per acre

B. $\frac{\text{\# pellet groups per acre}}{\text{12 pellet groups per deer per day}} =$ # deer days/acre

C. # deer days/acre × # acres in study area = # of deer days in study area

D. # deer days ÷ 180 days = **number of deer living in the study area.**

NOTE: Because only recent (within 6 months) pellet groups are counted, 180 days or 6 months is used (in calculation D). Please be aware that pellets decompose much faster in areas of high humidity. In order to determine a decomposition rate specific to your area for use in calculations, please contact your state wildlife agency. If you find pellets last three months (approximately 90 days), replace "180" with "90" in calculation D.

Playing Lightly on the Earth

Objectives

Students will (1) distinguish between games that are damaging and not damaging to the environment, and (2) invent games with a benign effect on the environment.

Method

Students look for evidence of games that harm the environment and then invent and play games with a benign effect on the environment.

Materials

None

Background

Personal choices of all kinds can have an effect on the environment. Students can look at the games they play outside and can choose those that have little or no damaging effect on the environment, rather than those that leave scars—aesthetically and ecologically.

Grade Level: Pre-K, K–4

Subject Areas: Environmental Education, Science, Expressive Arts

Duration: one 30- to 45-minute session

Group Size: any

Setting: outdoors

Conceptual Framework Topic Reference: RAIC1, RA1C2

Key Terms: game, harm

Appendices: Outdoors

The major purpose of this activity is for students to become aware of the choices they make each time they play a game outside and to consciously experience games that have a benign effect on the environment. The activity is designed for students to experience success at a personal and immediate level in maintaining and improving the quality of their own environments.

Procedure

1. Ask the students to think of examples of ways to play outside that do not cause serious or permanent damage to the environment and of ways that are damaging. The damage might affect nonliving things such as putting graffiti on cement walls. It might be damaging to plants and animals such as carving initials on tree trunks. Are there any games that do no damage? There may not be, but we can think about how much damage is done, how permanent it is, and what it affects.
2. Go outside and look for evidence of games that have damaged the environment. Ask students what could have caused the damage and how it might have been prevented.
3. Introduce the concept of playing games that do not seriously harm the environment.

4. Ask the students to work together in small groups—from two to seven or eight—to invent a game that does no serious harm to the environment, including plants and animals. The students could also try to invent games that could make this a better environment in some ways. Give the students about 15 minutes to invent their games.

5. Ask each group to present its game to the other students. Play each of the games. Ask the students to talk about their feelings about the importance of playing games that do little if any damage to the environment.

Extensions

Analyze various kinds of recreation for their impact on wildlife, vegetation, or other natural resources.

Evaluation

1. Keep a record of the games played outside for 1 week. Identify which, if any, are harmful to the environment. For 1 week or longer, play only games that do no harm to the environment.

2. Invent a game for younger children that does not harm the environment. Teach it to a younger child or group of children. Explain what the younger child or children learned about care for the environment.

Litter We Know

Objectives

Students will (1) identify and evaluate ways that litter pollution can endanger wildlife, and (2) propose ways to help eliminate these dangers to humans and wildlife.

Method

Students collect and evaluate litter, making collages.

Materials

Large sheets of poster board for mounting collages, glue, different types of litter collected, work gloves, trash bags

Background

Litter can be very harmful to wildlife that comes in contact with it. Discarded fishing line can trap the legs, wings, or beaks of waterfowl such as geese and herons. When the fishing line wraps around its beak, a bird cannot feed itself. If the bird's wings become tangled, then it cannot fly or swim.

Fish, birds, and other animals may also get trapped into the loop portions of plastic six-pack can holders. Many times animals will become trapped in the loops and then cannot feed themselves. If the animals get the loops tangled around their feet, they will not be able to escape from predators.

Broken glass from bottles and other glass objects can injure people, pets, and wildlife. Half-open cans also can be a problem for some animals. Smaller animals in search of food often get their heads stuck inside such cans and jars. Plastic items and bottle caps may be eaten by wildlife, including fish, thus injuring or killing them. Cigarette butts, cellophane wrappers, and polyurethane cups, when eaten by deer and other wildlife, can cause internal problems.

In some cases, animals have learned to take advantage of litter. Animals will come into urban areas or areas with discarded food to feed on the litter and garbage. This intrusion puts the animals and humans in danger.

Much of the waste that is thrown away can be reused or recycled. Improvements in product packaging can help reduce unnecessary waste, and proper disposal methods can help eliminate potential dangers to wildlife.

Contact your state wildlife agency, or other state agencies, for additional information about problems resulting from litter. Local cleanup campaigns, recycling organizations, and animal welfare organizations may also be able to assist you in considering alternatives for reducing litter problems.

Grade Level: 5–8

Subject Areas: Social Studies, Expressive Arts, Environmental Education

Duration: minimum of one 45-minute session

Group Size: small teams of three to five students

Setting: indoors and outdoors

Conceptual Framework Topic Reference: RAIC1, RAIC2

Key Terms: litter, pollution

Appendices: Outdoors, Using Local Resources, Early Childhood

Procedure

1. Divide the class into three or four groups.
2. Ask each group to bring a collection of litter to class in a paper bag. Suggest the students look in parks, camping areas, school grounds, or any other area where they will have permission to collect trash. Advise students to wear work gloves. Caution them about hazards such as broken glass and medical wastes.

NOTE: They should not take things out of garbage cans.

3. Have the groups make and display collages of these items.
4. Discuss the effects of litter. OPTIONAL: Ask a wildlife specialist to join the class for the discussion. If available, show a film or read brochures on the subject.
5. Ask the students to assign a numerical value to each kind of litter. The item potentially most harmful to wildlife has the highest score; the least harmful has the lowest score.
6. Have each group figure a total score for the collage using the numerical values of each piece of litter.
7. Propose and evaluate ways that people can eliminate litter pollution. For example, can manufacturers devise another method of packaging six-packs? Could companies produce plastic six-pack holders that would deteriorate? How could people fishing have more control over losing their fishing line? How can individuals be instructed about the dangers as well as the unsightliness of littering? What progress has been made in recent years? What actions still are needed? What can students do personally—as individuals, as groups, and as family units—to eliminate or reduce their own litter?

Extensions

1. Research local and state laws regarding recycling. Determine how those laws affect wildlife.
2. Is there a litter cleanup program in your community? If yes, learn more about it. If not, find out why not.

Aquatic Extensions

1. Focus specifically on litter that can be potentially harmful to aquatic wildlife.
2. Consider what happens to garbage that is dumped into the ocean. Where off the coast of the United States is this done? What towns and cities contribute to this ocean dumping? Where does the garbage go? How are coastal towns affected by this? How is wildlife affected by this? When considering the impact on wildlife, think about any possible effects on the wildlife's food, water, shelter, and space. Are there regulations affecting the dumping of garbage into the seas? If so, are they enforced?
3. Plan a "Volunteers for Wildlife" cleanup program.

Evaluation

1. Identify four ways that litter can harm wildlife.
2. Identify three things people can do to lessen the effects of litter on wildlife.
3. Propose what you consider to be one of the most effective ways to eliminate or reduce litter. Explain why you think this proposal would be effective.

Improving Wildlife Habitat in the Community

Objectives

Students will (1) apply their knowledge of wildlife by describing essential components of habitat in an arrangement appropriate for the wildlife, and (2) evaluate compatible and incompatible uses of an area by people and specified kinds of wildlife.

Method

Students design and accomplish a project to improve wildlife habitat in their community.

Materials

Writing and drawing materials; poster or butcher paper; or model making materials, such as plaster, clay, small replicas of animals, and so forth

Grade Level: 5–8

Subject Areas: Social Studies, Environmental Education

Duration: one or two 45-minute sessions, if hypothetical; much more time, if project is to be implemented

Group Size: any

Setting: indoors (and outdoors, optional)

Conceptual Framework Topic Reference: RAIC3

Key Terms: habitat, improvement

Appendices: Taking Action, Using Local Resources

Background

This activity provides an opportunity for students to evaluate and apply much of what they have learned about wildlife and its needs.

The major purpose of this activity is to provide students with experience in looking at their own communities, applying knowledge and skills they have acquired, and evaluating and experiencing the possibilities of enhancing their communities as places within which both people and wildlife can live suitably.

See the "Taking Action" Appendix beginning on page 487 for additional tips on involving students in environmental action projects.

Procedure

1. Ask the students whether their community could benefit from improved areas for wildlife habitat. If yes, this activity provides a process for helping to make such improvements. If a need is identified, the scope of such a project is a major decision. Habitat improvement projects can be large or small. If a project from this activity actually will be implemented, remember these points:
   - It needs to be within the scope and means of the students to experience success with it.
   - It clearly should be of benefit to wildlife and the community.

2. After general discussion, ask the group to divide into teams of four or five. Give each team the task of beginning a design for a habitat improvement project. The project could involve native plants and animals and could make a contribution to the community. Provide time for the students to discuss and make decisions about the following:
   - What is the purpose of the project?
   - Whom will it serve? Will people be able to visit? Will it be for plants and animals only? What plants and what animals? If people can visit, what will they be allowed to do? What won't they be allowed to do?
   - What positive contributions might this improved wildlife habitat area make to the community? What possible problems could arise, if any?
   - What will you need to accomplish the project? Where will you get the materials or services? What will it cost? How will it be paid for?
   - Where will the area be? How large will it be?
   - What are the habitat needs of any animals who will live there? What species of animals can live in the area that is available? (Some animals need more room than others. If you are to have a self-sustaining system, you will need a population in an area large enough for successful breeding over time.)
   - What herbivores and carnivores might be needed? Predators? Prey? What specific kinds of plants (herbs, shrubs, trees, grasses, etc.) are needed and in what arrangement?
   - What will be the water sources? How will air and water quality be maintained?
   - What kinds of programs, if any, will be necessary to maintain the area once it has been improved?
   - Who must be contacted so this project can be undertaken? What permissions will be needed? From whom?
   - In balance, is the project a good idea—for the wildlife, the environment, and the people who live in this community?

OPTIONAL: Make a site visit.

3. Ask the groups to prepare the following: (a) a written description of their habitat improvement project, including its location, characteristics, inhabitants, and purposes; and (b) a map or scale model of the area. The map or model can include
   - habitat components for various species;
   - wildlife living in the area, in their appropriate locations;
   - bodies of water, natural or made by people;
   - major areas of vegetation and a key as to type;
   - major landmarks (e.g., rock outcropping, roosts for birds, bare ground, meadows, brush, low trees, high trees);
   - major food sources and types (e.g., berry patch for birds, rodents for coyotes or birds of prey); and
   - areas developed for human access.
4. Ask each team to display its plans. After all the students have had an opportunity to read the background information and see the map or model of each habitat improvement project, ask the students to talk about what they learned in the process of creating these designs. They can include discussion of problems they encountered, what seemed realistic, what did not, and so forth. In discussion—and using their observations of the various proposed projects—ask the students to summarize what seemed to be the most important things to remember about designing such an area (e.g., size appropriate to wildlife, diversity, native elements, appropriateness to community wants and needs).

continued

Extensions

1. Consider the feasibility of designing and implementing one or more of these projects for your community. Have a local wildlife specialist and appropriate local officials (landowners, zoning authorities) critique and cooperate with you on any proposed project before you get under way with it. Make sure the project is worthy, feasible, and legal—and then proceed!
2. Tie your habitat improvement project into an existing network of habitat improvement projects. Contact your local wildlife or State Project WILD Coordinator and find out if any adopt-a-stream, backyard habitat, or school site habitat improvement programs are taking place in your area. If there are none, the Project WILD Coordinator may be able to refer you to a national program that could provide you and your students with ideas and assistance.

Aquatic Extension

Choose a habitat improvement project directly related to aquatic wildlife and aquatic habitats.

Evaluation

1. Rate the following uses of an area as either compatible or incompatible for people and wildlife:
   - houses being built 200 feet from a heron rookery,
   - picnic tables set up in an area heavily populated by squirrels,
   - snowmobile trails through a deciduous forest, and
   - swimming beach at a local lake.

   Think of your own examples. What could be done to make each of these uses more compatible for both people and wildlife?
2. Draw a picture or a blueprint of a community in which people have taken actions to improve the environment for both people and wildlife. Explain some of the features of the plan. Compare similarities and differences between the plan and the characteristics of your own community.

Enviro-Ethics

Objectives

Students will (1) distinguish between actions that are harmful and beneficial to the environment, and (2) evaluate the appropriateness and feasibility of making changes in their own behaviors related to the environment.

Method

Students develop and use a "Personal Code of Environmental Ethics."

Materials

None

Background

Ethics are derived from our guiding moral principles. They are influenced by age, gender, culture, family, and religion. Between the ages of 10 and 18, many people go through profound moral growth. During that time, they typically not only develop the mental reasoning abilities to grapple with moral issues, but also find themselves in more and more situations in which they have to make their own decisions. Ethics extend into many areas, including how people treat wildlife and the rest of the environment.

As students become more informed about wildlife and topics associated with the environment, as well as with the range of viewpoints surrounding them, they may experience shifts in their environmental ethics. Superficial understandings probably will lead to superficial ethical decisions. Having accurate information about wildlife and human effects on the environment will tend to help students reach more responsible decisions concerning wildlife and the environment upon which all life depends.

Class discussions related to ethics need to be designed to respect the student's right to privacy and nonparticipation. Educators could review and follow any policies related to teaching about ethics. Many educators have incorporated environmental ethics into drug prevention and other health programs. Developing ethical standards in one area can serve as a bridge to developing them in others.

The major purpose of this activity is to provide students with the encouragement and opportunity to examine personal lifestyles in light of their effects on wildlife and the environment.

Grade Level: 5–8

Subject Areas: Language Arts, Social Studies, Environmental Education

Duration: one or two 30- to 45-minute sessions

Group Size: any

Setting: indoors or outdoors

Conceptual Framework Topic Reference: RAIC2

Key Terms: ethics, responsibility, lifestyle

Appendices: Field Ethics, Animals in the Classroom

Procedure

1. Involve the students in discussion about the effects each of us has on aspects of the environment—from using electricity to make breakfast, to putting on clothes that were derived from some natural resources and transported to us by some means, to use

continued

of the varied products we choose and use each day, to our choices of recreation and entertainment.

2. Have each student identify someone who has done something that benefited wildlife and the environment. It could be someone famous like Theodore Roosevelt or Rachel Carson, or someone who might not be known by very many people at all. Ask about the beliefs or values that selected person holds (or has held) about the environment.
3. Next, ask each student to identify something they have done to help wildlife and the environment that they did not have to do. Ask why they chose to perform that task voluntarily. Talk about what "ethic" or "ethical standard" guided their decision. Explain that complex issues, like most wildlife and other environmental issues, contain a wide range of valid ethical positions.
4. Have the students brainstorm a list of the daily effects each of us has on the environment. This discussion can include our use of water, electricity, and fossil fuels; the effects caused by the production and manufacture of our food and clothing; and the environmental consequences of our recreation and entertainment choices.
5. Discuss how all living things affect the environment. Ask how some human environmental impact is different from the impact caused by oth r living things. Discuss how ethics can influence human effects on wildlife and the environment. Ask how a personal code of environmental ethics might have guided the people who were identified as having done something for wildlife and the rest of the environment. Now ask the students how they think a personal code of environmental ethics might guide them as they make decisions about the daily effects they just listed.
6. Ask each student to work alone to devise a "Personal Code of Environmental Ethics." This code may be written or not. Emphasize the importance of the code's being for the person who creates it. The code may consider daily actions that are harmful to the environment and those that are beneficial. The students could consciously create their code on the basis of actions they believe are beneficial, or at least not harmful, to elements of the environment.
7. Ask for volunteers to share their "Personal Code of Environmental Ethics." They might share the entire code or a segment of it. They might describe the thinking that went into the decisions they made in constructing their code. Students might illustrate a part of their code—if they chose not to write it—to convey a major idea. Encourage the students to ask each other questions about the codes—in the spirit of learning more about each person's priorities, but not in a judgmental approach. The purpose is for each student to evaluate his or her own priorities in a responsible consideration of day-to-day actions that affect the environment without being actively critical of another student's approach to the same problem. In this way, each student simply is encouraged to take responsibility for his or her own actions.
8. Encourage the students to try using their codes, keeping track of how easy or difficult it is for them to live by them. "Progress reports" are appropriate—again in the spirit of each person's paying attention to his or her own actions and bearing responsibility for them.

Extensions and Variations

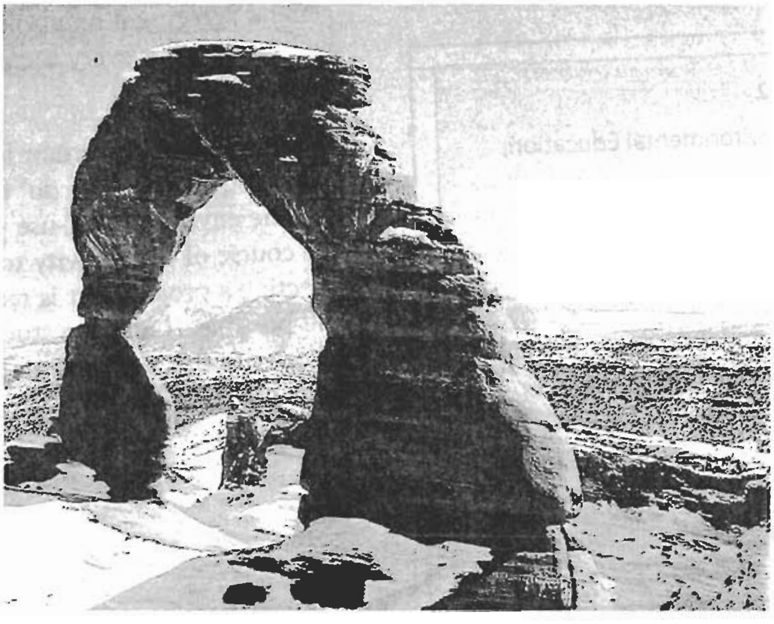
1. Reflect for a few minutes on your daily life. In fact, close your eyes and follow yourself through a typical day. What natural resources do you use? What choices do you make that affect the environment? What choices do you make that affect wildlife and its habitat? What choices do you make that affect other people, here and elsewhere on the planet? If you could, what things—if any—would you change about your daily life in order to have a more beneficial, or less harmful, effect on the environment? What things—if any—do you already do that you think are helpful, or at least not harmful, to the environment? Brainstorm 10 words that come to mind when you think of actions and behaviors you value. Create a sentence, paragraph, or poem that might capture the essence of your own "Personal Code of Environmental Ethics."
2. Develop a "life map." It could include where you want to live; whether you want a family; what kind of home, transportation, food sources, job, or recreation you want; and so forth. Look at the costs and benefits of your choices—for you personally, other people in your community, wildlife, other natural resources, and such.
3. Revisit this activity several times throughout the year. It can serve as a starting point for numerous classroom activities.

NOTE: Students can establish their own or class ethical guidelines for a variety of experiences. For example, students can establish guidelines related to having animals in the classroom, going on field trips, or using electricity and paper in the classroom.

4. Locate and study ethical codes issued by various environmental organizations.

Evaluation

1. Develop a list of five environmental issues.
2. Develop a list of ways that you directly or indirectly contribute to an environmental problem.
3. Identify, describe, and evaluate one way you could lessen your role in contributing to an environmental problem.
4. What changes can you make in your lifestyle that will reduce your role in contributing to an environmental problem?



Can Do!

Objectives

Students will (1) identify a problem involving wildlife in their community, (2) suggest and evaluate alternative means by which to either solve the problem or at least improve the situation, (3) successfully undertake the project, and (4) analyze and describe the process by which they successfully solved the problem or improved the situation.

Method

Students select an environmental project, conduct research, make plans, and follow procedures to accomplish the project.

Materials

Writing materials

Background

Each of us can make constructive contributions to improving the environment in which we live.

Grade Level: 9–12

Subject Areas: Environmental Education, Social Studies

Duration: minimum of three 45-minute sessions

Group Size: any

Setting: outdoors and indoors

Conceptual Framework Topic Reference: RAIC1

Key Terms: problem, authority, compromise, constructive, realistic, effective, alternatives

Appendices: Taking Action, Outdoors

Sometimes our actions can improve the environment for people, sometimes for wildlife, and sometimes for both. Sometimes our effectiveness can be improved if we work with other people—sharing ideas, information, and skills.

A working knowledge of the following terms will be useful to students in this activity:

environmental problem: a difficult situation involving the interaction between people and the environment

environmental issue: a situation in which there is a disagreement about solutions to an environmental problem, often because of differing values and beliefs

authority: an individual or group of people with the power to make changes

compromise: a way to settle a problem in which both "sides" usually give a little

consensus: when a group of people reach a general agreement on a solution (It may not be exactly what every member wants, but what they can agree to.)

Given that it is important for young people to learn that they "can do" for people, wildlife, and the environment—use your judgment in the course of this activity to assist students in selecting a project that is realistic, constructive, and possible. If not, the students may experience an activity that contributes to their thinking that they "can't do."

The major purpose of this activity is to provide students an opportunity to experience success in taking constructive actions to improve the environment for people and wildlife.

NOTE: See "Taking Action" beginning on page 487 for additional tips on involving students in environmental action projects.

Procedure

1. Ask the students to think of ways in which they could improve areas of the community as a home for wildlife. They might generate a list of activities that have a negative effect on wildlife. The list might include litter that poses a hazard for some kinds of wildlife; a muddy area that birds use for water but that has been recommended for paving to minimize dust and mud; a proposed pesticide spraying that will not only kill the "pest" but also perhaps affect other plants and animals; removal of a tree that presently helps contribute to cleaning the air, produces oxygen, and serves as a food and shelter source for varying kinds of wildlife, and so forth.
2. Looking at the list of possible issues and suggestions for ways to improve wildlife habitat at school, ask the students to select one they think they realistically could handle and do something constructive about. If they have difficulty in deciding which one and if reasonable support has been offered for each, the students might vote to decide. In hopes of swaying the class vote, students could also make speeches in support of the project they want to tackle.
3. Once the project has been selected, ask the students to work alone or in small groups to begin to generate ideas for possible solutions to the problems or the issue and to find ways to implement the project. Each individual or small group could come up with a plan, including a written description plus illustrations or sketches of how it will work and how it can be accomplished.
4. Ask the groups to present their plans to the rest of the students. Students may ask questions for clarification. Once all the plans have been presented, ask the students to select the plan that seems most (a) constructive, (b) realistic, (c) helpful to wildlife, and (d) apt to make a lasting contribution. Students might also develop a new plan that is based on the ideas presented.
5. Also ask the students to select one or more alternative plans, in case their first choices are not acceptable to authorities.
6. Once a plan and alternatives have been selected, ask the students to select a delegation to present their proposal to the authorities or whoever the appropriate authority is. Remember janitors, grounds-keepers, school board, and so on—anyone who would be physical or officially involved. A practice session before the students and any interested parents or other students would be helpful. At the practice session, the student delegation would make its presentation, responding to any questions from the audience.
7. Have the students make an appointment to present their proposal, make the presentation, and report back to their group. If their plan is accepted, they need to make sure they know whom to contact next to complete their project successfully. Making sure they have all necessary permissions secured, the students should proceed to accomplish their project successfully. If their plan, including alternatives, is not accepted, have the students identify why not. Have them find out exactly what people objected to in their original plan. The students can then respond to those objections with alternative proposals. Creating an alternative plan may require further research, careful interviews, and time.

continued

8. Once the project is accomplished, ask students to analyze their results. Did things work out as they wanted them to? Were there any surprises? Any unforeseen problems? How might they have been any more effective?

Aquatic Extension

Choose an issue to solve that involves water as a component of habitat.

Evaluation

Staff members at a nature center report they have noticed a smaller bluebird population in recent years. People are taking bluebird nest boxes down from trees and breaking them. The nature center director says there is no money to pay for security guards or to make repairs. Make a plan for helping the bluebirds.

Project WILD aquatic

Migration Headache

Objectives

Students will (1) list limiting factors affecting habitats and populations of migrating water birds, (2) predict the effects of such limiting factors, (3) describe the effects of habitat loss and degradation on populations of migrating water birds, and (4) make inferences about the importance of suitable habitat for migrating water birds.

Method

Students portray migrating water birds traveling between nesting habitats and wintering grounds.

Materials

Large playing field or gymnasium, two bases (paper plates or carpet squares, for example) for every two or three students

Background

Birds that migrate depend not just on having one suitable habitat, but two and often three habitats. For example, some birds nest and raise their young in the northern limits of their ranges. The same birds may also require suitable habitats in the southern limits of their range to live during winter. Because migrating birds travel hundreds or thousands of miles between nesting and wintering grounds, resting and feeding sites (known as stopovers) are crucial.

A variety of remarkable migrating shorebirds and waterfowl inhabit the skies and waters of the United States. Many migrating birds—ducks, geese, cranes, herons, rails, terns, and plovers, for example—require wetlands in their breeding, stopover, and wintering grounds. Without wetlands, dozens of species of water birds face loss of necessary habitat.

Over the past 150 years, water bird populations have been threatened by the alteration of habitats and direct mortality of birds. Numerous populations of water birds have declined, some significantly. The disappearance and degradation of wetlands are major threats to the survival of migratory water birds. Destruction of wetland habitats reduces the quantity of suitable nesting, feeding, and resting areas. Alteration of wetland habitats often reduces the quality of habitats, making them unsuitable for water birds. Wetland habitats, usually found in low, fertile plains along watercourses, were historically prized for conversion to farmland and settlements. Agriculture and development, both residential and industrial, have reduced the number and quality of natural wetlands.

Direct mortality of water birds occurs in various ways. The migration routes of North American water birds are well known. Before the passage of regulations regarding the hunting of water birds, market hunters of the 19th century and very early 20th century decimated the flocks by

continued

Grade Level: 5–8

Subject Areas: Science, Environmental Education, Expressive Arts

Duration: one 45-minute session

Group Size: 20 to 40 students or more

Setting: outdoors or large indoor area

Conceptual Framework Topic Reference: WPIIA2b2, WPIIA2a2a

Key Terms: migration, limiting factors, habitat, wetlands, water birds, shore birds

Appendices: none

taking advantage of the vast numbers of water birds that concentrated at strategic points along these routes. Pollution, through insecticides and herbicides for example, has also taken a toll. The birds ingest the poisons through the food chain, sometimes with lethal effects. In some cases, pesticides also kill the birds' food, reducing their food supply.

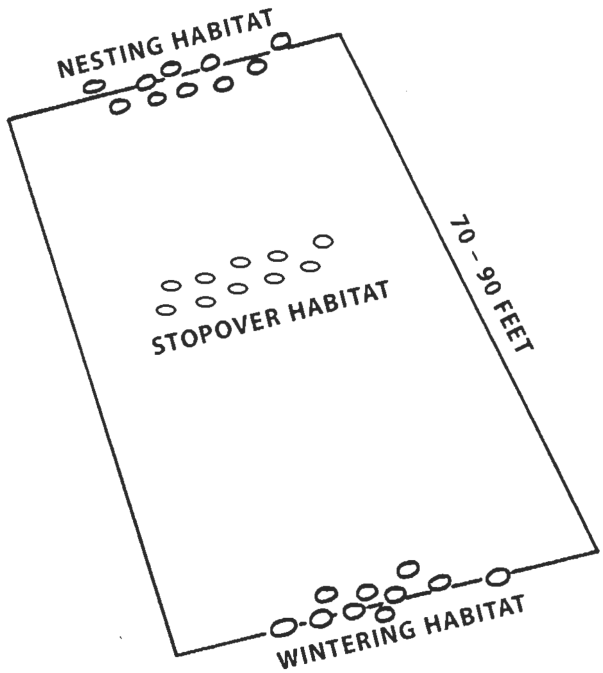
Many international, federal, state, and private groups recognize the importance of wetland habitats to wildlife preservation. In the early 1900s, several laws and treaties were enacted that regulated the hunting of water birds and protected the habitat on which they depended. Laws that conserve and enhance wetland habitats have slowed the alteration of these habitats. The Clean Water Act of 1977 and the Farm Bill of 1985 are two major pieces of such legislation. In addition, techniques have been developed to build new wetlands as well as enhance the quality of existing wetlands. The U.S. Fish and Wildlife Service (USFWS) has principal legal responsibility in the United States for managing migratory wildlife at the federal level. State wildlife agencies share some responsibilities with the USFWS in conserving migratory water birds.

The effects of natural occurrences and human management efforts during the 1990s have produced mixed results. The North American Waterfowl Management Plan, coordinated by the USFWS, has worked through private-public partnerships to conserve and enhance waterfowl habitat in Canada and the United States. This effort, aided by several years of plentiful rain and snow, has allowed populations of many species of waterfowl (ducks, geese, and swans) to rebound from near record lows in the 1980s and early 1990s to near historic high numbers. Conversely, shore birds like plovers, terns, and the red knot continue to suffer losses because of habitat loss and alteration along coastal regions.

In this activity, each student (assuming a class of 30) represents thousands, if not tens of thousands, of water birds. Thus, occasional losses to predation and other events of relatively minor magnitude during the course of migration are not emphasized in the simulation. The major purpose of this activity is for students to dynamically experience some important factors that affect habitat quality and the associated survival of migratory water bird populations.

Procedure

1. Select a large playing area about 70 feet in length. Place an equal number of bases in three areas on the playing field as shown below:



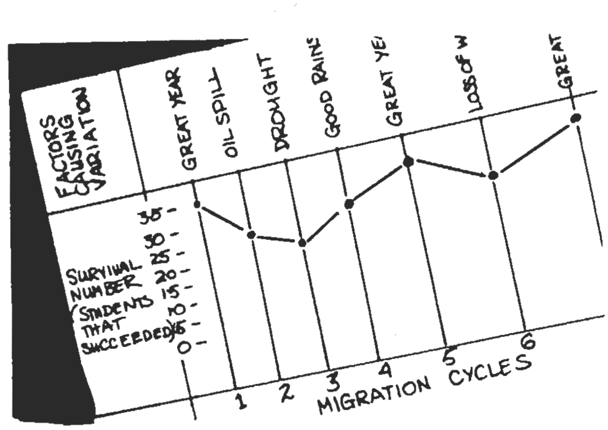
   Choose the number of bases so that there is one base for each two or three students at each of the three areas on the field. Designate one of the end areas the "wintering habitat," the other end as the "nesting habitat," and the area in the middle as "stopover habitat."

2. Explain to the students that they are water birds and will migrate between these three areas at your signal. Tell the students that the bases represent wetlands. These wetlands provide suitable habitat for water birds. At the end of each migration, the students will have to have one foot on a base in order to be allowed to continue (survive). Tell the students that only two (or three as decided in Step 1) water birds can occupy a habitat

(base) at one time. If they can't find a habitat that isn't "filled," that means they have not found any suitable habitat. They "pass away," and have to move, at least temporarily, to the sidelines. During migration, the students may want to "flap their wings," moving their arms like birds in flight.

3. Explain to the students that many factors will limit the survival of populations of migrating water birds. Some involve changes in the wintering, stopover, and nesting habitats. There will be periods of time where food, water, shelter, and space are suitably arranged to meet the habitat requirements of the birds. There will be other times when the habitat is stressed, with many factors limiting the potential for the birds' survival.
4. Begin the activity with all students at the wintering habitat. Announce the start of the first migration. Have the students migrate slowly until they become familiar with the process. Then they can speed up. On the first try, all the birds will successfully migrate to the stopover habitat.
5. Explain that most water birds need these areas to rest and eat before continuing the migratory journey. Then have them migrate from the stopover habitat to the nesting habitat. Explain that there has been no loss in the area of available high-quality habitat. Thus, a successful nesting season is at hand.
6. Before the students migrate back "south," remove one base from the stopover habitat. Explain that a developer has received a permit to drain a wetland to build a mall. Repeat the instruction to migrate, and send the birds to the stopover habitat. Have the students who could not find available habitat stand on the sideline. Tell the students that these birds died as a result of habitat loss. Remind any "deceased" birds that they will have a chance to get back into the activity. They can come back as surviving hatchlings when favorable conditions prevail and there is habitat available in the nesting ground.

NOTE: the migrations can be graphed as shown below.



7. Continue the migrations by reading the Habitat Scenarios on this page. Educators may want to appoint two students as monitors to remove and add bases (habitats) as required on the cards.
8. After the activity, ask the students to identify factors that caused water bird populations to decline or increase. What are the short- and long-term effects of the decline or increase? Which factors are human-caused? Which are natural? Which factors reduced or enhanced the quality of the habitat? What are the benefits and liabilities related to these factors for the community?

Habitat Scenarios

(Educators may want to photocopy these pages before beginning the activity.)

These scenarios can be used during the activity to assist educators with the factors that may reduce or enhance a wetland habitat.

- A marsh has been dredged to allow a marina to be built. Remove one habitat from the stopover habitat.
- A landowner has agreed to re-flood fields after harvesting, increasing acreage for wintering birds. Add one habitat to the wintering habitat.

continued

- A joint federal and state wetland restoration project involved removing drain tiles, allowing a former wetland to flood and return to its natural state. Add one habitat to the stopover habitat.
- A large increase in the number of mink and raccoons has reduced the value of a marsh nesting area. Remove one habitat from the nesting habitat.
- Wintering habitat is reduced by the conversion of bottomland hardwood forests to cropland. Remove one habitat from the wintering habitat.
- New legislation restricts motorboat traffic on a number of lakes and large marshes, reducing the human disturbance to wildlife. Add one habitat to stopover habitat.
- Several years of sufficient rain and snow has replenished the water supply, thus increasing the food supply. Add one habitat to the nesting habitat.
- A timber company has agreed to preserve a forested wetland in exchange for tax credits. Add one habitat to the stopover habitat.
- Filling and diking reduces the amount of tidal wetlands available to waterfowl. Remove one habitat from the wintering habitat.

Extensions

1. Research a species of water bird. Conduct this activity again with each student representing a specific kind of water bird.
2. Explore the major factors affecting habitat loss and alteration, or gain and restoration, in your area. Research the causes for long-term habitat loss, as well as any major efforts under way to prevent these increasing losses.
3. Using a map, plot the major migratory routes of North American birds.
4. Visit a national wildlife refuge, state wildlife area, bird observatory, private sanctuary, seashore, or other habitat for migratory water birds.
5. What other animals migrate? Are the problems they face similar to those of migratory birds?
6. There are national laws and international treaties protecting migratory species. Find out about some of these. What is their history? Are they effective? Are there problems enforcing them? What migrating species, if any, are unprotected by such laws?
7. Find out how wetlands have changed or remained the same in your community throughout the past 100 years. Are there wetland regulations or zoning laws in your community?

Evaluation

1. Name two human activities and two environmental factors that might interfere with water bird migration. For each activity and factor, describe the possible effects on the water birds.
2. Distinguish between effects on individual birds and effects on populations of birds. Indicate if an effect is short term or long term.
3. Why is suitable habitat important for migrating water birds? Include in your response a description of the different kinds of habitat that are needed by migrating water birds.
4. Is habitat loss a greater threat to the survival of migrating populations than for stationary populations of wildlife? Explain your answer.

Water Plant Art

Objectives

Students will identify aquatic plants as an important component of aquatic habitats and as a necessity for aquatic wildlife.

Method

Students create artwork showing aquatic habitats using drawings and pressed aquatic plants.

Materials

Seaweed, grasses, or samples of other aquatic plants; shallow pan filled with fresh water; heavy, porous white watercolor paper; waxed paper; newspapers; several large heavy books or plant press, if available; colored pencils; OPTIONAL: drying rack, 40-watt light bulb apparatus

Grade Level: K–4

Subject Areas: Science, Environmental Education, Expressive Arts

Duration: one 20- to 45-minute session for discussion and construction of artwork

Group Size: any

Setting: indoors and outdoors if students assist in gathering plant material

Conceptual Framework Topic Reference: IDIB

Key Terms: aquatic, ecosystem

Appendices: Using Local Resources, Outdoors, Field Ethics

NOTE: Guides to common aquatic plants, pond life, and seashores are helpful resources that tend to be readily available. One excellent resource is *Pond Life* (Golden Guide) by George K. Reid, 1967.

Background

Aquatic plants grow in a variety of sizes, shapes, and colors. They are essential to the web of life in any aquatic ecosystem. One benefit that aquatic plants provide is that submerged plants release oxygen into the water. The dissolved oxygen can then be used in respiration by aquatic animals.

Another benefit of aquatic plants is their ability to absorb excess nutrients in the water. The aquatic plant parts are also eaten by a variety of animals. Dead plants break down in water to form small particles of organic material called "detritus." This organic material feeds many small aquatic insects, shellfish, and small fish. These animals are then food for larger predators.

Aquatic plants benefit many aquatic animals by providing protected areas for breeding and hiding places for young. Aquatic plants also stabilize shorelines and reduce erosion.

The major purpose of this activity is to heighten students' awareness and appreciation of the importance of aquatic plant life.

continued

Procedure

NOTE: Plants may be collected from outdoors or purchased from pet or aquarium stores, some plant nurseries, and science supply catalogs. When planning to collect plants from the wild, be sure to follow local laws and ordinances for collecting plants. (See "Field Ethics" Appendix on page 216.) Purchased plants that are left over should be disposed of on dry land and not released into local aquatic ecosystems. OPTIONAL: If possible, take the students to a place where they can gather their own samples. They should use the same rules for not damaging animals, plants, or the habitat.

1. Discuss with the students the importance of a variety of plant life in aquatic habitats. Explain that plants are important parts of aquatic ecosystems.
2. Show the students pictures of some different kinds of aquatic plants, animals, and ecosystems. Freshwater habitats (like streams and lakes), and marine habitats (like saltwater bays and ocean environments), can be compared. Ask the students how they think the plants help the animals in each of these environments.
3. Display a small sample of a variety of local aquatic plants to the students. Seaweed from saltwater areas or grasses and algae from freshwater areas work well.
4. Place the seaweed, grasses, or algae in a pan filled with water. Clean the seaweed or other water plants. If necessary, separate the plants into smaller sizes for mounting and designing artwork.
5. Distribute the heavy, white, porous paper to the students. NOTE: Students may work on their own, in small groups, or as a class.
6. Using colored pencils, the students should draw aquatic wildlife on the art paper. Students should not fill the entire page with art because the plants will be placed on top of the art to illustrate plants in the habitat.
7. When the animal drawings are complete, gently lift the plants and place them on paper. Arrange the plant or parts of plants so that they provide a habitat for the wildlife in the students' drawings.
8. Cover the arrangement of plants with waxed paper.
9. Lift the artwork—white paper and wax paper, too—and place it between several sheets of newspaper. (The wax paper protects the plant while the water will seep through the white paper. As the plant dries, it will adhere to the white paper.)
10. Place the stack of newspapers containing the plant on a flat surface. Stack several heavy books on top to serve as a plant press. An actual plant press is ideal, if available.

    (If possible, elevate the stack of newspapers and plants on a rack or a set of bricks. Place a low [40] watt bulb under the stack. Do not let the bulb or socket rest against the stack or any potentially flammable materials. The heat from the lit bulb is just warm enough to dry the stack without damaging the plants.)
11. Drying may take from a few days to several weeks, depending on humidity.

NOTE: These plant prints can serve many purposes, for example, as plant identification keys for classroom use and for bulletin board artistic displays. The wax paper can be retained as protection or can be removed gently, leaving the plant dried flat to the paper. If the plants do not stick to the paper, use a glue stick or spray fabric glue to re-attach loose parts.

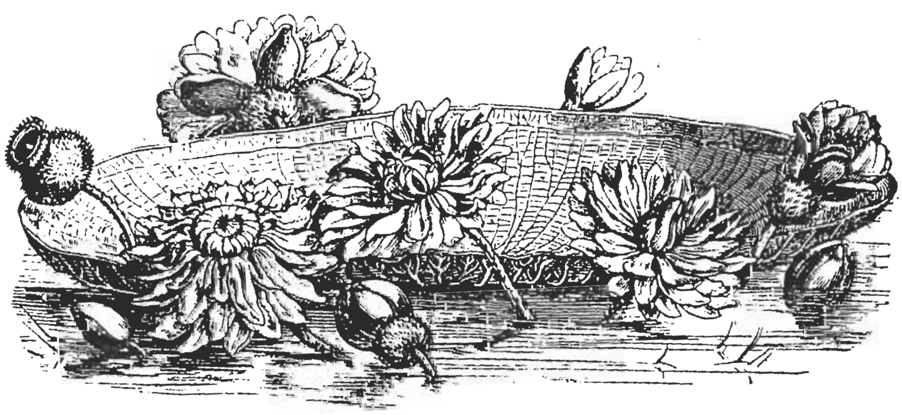
12. Display the aquatic art, and ask the students to discuss what they learned. Again talk with the students about the importance of plant life in aquatic habitats. Ask the students to give examples of ways these plants are important.

Extensions

1. Identify local plants that are found in water. Ask the students to identify the plants used in the activity.
2. Tell how plants that grow in water can provide food and protection for animals that live in water.
3. Give reasons why it is important to have a variety of aquatic plants in aquatic ecosystems.
4. When discussing aquatic life, use a brainstorming technique to discover how plants are similar to animals. Write down common characteristics of plants and animals, or make posters.
5. Find out more about the habitat in which an aquatic plant grows. What is it like? What animals live there? What plant and animal adaptations are evident?

Evaluation

1. Draw and identify two aquatic plants other than the plants pressed in the activity. What aquatic animals can be added to the pictures to show how these plants help aquatic animals?



Marsh Munchers

Objective

Students will (1) identify components of a food web in a salt marsh, and (2) identify their interconnectedness in the food web.

Method

Students use body movement and pantomime to simulate the feeding motions of marsh animals.

Materials

Timer; construction paper for tokens in five colors: white, green, yellow, blue, red; predator feeding-behavior cards; detritus-eater cards (master provided on page 38); one envelope per student

NOTE: This activity is written for an estimated 25 students. One-fifth of the class will be designated predators and four-fifths will be other organisms.

Grade Level: K–4

Subject Areas: Science, Environmental Education, Expressive Arts (see Skills Index)

Duration: one 20- to 60-minute session

Group Size: designed for 25 students (can be adapted for smaller or larger groups)

Setting: outdoors or large indoor playing area

Conceptual Framework Topic Reference: IDIB, IDIIA, IDIIB, IDIIB1, IDIIB2, IDIIB2b, IDIIC

Key Terms: salt marsh, food web, decomposer, detritus; OPTIONAL: predator, prey, producer, consumer

Appendices: Ecosystem, Simulations

Background

A salt marsh is an important ecosystem found between a landmass and the ocean. It is a place where fresh water and salt water come together to form a unique habitat for wildlife. Life forms in salt marshes are often more complex and diverse than those in other habitats because of the constantly changing mixture of both fresh and salt water.

Salt marshes are one of the most productive ecosystems on Earth, producing up to two times as much food as the most fertile agricultural lands. The main producer for this important ecosystem is salt marsh grass, which grows and thrives in the nutrient-rich waters of estuaries where salt water from the ocean mixes with fresh water from land drainage. A salt marsh is always producing new grass as old grass dies. Bacteria promote the decay of the marsh grass, which in turn produces detritus. Detritus is dead and decaying plant or animal matter. Fiddler crabs, snails, small shrimp, and fish such as minnows feed on decomposed marsh grasses. Oysters and clams filter detritus and tiny living plants from the water. These organisms become food for crabs, birds, and a variety of fish. Many marine organisms and commercially valuable fish species—including flounder, red drum, and striped bass—depend on marsh ecosystems during their lifetimes.

Countless numbers of birds also depend on salt marshes for food and nesting areas. Ospreys, sandpipers, and members of the heron family can be seen feeding along marsh creeks during the spring and summer, while ducks and northern harriers are common sights in the winter months. Other animals seen wandering

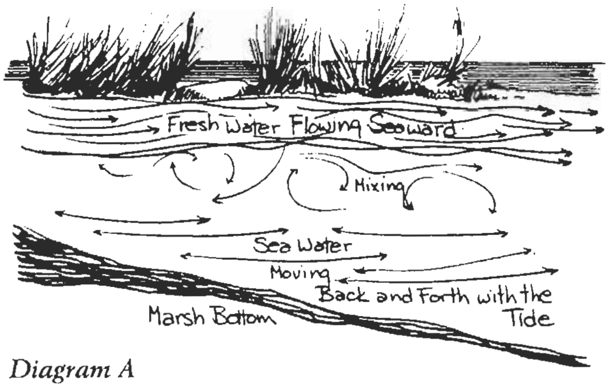


Diagram A

4. Instruct the students to open their envelopes and to see what animal they are and what feeding behavior they use. Remind students to keep their identities a secret from the other students. The students will indicate what animals they are by the feeding behavior. OPTIONAL: Model each behavior first, and identify it so the students will know which animal does what. However, it may be more productive to allow the students to improvise.
5. Explain the rules:
   - Each student represents an a *detritus-eater* or a *predator*.
   - Each detritus-eater has five food tokens, representing five individual marsh animals of the same species.
   - The detritus-eater must give a food token to a predator when tagged.
   - Each predator must acquire 10 food tokens to stay alive during a tidal cycle.
   - A tidal cycle is one playing period of the game.
   - Each predator can acquire only one token from each other organism at any one time in a tidal cycle, but needs to acquire as much prey as possible during the tidal cycle.
   - Detritus-eaters keep eating even after predators have eaten them. They represent the remaining animals of that species, until they run out of food tokens. When they run out of food tokens, they sit quietly in place *decomposing* in the salt marsh.
   - Detritus-eater and predators must display their feeding styles during the activity.
   - Detritus-eaters will show their feeding styles from stationary squat positions, while predators will walk as they display their behavior.
6. Establish a play area (inside or outside) and have all detritus-eaters take their envelopes with them as they spread out on the playing field and start pantomiming their feeding behaviors.
7. Tell predators to begin to pantomime their respective feeding behaviors, capture their prey, and secure a food token from the prey, then place it in their envelope.
8. Call time when appropriate (after most predators have acquired 10 food tokens).
9. Tell students to hold on to their food envelopes so that they can participate in the discussions.
10. Discuss the results. Did every predator acquire 10 food tokens during the tidal cycle? If not, why not? (Some animals are more selective in their feeding preferences and, therefore, may have a more difficult time finding food.) Discuss the different ways the animals are connected to each other and to the detritus. Mention that decomposers break down plants and animals to produce the detritus. Be sure the supporting role of the producers—the plants that become the detritus—is not overlooked because of the more intense activity of the consumers.

Table of Materials to Be Prepared and Placed in Envelopes (One Envelope per Student Representing One Predator or Other Organism)

	Feeding-Behavior Cards	Colored Food Tokens
Predators		
1 raccoon	1 each	
1 blue crab	1 each	
1 red drum fish	1 each	
1 egret	1 each	
1 person	1 each	
Other Organisms (Detritus-Eaters)		
4 fiddler crabs	1 each	5 red tokens each (20 total)
4 snails	1 each	5 blue tokens each (20 total)
4 oysters	1 each	5 yellow tokens each (20 total)
4 juvenile fish	1 each	5 green tokens each (20 total)
4 shrimp	1 each	5 white tokens each (20 total)

through the marsh in search of food are raccoons and small mammals such as shrews and mice. Deer, grasshoppers, and geese can be seen consuming the grasses at different times of the year.

Salt marshes contribute to flood control and provide water filtration. As water flows through the marsh, much of the sediment load is filtered out to create cleaner and clearer water. Salt marsh grasses and soils also help absorb floodwaters and act as natural buffers between land and ocean. These marshes protect upland organisms as well as billions of dollars worth of human businesses, homes, and cities from storms.

Coastal development and pollution are threatening salt marsh environments. Salt marshes, like other wetlands, are destroyed or damaged when land is converted to agriculture production, filled for coastal development, dredged, or used for other purposes.

The major purpose of this activity is for students to learn about salt marshes and to reinforce their understanding of the concept of a food web.

NOTE: Since this is a simulation, some of the animals' roles are simplified. In actual salt marshes, some animals have several roles. For this activity, one dominant role for each animal has been identified.

Procedure

1. Cut the appropriate colored construction paper into food tokens, according to the table on this page. Reproduce the feeding-behavior cards (five predator cards, 20 detritus-eater cards). Place feeding-behavior cards and food tokens into the appropriate envelopes.
2. Discuss the characteristics of a salt marsh habitat with the students. Also discuss the importance of salt marshes with emphasis on their high productivity as a place for animals and plants to inhabit. Discuss the role of detritus in the marsh food web. Mention decomposers and their importance. If appropriate, introduce the terms "predator" and "prey", and "producers" and "consumers." Show the students Diagram A, and emphasize the unusual relationship between fresh water and tidal salt water found in this habitat.
3. Give one envelope to each student. Explain that their creatures' identities are a secret. Each envelope contains the identity of one animal that lives in a salt marsh. The only way others will know what they are is by the way they feed. When they receive their envelopes, explain that some students will be detritus-eaters and the others will be predators who prey on the detritus-eaters.

continued

11. Draw a food web based on the feeding interactions that took place during the game. Include the plants that the decomposers eat to produce detritus.

12. Collect the envelopes, and put the color-coded tokens back into their original envelopes. OPTIONAL: Shuffle the envelopes, and redistribute them to the students. Replay the simulation, and draw a second food web. Compare and contrast the food webs.

13. Summarize by emphasizing the importance of salt marshes. Salt marshes provide habitat for a variety of kinds of animals. Salt marshes are unusually productive habitats, growing large amounts of vegetation that supports a variety of species of wildlife.

Extensions

1. Draw or paint a food web of a salt marsh as a mural, drawing an accurate portrait of each animal. Place each drawing in the appropriate place in the cycle. With yarn, connect each animal with what it eats.

2. If possible, visit a salt marsh.

3. Modify this activity to simulate a freshwater marsh by substituting the following freshwater animals for the previously described saltwater animals:

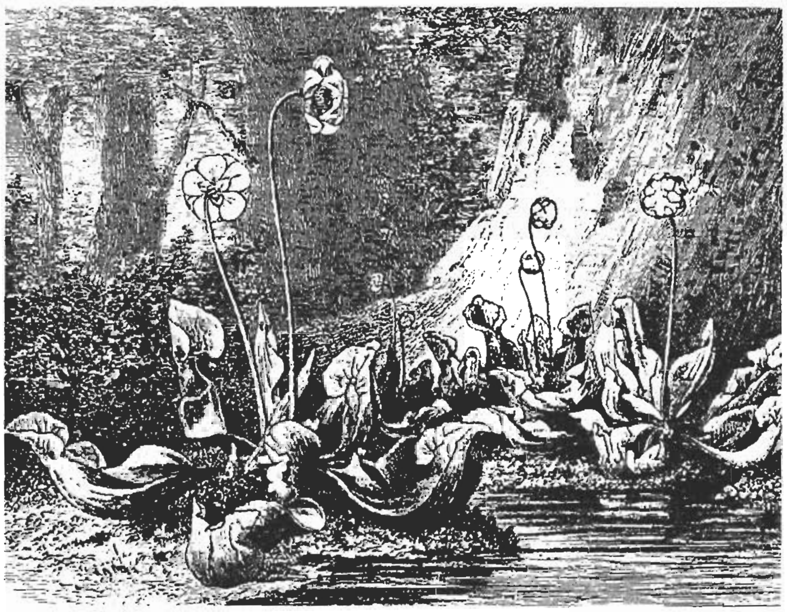
Detritus-Eaters	Predators
4 crayfish	1 raccoon
4 clams	1 great blue heron
4 dace (small fish)	1 bluegill
4 scuds (shrimp-like crustacean)	1 northern pike
4 mosquito larvae	1 person

Follow the rest of the procedures as previously outlined.

Evaluation

1. Give examples of two predators and two prey species that live in salt marshes.

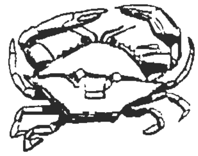
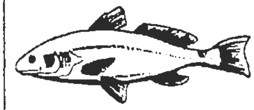
2. Use some of the organisms listed below, and others of your choice, to construct a food web that might be found in a salt marsh: people, raccoons, marsh grass, bacteria, snails, oysters, detritus, young fish, egrets.



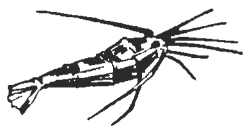
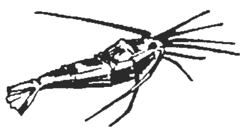
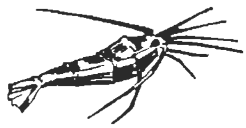
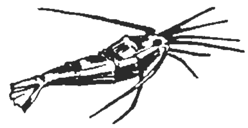
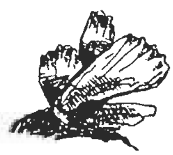
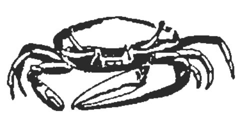
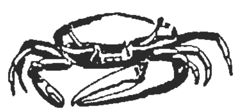
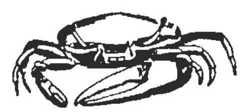
continued

Master for Marsh Muncher

Predators

				
Person Fishing: Student walks forward casting line, and tags prey by grasping on the shoulder.	**Blue Crab:** Student walks sideways, waving arms like claws and grasps prey.	**Raccoon:** Student walks forward washing hands and grasps prey.	**Red Drum Fish:** Student walks with hands held forward like a mouth, and grasps prey.	**Egret:** Student struts with hands on hips, so elbows are like wings. Nearing prey, arms become a beak to grasp prey.

Detritus-Eaters

			
Juvenile Fish: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)	**Juvenile Fish**: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)	**Juvenile Fish**: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)	**Juvenile Fish**: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)
			
Shrimp: Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)	**Shrimp:** Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)	**Shrimp:** Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)	**Shrimp:** Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)
			
Snail: Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)	**Snail:** Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)	**Snail:** Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)	**Snail:** Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)
			
Oyster: Filters detritus from water using gills. (Student waves arms back and forth in air.)	**Oyster:** Filters detritus from water using gills. (Student waves arms back and forth in air.)	**Oyster:** Filters detritus from water using gills. (Student waves arms back and forth in air.)	**Oyster:** Filters detritus from water using gills. (Student waves arms back and forth in air.)
			
Fiddler Crab: Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)	**Fiddler Crab:** Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)	**Fiddler Crab:** Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)	**Fiddler Crab:** Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)

Wetland Metaphors

Objectives

Students will (1) describe the characteristics of wetlands, and (2) evaluate the importance of wetlands to wildlife and humans.

Method

Students are presented with a selection of objects to investigate as metaphors for the natural functions of wetlands.

Materials

A large pillowcase, bag, or box; sponge; small pillow; soap; eggbeater or mixer; small doll cradle; sieve or strainer; paper coffee filter; antacid tablets; small box of cereal or rice; 3″ × 5″ cards with pictures that could be used to show other wetland metaphors (a zoo could represent the idea of wildlife diversity in a wetland; a lush vegetable garden could represent the idea of a productive wetland in which food is abundant; a vacation resort could represent the idea of a resting or wintering place for migrating waterfowl)

NOTE: A metaphoric approach such as this allows a variety of objects to suggest appropriate linkages to the basic characteristics of wetlands.

Grade Level: 5–8

Subject Areas: Environmental Education, Language Arts

Duration: one or two 30- to 60-minute sessions

Group Size: any

Setting: indoors or outdoors

Conceptual Framework Topic Reference: IDIA2b

Key Terms: wetlands, metaphor

Appendices: Outdoors, Simulations

Background

Wetlands are many different things to many different people. Some people have never heard or thought about wetlands. Others are working actively to protect wetlands because of their importance.

Wetlands include areas such as freshwater and saltwater marshes, wet meadows, swamps, lagoons, bogs, and prairie potholes. All wetlands, whether coastal or inland, provide special habitats that serve areas far beyond their boundaries. Wetlands are especially important to plants, animals, humans, and the total environment.

Because of the abundance of food, vegetative cover (shelter), and water found there, most wetlands are rich with diverse wildlife species.

Coastal and inland marshes, for example, provide breeding, resting, and wintering habitats for thousands of migratory birds—including ducks, geese, swans, cranes, and shore birds. Many species of fish that are important for commercial and personal use by humans reproduce and spend part, or all, of their life cycles in fertile wetlands adjacent to larger, more open bodies of water. These fish species include bass, salmon, walleye, perch, and pickerel. A wide variety of reptiles, amphibians, insects, and crustaceans also

continued

breed and live in wetlands. Frogs and toads, turtles of all kinds, salamanders, snakes, dragonflies, water striders, clams, and crayfish flourish in wetland habitats. Many mammals—from muskrats and beaver to white-tail deer and moose—also depend on wetland areas.

Wetlands are often referred to as "nurseries" because they provide critical breeding and rearing habitats for countless numbers and kinds of wildlife.

Wetlands also have the unique ability to purify the environment. They act as natural filtering systems and have been shown to be extremely effective. For example, they can trap and neutralize sewage waste, allow silt to settle, and promote the decomposition of many toxic substances.

The importance of vegetation associated with wetlands cannot be overlooked. Plants absorb nutrients and help cycle them through food webs. Plants also help keep nutrient concentrations from reaching toxic levels. Plants slow down water flow, causing silt to settle out. Through photosynthesis, plants add oxygen to the system and provide food to other life forms. Of great importance to humans are the flood-control characteristics of wetlands. When runoff from rains and spring thaws is high, wetland areas absorb excess water until it gradually drains away down streams and rivers and through the soil. Acting as buffers, healthy wetlands prevent flooding and erosion. In dryer periods, wetlands hold precious moisture after open bodies of water have disappeared.

The many activities that take place in wetlands make them among the most productive ecosystems in the world.

As remarkable and resilient as wetlands are, these unique areas have limits. Their destruction or abuse can have devastating effects on wildlife, humans, and overall environmental quality.

Many of the major attributes of wetlands can be explored through the use of metaphors. To use a metaphor is to apply a word or phrase to an object or concept that the word or phrase does not literally denote in order to suggest a comparison between the two. A metaphor represents a concept or idea through another concept or idea. "A tree is a home" and "Books are windows of thought" are two examples. In this activity, a variety of everyday objects can be used to represent the natural functions of wetlands. For example,

Object	Metaphoric Function
sponge	absorbs excess water caused by runoff; retains moisture for a time even if standing water dries up (e.g., sponge placed in a small puddle of water absorbs water until saturated, then stays wet after standing water has evaporated)
pillow or bed	is a resting place for migratory birds
mixer or eggbeater	mixes nutrients and oxygen into the water
cradle	provides a nursery that shelters, protects, and feeds young wildlife
sieve or strainer	strains silt, debris, and such, from water
filter	filters smaller impurities from water
antacid	neutralizes toxic substances
cereal or rice	provides nutrient-rich foods (rice is grown in wetland areas)
soap	helps cleanse the environment (as wetlands do)

Wetland habitats are being converted to other uses (agriculture, roadways, housing developments) or otherwise being altered (drained for pest control or polluted) at the rate of about a half million acres per year. And although many wetlands are protected by federal and state laws, there still appears to be a significant need to create a greater understanding of the importance of wetlands as ecosystems and as wildlife habitat.

The major purpose of this activity is for students to develop an appreciation and understanding of wetlands through the power of metaphor, linking the characteristics and natural functions of wetlands to the familiar realm of everyday life.

Procedure

1. Prepare a "Mystery Metaphor Container" (pillowcase, bag, or box). It should be possible for students to put their hands into the container and pull out an object without being able to see inside the container. Educators may want to collect as many as one metaphoric object per student, but at least have enough for one per group of four students. Put the container aside to use later.
2. Discuss the variety of wetlands found in your local area, state, country, and elsewhere. Then invite the students to sit quietly and close their eyes. Ask them to picture a wetland. Have them examine what it looks like and look carefully at the plants and animals, including insects and small creatures. What does the air feel like? How does it smell?
3. Invite the students to tell what they imagined. Compile a list of their offerings. Encourage discussion and mutual sharing.
4. With their lists as a point of reference, help the students identify which plants and animals are most likely to be found in a wetland. If possible, have them classify the plants and animals according to the kind of wetland in which they would be found. State or federal wildlife officials and representatives of private conservation or nature-related organizations can be helpful.
5. Next provide the students with background information to serve as an overview of the basic ecological activities that characterize the wetland habitat. For example, educators might include the following:
   - **sponge effect:** absorbs runoff
   - **filter effect:** takes out silt, toxins, wastes, and such
   - **nutrient control:** absorbs nutrients from fertilizers and other sources that may cause contamination downstream
   - **natural nursery:** provides protection and nourishment for newborn wildlife

   Suggest that these activities and many more that they could probably think of are taking place in wetlands all the time.
6. Now bring out the "Mystery Metaphor Container." Tell the students that everything in the container has something to do with a wetland. Have the students divide into groups of four. Announce that when it is their team's turn, a representative from the group will draw an object from the container. Then, as a group, they must figure out how the object could represent what a wetland is or does.
7. Have the designated student reach into the container and withdraw one object. When each group has an object, ask them to work as a team to identify and describe the relationships between their metaphoric object and wetlands. Encourage the students to build on each other's ideas. You can also assist by strengthening their connections.

NOTE: Allow the students time to discuss their ideas within their groups before doing so in front of the entire class.

8. Ask each group to report its ideas to the class.

continued

9. Following discussion and review of the functions represented by each metaphor, ask the students to summarize the major roles that wetlands perform in contributing to habitat for wildlife. List the ways in which wetlands are important to humans. Why do humans convert wetlands to other uses? Ask the students if their own attitudes about wetlands are different now. If yes, how? If not, why not?

10. For the final part of this activity, encourage the students' understanding of how the wetlands' condition depends on each of us. Many kinds of wildlife depend on wetlands. Our own well-being requires wetland ecosystems. Strengthen the students' understanding of how humans are connected to wetlands. Recreation, aesthetics, utilitarian uses, environmental quality, and nature study are but a few of the connections we each have with wetlands.

Extensions

1. Visit a wetland to verify the appropriateness of the metaphors explored in the classroom. Identify and discuss any limitations to the appropriateness of those metaphors. Identify what seem to be the most compelling attributes of the metaphors in helping you understand the characteristics and nature of the wetland. Expand on your understanding of those metaphors. Identify new and appropriate metaphors.
2. Investigate local, county, state, and federal regulations and laws that govern uses of wetlands.

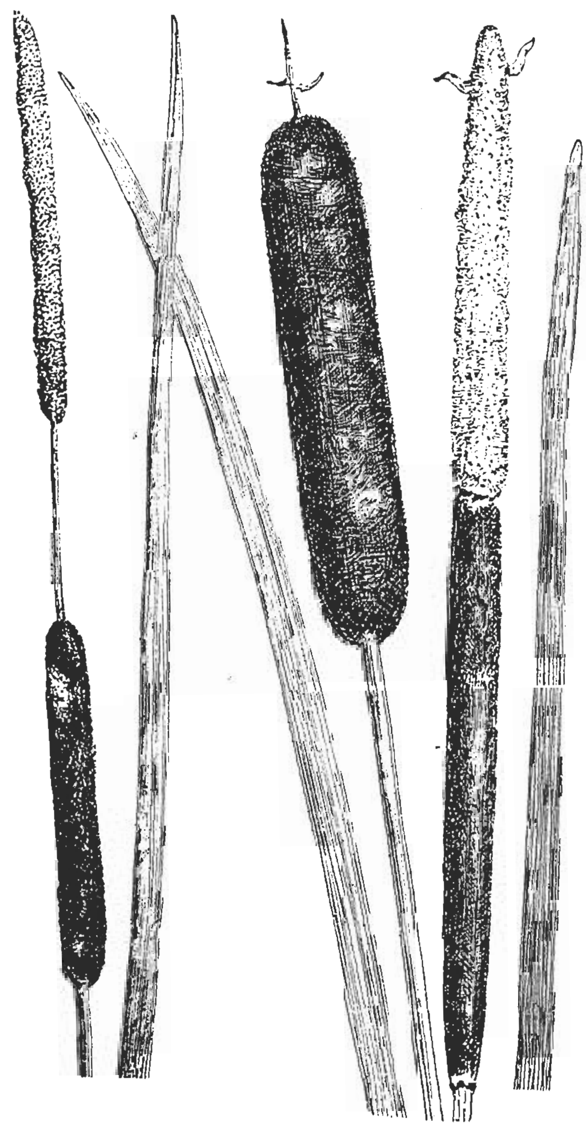
Evaluation

1. Explain why wetlands are among the world's most productive ecosystems.
2. Wetlands are important to a range of organisms in the animal kingdom, from zooplankton to humans. Select five species of animals, and describe how wetlands are important to each.

Additional Resources

wetlands.fws.gov/mapper-tool.htm

epa.gov/owow/wetlands/contents.html



Hooks and Ladders

Objectives

Students will (1) describe how some fish migrate as part of their life cycles, (2) identify the stages of the life cycle of one kind of fish, (3) describe limiting factors affecting Pacific salmon as they complete their life cycles, and (4) generalize that limiting factors affect all populations of animals.

Method

Students simulate the Pacific salmon and the hazards faced by salmon in an activity portraying the life cycle of these aquatic creatures.

Materials

Large playing area (100 feet × 50 feet), about 500 feet of rope or string or six traffic cones for marking boundaries (masking tape may be used if area is indoors), two cardboard boxes, 100 tokens (3″ × 5″ cards, poker chips, macaroni, etc.), jump rope

Grade Level: 5–8

Subject Areas: Social Studies, Science, Environmental Education, Expressive Arts

Duration: one 30- to 60-minute session

Group Size: 20 to 30 students or more

Setting: outdoors or large indoor area

Conceptual Framework Topic Reference: IDIIB

Key Terms: life cycle, limiting factors, population, migration

Appendices: Simulations, Ecosystems

Background

Many fish migrate from one habitat to another during their lives. Both the Atlantic and Pacific salmon are examples of fish that endure a spectacular migration.

The life cycle for Pacific salmon begins when the female deposits 1,000 to 5,000 eggs in her freshwater spawn. The eggs are deposited in a shallow gravel depression that she digs by flapping her tail from side to side. Once the eggs are deposited, the male fertilizes them; then both fish nudge the gravel back over the eggs to offer as much protection as possible. The eggs are susceptible to factors such as predation or oxygen deprivation. Within a few days, both the male and female salmon have completed their reproduction cycle and soon die.

Newly hatched salmon, called "alevins," live in the gravel and survive by absorbing proteins from their yolk sacs. After a few weeks, the yolk sacs are gone and the small fish, known as "fry," move into deeper water to find food on their own. Salmon remain in freshwater streams feeding and growing for many months or even years before migrating downstream to the ocean. These small ocean-bound salmon are now called "smolts." These salmon will feed in estuaries where fresh and salt water mix. After a few weeks of adjusting to the brackish water, the young salmon swim into the ocean.

In the ocean, the salmon grow rapidly by feeding on a rich food supply that includes other fish, shrimp, and crustaceans. Young salmon may encounter many limiting factors, including sharks, killer whales, other marine mammals, and humans who are fishing for salmon for commercial and personal uses.

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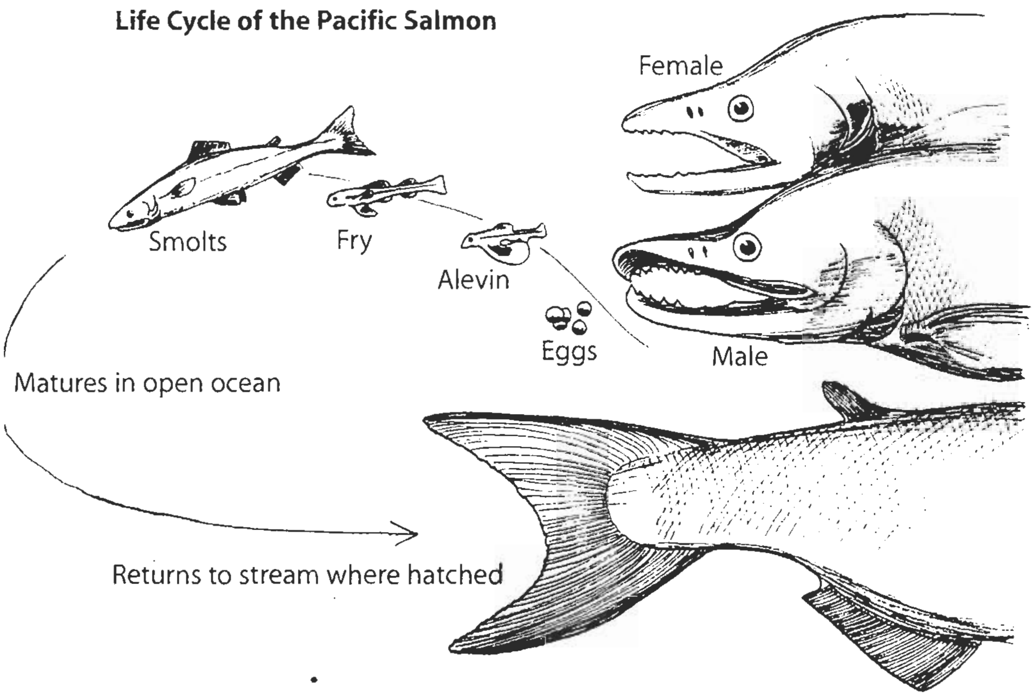


After 2 to 5 years in the ocean, the Pacific salmon begin the journey that guides them to their own hatching sites. Pacific salmon spawn only once in their lives. Salmon have an inherent ability to return to their original streams. Juvenile salmon imprint or memorize the unique odors of their home streams. As returning adults, they use their senses of smell to detect those odors and guide them upstream to where they were hatched. Once there, the salmon spawn and then die.

Salmon face a variety of limiting factors in the completion of their life cycle. A limiting factor is a reason or cause that reduces the population of an organism. Some limiting factors are natural, and some result from human intervention into natural systems.

Natural limiting factors include drought, floods, predators, and inadequate food supply. Throughout their lives, salmon depend on a habitat that provides plants to shade streams and deep pools of water for spawning and resting. Incorrect logging practices, grazing, mining, road building, and development often destroy streamside vegetation, erode land, and fill streams with silt that covers gravel beds.

Dams are another limiting factor that block or slow migration to and from the ocean. Salmon become disoriented by the reservoirs formed by dams and become exposed to unhealthy conditions like high water temperatures and predators. Fish ladders can be installed to help salmon through the dams. Fish ladders can be water-filled staircases that allow migrating fish to swim around the dam.

Another threat to salmon is overfishing. Overfishing, combined with habitat destruction, is viewed by biologists as a cause for the decline of salmon populations.

NOTE: All possible conditions are not covered by the design of this activity. However, the activity does serve to illustrate three important concepts: life cycle, migration, and limiting factors.

Procedure

1. Ask the students what they know about the life cycles of fish that live in their area. Do any local fish migrate to spawn? If yes, which ones? (Mullet, shad, lake trout, striped bass, suckers, carp, and salmon are examples of fish that migrate to spawn.)

2. Set up a playing field as shown in Diagram A, including spawning grounds, reservoir, downstream, upstream, and ocean. The area must be at least 100 feet by 50 feet. Assign roles to each of the students. Some will be salmon; others will be potential limiting factors to the salmon. Assign the students roles as follows:

   - Choose two students to be the turbine team. They will operate the jump rope, which represents the turbines in hydroelectric dams. Later in the simulation, when all the salmon have passed the turbine going downstream, those students move to the upstream side to become the waterfall-broad jump monitors. (See diagram.)
   - Choose two students to be predatory wildlife. At the start of the simulation, the predators will be stationed in the reservoir above the turbines to catch the salmon fry as they try to find their way out of the reservoir and move downstream. Then they will move to below the turbines where they catch salmon headed downstream. Later in the activity, when all the salmon are in the sea, these same two predators will patrol the area above the "broad jump" waterfalls. There they will feed on salmon just before they enter the spawning ground. (See diagram.)
   - Choose two students to be humans in fishing boats catching salmon in the open ocean. The students in the fishing boats must keep one foot in a cardboard box to reduce their speed and maneuverability.
   - All remaining students are salmon.

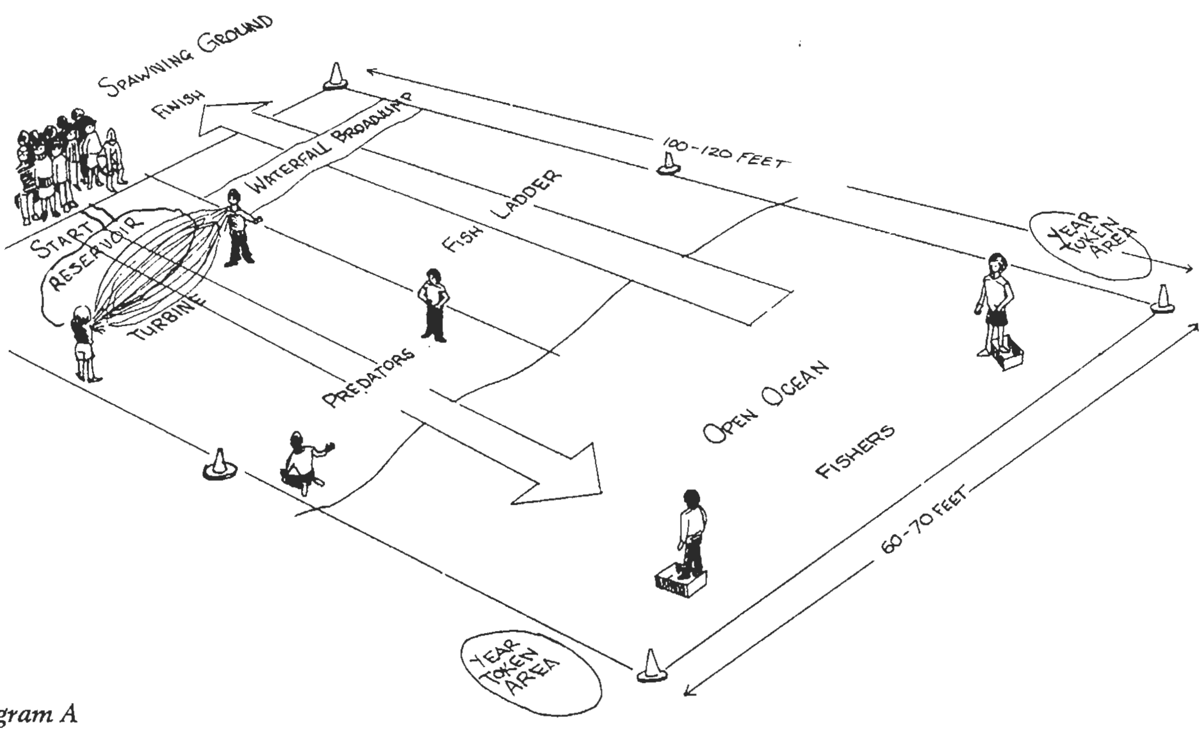


Diagram A

continued

NOTE: These figures are based on a class size of 25 to 30. If the group is larger or smaller, adjust the number of people who are fishing and predatory wildlife accordingly.

3. Begin the activity with all the salmon in the spawning ground. The salmon first move into the reservoir above the dam. They must stay in the reservoir while they count to 30. This pause simulates the disorientation that salmon face because of a lack of current in the lake to direct them on their journey. During this time the predators may catch the salmon and escort them one at a time, to become part of the fish ladder. The salmon then start their journey downstream. The first major limiting factor that the salmon encounter is the turbines at the dam. At most dams, escape weirs guide migrating salmon past the turbines. The student salmon cannot go around the jump-rope swingers, but they can slip under the swingers' arms if they do not get touched while doing so. A salmon dies if the turbine (jump rope) hits it. The turbine operators may change the speed at which they swing the jump rope. Any salmon that "dies" at any time in this activity must immediately become part of the fish ladder. The student is no longer a fish, but becomes part of the physical structure of the human-made fish ladders now used by migrating salmon to get past barriers such as dams. The students who are the fish ladder kneel on the ground as shown on page 47, with one body space between them.

4. Once past the turbines, the salmon must pass some predatory wildlife. The predators, who have moved from the reservoir area to the area below the turbine, must catch the salmon with both hands—tagging isn't enough. Dead salmon are escorted by the predator to become part of the fish ladder. Later, the salmon that survive life in the open ocean will pass through the fish ladder to return to the spawning ground. NOTE: Both the predatory wildlife in the downstream area and the people fishing in the open ocean must take dead salmon to the fish ladder site. This action moves the predators and fishing boats off the field regularly, helping to provide a more realistic survival ratio.

5. Once in the open ocean, the salmon can be caught by fishing boats. The salmon must move back and forth across the ocean area in order to gather four tokens. Each token represents 1 year of growth. Once each fish has four tokens (4 years' growth), that fish can begin migration upstream. The year tokens can be picked up only one at a time on each crossing. Remember, the salmon must cross the entire open ocean area to get a token. The "4 years" that these trips take make the salmon more vulnerable; thus they are more readily caught by the fishing boats. For this simulation, the impact of this limiting factor creates a more realistic survival ratio on the population before the salmon begin the return migration upstream.

6. When four of the year tokens have been gathered, the salmon can start upstream. The salmon must walk through the entire pattern of the fish ladder. This enforced trip through the fish ladder gives the students a hint of how restricting and tedious the upstream journey can be. In the fish ladder, predators may not harm the salmon.

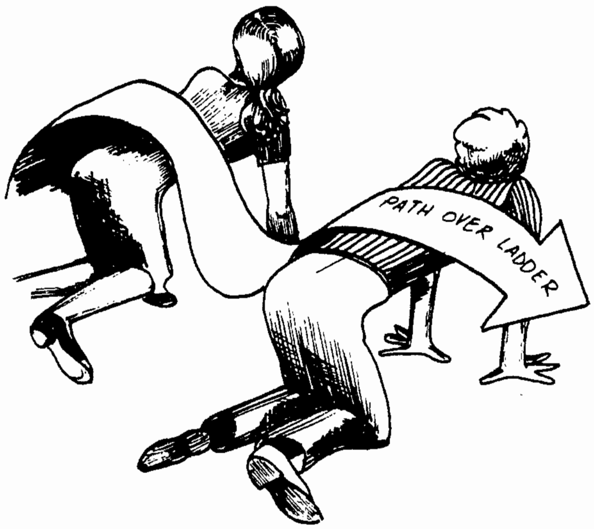
7. Once through the ladder, the salmon face the broad-jump waterfall. The waterfall represents one of the natural barriers salmon face going upstream. Be sure the jumping distance is challenging but realistic. The two former turbine students will monitor the jump. The salmon must jump the entire breadth of the waterfall to be able to continue. If the salmon fails to make the jump, then it must return to the bottom of the fish ladder and come through again.

NOTE: When playing indoors, the broad-jump waterfall may be changed into a stepping-stone jump defined by masking tape squares on hard floors.

8. Above the falls, the two predators who started the simulation as the predators below the turbines have now become the last set of limiting factors faced by the salmon. They represent bears—one example of predatory wildlife. Again, remember that the predators must catch the salmon with both hands. If they catch a salmon, they must then take the student they caught to become part of the structure of the fish ladder.

9. The activity ends when all the salmon are gone before the spawning ground is reached—or when all surviving salmon reach the spawning ground.

10. Next engage the students in a discussion. Explore topics such as
    - the apparent survival or mortality ratio of salmon,
    - the role of the barriers,
    - the role of the predatory wildlife and the people fishing,
    - where the losses were greatest,
    - where the losses were least,
    - what the consequences would be if all the eggs deposited made the journey successfully, and
    - what seemed realistic about this simulation and what did not.



11. Ask the students to summarize what they have learned about the life cycle of salmon, the salmon's migration, and limiting factors that affect salmon. Make sure the students have a clear working definition of limiting factors. Encourage the students to make the generalization that all animals—not just the Pacific salmon—are affected by limiting factors. Ask the students to give examples of limiting factors. They might mention the availability of suitable food, water, shelter, and space; disease; weather; predation; and changes in land use and other human activities.

Variation: Atlantic Salmon

This activity can easily be adapted to feature Atlantic salmon. The most significant difference between Pacific and Atlantic salmon is that the Atlantic salmon can spawn more than once. Many Atlantic salmon make their complete migratory journey and spawn two or more times. All Pacific salmon die after spawning only once. To adapt this activity for Atlantic salmon, students are to make as many complete migratory trips as possible. After the activity is finished, ask students to report how many times they successfully completed the migratory cycle. Graph the data. Have the students explain how age influences mortality rates and susceptibility to limiting factors.

Variation: Striped Bass

This activity can also be adapted to feature striped bass rather than salmon. The striped bass is more widely distributed along the United States' coastlines than either the Atlantic or Pacific salmon. Like the salmon, striped bass reproduce in fresh water and migrate to and mature in salt water. They also must face the same limiting factors described in this activity.

continued

Extensions

1. Write a report on the life history of one of the species of salmon (e.g., chinook or king, chum or dog, pink or humpback, coho or silver, sockeye or red, Atlantic). Create a mural showing the life cycle of this salmon.
2. Research and illustrate the life cycle of any local fish. If possible, look for one that migrates.
3. Compare how the life cycle of a Pacific salmon is similar to and different from the life cycle of one or more local fish.
4. Investigate similarities and differences in the migration and life cycles of an Atlantic and a Pacific salmon. Investigate the life cycle of salmon in the Great Lakes region of the United States.
5. Visit fish hatcheries that work with migratory species and investigate how they function.
6. Explore ways that dams can be modified to let fish safely pass downstream and upstream. Design the "perfect" fish ladder.
7. Investigate and discuss commercial fishing for salmon. Investigate and discuss personal, including recreational, fishing for salmon.
8. Find out about laws protecting migratory species, including fish.
9. Consider this approach, and try the activity again:

   In the past 100 years, salmon have experienced many new, human-caused limiting factors. Dams, commercial fishing, timber harvest, and road construction have had a tremendous impact on salmon populations. In 1991, the Snake River sockeye salmon was placed on the federal endangered species list. In the past, tens of thousands of sockeyes would make the 900-mile return trip from the sea to Idaho's mountain streams and lakes. There they spawned and died. Their offspring hatched and began their early development in fresh water. The actual migration to the Pacific Ocean could be completed in as few as 9 days. Today that trip takes more than 60 days. In 1991, only four Snake River sockeye salmon returned to their spawning grounds.

   To simulate these increases in salmon limiting factors, play several rounds of "Hooks and Ladders." Allow each round to represent the passage of 25 years. Start in 1850. In that year, do not include dams or commercial fishing operations in the scenario. As time passes, add the human commercial fishing operations. Build dams (jump ropes) as the scenario progresses into the 21st century.

   Describe some of the possible effects on salmon from increased limiting factors as a result of human activities and interventions. Discuss possible positive and negative effects on both people and salmon from these increases in limiting factors affecting salmon. When the activity reaches "the present," predict what might happen to salmon in the future. Recognizing the complexity of the dilemma, discuss possible actions, if any, that might be taken to benefit both people and salmon.
10. Find out if salmon exist in your state. If so, are they native or were they introduced?

Evaluation

1. List, describe, and illustrate the major stages in a Pacific salmon's life cycle.
2. Identify and describe some of the limiting factors that affect salmon as they complete their life cycles.
3. Identify and describe some limiting factors that might affect other animal populations.

Pond Succession

Objectives

Students will (1) recognize that natural environments are involved in a process of continual change (2) discuss the concept of succession, (3) describe succession as an example of the process of change in natural environments, and (4) apply understanding of the concept of succession by drawing a series of pictures showing stages in pond succession.

Method

Students create murals showing three major stages of pond succession.

Materials

Long pieces of drawing paper for murals, tape for securing paper to walls, drawing materials

Grade Level: 5–8

Subject Areas: Science, Social Studies, Environmental Education, Expressive Arts

Duration: one or two 30-minute sessions or longer

Group Size: any

Setting: indoors (outdoors optional)

Conceptual Framework Topic Reference: CAIA, CAIB, CAIB1

Key Terms: succession, sediment, change, pond

Appendices: Ecosystem

Background

Succession is a term used to describe the ever-changing environment and the gradual process by which one habitat is replaced by another. Many habitats that appear to be stable are changing before us, perhaps at a slow rate in human eyes, but are evolving rather quickly according to the Earth's clock.

For example, a shallow pond may be transformed into a marshy, then a forested, area in only a thousand years or so. Windblown or waterborne spores of algae are the first inhabitants. Eggs of flying insects are deposited. Small fish and amphibians arrive through the inlet. Surrounding sediments begin to fill the pond, some borne on wash-out from rainfall, some entering through the pond's inlet. Marshy plants growing along the shoreline spread inward as sediments fill the pond. Land plants also spread inward and replace the marsh plants as the ground is consolidated. As more plants and animals enter the system, more opportunities for habitat become available to others. Changes from ponds to forest are only one example of succession.

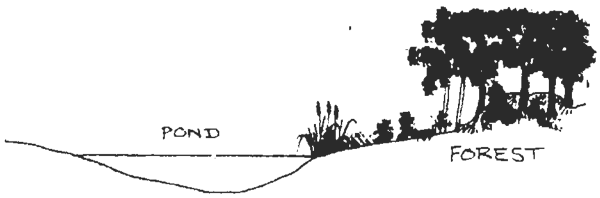
Succession is generally thought of as an orderly process in which plant communities change over time in an environment. Theoretically, succession begins with bare ground and is completed when a climax forest, grassland, or other environment becomes established. Seral or early successional plants are generally short-lived, thrive in sunlight, colonize rapidly, and spread their seeds far and wide. Roadsides, recent burns, clear-cuts, and other areas of recent disturbance are good places to find examples of early succession.

The first plants change the environment by adding nutrients to the soil from fallen leaves and other plant parts, and by providing shade to the soil. These changes allow other plants to grow. The presence of the newer plants changes the environment to allow even later stage successional plants to develop. Climax or late successional plants usually thrive in shade, live a long time, and reproduce more slowly. Old growth forests are good examples of a climax stage of succession.

Succession influences what kinds of animals live in an area. As the plants in an area change, the habitat available to animals changes character. Therefore, the kinds of animals that live in the area are associated with the area's stage of succession.

Procedure

1. Review with students the idea of succession, a process that is generally an orderly, gradual, and continual replacement of one community of organisms in an environment with another.
2. Start the activity by talking about a pond. How many people have seen a pond? What did it look like? After a description of ponds, ask the students to imagine what a pond would look like from a side view if you could see under the water and show the nearby environment. For example,



3. Explain to the students that they will be drawing a series of three views of a pond over a period of about 800 years. The first (left-hand) section will show the pond as it is today, the middle section will show how it might look 500 years later after natural changes, and the third (right-hand) will show how the pond could look in 800 years. (These time periods are approximate and can vary greatly.)
4. Discuss with students the possibilities of plant and animal life in the first section. What kinds of plants and animals live
   - in the water,
   - along the shoreline, and
   - in the surrounding area?
5. Then give each group a piece of paper that members will divide into three equal sections (by folding or drawing). Instruct students to fill in the first section with their drawing of the pond and the surrounding area. Set a specific time frame for the students to draw (about 10 minutes).
6. Bring the class together again for a discussion of the second section, which will be labeled "500 Years Later." Consider the following items:
   - What changes have taken place in the environment?
   - How will the pond look now?
   - What lives and grows in the water now that it is much shallower and smaller?
   - What lives and grows around the shoreline, which is now more marsh-like? (Marsh animals and plants, perhaps some willow bushes.)
   - What lives and grows in the surrounding area? (Larger trees, same types of animals.) Have each group complete the second section of their mural, labeling it "500 Years Later."
7. Repeat the process for the third section, labeling it "800 Years Later" and discussing the following topics:
   - By this time, the pond is almost totally filled with sediment, leaving only a small marshy area with perhaps a stream running through. What changes have taken place?
   - What lives and grows in the environment?
   - What lives and grows where the shoreline used to be? (Bushes, small trees.)

continued

- What effects does the pond succession have on the surrounding area? (Different animals, trees requiring less water.)

8. After the murals are completed, students should sign them. Then they may be displayed in the classroom so all students can see and discuss differences and similarities among the various murals. Ask the students to summarize what they have learned, including how succession is one example of the ongoing process of change in natural environments.

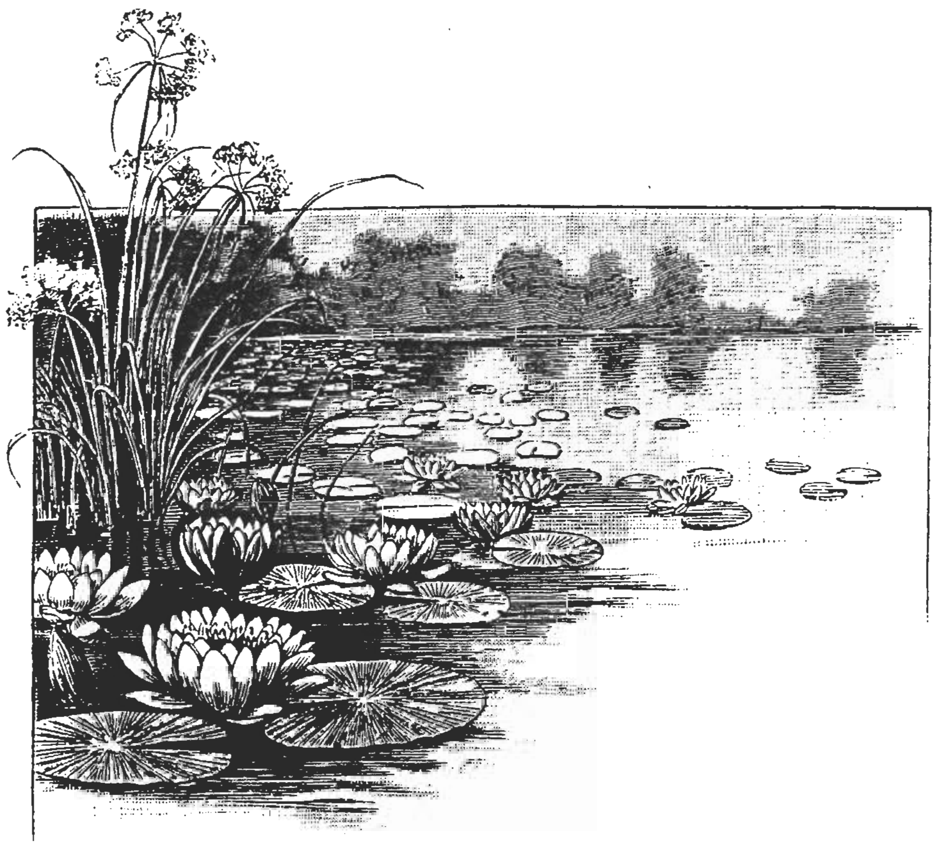
Variation: Use a stream table filled with standard soil to illustrate three-dimensionally the processes of succession. Fill the table with soil; make an indentation in the center to represent the pond; run water into the table to represent rainfall, streams feeding the pond, and so forth; and watch the pond fill as sedimentation takes place. This table can show the geologic life cycle of the pond. Add replicas of plants and animals during successional stages for even more interest.

Extension

What might happen to your model of succession if an intense forest fire burned the trees surrounding the pond? Would the pond silt in faster? Would there be a source for tree seeds to colonize the pond site? Would there be differences if the fire were not as hot? How might fires affect the species that live there? Describe some possible differences in environments where fire affects succession and where it does not.

Evaluation

1. Draw a picture, with explanations, to show stages in pond succession.
2. Select a field, vacant lot, park, or other area in your community. Make a sketch and write a paragraph to describe the area as it appears today. Make a sketch and write a paragraph to describe what the area might look like in 100 or 500 years from now if a gradual process of succession took place.



When a Whale Is Right

Objectives

Students will (1) describe general characteristics and status of whales, (2) recognize that international alliances affect wildlife, and (3) evaluate the possible impact of wildlife issues on alliances and other relationships between and among nations.

Method

Students hold a hypothetical meeting of the International Whaling Commission.

Materials

Writing materials, research materials

Background

Whales are the largest animals on Earth. There are approximately 80 known species of whales, which range in size from approximately 4 to almost 100 feet in length, and from 160 pounds to 220 tons in weight. Whales are mammals, bearing live young. Some research suggests that whales and other Cetacea, including the dolphins, are creatures of such intelligence that—among other things—they have unusual capacities for communication.

Grade Level: 9–12

Subjects Areas: Social Studies, Environmental Education

Duration: two or three 45-minute sessions

Group Size: any, excellent for large group

Setting: indoors

Conceptual Framework Topic Reference: PLIIA

Key Terms: whale, Cetacea, alliance, regulation, commission, harvest, subsistence, sanctuary, species

Appendices: Agencies and Organizations

Out of concern for maintaining viable populations of whales, the International Whaling Commission (IWC) was established under the International Convention for the Regulation of Whaling. This treaty was signed in December 1946. The main duty of the IWC is to keep under review and revise as necessary the measures laid down in the Schedule to the Convention, which governs the conduct of whaling throughout the world. Those measures provide for the complete protection of certain whale species, designate specified areas as whale sanctuaries, set limits on the numbers and size of whales that may be taken, prescribe open and closed seasons and areas for whaling, and prohibit the capture of suckling calves and female whales accompanied by calves. The compilation of catch reports and other statistical and biological records is also required.

In addition, the commission encourages, coordinates, and funds whale research; publishes the results of scientific research; and promotes studies into related matters. Membership in the IWC is open to any country in the world that formally adheres to the 1946 Convention.

There are many stocks or populations of the twelve species of "great whales." Many of those have been depleted by overexploitation, some seriously, both in recent times and in earlier centuries. Fortunately, several species are showing signs of increase since their protection. Whales, like any other animal population, have a natural capacity to increase and a natural rate of mortality. A stock remains more or less in equilibrium at its initial level because those two factors balance one another. If the number of whales in a stock is reduced, the population will begin to rebound—possibly as a result of greater food availability—by higher pregnancy rates, earlier maturation, increased survival rates, or a combination of these factors.

In 1975, a new management policy for whales was adopted by the IWC using those characteristics. This policy was designed to bring all stocks to the levels that provide the greatest long-term harvests, as it sets catch limits for individual stocks below their sustainable yields. However, because of uncertainties in the scientific analysis and, therefore, the precise status of the various whale stocks, the IWC decided at its meeting in 1982 that there should be a pause in commercial whaling on all whale stocks from 1985 to 1986. A Revised Management Procedure has been developed subsequently, which the commission accepted and endorsed in 1994, but it has yet to be implemented. This plan balances the somewhat conflicting requirements to ensure that the risk to individual stocks is not seriously increased, while allowing the highest continuing yield. It is an important step in the development of wildlife resource management in that it takes into account the inevitable scientific uncertainty and requires relatively simple data to obtain information (knowledge of population size, past and present catches, and stock identity).

The pause in commercial whaling does not affect aboriginal subsistence whaling, which is permitted from Denmark (Greenland, fin and minke whales), the Russian Federation (Siberia, gray whales), St. Vincent and the Grenadines (humpback whales), and the United States (Alaska, bowhead, and occasionally gray whales).

As part of their response to the decision for a pause in commercial whaling, some member governments have implemented major research programs that may include the sampling of whales caught under special permits that the convention allows them to grant.

The commission also sponsors and promotes international research. A major undertaking has been a series of ship surveys of the Antarctic minke whale stocks. This series has now been expanded into a new Southern Hemisphere research program called SOWER. Other funded research includes work on developing and improving new techniques such as photo-identification studies, acoustic and satellite/radio tracking of whales, and genetic analysis of populations.

The Scientific Committee has been concentrating on a "Comprehensive Assessment" of whale stocks, defined as an in-depth evaluation of the status of the stocks in the light of management objectives. This latter emphasis led to the development of the Revised Management Procedure. The committee is also working to assess the effects on cetaceans of environmental change, such as global warming and pollution, and of whale watching activities.

The commission has no enforcement powers. Beyond economic sanctions and national laws by members, the commission relies on voluntary adherence to its rules. World public opinion is an important force on the commission and its member nations to make and enforce responsible conservation decisions.

Procedure

1. Divide the students into four groups. One group will research the International Whaling Commission, one will research nonwhaling nation members of the IWC, one will research whaling nation members of the IWC, and one will research whales.
2. Ask each group to conduct library and Internet research. Possible questions for each group might include the following:

International Whaling Commission

What is the International Whaling Commission? When, why, and how was it established? Who are its members? What members are whaling nations? Are there any active whaling nations that are not members of the IWC? If so, what

continued

are their current practices affecting whales? What are the major reasons for and against continued whaling? Include economic, political, cultural, scientific, and ethical considerations.

What positions do member nations tend to take on issues? For what reasons? What are the accomplishments of the IWC? What problems does the IWC face? What is the role of world opinion in affecting the activities of the IWC and its member and nonmember nations? What recent recommendations and regulations has the IWC passed? How effective does the IWC seem to be in meeting its objectives? What other international agreements affect whales? Which countries participate in these agreements?

Nonwhaling Nation Members of the IWC

Have these nations ever actively engaged in whaling? If yes, what are historic reasons for whaling among people of their nation? For what reasons are these nations now nonwhaling nations? How did they vote on the moratorium decision of 1982? What, if any, national laws do they have involving whales?

Whaling Nation Members of the IWC

What are historic and contemporary reasons for whaling among people of their nation? What practices have they used and do they use in killing whales? What regulations, if any, do they support that affects the killing of whales? How did they vote on the moratorium decision of 1982? What, if any, national laws do they have involving whales?

Whale Researchers

How many different kinds of whales exist today in the world? Have any whales become extinct? If yes, which? What are the characteristics of the different whale species? What is the status of each of these species? What is the reproductive rate and success of these species? What population increase is possible? What food and other habitat needs do they have? What problems do they face? What species are most hunted and for what purposes, historically and in the present? Which species are most scarce and which are most abundant? How intelligent might they be? What does the future hold for whales?

3. After students have completed their research, set up the classroom to resemble a meeting hall. Hold a meeting of the IWC attended by scientific advisors and any guests, including other interest groups. Organize discussion and debate among the students, representing different interests (e.g., commercial interests, subsistence hunters, preservationists, animal welfare interests, conservation organizations).
4. The next task is to come up with a set of recommendations and regulations that the IWC, including its member whaling and nonwhaling nations, can agree upon. This task may be done through discussion by the whole class or by a subcommittee approach. If done by subcommittee, ask for volunteers to represent the IWC, with representatives of both whaling and nonwhaling nations. They should come up with a set of recommendations and regulations to present in written form to the rest of the class for review. Include other interest groups as well. Note whether this approach is actually how the IWC makes decisions.
5. Discuss any final recommendations. Evaluate the possible impact of wildlife issues on relationships between and among nations.

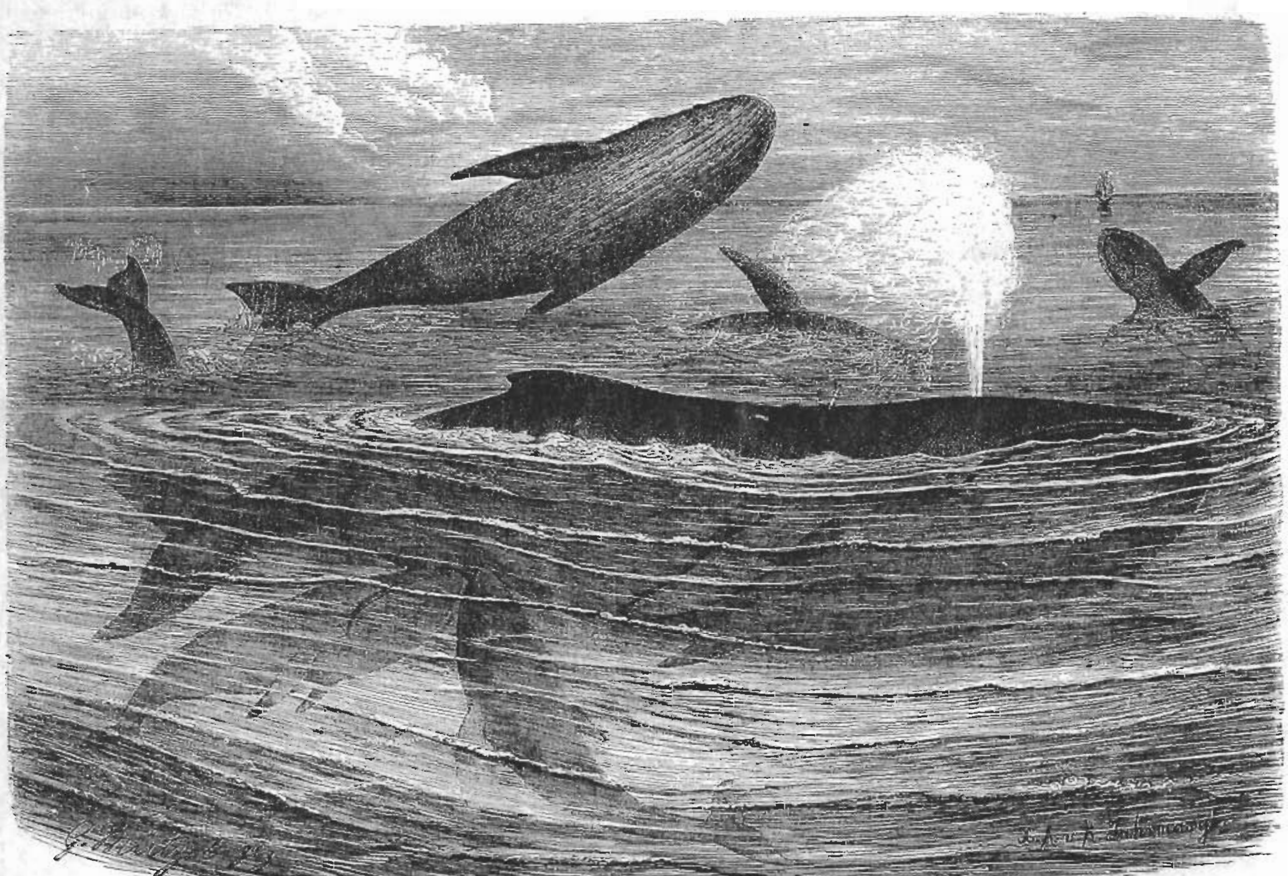
Extension

Identify any other international bodies that have an influence on aquatic species of wildlife. Research these groups and what issues are of concern to their organizations.

Evaluation

1. List four basic characteristics of two different species of whales.
2. Identify 10 countries that are members of the International Whaling Commission. Indicate the countries that are whaling countries, and list which species of whales they harvest. Explain how each country uses its harvested whales.
3. What is the purpose of the International Whaling Commission? Describe one action the Commission has taken to achieve its purpose. How are actions of the IWC enforced? What is your assessment of the IWC's importance and effectiveness?
4. Summarize your impressions of the impact of this issue—and other wildlife issues, if possible—on alliances and other relationships between and among nations.

NOTE: The name of this activity is not intended to imply that human use of whales is, or is not, a right. Students may want to investigate how the right whale was named, and discuss various interpretations of the meaning of "right" in this context.



Sea Turtles International

Objectives

Students will (1) analyze the policies and philosophies that countries have relating to wildlife ownership and protection and to habitat management, (2) explain the importance of international agreements and organizations that manage species that cross national boundaries, and (3) define the difference between ownership of land and ownership of wildlife.

Method

Students portray the political interactions of citizens from different countries who have a variety of perspectives on the conservation of wildlife and habitat.

Materials

Copies of the Scenario Cards (one card per student) and the Haves Cards

Grade Level: 9–12

Subject Areas: Social Studies, Environmental Education

Duration: two 45-minute sessions

Group Size: at least 18 students

Setting: indoors

Learning Framework Concepts: PLIB, PLIC, PLIIA, PLIIB

Key Terms: political process, international agencies, wants, needs, entrepreneur, compliance

Appendices: none

Background

The boundaries that exist between countries are more often political in nature than actual barriers and allow for the free movement of people and wildlife. Nations and their governments throughout the world vary on how they perceive the protection of wildlife and their habitats. The policies are based on the country's economics and culture. For instance, a developed country may be secure enough economically to be able to afford banning the sale of wildlife products or restricting the sale of property that would harm wildlife habitat. Developing countries often do not have this luxury. Those countries need to use all of the natural resources within their boundaries to sustain themselves economically. Even if a country has entered international agreements to protect wildlife and habitat, it may not have the funds to enforce those agreements, and its citizens may feel that the financial gain is worth the risk of breaking the law. Additionally, in some countries, land ownership includes the wildlife found on the land. Therefore, even if laws exist to protect wildlife and the habitat, private landowners are exempt.

With respect to culture, the people of some countries have used wildlife products for centuries as part of their lifestyle and customs. Cultures may use ground shells to treat arthritis, gall bladders to treat disease, or ground horns to improve fertility. People from such countries may have been eating rare animal parts as delicacies for generations. Wildlife products are often an integral part of cultural celebrations and ceremonies. As a result, countries may be reluctant to join international agreements banning the possession of animal products. Where usage is restricted, citizens may resort to obtaining the product illegally.

The sale of wildlife products has caused a decline in many populations of animals throughout the world. In the 1970s, four conventions were held among nations to protect certain migratory species: (1) the Convention on Migratory Species of Wild Animals, (2) the World Heritage Convention, (3) the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, and (4) the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). CITES was adopted on July 1, 1975, and currently has 146 member countries. Those countries have agreed to ban commercial, international trade of listed endangered species and require a license for trading threatened species as a way of monitoring those that may become endangered. While most countries have joined CITES and have ratified those agreements found within, not all comply stringently, as enforcement is decided by the individual country.

All species of sea turtles are either listed as endangered or threatened and are covered by CITES. Although sea turtle populations have declined, they are still being captured for their value and ties to cultural traditions. Sea turtles are found in oceans throughout the world. Some species migrate as many as 3,000 miles in a year often crossing one or more international boundaries. Besides being harvested in many countries, sea turtle populations are threatened by pollution and habitat loss. The turtles' nesting grounds, found on ocean beaches, are also declining because of development. Another threat to the sea turtle populations is the lights from homes and businesses along beach areas. After they hatch, baby sea turtles instinctively go toward light, which is usually moonlight over water. When sea turtle eggs hatch near developed areas, the lights from homes and businesses sometimes confuse the baby sea turtles and cause them to head inland instead of out to the ocean. Anglers catch sea turtles in their nets or cages. Turtle hunters around the world harvest sea turtles either legally or illegally to sell their shells, meat, or body parts to international traders. In some countries, sea turtle eggs are a delicacy and can be found in the open market.

Students will represent citizens of three different countries either trying to make a living, make a profit, gain wealth, enforce laws, or enforce international agreements. Each student will receive a description of their character, a list of their *"wants,"* and a list of *"haves"* (items to be exchanged to obtain their *"wants"*). It is the understanding of this exchange of *"wants"* and *"haves"* that drives the political process and allows the citizens to achieve their goals. In this activity, the characters are all connected by chains of need, and certain players are key to moving the solutions forward: the CITES representative who supports the judge, the judge who then issues a judicial order allowing the government bureaucrat to permit critical business developments, and the sea turtle advocate who supplies needed funding.

The purpose of this activity is to show that governments and societies develop different programs and policies relating to wildlife ownership and protection and to wildlife management. The movement of wildlife species across national boundries often necessitates the adoption of international agreements and the formation of international organizations to ensure the protection and management of these species.

Procedure

1. Review the background information with the students.
2. Hand out a Scenario Card to each student. If more than 18 students are in the class, ask the students to team up. Direct the students to group themselves into the three countries according to the information assigned to their character in their Scenario.
3. Describe each country using the background information on page 101. Briefly describe the various characters from each of the countries. Discuss probable economic and cultural issues found within each country that would affect the safety of sea turtles. Also, review any vocabulary that may be unfamiliar to the students, such as "entrepreneur" and "compliance."

continued

4. Give students time to review their own characters. Tell them that the objective of the activity is to collect ONE *Haves Card* for each *Want* listed in their scenario. They will get these *Haves Cards* from the other students during the activity.

5. Pass out the *Haves Cards*. Tell the students they will be keeping their scenario information, but they will distribute the *Haves Cards*. During the activity, they will (1) give away their initial *Haves Cards* to classmates who request them and (2) obtain the new cards they want. To find their cards, each student must first determine who the other characters are and who has the cards they want. Cards are obtained simply by asking for them. No direct trading is required. However, sometimes the initial holder of the card may not be permitted to give the card away until certain conditions specified on the card are met. Students should pay attention to and follow these conditions.

6. Begin the activity by letting the students move around the room to meet the other characters and fulfill their goals. Allow students time to work through their Scenarios. Tell the students to write on the cards the name of the character from whom they received the card. This information will help the class track the interactions during discussion later.

7. When all characters have fulfilled their needs by obtaining the necessary *Haves Cards*, tell the students to return to the three countries. Have the students describe their characters, what they wanted, and where they got the item they needed.

8. Discuss as a class the reactions and interactions that came about from the Scenario. Did all characters fulfill their *Wants*? Which characters had their *Wants* fulfilled by a character outside of their country? What difficulties did they find in getting their *Wants* met? How did the international organizations and agreements facilitate the protection of the sea turtles in this activity? What might have happened without their contributions? What more might be done?

9. Ask the students to differentiate between ownership of land and ownership of wildlife. In the United States, who owns wildlife? Ask the students if they can articulate the different policies and philosophies that these three countries had relating to wildlife ownership and protection and to habitat management. Did the students think the landowner wanted the poachers arrested in order to protect the turtles or to eliminate competitors? Students should support their responses.

Extensions

1. Investigate the Sea Turtle Survival League, and track a turtle's health and movement around the world. Go to the Sea Turtle Migration-Tracking Education Program at **www.cccturtle.org/sat1.htm**.

2. Research all of the products that have been made from migrating animals and that can be found in the United States. Determine their worth and their economic impact on both the buyer and the seller.

3. Research the endangered or threatened species that migrate between the United States and Canada or Mexico. Determine if there are any economic, cultural, or political circumstances that may create a desire to protect or poach these animals.

Evaluation

Have students choose a current conflict in the world dealing with the protection of wildlife species and international borders. Have students research the topography; natural features; economic, cultural, and political structures of the countries involved; and what, if anything, is being done internationally or locally to help the migrating wildlife. Students should specifically address how culture, economics, and politics of the selected countries determine the fate of wildlife species that cross international borders.

COUNTRY BACKGROUND INFORMATION

Pargimo

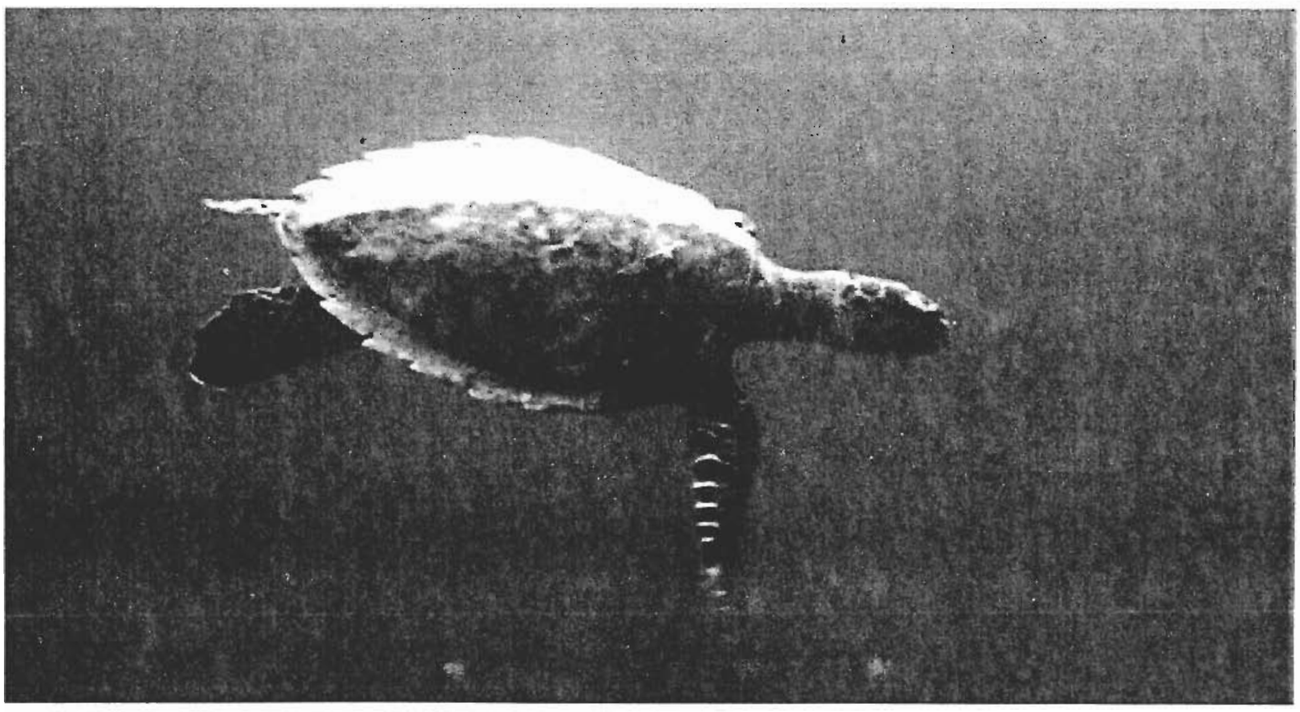
- Developing country.
- Some coastal land development.
- Coastal village income is based on fishing.
- Borders the Republic of United Peoples (RUP).
- Sea turtle and sea turtle eggs are a common food.
- Sea turtles, sea turtles eggs, and products made from sea turtles have been traded internationally for centuries and were an important part of the country's and individuals' incomes.
- Sea turtles migrate from the RUP coast to the Pargimo coast to spend their nonbreeding season.
- Some of the turtles migrate from the south of Pargimo to the north where they lay their eggs on the furthest northeast shores.
- A member of CITES, but lacking financial resources for enforcement.
- Ocean pollution by industrial sources is a concern.

The Republic of United Peoples (RUP)

- Developed country.
- A very active member of CITES with active enforcement.
- Borders Pargimo.
- Sea turtles migrate from the coast of Pargimo to the coast of RUP to lay eggs.
- Coastal lobster and shrimp fishery is a large source of income for many coastal communities.
- Extensive coastal land development.

Chumas

- Developed country.
- Landlocked, therefore, no sea turtles.
- Nonenforcing member of CITES.
- Culture encourages the use of sea turtles and sea turtle products as a food source, as a health aid, and for ceremonial uses.
- Black market for sea turtle products that goes unchecked by the government.



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Scenario Cards

Country: Chumas

Sea turtle jewelry dealer
Because you know how valuable sea turtle jewelry is all over the world, you buy as much as you can, even though it is prohibited.

Wants:
Turtles
Money

Country: Chumas

Restaurant owner
The people of your community have been eating sea turtle eggs and sea turtles for thousands of years as a delicacy. You buy as many eggs and turtles as you can.

Wants:
Turtles
Turtle eggs
Money

Country: Chumas

Turtle trader
Middle class. You buy sea turtles from collectors in Pargimo to sell to companies in Chumas that make medicine, ceremonial products, and traditional food. Although your work has been respected and needed, it has now become illegal.

Wants:
Job

Country: Chumas

Ceremonial sea turtle buyer
You buy products made from sea turtles to sell for ceremonial uses. People in your community have been using sea turtle products for generations. Without them, the ceremonies would fail and harm would fall on the village.

Wants:
Turtles

Country: Chumas

Turtle egg trader
Middle class. You buy sea turtle eggs from collectors in Pargimo to sell to companies in Chumas that make medicine and traditional food. Although your work has been respected and needed, it has now become illegal.

Wants:
Job

Country: Pargimo

Government bureaucrat
You are interested in the agency operating efficiently. You have received a request for a special land development permit, but because of the new CITES regulations, must wait for judicial orders before you can fulfill this request.

Wants:
Judicial order (requiring beach habitat to be set aside) for coastal building permits

Country: Pargimo

Landowner
You have extensive coastal land holdings but are cash poor and need money to rejuvenate other businesses. You believe wild animals are property of landowner. You want poachers arrested.

Wants:
Capital investment funds

Country: Pargimo

Judge
You are frustrated by a lack of professional recognition for community efforts. You would like to further CITES by requiring developers to set aside beach natural areas for turtle habitat when applying for building permits. You hope that ecotourism will develop. You believe wildlife belongs to the public for protection.

Wants:
Professional recognition

Country: Pargimo

Collector of turtles (poacher)
You poach turtles from beach and ocean to sell to traders in Chumas in order to support large family. You believe wildlife should be available for public taking, but would prefer a legal job.

Wants:
Job

Country: Pargimo

Collector of turtle eggs (poacher)
You poach turtle eggs from beach to sell to traders in Chumas in order to support large family. You believe wildlife should be available for public taking, but would prefer a legal job.

Wants:
Job

Country: Pargimo

Wildlife biologist and manager
You are frustrated by poaching of turtles and by news of potential beach development. You would like to see the beaches protected and have a way to replenish the population of baby turtles.
You believe wildlife belongs to the public.

Wants:
Beach in natural condition
Compliance by poacher
Turtle eggs

Country: Pargimo

Law officer
You are required to arrest poachers and traders of turtles or turtle products. Your position is difficult because you personally know the families that are trying to subsist through this illegal activity. You believe wildlife should be available for public taking, and you wish you did not have to arrest poachers.

Wants:
Compliance by poacher
Compliance by trader
Compliance by ceremonial sea turtle buyer

continued

Country: The Republic of United Peoples

CITES organization head stationed in Pargimo
You are trying to ensure that the agreements of CITES are being enforced. You are well connected to government and environmental organizations in your country, and are willing to help anyone achieve recognition who facilitates compliance with CITES regulations.

Wants:
Compliance by poacher
Compliance by trader
Compliance by ceremonial sea turtle buyer

Country: The Republic of United Peoples

Sea turtle advocate
You are an advocate for the protection of endangered and threatened species. You would like to see the coastal areas left in a natural state and the citizens respecting the new laws to protect the turtles. You are well financed.

Wants:
Beach in natural condition
Compliance by poacher
Compliance by trader
Compliance by ceremonial sea turtle buyer

Country: The Republic of United Peoples

Wealthy developer
Because of increased demands for isolated vacation sites, your company plans to buy land on the southeast coast of Pargimo—natural areas that are prime sea turtle egg laying habitat. You plan to develop the area by building an elegant but rustic-looking hotel/lodge and to make a profit for the company and its investors.

Wants:
Money
Land
Land development permit

Country: The Republic of United Peoples

Entrepreneur
You would like to make a fresh start and move to Pargimo. The business you would like to develop is a turtle farm. Most of the turtles raised on the farm will be sold to local companies, although a set number of turtles can be donated to natural resource agencies each year if needed to maintain populations. You need a loan to begin the business.

Wants:
Start-up funds
Business operating license
Hotel

Country: The Republic of United Peoples

Tourist
You are looking for rare items (food and jewelry) to buy. You also need some experimental medicines not found in the RUP. On future trips, you would like to find a safe, comfortable hotel for your family to "get away from it all." You would also like to find out about local natural features for this next trip.

Wants:
Food Jewelry
Medicine Safety
Information on natural features

Country: The Republic of United Peoples

Owner of pharmaceutical company
Your company makes medicines, but the high cost of labor in the RUP is forcing you to move to Pargimo, where salaries are lower. It would also be closer to a source of turtle eggs, which contain chemicals that are ingredients in some medicines.

Wants:
Money
Turtle eggs
Business operating license

Haves Cards

Initially hand these cards out to the students representing the character typed in bold on the card. Most characters will get several cards. These cards will be traded to other characters during the activity. (Note trading conditions in *italics*.)

Country: Chumas **Sea turtle jewelry dealer** Jewelry *May not be sold until receives turtles.*	Country: Chumas **Restaurant owner** Food *May not be sold until receives turtles.*
Country: Chumas **Turtle trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Ceremonial sea turtle buyer** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Ceremonial sea turtle buyer** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Ceremonial sea turtle buyer** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle egg trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Turtle egg trader** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle egg trader** Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Landowner** Beach in natural condition *Card may not be given away until judicial order is issued setting aside this land.*
Country: Pargimo **Landowner** Land *May not sell until notified that developer has received a land development permit.*	Country: Pargimo **Landowner** Beach in natural condition *Card may not be given away until judicial order is issued setting aside this land.*
Country: Pargimo **Collector of turtles** (poacher) Compliance to Laws *May not be given until receives a job.*	Country: Pargimo **Judge** Judicial order (to set aside habitat) *Will not be issued until receives professional recognition from CITES.*

continued

Country: Pargimo **Collector of turtles** (poacher) Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Collector of turtles** (poacher) Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Collector of turtles** (poacher) Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Wildlife biologist and manager** Information *May be given at any time.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Government bureaucrat** Land Development Permit *Cannot be given until a judicial order is received.*	Country: Pargimo **Law enforcement officer** Safety *May be given at any time.*
Country: Pargimo **Government bureaucrat** Business operating license *May be given at any time.*	Country: Pargimo **Government bureaucrat** Business operating license *May be given at any time.*
The Republic of United Peoples **CITES organization head stationed in Pargimo** Professional recognition *May be given at any time.*	The Republic of United Peoples **Sea turtle advocate** Start-up funds *May be given at any time.*
The Republic of United Peoples **Wealthy developer** Capital investment funds *May be given at any time.*	The Republic of United Peoples **Entrepreneur** Job *May not be given until start-up funds and business operating license are received.*
The Republic of United Peoples **Wealthy developer** Hotel *May not be given until a land development permit is received.*	The Republic of United Peoples **Entrepreneur** Job *May not be given until start-up funds and business operating license are received.*

The Republic of United Peoples
Entrepreneur
Turtles
May not be given until start-up funds and business operating license are received.

The Republic of United Peoples
Entrepreneur
Turtles
May not be given until start-up funds and business operating license are received.

The Republic of United Peoples
Entrepreneur
Turtles
May not be given until start-up funds and business operating license are received.

The Republic of United Peoples
Entrepreneur
Turtle Eggs
May not be given until start-up funds and business operating license are received.

The Republic of United Peoples
Entrepreneur
Turtle eggs
May not be given until start-up funds and business operating license are received.

The Republic of United Peoples
Entrepreneur
Turtle eggs
May not be given until start-up funds and business operating license are received.

The Republic of United Peoples
Tourist
Money
To be exchanged directly for item on "Wants" list only.

The Republic of United Peoples
Tourist
Money
To be exchanged directly for item on "Wants" list only.

The Republic of United Peoples
Tourist
Money
To be exchanged directly for item on "Wants" list only.

The Republic of United Peoples
Tourist
Money
To be exchanged directly for item on "Wants" list only.

The Republic of United Peoples
Owner of pharmaceutical company
Job
May not be filled until business operating license and turtle eggs are received.

The Republic of United Peoples
Owner of pharmaceutical company
Job
May not be filled until a business operating license and turtle eggs are received.

The Republic of United Peoples
Owner of pharmaceutical company
Medicine
May not be filled until business operating license and turtle eggs are received.

The Glass Menagerie

Objective

Students will describe the characteristics of oligotrophic and eutrophic aquatic habitats, emphasizing the effects of nutrient loading.

Method

Students observe and describe changes in physical characteristics of several different experimental aquatic habitats that they create.

Materials

Seven 1-quart (1-liter) glass jars; masking tape for labels; 1 gallon (4 liters) of distilled water; tap water; a small bottle of household plant fertilizer; a roll of aluminum foil; 1 gallon (4 liters) of recently gathered pond water (with abundant life forms); microscopes, both stereo and standard; soda straws; identification guides for pond life

Grade Level: 9-12

Subject Areas: Science, Environmental Education

Duration: four weeks for classroom observations

Group Size: any

Setting: outdoors and indoors

Conceptual Framework Topic Reference: HIIIB5

Key Terms: oligotrophic, eutrophic, nutrient loading

Appendices: Ecosystems, Field Ethics, Outdoors, Animals in the Classroom

Background

A healthy body of water is a delicate balance of dissolved oxygen, nutrients, temperature, and transparency. The amount of plant and animal life in a pond or lake depends on the balance of these factors.

When the water of a young pond or lake is cold and clear, it supports very little life. Over time, erosion and runoff bring organic material into the lake. The organic material—drainage from surrounding watersheds (runoff), bottom sediments in the lake and organisms (living and dead)—are broken down by the bacteria and become food for nutrient loving algae. As the algae multiply, so do the number of fish that feed on the algae. Over time, as the lake fills with the silt from the erosion and runoff and as the water becomes warmer, marsh plants take root and fill the lake basin. Fish populations and other aquatic organisms decline because of the limited dissolved oxygen. When this change happens, a lake or pond supports more plant life than animal life, and its waters are rich in nutrients.

A pond or lake low in nutrients is called "oligotrophic." Low plant production and high transparency (clear water) characterize lakes that are oligotrophic.

The clarity of the water is correlated to the absence of an abundance of plant life. Oligotrophic lakes often have a relatively small surface area and greater depth. They also tend to have sand or gravel bottoms.

In eutrophic systems, the organic materials, or nutrients, can cause modifications to the

continued

lake such as algae blooms and small fish kills. A sudden bloom of algae uses up the nutrients rapidly and is often followed by an alga die-off. The algae that have died begin to decompose rapidly. Bacteria promoting the decomposition use up much of the available oxygen in the water. During the night, the algae continue to use oxygen that fish and other aquatic organisms need to breathe.

Human activity increases the rate of eutrophication in lakes. Domestic sewage, industrial wastes, and chemical fertilizers are some of the sources of human-caused nutrient enrichment. These "unnatural" nutrients are frequently introduced into lakes through municipal and industrial discharges.

Eutrophication can be good or bad, depending on degree and perspective. Usually, lakes in the early stages of eutrophication provide excellent recreation and fishing. In later stages, as nutrients build up, lakes can become obstructed with vegetation and covered with algae. This condition typically indicates that a lake or pond has a nutrient overload. Eutrophication is a natural process that can be accelerated by humans. This acceleration is called "nutrient loading," and it has complex effects on people, wildlife, and the environment.

Procedure

NOTE: The following procedure is designed to have students explore the aspects of eutrophication. Further investigation and discussion of the characteristics of oligotrophic and eutrophic lakes in terms of depth, surface size, temperature, and turnover are encouraged.

1. Collect (with the students if possible) a gallon of viable pond water. The water must be a source of active organisms, both plant and animal. A microscope may be needed to verify how active the organisms are.
2. Label and prepare the seven jars as follows:
   - Jar 1 Control—3 cups (750 ml) distilled water.
   - Jar 2 Distilled Water—3 cups (750 ml) distilled water, ½ cup (125 ml) pond water.
   - Jar 3 Tap Water—3 cups (750 ml) tap water, ½ cup pond water.
   - Jar 4 Pond Water—3 ½ cups (875 ml) pond water.
   - Jar 5 Distilled Water with Fertilizer—3 cups (750 ml) distilled water, normal amount of fertilizer (as on instructions), ½ cup (125 ml) pond water.
   - Jar 6 Distilled Water with Fertilizer Overload × 10—3 cups (750 ml) distilled water plus 10 times the normal fertilizer, ½ cup (125 ml) pond water.
   - Jar 7 Distilled Water with Fertilizer Overload × 20—3 cups (750 ml) distilled water plus 20 times the normal fertilizer, ½ cup (125 ml) pond water.

   NOTE: Be sure to agitate the pond water before introducing it into the other jars. It is best to have equivalent concentrations of life forms in each of the experimental jars. Save the leftover pond water for examination with the microscopes.
3. Cap the jars loosely with aluminum foil to prevent excessive evaporation. Place the jars in a cool, visible, and well-lighted place. Avoid placing the jars in direct sunlight. The students will now observe and record what takes place in the jars for a 4-week period. As a pre-assessment, ask the students to generate a hypothesis concerning the effects or outcomes in each of the jars. Tell them they will test their hypotheses against the evidence they gather during the 4-week observation period.
4. Have students use microscopes, either standard or stereoscopic, to examine the pond water not used in the experimental jars. Have them record their observations, including drawings or illustrations of the various life forms found in the water. Research the names of the animals in identification guides or other resource books on pond life.

5. Throughout the observation period, record daily entries on a data sheet for each jar. These observations may be completed with or without the use of microscopes, as changes will be visible to the eye without optical assistance. Have the students work on a rotation basis for the data recording.
6. Some changes will begin to appear during the second week of the experiment. When life forms begin to be visible, use an eye-dropper to remove some organisms carefully for study with a microscope.
7. Observe changes in the jars, and discuss the findings.
8. At the end of the 4-week observation period, discuss the role of nutrients and how they occur in nature. Label the jars with abundant organisms "eutrophic," showing nutrient loading. Label the jars without many organisms "oligotrophic." What is the role and impact of accelerated growth caused by introduced nutrient loads? What are the natural sources of nutrients and human-related sources? Compare the similarities and contrast the differences. How does nutrient loading change the number of life forms in the water? What are the indications of these accelerated changes? What kinds of effects might nutrient loading have on aquatic wildlife? On people? OPTIONAL: If possible, end the activity with a visit to the pond where the water was collected. If possible, visit lakes or ponds at various stages of eutrophication.

Extensions

1. Investigate the role of temperature and dissolved oxygen in pond life.
2. Investigate the role of pollutants in pond life.
3. Find out whether a pond or lake in your community is directly affected, indirectly affected, or both by eutrophication.

Evaluation

Code each of the following as a characteristic of eutrophic lakes (E), oligotrophic lakes (O), both kinds of lakes (B), or neither type of lakes (N) by writing one letter beside each statement.

______ Deep, greater than 60 feet (18 meters)

______ Have many species of plankton (both zooplankton and phytoplankton), but low number of each species

______ High transparency (can see a long way down into the water)

______ Large number of fish that many people consider desirable

______ Large amount of decaying organic matter

______ Little oxygen available

______ Large amount of algae

______ Taste and odor problems

______ Bacteria mostly aerobic (oxygen using)

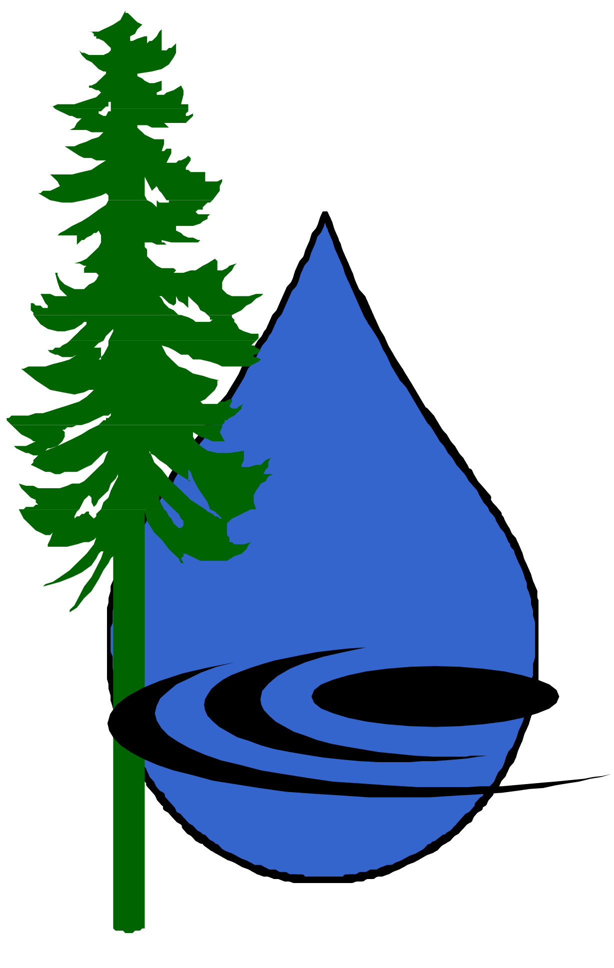
______ A result of natural or human-caused erosion

______ High total productivity

______ Few plant nutrients (nitrates, phosphates, manure)

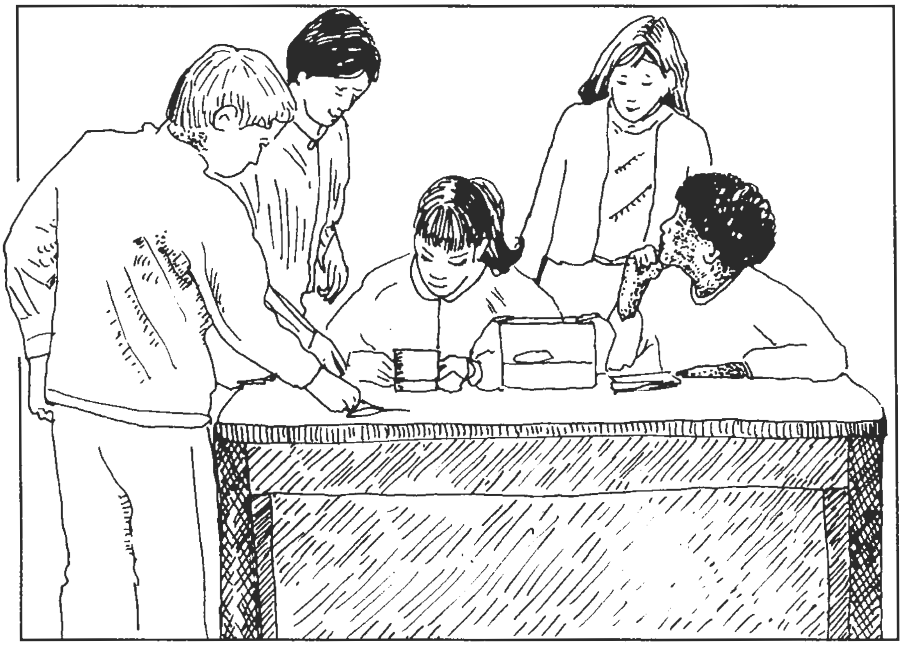
______ Considered an old lake, in terms of succession

______ High rate of nutrient cycling



Alaska's Ecology

It's Alive! Or is It?
1 EXTENSION



Section 1
ECOLOGY ACTIVITIES

Grade Level: 3 - 12

State Standards: S B-1, S B-2, S B-5, S B-6

Subject: Science, language arts

Skills: Observing, classifying, note-taking, predicting

Duration: One or two 50-minute periods over one week

Group Size: 2-3

Setting: Indoors

Vocabulary: Ecosystem, living, microscopic, mold, nonliving, organism, spores, yeast

Objectives:
1. Given a variety of living and nonliving objects, students will be able to identify some of the differences between living and nonliving things.

2. Students will work in groups to describe and perform some experiments to determine whether an object is living or nonliving.

Teaching Strategy:
Students examine and classify a variety of living and nonliving things and then test their conclusions.

Complementary Activities:
"Five Kingdoms But No King," "Investigating Heat Energy," "Investigating Soil," "Investigating Water," "Investigating Air," *and* "Take a Deep Breath" *in this section. All the* "Investigating ..." activities *in Section* 3, *Living Things in Their Habitats.*

Materials:
A jar of water, a jar of air, soil, a rock, a ray of sunlight (*if possible*), a wind-up toy, a group of rocks (*two large and several small*), sugar crystals (*a jar of water with sugar dissolved in it and a string – allow to set for a day prior to class*). Photocopies of data sheet – one per group per station (*following*), microscopes, slides and covers, hand lenses, or bug boxes.

A small bird or mammal, several different live insects and/or other invertebrates (*such as flat worms, shellfish*), microscopic organisms, yeast, bread mold, spores from a fern or mushroom, and various kinds of plant seeds. Try to include at least some small living things that are unfamiliar to your students. Number the objects.

Background:
See INSIGHTS, *Section* 1, *Elements of Ecosystems*.

Procedure:
IN ADVANCE: at least one day earlier, dissolve sugar in hot water and hang a string into the water so that crystals will form. Number the objects to be identified and label them or their containers with any specific rules (*e.g.* "*Do not open*" *or* "*Handle Gently*").

BEFORE CLASS: place the selected materials at numbered stations around the room.

1. IN CLASS, discuss the differences between living and nonliving things. *All living things are able to move, to reproduce in some way, to change, and to respond to stimuli from their outside environment.* Use examples of things commonly found in the classroom as a basis for discussion.

2. On the chalkboard, create a class list of the traits of living things.

3. Explain that students are scientists from another planet, and that the items placed around the room were found on Planet Earth by their expedition. As scientists, they must create and use tests to determine which of the objects are living and which are nonliving.

4. Discuss a few questions that might be asked in these tests to start the students thinking. *Does the object die without sun, water, or oxygen? Does it move? What happens when you poke it?* The students may conclude that further tests are needed, but they must describe these further tests.

5. Divide into groups. Each group determines the tests that it will use to decide whether an object is alive.

6. Groups then visit each station, performing their tests on each object and recording the results. Tasks can be divided so that all students are involved in testing and recording data during the experiments.

(*Teachers may want to model how to take data and summarize findings into conclusions before sending groups out to the stations.*)

7. Before leaving each station, students should summarize their conclusions regarding which objects are living and which are not, based on the tests performed by their group. Before students switch stations, give them five minutes to write their summaries. Remind the scientists that before they return to the spaceship, all data must in writing!

8. After students have visited all stations, tally the class findings for each item on the blackboard.

9. Ask students to explain why their group classified the item as living or nonliving. What tests did they conduct and what were the results? What other tests might they conduct to better determine the classification of items? *Prompt students to think of observing the questionable objects over time to see if they grow, change or reproduce.*

10. Keep the stations in question in place for several days or a week, so students can compare the items over time. You may want to grow the seeds and the spores to prove they are alive, but explain they need to be placed in the proper environment to grow.

11. Ask whether further observations change any opinions about the classification of the various items. In the end, reveal the actual classification of the items, and discuss any discrepancies between the students' conclusions and the facts.

Evaluation:

1. Students name living and nonliving things in their report as space scientists and tell what tests they used as the basis for their conclusions.

2. Give students a set of new, ambiguous objects. Have them tell or write how they would test the objects to see if they are living or nonliving.

3. Students write their own definitions of the terms "living" and "nonliving."

EXTENSION:

Living and nonliving charades. Review the differences between living and nonliving things (*the ability to move, respond to environment, grow, and reproduce*) with the class. Place drawings, photos, or names of various living and nonliving things in a jar. Divide the class into groups and have each group choose an item from the jar. Allow the group time to decide how to pantomime their item. Groups take turns performing.

Each group in the audience has one chance to determine if the item is a living or nonliving thing. Each group should either write down its answer or tell it to the teacher. Each group that answers living or nonliving correctly, gets one point. The actors receive one point for each group that answered correctly, indicating that they were good actors.

You may choose to award bonus points to both the actors and answering groups if any can identify the pantomimed item more specifically (*i.e., animal, plant, fungi, microscopic organism, seaweed, or other categories*). Play one or more rounds. The group with the most points wins.

Curriculum Connections:
(See appendix for full citations)

Books:
Ecology (Pollock)

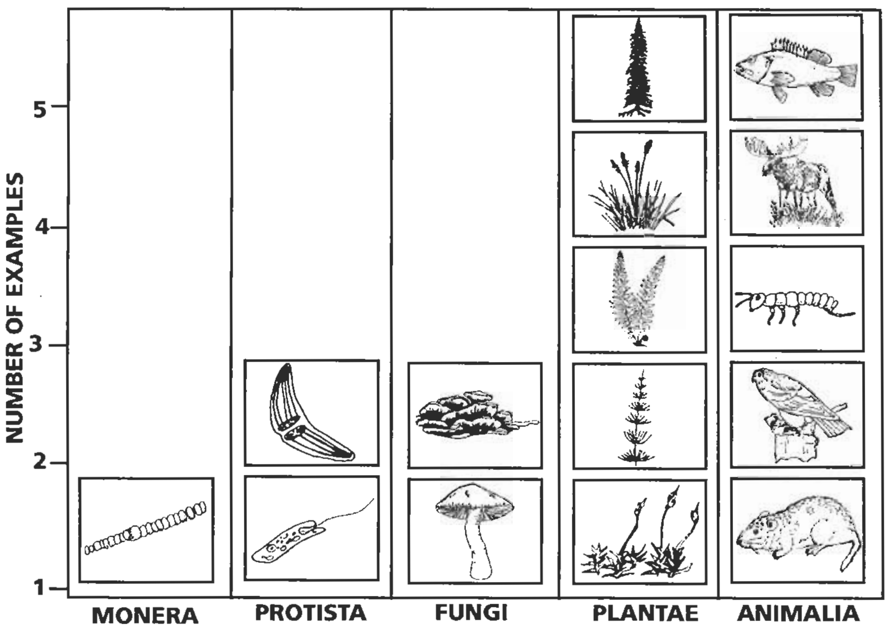
DK *Science Encyclopedia* (also on CD)

How Nature Works (Burnie)

Teacher Resources:
(See appendix)

Five Kingdoms But No King

ALERT: ALASKA ECOLOGY CARDS OPTIONAL



Section 1
ECOLOGY ACTIVITIES

Grade Levels: 1 - 6

Subjects: Science, language arts, art

Skills: Classifying, applying, drawing, listening, sorting

Duration: Two 30-minute periods

Group Size: Any

Setting: Indoors

Vocabulary: Algae, Animalia, bacteria, detritivores, eukaryotic, Fungi, living things, kingdoms, Monera, nonliving things, Plantae, prokarotic, Protista

Objectives:

1. Students will name the five kingdoms of living things.

2. Students will be able to identify an example from each kingdom.

Teaching Strategy:

Students become more familiar with living and nonliving things in an ecosystem and with the five kingdoms by classifying sets of pictures.

Complementary Activities:

"It's Alive, Isn't It?" *in this section. And all* "Investigating...." *living things in their habitats* activities *in Section* 3.

Materials:

"Five Living Kingdoms" fact sheets (*from* INSIGHTS *Section* 1). *Alaska Ecology Cards* or magazines and/or books (*that can be cut*) with pictures of nature or wildlife. Index cards (3x5 or 5x7) at least five per student, glue, crayons or markers, and something to represent each of the five kingdoms (*pond water for protists, mushrooms and lichens for fungi, microscope slides of bacteria for monerans*).

Background:

See INSIGHTS, *Section* 1, *Elements of Ecosystems*.

Procedure:

1. Review definitions for the terms **living** and **nonliving**. Brainstorm with students a list of living and nonliving things. Introduce the Five Kingdoms of Living Things and discuss the differences between each. Ask students to think of representatives of each kingdom.

VARIATION FOR YOUNGER STUDENTS

For younger students, teachers may want to focus on the plant and animal kingdoms, or on the concepts of "living" and "nonliving."

2. *This step may be done in class, as homework, or as preparation by the teacher*: Ask students to go through the resource materials and make a collection of pictures of living things from the five kingdoms and some nonliving things. Encourage students to look

for microscopic living things as well as large, easily recognizable things.

3. Students draw or paste their pictures on separate index cards. Each student makes five cards, one image per card. If appropriate, students write the name of the pictured item on the card. Collect the cards.

3. Divide the class into teams or have students play individually. Shuffle all the cards together.

4. Pass 5-10 cards to each team, leaving a small class pile in the center. Explain that the object of the game is for each team to get rid of all its cards by correctly classifying the item pictured.

5. Depending on grade level and experience, the cards can be classified as living or nonliving, or by kingdoms. The teacher calls out a category, living or nonliving (or plants, animals, fungi, etc.).

6. If a team has a card that fits the category, the students should hold it up. If their classification is correct, they discard the card to the central pile. If their classification is wrong, they have to draw another card from the pile and they can't discard. Allow the teams time to come to a decision among themselves about which card to hold up.

7. The first team to discard all of its cards wins.

Evaluation:

1. Students list the five kingdoms of living things and give an example for each.

2. The teacher posts a blank bar graph of the Five Kingdoms of Living Things. Each student randomly chooses any five cards and sorts them according to the appropriate kingdom. Students glue their cards on the graph in the appropriate column. The teacher checks each student's placement.

Curriculum Connections:

(See appendix for full citations)

Books:

DK *Science Encyclopedia* (also on CD)

How Nature Works (Burnie)

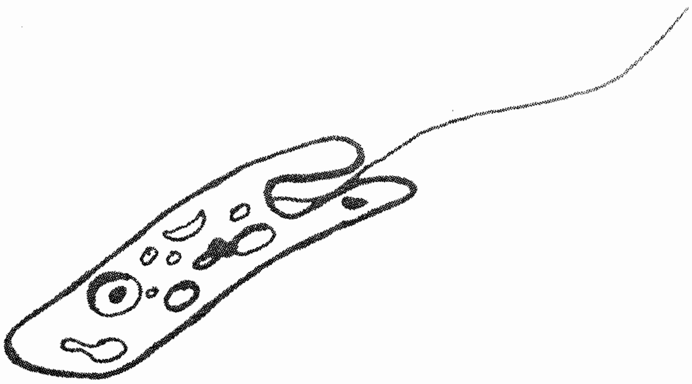
Nature (Rainis)

Website:

Natural Perspective (on-line periodical)
<www.perpective.com/nature>

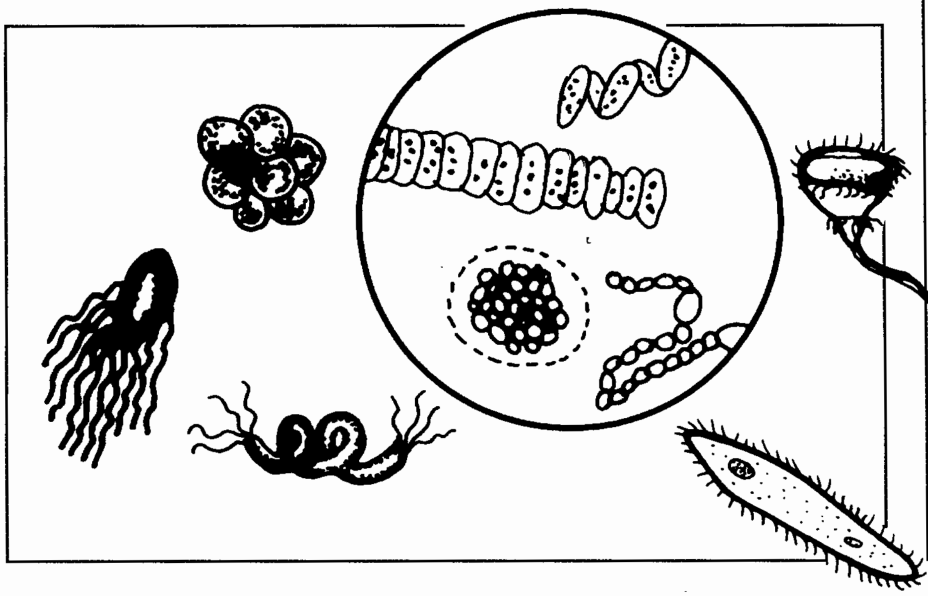
Teacher Resources:

(See appendix



Investigating Monerans and Protists

2 EXTENSIONS ***ALERT: ALASKA ECOLOGY CARDS OPTIONAL***



Section 3
ECOLOGY ACTIVITIES

Grade Level: 4 - 12
State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6
Subject: Science, math, language arts, art
Skills: Observing, recording, analyzing, describing, drawing, computing, measuring, estimating, identifying
Duration: 2 50-minute sessions
Group Size: 2-4
Setting: Indoors /outdoors
Vocabulary: Amoeba, cilia, cyanobacteria, euglena, habitat, microscopic organism,

Objectives:

1. Students will observe and describe one-celled organisms in their local ecosystem, noting their visible characteristics in writing.

2. Students will describe some of the habitats where monerans and protists can be found.

Complementary Activities:

"Five Kingdoms But No King," "Investigating: Soil," "Investigating Water," and "It's Alive or Is It?" *in Section* 1, *Elements of Ecosystems. Also all the* "Investigating (Living Things)" *in this section.*

Materials:

Microscopes for each pair of students, slides and cover slips, eye droppers, several small jars or containers, masking tape and a marker, boiled rice grains, paper and pencil.
OPTIONAL: guidebook for identifying protists or appropriate *Alaska Ecology Cards.*

Background:

See INSIGHTS, *Section* 1, *Elements of Ecosystems*: "*Monerans & Protists*" fact sheet; INSIGHTS, *Section* 2, *Community Connections*; and INSIGHTS, *Section* 3, *Living Things in their Habitats*.

Procedure:

1. Introduce the fact that many living things in our environment are seldom noticed and best seen under a microscope. Members of the Kingdoms **Monera** and **Protista** fall in that category of living things.

2. Ask students to predict if there are microscopic living things around the school or even in the classroom. *Although all individual monerans and many protists are microscopic, it is sometimes possible to see some types when many are gathered in one spot.*

3. Ask students in what environment what microscopic living things might be found? *Water is a reliable environment to find these organisms.*

4. GO OUTDOORS to collect several samples of water from around the school. *Roadside ditches, puddles, pools*

formed by melting snow or ice, ponds, lakes, streams are possible places to collect water. IF WINTER, *a neglected vase of flowers might also provide an adequate sample.*

5. Tell students to put the water samples in separate jars, marking the source and the water level with masking tape. Collect an extra jar of water from each site (marking the source) as a refill supply (*per step* #8).

6. BACK IN CLASS, students place the jars in indirect light (not direct sun). Add 2-3 grains of rice to each sample to feed any organisms in the water.

7. FOR SEVERAL DAYS, let the samples stand uncovered or with the lids open part way.

8. Ask students to keep the water level at the original mark by adding water from the original source, if possible. Tap water will work, but make sure it has been standing for several days.

9. AFTER 3-4 DAYS, examine the samples through the microscope. Use the eyedropper to take samples of water at the top, middle and bottom of the jar. Demonstrate to the students how to make a wet-mount. (*Procedures for making simple wet mounts are found in most basic science text books.*)

Note: Organisms may dive to the bottom of the wet mount. Make sure students adjust the focus on the microscope at different levels in the mount so that they can see the bottom as well as the top of the drop of water.

10. Ask students to draw the organisms they see in each sample. Count (or estimate) the organisms on each slide. Look at three slides representing the bottom, middle, and top of the jar and make a count for each one.

11. Share results and discuss the drawings. Determine similarities and differences between the organisms, noting things like the existence of **cilia**, method of movement, or how the organisms might gather food.

12. Brainstorm and draw a chart on the board that lists the food, water, shelter, and space characteristics – **habitat** – of each source.

Evaluation:

Draw or describe at least three kinds of microscopic organisms and their food, water, shelter, and space requirements.

EXTENSION:

Observe a colony of protists and conduct experiments. *Many protists are available for purchase from scientific supply companies. If you choose to order live protists, students can create their own ecosystems and transplant the living protists into their water samples.*

- Students create ecosystems in jars, using distilled water, mud, rocks, a pinch of yeast, and the purchased protists.

- Students observe and keep journals on their ecosystems, noting changes on a daily basis.

- Students may also develop hypotheses and perform experiments on their ecosystems. For example, what happens when the ecosystem is denied oxygen? How does the ecosystem respond to light? What happens if there is an oil spill in the ecosystem? How do ecosystems respond to fertilizers or phosphates?

This is a good way to incorporate the scientific method: students test their own hypotheses by designing an experiment, collecting data, presenting results, and drawing conclusions from their experiments.

Curriculum Connections:

(See appendix for full citations)

Books:

Guide to Microlife (Rainis)

Monerans & Protists (Silverstein)

Website:

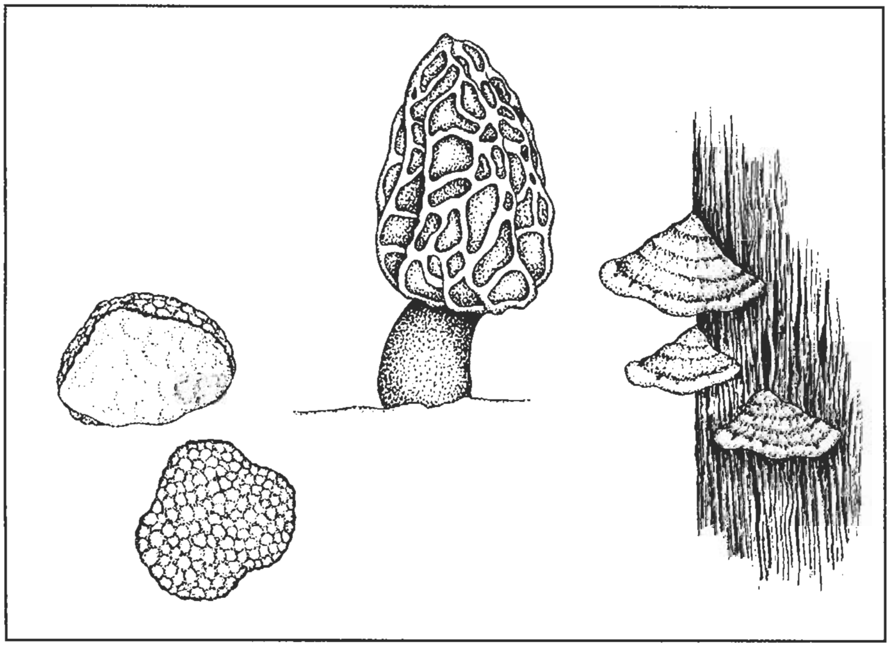
Protist Image Data <megasun.bch.umontreal.ca/protists/protists.html>

Teacher Resources:

(See appendix)

Investigating Fungi

ALERT: ALASKA ECOLOGY CARDS OPTIONAL



Section 3
ECOLOGY ACTIVITIES

Grade Level: 4 - 12

State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6

Subject: Science, math, language arts, art

Skills: Observing, recording, analyzing, describing, drawing, computing, measuring, estimating, identifying

Duration: 60 minutes

Group Size: 2-3

Setting: Indoors /outdoors

Vocabulary: Absorption, algae, detritivore, detritus, fungus/fungi, lichen, mold, photosynthesis

Objectives:

1. Students will describe and locate places in an ecosystem where fungi might grow.

2. Students will identify a fungus and determine the nonliving elements needed for survival.

Complementary Activities:

"Five Kingdoms But No King," "Investigating: Soil," "Investigating Water," and "It's Alive or Is It?" *in Section* 1, *Elements of Ecosystems. Also all the* "Investigating (Living Things)" *in this section.*

Materials:

Hand lens, microscope, moist bread, plastic bag or container, slides and cover slips, paper and pencil. OPTIONAL: Appropriate *Alaska Ecology Cards*.

Background:

See INSIGHTS, *Section* 1, *Elements of Ecosystems*: "*Fungi*" fact sheet; INSIGHTS, *Section* 2, *Community Connections*; and INSIGHTS, *Section* 3, *Living Things in their Habitats*.

Procedure:

1. Ask students to think about the words **fungus** (singular) or **fungi**, sharing any information or examples of fungi with the class. Discuss the Kingdom Fungi and some of its more common members (*mushrooms and bread mold*).

2. Explain to students that most of these organisms (with the exception of lichens) recycle organic material from dead or waste materials to obtain their food.

3. Fungi can be found anywhere that dead plants are found, especially in moist places. Discuss possible locations of **detritus** (dead organisms) that students might find fungi (*dead standing trees, decayed logs, leaf litter on the ground*.)

4. To identify fungi, students should look for things that are spongy (such as mushrooms and shelf fungus), things that look like silt or dust (such as mold), or things that are hard and brittle growing very close to the ground or on rocks (such as lichens).

****CAUTION!**** Many people are allergic to molds. Some molds may cause infections or even blindness. Only teachers, not students, should handle molds in the classroom. You should avoid direct contact with mold and keep mold cultures away from your face to avoid breathing of mold spores.

9. The teacher may prepare a slide of the bread mold for students to observe, or a bioscope might be used for class viewing.

5. OUTDOORS, take a walk in the area near your school. Students work in groups of 2-3 to look for examples of fungi. Students draw pictures of what they find, bringing small samples inside. Make notes of where each fungus was found.

6. Students share drawings or samples, noting similarities and differences. Discuss the nonliving elements of the ecosystem that are critical to the survival of these organisms.

7. Discuss what might happen if these organisms did not exist? What would happen if things didn't decay?

8. IN CLASS, grow your own fungus. Place some moist bread in a sealed plastic bag or container. In several days, you will have a healthy culture of bread mold, a common fungus.

10. Students draw a picture of the bread mold. As a class, identify the **hyphae** and the **spores** which are common to fungi. What nonliving elements does bread mold need to survive? What happens to bread mold if left in an airtight container for an extended time period?

11. Identify human uses of fungi.

Evaluation:

1. Given several examples and non-examples of fungi, determine which examples belong to the Kingdom Fungi and why.

2. Draw and label a picture of a mold (if applicable).

3. Describe three places in the local environment where fungi might grow.

Curriculum Connections:

(See appendix for full citations)

Books:

Guide to Microlife (Rainis)

Mushrooms (Parker)

Slimes, Molds, and Fungi (Pascoe)

Fungi (Silverstein)

Fungi (Tesar)

Website:

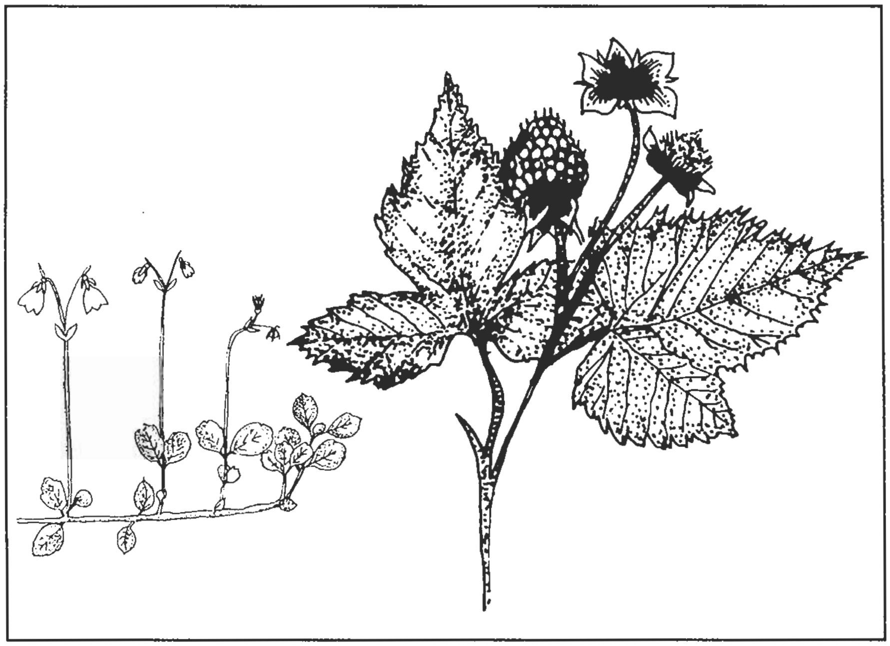
Introduction to the Fungi <www.ucmp.berkeley.edu/fungi/fungi.html>

Teacher Resources:

(See appendix)

Investigating Plants

2 EXTENSIONS ALERT: ALASKA ECOLOGY CARDS OPTIONAL



Grade Level: 4-12

State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6

Subject: Science, math, language arts, art

Skills: Observing, recording, analyzing, describing, drawing, computing, measuring, estimating, identifying

Duration: 90 minutes

Group Size: 2-5

Setting: Outdoors /indoors

Vocabulary: Abundance, annual plants, chlorophyll, dominant plants, dormant, fruit, habitat, multi-cellular, transect

Objectives:

1. Students will recognize and identify some plants from their local ecosystem, including plant signs during the non-growing seasons.

2. Students will describe the differences in abundance of plants in their local environment.

Complementary Activities:

"Five Kingdoms But No King," "Take a Deep Breath," *and all the* "Investigating(Nonliving Things)" *in Section* 1, *Elements of Ecosystems. Also* "Who Eats Whom," "Mineral Cycling," *and* "Create a Classroom Compost Box" *in Section* 2. *Also all the* "Investigating (Living Things)" *activities in this section.*

Materials:

For each student: hard surface for drawing or recording data. For each group: one copy of the "Science Card" several copies of the "Plant Data Sheets I and II" (*see following pages*), paper for drawing, field guide to plants or *Alaska Ecology Cards*, small plastic cup or container for collecting soil, and a transect line made with a 3-meter (*or shorter – see step #5*) piece of rope or string.

OPTIONAL: a journal for drawing and recording names of plants.

Background:

See INSIGHTS, *Section* 1, *Elements of Ecosystems*: "*Plants*" fact sheet; INSIGHTS, *Section* 2, *Community Connections*; and INSIGHTS, *Section* 3, *Living Things in their Habitats*.

Procedure:

1. IN CLASS: review how plants are different from fungi, monerans, and protists. (*Plants are **multi-cellular** and have **chlorophyll** for performing photosynthesis*). Explain to the class that they will investigate their local ecosystem for **diversity** and **abundance** of plants.

2. Explain that students will be locating and drawing as many plants as they can find along **transect** lines. They will include any plants within five centimeters to each side. Demonstrate how to draw a plant and

note which characteristics help to identify one plant from another. *Shape, size, edges, and texture of leaves are important.*

3. Give examples of questions to ask as students draw and take notes about plants they find: *Do leaves form a pattern such as three leaves on a stalk? Are leaves found opposite one another on a stalk or do they alternate? Does the plant hold dried flowers or* ***fruit****? Is the plant stem woody or easily bent? Does this plant grow under trees, on rocky soil, or in wet places?*

4. Discuss "annual plants" *that grow from seeds or buried roots, flower, produce new seeds, and die in one calendar year.* What evidence do these organisms leave behind? *Dead leaves, tubers, seed pods, and roots.* Instruct students to include such evidence when they identify plants along their transect lines.

5. OUTDOORS: if you are studying an area with a high **biodiversity** (*i.e. many different plant types*), use a shorter piece of **transect** line so that students won't get overwhelmed.

6. Distribute the "Plants Data Sheets I and II" to each group.

7. Ask each group to lay its transect in a straight line. You may want to challenge the groups to lay their rope so that it touches the highest number of kinds of plants and still maintains a straight line. Have students identify their working area of 5 centimeters to each side of the line.

8. The following roles could be rotated so everyone experiences each assignment: Project Coordinator (*makes sure everything runs smoothly and watches for duplication in plants that are drawn*), Plant Illustrator, Plant Counter, a Plant Classifier (*to key out names for plants*), and a Plant Recorder (*to record the group's answers to the worksheet*).

9. Students begin surveying. They will describe each kind of plant and then keep a tally of how many of each kind grow along their transect. Students can each draw plants, if desired, checking with the coordinator to avoid duplication. After the observation/drawing session is complete, the Plant Recorder should collect all drawings.

10. When all plants along the transects are drawn and recorded, distribute the Science Cards and ask the groups to sit together and answer the questions.

11. Give each group a small container (such as a paper cup) to collect soil to take back to the classroom to make a "mystery garden."

12. IN CLASS, share information and drawings on the plants. Was there a pattern in where the groups found certain plants growing? Why do certain plants grow better in some places than others? Focus the discussion on the **habitat** of the plants.

VARIATION
Instead of a making a transect line, have groups make study plots. Cut a 4-meter piece of string and tie the ends together. Instruct students to make a square out of their length of string, thus creating a one-meter-square plot. Students examine all the plants within the plot.

Evaluation:

1. Given drawings, pictures, or specimens, recognize and identify abundant local plants.

2. During discussion, demonstrate awareness of the dominant plants in the local ecosystem.

3. Give examples of evidence of annual plants during the non-growing season.

EXTENSIONS:

A. **Use the drawings to create a display.** Have the students sort through the drawings to find samples of each kind of plant found along their transects. Use those to create posters or a display of schoolyard plants. Students research plant facts from field guides, the *Alaska Ecology Cards*, and other sources.

B. **Make a school herbarium.** Students collect and press *one example* of each plant found. Herbarium specimens may be used by future groups or classes to help identify plants on their transect studies.

NOTE: *Before collecting any living thing, discuss with the students the importance of preserving the environment and disturbing the area as little as possible.*

- For small plants, collect the entire plant including the root, flowers, stems, and leaves if possible. Shake off any loose dirt.

- For trees and shrubs, collect sample branches, leaves, flowers or seeds. Make rubbings of bark by using paper and crayons or charcoal.

- Press samples in a plant press (between sheets of cardboard and newspaper, bound with rubber bands or weighted with heavy books), changing the newspaper every few days.

- When samples are dry, students mount them on poster board and label with the plant's name, where it was found, who collected it, and the date that it was collected. Also identify plants using local names and uses.

Curriculum Connections:
(See appendix for full citations)

Books:
How Nature Works (Burnie)

Plant (*Eyewitness*) (Burnie)

Plants (Silverstein)

Science of Plants (Bocknek) (Gr. 4-6)

Website:
Plants Database <plants.usda.gov/plants/home_page.html>

Teacher Resources:
(See appendix)

SCIENCE CARD

Plant Transect

1. **Biodiversity.** How many kinds of plants did you find along your transect line?

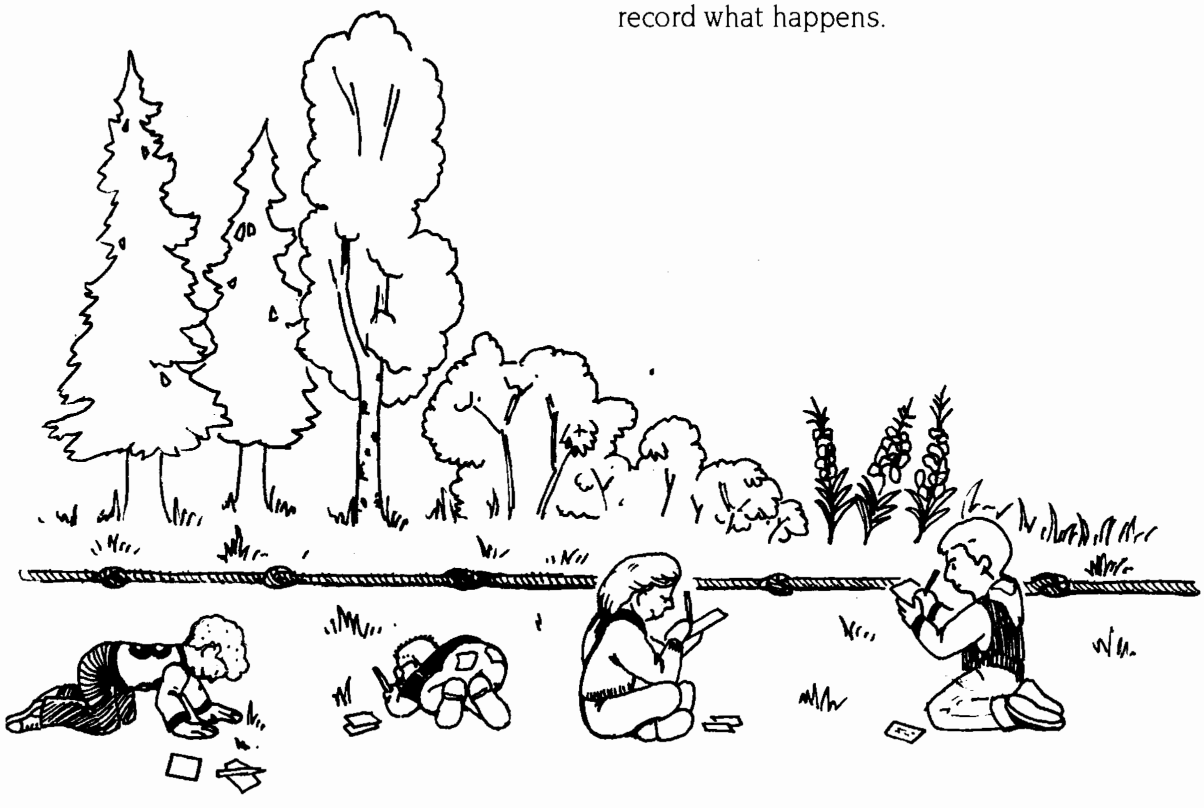
2. **Identification.** If you haven't already, try to identify the most common plants by using a field guide to plants. If you cannot find the name of the plants in your guide, or if a field guide is unavailable, record details about the plant to help you identify it later.

3. **Dominant species.** Which three kinds of plants were the most abundant on your transect? These "dominant" species will have the highest numbers in the third column of your "Plant Data Sheet I." *Make sure that you have counted individual plants, not every leaf or stem. Count a moss clump as one plant.* Write the total for each plant on its drawing.

4. **Dormant annual plants.** Depending on the time of year and where you are, many plants may be dormant, which means you won't clearly see their leaves, flowers, or even stems. Describe the kind and amount of the following plant remnants that you found on your transect:

(a) Dead leaves or needles
(b) Dead flowers
(c) Seeds
(d) Roots above the ground

5. **Mystery gardens.** You can find out more about what plants are in the soil as seeds by taking a small sample of soil back to the classroom, putting it in an open container (an empty milk carton, for example), watering it well, covering it with plastic, and placing it in a sunny spot. Watch your mystery garden closely for 2-3 weeks and record what happens.



Plant Data Sheet I

LIST OF PLANTS

Names ______________________________ Date ____________

Location of Site ______________________________

Plant Number	Plant Name or Description	Number of Individual Plants
(Example)	Fireweed	~~IIII~~ III

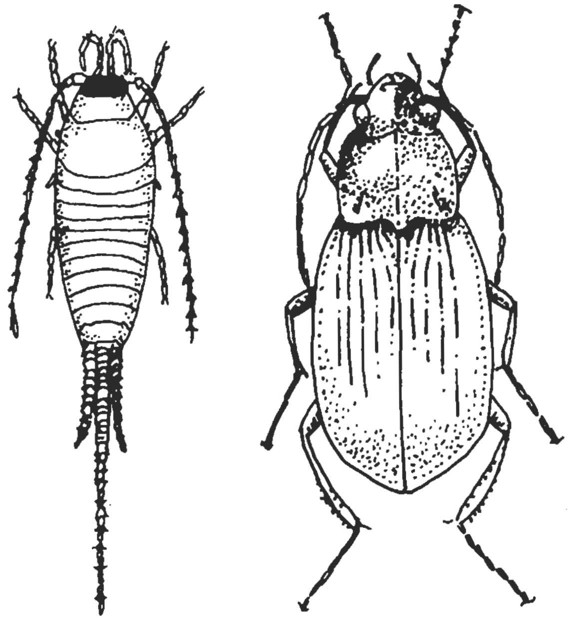
Plant Data Sheet II

PLANT DRAWINGS

Plant #______ **Name** ________________	**Plant #** ______ **Name**________________
Plant #______ **Name** ________________	**Plant #** ______ **Name**________________
Plant #______ **Name** ________________	**Plant #** ______ **Name**________________

Investigating Animals in Soil

1 EXTENSION ***ALERT: ALASKA ECOLOGY CARDS OPTIONAL***



Section 3
ECOLOGY ACTIVITIES

Grade Level: 4 - 12

State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6

Subject: Science, language arts, art

Skills: Observing, recording, analyzing, describing, drawing, computing, measuring, estimating, identifying

Duration: 90 minutes

Group Size: 2-4

Setting: Outdoors /indoors

Vocabulary: Adaptations, domesticated, habitat, insects, larvae, mammals

Objectives:

1. Students will describe signs of animal activity in the soil.

2. Students will describe and name some animals found in local soil habitats.

Complementary Activities:

"Five Kingdoms But No King," "Take a Deep Breath," *and all the* "Investigating (Nonliving Things)" *in Section* 1, *Elements of Ecosystems. Also* "Who Eats Whom," "Oh Moose," "Mineral Cycling," *and* "Create a Classroom Compost Box" *in Section* 2. *Also all the* "Investigating (Living Things)" *in this section*.

Materials:

For each group OUTDOORS: coffee can or similar container with holes in the bottom, plastic bag, 4-meter lengths of string, copies of the "Soil Animals Data Sheets I and II" (*see following pages*), paper, pencil.

INDOORS: microscope or hand-lens, field guides if available, graduated cylinder, white tray. Field guides or *Alaska Ecology Cards*.

OPTIONAL: light, funnel, flask for Berlyse Funnel (*see following*).

Background:

See INSIGHTS, *Section* 1, *Elements of Ecosystems*: "*Animals (Invertebrate)*" fact sheet; INSIGHTS, *Section* 2, *Community Connections*; and INSIGHTS, *Section* 3, *Living Things in their Habitats.*

Procedure:

1. IN CLASS: review the five kingdoms. Remind students there are many members of the animal kingdom that are very small and seldom seen by humans. Challenge the class to list some tiny animals. (*shrews, mice, weasels, insects, snails, spiders, worms, etc.*)

2. Discuss what kind of habitat or environment would be safe for very small animals. Lead the discussion toward life underground. *Some animals are* ***adapted*** *to spending most of their life in the dark, living on other animals or nutrients found in the soil.*

3. Explain that the students will become scientists, looking for animals and their signs in the soil. Show

students pictures of **larvae**, casings, and other evidence that they may find in the soil.

4. OUTDOORS: direct each group to "stake out" a square study plot, 1-meter by 1-meter, using their string as the boundary. Challenge them to examine the area carefully. *Look for small holes or tunnels dug into the ground, droppings, or leaves that seem to have been bitten by a small animal.*

5. Each group has the following duties that may be rotated: Mapmaker, Recorder, Classifier, Counter/ Estimator.

6. The Mapmaker draws a map of the plot, noting large rocks, large plants or trees, hills, and depressions.

7. The Recorder writes down evidence of animals that the group finds, noting the location on its plot map. When soil animals are found, the Recorder includes the information on the "Soil Animals Data Sheets I and II."

8. Using an empty can as a sampling tool, one member of each group presses the open end into the soil until the can is at least half buried. Turn the can right side up and dig out the soil marked by where the can was, filling the can half full.

9. Empty the soil into a plastic bag for transport to the classroom (*since the can has holes in the bottom*).

10 IN CLASS, each group places its soil in a tray and sorts through it, looking for animals, larvae, or any other evidence of life in the soil.

11. All members of the groups draw the organisms they find.

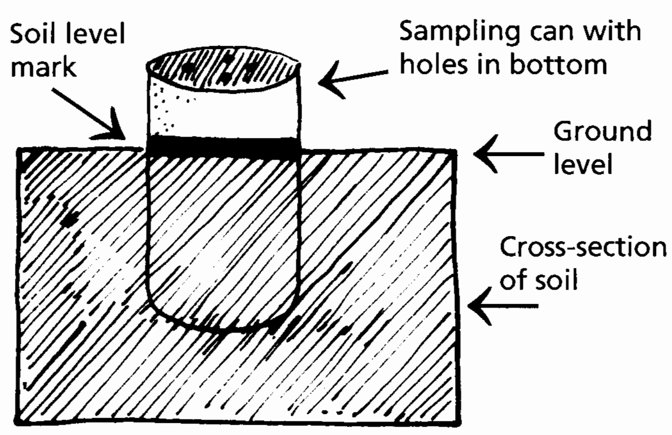
12. Challenge students to identify their creatures by using field guides. The Classifier keeps track of the kinds of creatures so that the same animal is not named twice. If field guides or the *Alaska Ecology Cards* are unavailable, ask students to make up their own descriptive names for each species.

13. Wrap-up the investigation with a class discussion concerning the **habitat** of these small animals. What special **adaptations** do soil animals have that help them to live on or in the soil?

Evaluation:

1. Complete drawings and name animals found in the soil of the local ecosystem.

2. Describe possible signs of animal activity in the soil of their local ecosystem.



Core Sampler

EXTENSION:

Use a Berlyse funnel to find more animals. Set up the Berlyse funnel as illustrated for each group (or rotate one for each group to use on succeeding days.) Leave a light shining on the funnel contents overnight. Many of the living things in the soil will move away from the warm, bright light and fall into the collecting bottle.

Curriculum Connections:

(See appendix for full citations)

Books:

Handful of Dirt (Bial)

One Small Square: Backyard (Silver)

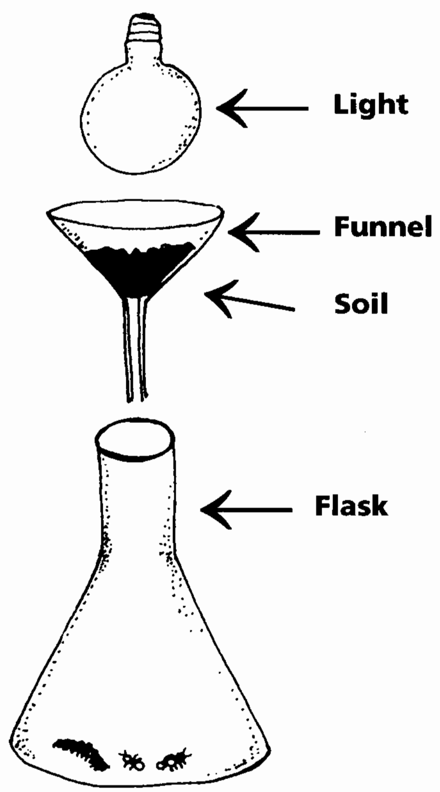
Our Endangered Planet: Soil (Winckler)

Media:

Dirt Made My Lunch (Audio Tape or CD) (Banana Slug String Band)

Teacher Resources:

(See appendix)



Berlyse Funnel

Soil Animals Data Sheet I

LIST OF ANIMALS

Names ______________________________ Date ____________

Location of Site ______________________________

Characteristics

Animal Number	Number of Legs	Number of Wings	No. of Body Segments	Mouth Parts	Length in mm	Color	Other Information

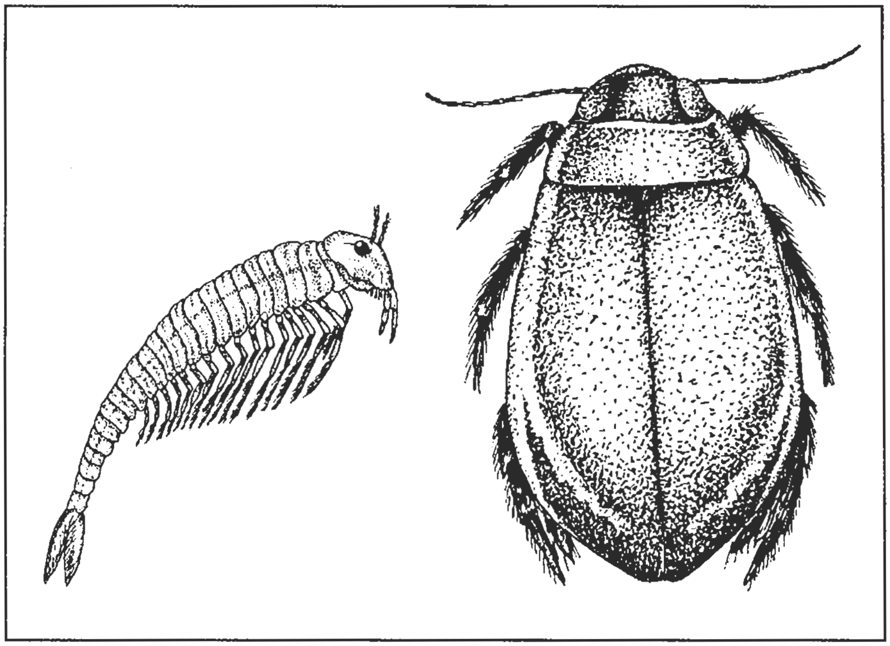
Soil Animals Data Sheet II

ANIMAL DRAWINGS

Animal # ______ Name ________________	Animal # ______ Name ________________
Animal # ______ Name ________________	Animal # ______ Name ________________
Animal # ______ Name ________________	Animal # ______ Name ________________

Investigating Animals in Water

1 EXTENSION <u>*ALERT: ALASKA ECOLOGY CARDS OPTIONAL*</u>



Section 3
ECOLOGY ACTIVITIES

Grade Level: 4 - 12
State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6
Subject: Science, language arts, art
Skills: Observing, recording, analyzing, describing, drawing, computing, measuring, estimating, identifying
Duration: 90 minutes
Group Size: 3-4
Setting: Outdoors/indoors
Vocabulary: Invertebrates, larvae, pupae, sediments, wetlands

Objectives:

1. Students will recognize and identify some local water animals.

2. Students will predict and describe the habitats where water animals can be found.

Complementary Activities:

"Five Kingdoms But No King," "Take a Deep Breath," *and all the* "Investigating (Nonliving Things)" *in Section* 1, *Elements of Ecosystems*. *Also* "Who Eats Whom " *and* "Mineral Cycling" *in Section* 2. *Also all the* "Investigating (Living Things)" *in this section.*

Materials:

For each group: underwater viewer, kick sampler, sweep net (*illustration following*), copies of "Water Animals Data Sheets I and II" (*see following pages*). OPTIONAL: Field guides or *Alaska Ecology Cards*.

Background:

See INSIGHTS, *Section* 1, *Elements of Ecosystems*: "*Animals* (*Invertebrates*)" fact sheet; INSIGHTS, *Section* 2, *Community Connections*; and INSIGHTS, *Section* 3, *Living Things in their Habitats.*

Procedure:

1. IN CLASS: review the five kingdoms. Remind students there are many members of the animal kingdom that are very small and seldom seen by humans. Challenge the class to list some tiny animals that (*mice, minnows, insects, snails, spiders, worms, etc.*)

2. Discuss what kind of habitat or environment would be safe for very small animals. Lead the discussion toward life in ponds, streams, **wetlands.** *Each wet area in Alaska erupts with young* ***invertebrates*** *(animals such as worms and insects that have no backbone) each spring as ice thaws. These invertebrates are food for fish. Who eats fish?*

3. Explain the students will become scientists, looking for animals in the water. *Many of the easily recognizable flying insects in Alaska such as mosquitoes and dragonflies lay their eggs in water.* ***Larvae*** *and* ***pupae*** *develop from these eggs.*

4. OUTDOORS: in groups, students place the underwater viewer on the water surface and look for fish, insect larvae, worms, or other creatures. Record the invertebrates that they see on the "Water Animals Data Sheet I" under the column "Surface Sample."

5. Students pick up rocks both at the water's edge and in the water and look on the underside of them. *Remind students to put the rocks back in the same place so the animals that live there will still have their home.* Record any evidence of water animals on the "Water Animals Data Sheet I" under the column "Bottom Sample."

6. One student from each group places the kick sampler at the bottom of a stream with the open end facing the current. Another student "kicks" or disturbs the rocks upstream from the sampler.

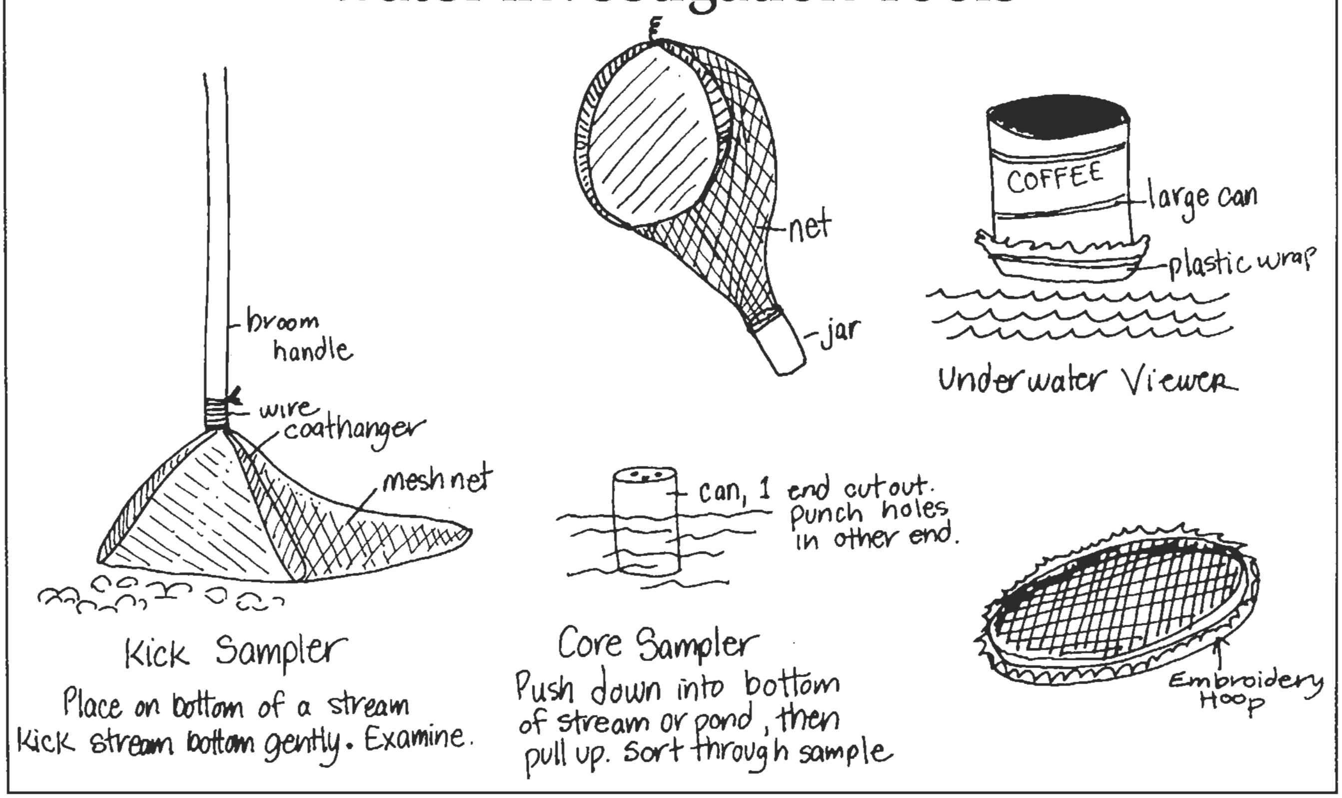
7. Take the sampler out of the water and check for invertebrates. Students describe and record the invertebrates on the "Water Animals Data Sheet I" under "Kick Sample." *Be sure to treat the creatures gently and to return them to their homes after examining them.* Check field guides to help identify insect larvae and other invertebrates.

8. Use the "core sampler" to examine animals that live in **sediments**. Each group pushes the can into the bottom of a stream or pond and then pulls it up. Sort through the sample for invertebrates. Describe and record creatures on the "Water Animals Data Sheet I" under the column "Core Sample."

9. When all groups are together, discuss any similarities they found among their water critters. Identify any features that have helped water critters to adapt to their environment.

10. Discuss the habitat of these small animals, focusing on elements critical to their survival. How might human activity affect this environment?

Water Investigation Tools



Evaluation:

1. Complete the "Water Animals Data Sheet I and II" and describe where water animals can be found in the local environment.

2. Identify some local water animals and describe their role in your ecosystem.

EXTENSION:

Predict and calculate density. Predict the number of animals in the water by estimation. Students measure the volume of water or sediment that they collected in a measuring beaker or a graduated cylinder. Count the number of organisms found in that sample. Students might also count the number of organisms found per rock examined. Record the number of organisms located per unit area.

Curriculum Connections:

(See appendix for full citations)

Books:

Insects: A Guide to Familiar American Insects (Cottam)

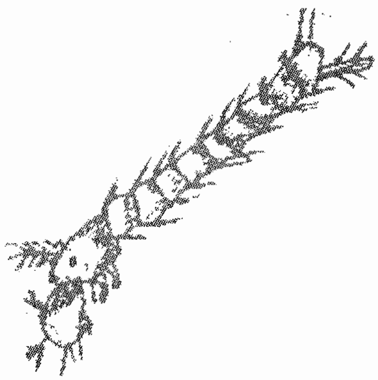
National Audubon Society Field Guide to North American Insects and Spiders (Milne)

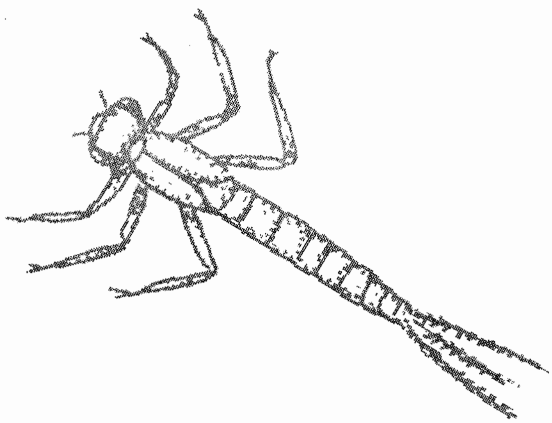
Pond and River (*Eyewitness Book*) (Parker)

Water Insects (Johnson)

Teacher Resources:

(See appendix)





Water Animals Data Sheet I

LIST OF ANIMALS

Names ______________________________ Date ____________

Location of Site ______________________________

Number Observed

Animal Number	Surface Sample	Bottom Sample	Kick Sample	Core Sample	Total Number
Total Number Observed					

Water Animals Data Sheet II

ANIMAL DRAWINGS

Animal # ______ Name ________________

Animal # ______ Name ________________

Animal # ______ Name ________________

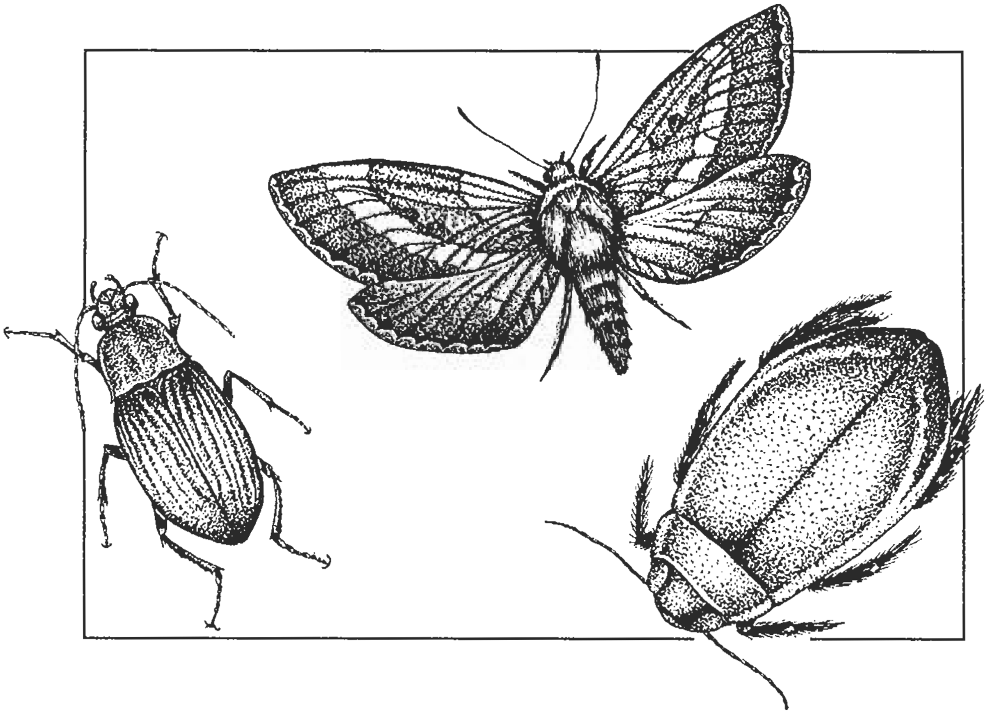
Animal # ______ Name ________________

Animal # ______ Name ________________

Animal # ______ Name ________________

Investigating Insects

1 EXTENSION ***ALERT: ALASKA ECOLOGY CARDS REQUIRED***



Section 3
ECOLOGY ACTIVITIES

Grade Level: 4 - 12

State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6

Subject: Science

Skills: Observing, comparing, inferring, identifying

Duration: 50 minutes

Group Size: Individuals

Setting: Outdoors & indoors

Vocabulary: Cambium, consumer, food chain, gall, habitat, larvae, names of insects, predator, prey, sap

Objective:

Students will identify signs of insect activity and determine its role in a local ecosystem.

Complementary Activities:

"Five Kingdoms But No King," "Take a Deep Breath," *and all the* "Investigating (Nonliving Things)" *in Section* 1, *Elements of Ecosystems. Also* "Who Eats Whom," "Follow a Food Chain," *and* "Ecosystem Partners" *in Section* 2. *Also all the* "Investigating (Living Things)" *in this section.*

Materials:

Copies of "Insect Signs Chart" and "Insect Signs Science Card" (*next page*) for each student, hand lens, clipboards and writing paper or field note books, pencils or pens. *Alaska Ecology Cards* of forest insects.

Background:

See INSIGHTS, *Section 1, Elements of Ecosystems*: "*Animals (Invertebrate)*" fact sheet; INSIGHTS, *Section 2, Community Connections*; and INSIGHTS, *Section 3, Living Things in their Habitats.*

Procedure:

IN ADVANCE: locate a nearby site with a variety of live plants (trees, shrubs, and groundcover) and dead leaves. Look for a spot that shows galls (*see illustration on Insect Signs Chart*) on plants, or a tree with bark engravings or reddish brown sawdust at its base. Record the number and location of insect signs you find for later comparison with student notes.

1. IN CLASS: discuss the role of insects in an ecosystem. Are insects **consumers**? What do they consume? Where are they represented on a **food chain**?

2. Using the information on the *Alaska Ecology Cards* of forest insects, review some of the traits, **habitats**, **prey**, and **predators** before going to the forest site.

Classroom Follow-Up:

1. Students should discuss and compare their findings. Where do the found insects fit in the food chain? Students can use the *Alaska Ecology Cards* to learn more about these insects to enhance the discussion.

2. Ask if they think they might find more or less insect signs at other seasons of the year. Why? How does this affect decomposition in the local ecosystem?

3. If they have studied other ecosystems (tundra, rainforests, wetlands, etc.), students compare what they found in their local ecosystem to the work and abundance of insects elsewhere.

EXTENSION:

Research forest insects and create a display. Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources (*below*) to find out more about their local insects. They use this information along with sketches of the insect signs they found to make posters or a display of local wildlife.

Curriculum Connections:

(See appendix for full citations)

Books:

Insects: A Guide to Familiar American Insects (Cottam)

Insects and Diseases of Alaskan Forests (Holsten)

National Audubon Society Field Guide to North American Insects and Spiders (Milne)

Website:
Alaska Science Forum <www.gi.alaska.edu/ScienceForum>

Teacher Resources:

(See appendix)

SCIENCE CARD

Insect Signs

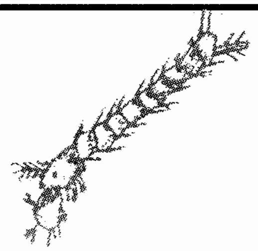
Insects are some of the most important **consumers** in many ecosystems. The "Insect Signs Chart" shows some of the evidence insects leave behind. How many of these signs can you find in this area?

1. Write the heading "Insect Signs" on a page in your field notebook. Record the number of different types of insect signs you find in this area.

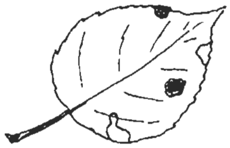
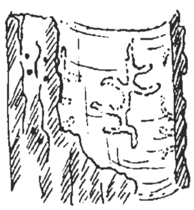
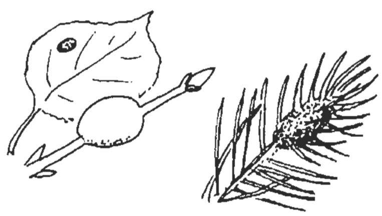
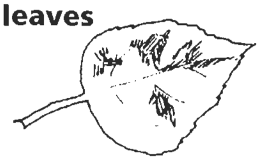
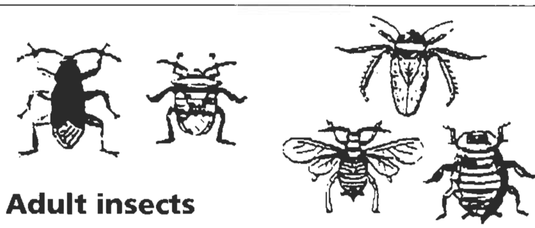
2. List each type of insect for which you find evidence. Draw a sketch to remind you what its sign looked like. Your sketch or its label should include the leaf, plant, or type of wood where you found the sign – the insect's **habitat**.

3. Where do the insects whose evidence you found fit in the food chain? Would another kind of forest have different insects? Record your answers in your notebook.

4. If you find the insects themselves, draw a picture of them in your notebook to help you identify them later.



Insect Signs Chart

FEEDING METHOD	SIGNS	EXAMPLES OF INSECTS THAT LEAVE THESE SIGNS
Leaf-chewing Insects		 Larvae of moths, butterflies, sawflies, and beetles
Leaf-mining Insects		 Tiny larvae of moths, beetles, flies, and wasps
Leaf-rollers and Tent Caterpillars		 Larvae of moths
Cambium-eating Insects	 Bark engravings or fine, reddish brown sawdust-like material 	 Larvae of bark beetles, a few moths, and some flies
Gall-making Insects		 Wasps, flies, sawflies, gall-making aphids, and spruce aphids
Sap-sucking Insects	Yellowed or discolored leaves 	 Adult insects

Investigating Birds

2 EXTENSIONS ***ALERT: ALASKA ECOLOGY CARDS OPTIONAL***

Section 3
ECOLOGY ACTIVITIES

Grade Level: 4 - 12

State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6

Subject: Science

Skills: Observing, identifying, inferring

Duration: 50 minutes

Group Size: 2

Setting: Outdoors

Vocabulary: Bird names, habitat

Objective:

Students will recognize bird signs and identify the species and behavior of birds in the area.

Complementary Activities:

"Five Kingdoms But No King," "Take a Deep Breath," *and all the* "Investigating (Nonliving Things)" *in Section 1, Elements of Ecosystems. Also* "Who Eats Whom," "Follow a Food Chain," *and* "Ecosystem Partners" *in Section 2. Also all the* "Investigating (Living Things)" *and* "Ecosystem Scavenger Hunt" *in this section.*

Background:

See INSIGHTS, *Section 1, Elements of Ecosystems:* "*Animals (Vertebrate)*" fact sheet; INSIGHTS, *Section 2, Community Connections*; and INSIGHTS, *Section 3, Living Things in their Habitats.*

Materials:

"Bird Signs Chart," and "Bird Signs Science Card" for each student, clipboards and writing paper or field note books, pencils or pens.

OPTIONAL: Field guides to birds and animal tracks, binoculars, and *Alaska Ecology Cards.*

Procedure:

IN ADVANCE: locate nearby sites where you can find evidence of several birds. Good choices may be near open water, sites with snow, and areas with a variety of shelter. *It is okay to salt the area you choose with a feather or raptor casting.*

Record the number and kinds of bird signs you find for later comparison with student observations and notes. Fill in the number of signs on the "Bird Signs Science Card."

2. IN CLASS: brainstorm what kind of birds live nearby. Discuss what birds obtain from where they live (*food, shelter, water, space* — ***habitat***) and why this habitat is important for their survival.

3. Tell the students they will go in search of birds. Students may not see specific birds, but they could find bird signs such as feathers, nests, whitewash (droppings), or tracks.

4. Give each student the "Bird Signs Science Card" and the "Bird Signs Chart."

Classroom Follow-Up:

1. Students discuss and compare their findings.

Based on what they found, what habitat do their birds use in the ecosystem?

2. Ask if they think they might find more or less bird sign at other seasons of the year. Why?

3. Where might they go to find the birds or their signs illustrated on the Chart that were not found during class? What does that habitat offer that the class habitat does not offer?

EXTENSIONS:

A. **Research local birds and create a display.** Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources to find out more about their local wetland, ocean, tundra, or forest birds. They use this information along with sketches of tracks or signs to make posters or a display.

B. **Set up a winter bird feeding station visible from the classroom.** If bird habitat is near your classroom window, depending on grade level, students set up a winter bird feeding station after researching the best devices, food, and location through their local Alaska Fish and Game office; Audubon Chapter, or "Curriculum Connections."

Students keep a class chart of the kinds of birds that come to their feeding station, how often they are seen, and note their behaviors. Before the school year ends, students calculate the results and discuss the seasonal changes in bird visits.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Wildlife Notebook Series (ADF&G)

Guide to the Birds of Alaska (Armstrong)

The National Audubon Society North American Birdfeeder Handbook (Burton)

Website:

Birdhouses for Alaska < www.state.ak.us/adfg>

Teacher Resources:

(See appendix)

SCIENCE CARD

Bird Signs

You have heard of mammal tracks. Did you know birds leave signs too? Open your eyes and look carefully, you will be able to find ____ bird signs that are in this area.

1. Write "Birds" at the top of a page in your notebook.

2. Record the number of birds whose evidence you find at this site. Then list them by name along the left side of the page.

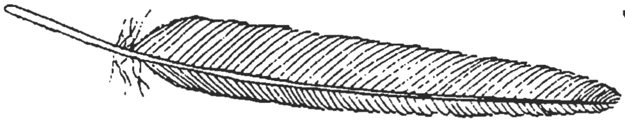
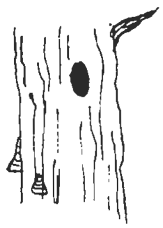
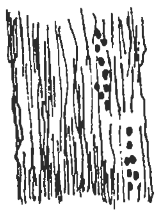
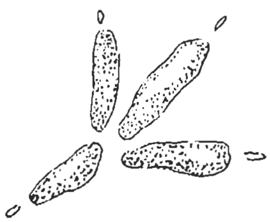
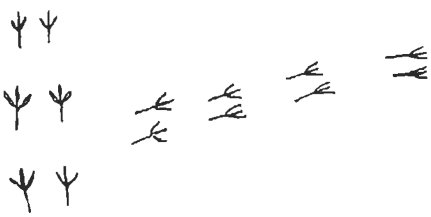
3. Listen and look carefully, for these birds may still be nearby. Make a "shhh, shhh, shhh" sound. Sometimes birds will move or call when they hear this sound.

4. If you see birds, watch them. Can you identify them using the guide book? Watch and record their behavior. What habitat do they like most? Are they eating? What are they doing? Record what you see in sketches or words.

5. If you found signs of grouse or woodpeckers, look for these groups in a field guide to birds. Based on the season and the habitat you are in, can you figure out which kind of grouse or woodpeckers might be in this area? List the species you think are most likely to have made the signs.

6. If you find signs of other birds enroute to the site, make notes of your findings in your notebook.

Bird Signs Chart

BIRD	SIGNS	
Signs Left by Many Birds	 **Feathers**	 **Stick or Grass Nests**
Grouse	 	**Grouse make 3-toed tracks on solid snow or wet soil, but in deep soft snow they make a trail that looks like a ditch in the snow. Their droppings seem dry and are shaped like fat worms. Listen for their hooting or low drumming calls.**
Woodpeckers	 	**Listen for tapping or drumming sounds. Look on live and dead trees for small or large holes that look like something drilled into the bark of the tree. Also look for flakes of bark around the base of trees.**
Raven	 	**Droppings and tracks around a dead animal.** **Hoarse croaking sounds.**
Hawks and Owls	 	**Hawks and owls regurgitate pellets of fur, feathers, and other indigestible bits of the prey. These pellets are cleaned of all meat, so that they smell and feel clean.**
Songbirds		**Listen for twittering, chirping, or other calls and songs.**

Investigating Mammals

2 EXTENSIONS ALERT: ALASKA ECOLOGY CARDS OPTIONAL

Section 3
ECOLOGY ACTIVITIES

Grade Level: 4 -1 2

State Standards: M A-3, M A-6, S A-14, S A-15, S B-1, S B-5, S B-6

Subjects: Science, language arts

Skills: Observing, identifying, inferring, comparing, descriptive writing

Duration: 50 minutes

Group Size: Individuals

Setting: Outdoors

Vocabulary: Animal names, habitat, nocturnal

Objective:
Students will use a variety of signs to identify the presence of specific mammals and determine their diet.

Complementary Activities:
"Five Kingdoms But No King," "Take a Deep Breath," *and all the* "Investigating (Nonliving Things)" *in Section 1, Elements of Ecosystems. Also* "Who Eats Whom," "Follow a Food Chain," *and* "Oh Moose," *in Section 2. Also all the* "Investigating (Living Things)" *in this section.*

Materials:
Copies of "Mammal Signs Chart" (*following pages*) and "Mammal Signs Science Card" for each student, clipboards and writing paper or field note books, pencils or pens.
OPTIONAL: *Animal Tracks of Alaska* and *Alaska Ecology Cards.*

Background:
See INSIGHTS, *Section 1, Elements of Ecosystems:* "*Animals (Vertebrate)*" fact sheet; INSIGHTS, *Section 2, Community Connections*; and INSIGHTS, *Section 3, Living Things in their Habitats.*

Procedure:
IN ADVANCE: locate nearby sites where you find evidence of two or more mammals. Good choices may be near open water, sites with snow, and areas with a variety of shelter.

Record the number of signs you find on the instruction card below as an incentive for students. Make a separate record of the mammal signs at these sites for later comparison with student notes.

1. IN CLASS: brainstorm what kind of mammals live nearby. Discuss what these wildlife obtain from where they live (*food, shelter, water, space* — ***habitat***) and why this habitat is important for their survival.

2. Tell students they will go in search of local mammals. Many mammals move around over large areas and try to stay hidden, and some are **nocturnal**. But they leave signs of their presence. Students will look for animal droppings, tracks, hair, plants that have been nipped or browsed, and dens.

3. Discuss student behavior that will enhance chances of seeing mammals. *It is important for students to be quiet – talking and moving fast and noisily will scare animals away.*

4. Give each student the "Mammal Signs Science Card" and the "Mammal Signs Chart."

Classroom Follow-Up:

1. Students discuss and compare their findings. Based on what they found, what habitat do their mammals use in the ecosystem?

2. Ask if they think they might find more or less mammal sign at other seasons of the year. Why?

3. Where might they go to find signs of mammals illustrated on the Chart that were not found during class? What does that habitat offer that the class habitat does not offer?

EXTENSION:

A. **Research local mammals and create a display.** Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources to find out more about their mammals. They use this information along with sketches of tracks and signs to make posters or a display of forest wildlife.

B. **Make plaster casts of animal tracks.** Details are given in the activity "Track Casting" in Section 3 of the companion book *Alaska's Forests & Wildlife.*

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska's Mammals (Smith)

Alaska Wildlife Notebook Series (ADF&G)

Animal Tracks of Alaska (Sheldon)

Animal Tracks of Alaska (Stall)

Mammals of Alaska (Alaska Geographic)

Website:

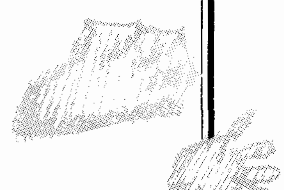
Animal Diversity Web
<animaldiversity.ummz.umich.edu/index.html>

Teacher Resources:

(See appendix)

SCIENCE CARD

Mammal Signs



1. Write "Mammals" at the top of a page in your field notebook. Record the number of mammals whose evidence you find in this area.

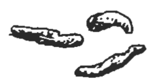
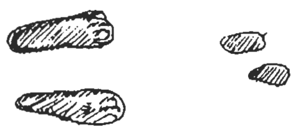
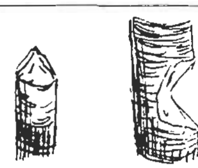
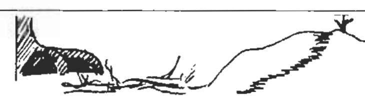
2. List mammals whose evidence you find along the left side of your page.

3. Write what you think they eat based on the signs you find on the right side of the page. Do they eat plant or other animals?

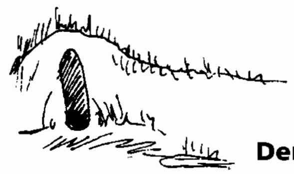
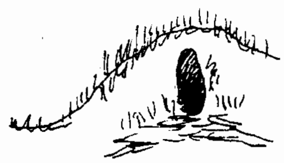
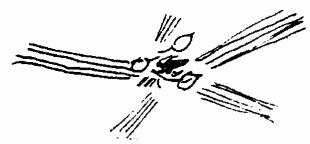
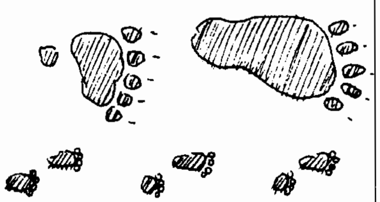
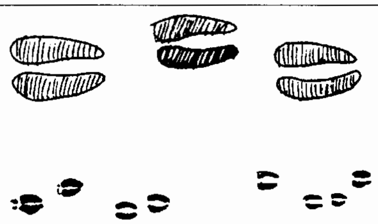
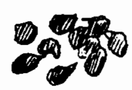
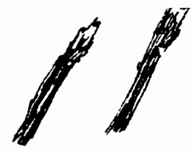
4. Write a short description of the signs next to each animal's name. Try to compare each sign to something familiar. Make a rhyme, or a humorous statement in order to help you remember which sign is evidence of which animal. (*For example: Deer droppings look like big chocolate chips. Hare-browsed willows are sharp. Ow!*)

5. If you find signs of other mammals while walking to or from this site, make notes of your findings on the page. The "Mammal Signs Chart" shows evidence of mammals that you might find in this forest. There are signs of at least ____ kinds of mammals in this area. Can you find these signs and identify them?

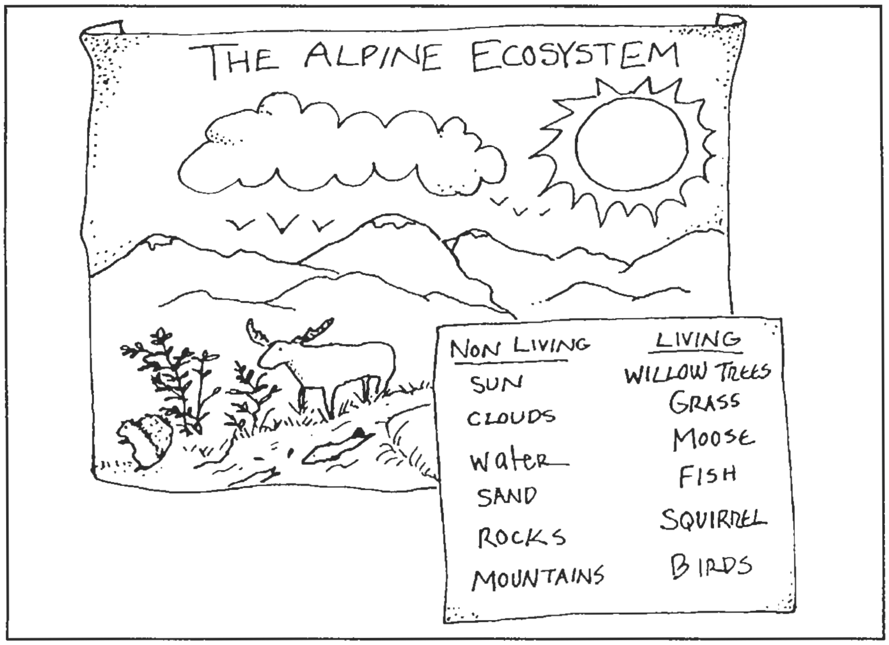
Mammal Signs Chart

ANIMAL	TRACKS	DROPPINGS	OTHER SIGNS
Shrew			
Vole, Mouse or Lemming			 Tunnels under the snow or, after the snow melts, small piles of grasses lying in patterns like tunnels.
Squirrel			 Middens or large piles of cones, cone scales, and cone cobs. Also, mushrooms hanging in trees.
Snowshoe Hare			 Willows, birch, rose, aspen, or other plants with stems neatly clipped.
Porcupine			 Large strips or patches of bark missing from a tree trunk.
Beaver			 Tree stumps or branches with gnawing marks; lodges or dams of sticks and branches.
River Otter			 Strong odor; trampled grasses and plants, dens under tree roots, and sledding trails on small slopes.

Mammal Signs Chart

ANIMAL	TRACKS	DROPPINGS	OTHER SIGNS
Marten			
Fox or Coyote			 **Dens**
Wolf			 **Dens**
Lynx			 **Scrapings around droppings.**
Bear			 **Grasses and sedges that have been grazed or clipped off. Skunk cabbage that is torn or dug up.**
Deer			 **Huckleberry or other shrubs with stems that appear to have been chewed off.**
Moose			 **Birch, aspen, willow, or other plants with stems roughly browsed (not neatly clipped).**

What Makes an Ecosystem?
2 PARTS & 1 VARIATION



Section 3
ECOLOGY ACTIVITIES

Grade Levels: 3 - 6

State Standard: S A-14

Subjects: Science, language arts

Skills: Listening, visualizing, writing, observing

Duration: 60 minutes

Group Size: Any

Setting: Indoors

Vocabulary: Ecosystem, energy, living, nonliving

Objective:
Students will be able to identify the living and nonliving components of an ecosystem and how they interact.

Teaching Strategy:
Students take an imaginary or real walk through the schoolyard and create their own imaginary ecosystems.

Complementary Activities:
"Five Kingdoms But No King," "Take a Deep Breath," *and all the* "Investigating (Nonliving Things)" *in Section* 1, *Elements of Ecosystems. Also* "Who Eats Whom," "What's for Dinner?" "Ecosystem Partners," *and* "Create a Classroom Compost Box" *in Section* 2. *Also all the* "Investigating (Living Things)" *in this section.*

Materials:
Alaska ecosystem posters from INSIGHTS, *Section* 3, *Living Things in their Habitats*, or pictures of Alaskan natural environments. Examples of living and nonliving things (plants, rocks, plastic), paper and crayons.

Background:
See INSIGHTS, *Section* 1, *Elements of Ecosystems*: "*Five Living Kingdoms*" fact sheets; INSIGHTS, *Section* 2, *Community Connections*; and INSIGHTS, *Section* 3, *Living Things in their Habitats*.

Procedure:
PART ONE

1.Review the terms **living** and **nonliving**. Use the classroom to point out examples. Ask students to think about what makes something "alive" and write a class definition for "living things."

2. Ask the students to visualize a wild area near their school with which they are familiar. Some examples might be the tundra, forest, wetlands, stream or river valley, ocean, or park near the school. Each student, working alone, makes a list of all of the living and nonliving elements of this local habitat.

3. Make a class list of all of the elements of the local habitat, under the categories "living" and "nonliving."

4. Review the definition of the **ecosystem** (*a community of living things and its nonliving surroundings linked together by energy and nutrient exchange*). Discuss how your local wild area fits this ecosystem definition.

5. Work together to show the connection between the parts of the ecosystem, showing how each part depends on another. If possible, take a walk into the ecosystem surrounding the school and look for things to add to the class list. *Some nonliving things require creativity to "see." Energy is observable in the form of heat, sunlight, wind, and the movement of body parts and body fluids in living things.*

PART TWO

6. Discuss how different ecosystems have different *nonliving environments* and therefore, different living things. *Some ecosystems are dominated by hot or cold temperatures, lots of rain or hardly any rain, for example.* Can a fish that lives in an ocean ecosystem also live in a desert ecosystem?

7. If appropriate, show poster or picture examples of Alaskan ecosystems.

8. Challenge the students, working in groups or as a class, to create their own real or imaginary ecosystem as a drawing, mural, model, or a collage. The ecosystems should include at least 5-10 living things and the nonliving things on which the living things depend.

Students might start by listing the living and nonliving things that might be a part of their ecosystem and how they are connected or interdependent. The living creatures can be fictional, but must stick to the definition of "living" that the class discussed earlier. Nonliving elements must be present on earth. If using fictional creatures, students should provide a description, including what the creatures need to live.

The murals or drawings should clearly show the connections between the living and nonliving parts. The imaginary ecosystems may include a descriptive paragraph entitled "A visit to the ________ ecosystem."

7. Students share their ecosystems, pointing out the living and nonliving elements, and how they are connected. After sharing their paragraphs, students discuss whether or not they would like to live in their ecosystems.

VARIATION FOR YOUNGER STUDENTS

1. Ask students to close their eyes, listen carefully, and imagine themselves walking in a wild area nearby, in an "ecosystem." Ask them to imagine that they have extraordinary senses and can see and feel everything that is going on around them.

2. Explain that you will read a few lines to get them thinking, but then they will continue their walks in their own imaginations. Read the following passage aloud to the class:

> *"What a beautiful day to spend outside.*
> *Most of the winter snow has melted,*
> *leaving the ground wet and muddy.*
> *The air is still a little chilly, but the sun breaks*
> *through the big fluffy clouds and warms my face.*
> *High above me, a flock of geese honk wildly,*
> *heading to their nesting places.*
> *I have the whole day to enjoy this!*
> *I wonder what I will find ..."*

3. Wait a few minutes. Then ask students to write a list or a paragraph describing what they saw, felt, and heard in the wild area. Younger students can do this verbally, as a class.

4. Ask a few students to read their list/paragraphs. List on the board the things that were mentioned in the reading passage that the students observed, *such as sunshine, clouds, water, snow, and geese.*

Encourage students to share the things they imagined on their own after listening to the passage, *such as plants, animals, people, and man-made things.* Note whether students visualized any interactions between the living things.

5. Using the list on the board as examples, brainstorm the differences between living and nonliving things. Summarize the differences.

6. Give each student a box of objects representing living and nonliving things. Students divide objects into living and nonliving piles.

7. Students choose two objects from each category to draw and label an imaginary ecosystem for the objects.

Evaluation:

1.Students identify living and nonliving parts of an ecosystem and explain their interaction.

2. Students identify what makes ecosystems different and provide examples using the created, imaginary ecosystems.

Curriculum Connections:

(See appendix for full citations)

Books:

Ecology (Pollock)

A Caribou Journey (Miller)

A Dead Log (Green)

Disappearing Lake: Nature's Magic in Denali National Park (Miller)

Earthwatch: Earthcycles and Ecosystems (Savan)

A Freshwater Pond (Hibbert)

One Small Square Series (Silver)

Polar Bear Journey (Miller)

The River of Life (Miller)

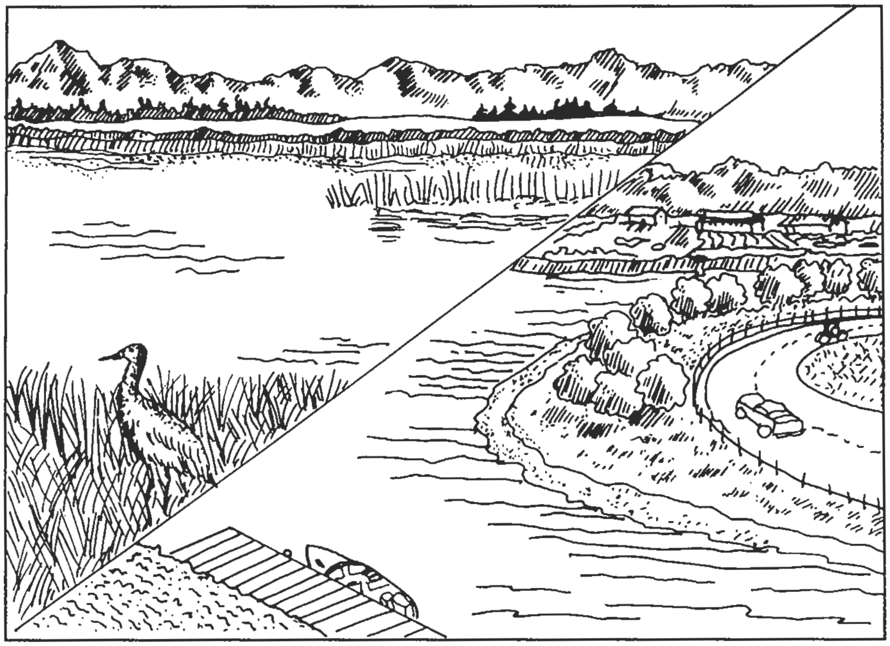
A Tidal Pool (Steele)

Under a Stone (Green)

Teacher Resources:

(See appendix)

Create and Destroy
3 EXTENSIONS



Section 4
ECOLOGY ACTIVITIES

Grade: 4 - 12

State Standards: S A-14, Geo E-5

Subjects: Social studies, science, art

Skills: Analyzing, classifying, interpreting, drawing

Duration: 45-90 minutes

Group Size: 2-4 and whole class

Setting: Indoors

Vocabulary: Conservation, create, destroy, habitat, nonrenewable resources, rehabilitate, renewable resources

Objectives:
1. Students will define and give examples of **conservation**.

2. Students identify and describe factors that change or destroy **habitat**.

3. Students will recommend methods for easing habitat destruction and rehabilitating destroyed habitat.

Teaching Strategy:
Students create an image of a beautiful environment, destroy it, put it back together, and discuss the relative time that it takes to **create**, **destroy**, and **rehabilitate**.

Complementary Activities:
This is applicable to all activities in this book.

Materials:
For each group: large sheets of newsprint or butcher paper, colorful drawing implements (markers, crayons, pastels, etc.), roll of masking or transparent tape.

Background:
See INSIGHTS, *Section 1, Elements of Ecosystems*; INSIGHTS, *Section 2, Ecosystems – Community Connections*; INSIGHTS, *Section 3, Living Things in their Habitats*; and INSIGHTS, *Section 4, Human Impacts*.

Procedure:
1. Divide your class into groups and distribute the art supplies (*but not the tape*). Tell students they will make group pictures of the most beautiful place they can imagine.

2. Brainstorm some items they might draw – things like rainbows, lakes, colorful sunsets, tundra, mountains, or forests. You may want to direct them to draw only natural objects instead of man-made items. Encourage them to include wildlife.

3. Tell the students that you will be timing the class as they **create** their pictures.

4. After 20 minutes or when the students are finished (*whichever comes first*), collect the markers and have a spokesperson from each group describe their picture to the entire class.

5. Ask the groups to exchange drawings so that each group ends up with another group's creation.

6. Tell the students that they will have 5 *seconds* to **destroy** the creation in front of them. Do not give them tools such as scissors. *Most kids figure out how to destroy the drawings without help*! Students may not touch the paper until you give the signal.

7. When the ripping frenzy is over, distribute a roll of masking or transparent tape to each group. Return the originals to their creators. Ask each group to reconstruct its creation *as close to its original form as is possible*. Tell the groups that you will time this process, too.

8. As the groups finish, display their reconstructed drawings at the front of the room.

9. Draw a chart on the board with the times needed to **create**, **destroy**, and **rehabilitate** each drawing.

10. Ask students to compare the times in each of the columns. Were students able to restore any of these destroyed habitats perfectly?

11. Ask the class the following questions.

- What were your feelings when you were creating your beautiful place?
- How did you feel when you saw it destroyed?
- Did you have difficulty getting your creations back together perfectly?
- Are the drawings the same as they were before destruction?
- Is it possible for humans to live in this world without destroying some habitat?
- Do we ever destroy habitat needlessly?
- How can we prevent habitat destruction?

12. Brainstorm a list of beautiful natural habitats and add them to the class chart. Discuss human actions or natural phenomena that affect their list of habitats. *For example, road-building and forest fires*. Students will have to estimate the time it takes to create and destroy each habitat unless they've already done some research.

13. Discuss **renewable** and **nonrenewable** resources. A *renewable resource is a naturally occurring raw material or form of energy which has the capacity of replenishing itself through ecological cycles and sound management practices. The sun, wind, falling water, plants, and many animals are renewable resources. Nonrenewable resources such as oil, coal, copper, and gold can only be replaced in geologic time, not human time.*

14. Discuss the word **conservation** — the use of mineral, plant and animal resources in a way that assures their continuing availability to future generations.

How can habitat conservation reduce habitat destruction? What are some current examples of (a) **habitat destruction** (*clearing a forest for a school or mall, fishing on unprotected river banks, etc.*), (b) **conservation** (*prescribed burns, planning for human access, etc.*) and (c) **rehabilitation** (*river bank improvement projects, rehabilitation following mining and logging*)?

Evaluation:

1. Write a paragraph or poem describing your feelings about environmental destruction and rehabilitation.

2. Name five types of environmental destruction and five ways that humans can rehabilitate a habitat following this destruction.

EXTENSIONS:

A. **Schoolyard rehabilitation project.** Students consider how they can rehabilitate the environment around their neighborhood or school and develop a class project based on class suggestions.

B. **Research, design, present solution to dilemma.** Students write to a local, state, or national government official or governing body presenting a position, solution, and defense to a real conservation dilemma. The students will need to research an area which is being affected, design a plan to conserve the area, estimate costs of the rehabilitation plan, and defend his/her idea in writing.

View points should come from the students' values, interest, and knowledge gained through research. Opinions may vary from student to student on how lands should be conserved. Create an acceptable environment for students to have differing viewpoints.

C. **Turn thoughts into poetry.** Share the following poem with students. Students may want to write their own poetry following a discussion of the poem.

> ***The Peace of Wild Things***
> by Wendell Berry
>
> *When despair for the world grows in me*
> *and I wake in the night at the least sound*
> *in fear of what my life and my children's lives may be,*
> *I go and lie down where the wood drake*
> *rests in his beauty on the water, and the great heron feeds.*
> *I come into the peace of wild things who do not tax their*
> *lives with forethought of grief.*
> *I come into the presence of still water.*
> *And I feel above me the day-blind stars*
> *waiting with their light. For a time*
> *I rest in the grace of the world, and am free.*
>
> From *Collected Poems*, 1957-1982, Berkeley, California North Point Press, 1985.

Credit:

Contributed by Colleen Matt, Alaska Department of Fish and Game, Division of Wildlife Conservation.

Curriculum Connections:

(See appendix for full citations)

Books:

Farewell to Shady Glade (Peet)

Kid's Guide to Social Action (Lewis)

Little House (Burton)

Miss Rumphius (Cooney)

Sign of the Sea Horse (Base)

Window (Baker)

The Wump World (Peet)

Website:

School Resources for Waste Prevention and Recycling <www.deq.state.ok.us/waste/education/resources2.html>

Teacher Resources:

(See appendix)

Watching Your Waste
3 EXTENSIONS

Section 4
ECOLOGY ACTIVITIES

Grade Level: 2 - 9

State Standards: S B-1, Gov E-6

Subject: Social studies, science, math, language arts, art

Skills: Observing, recording, analyzing, applying

Group Size: Small or Individual

Duration: Teacher determines

Setting: Indoors

Vocabulary: Decomposers, detritivores, limited resources, nonrenewable, recycle, renewable, synthetic

Objectives:
1. Students will measure, describe, and evaluate their household's or school's output of waste materials.
2. Students will make a waste reduction plan for home or school.

Complementary Activities:
"Create and Destroy" *in this section; and* "Mineral Cycling through an Ecosystem" *and* "Create a Classroom Compost Box" *in Section 2, Ecosystems – Community Connections.*

Materials:
Pencil and paper, bathroom scale, containers for separating and weighing trash.

Background:
See INSIGHTS, *Section 4, Human Impacts* and INSIGHTS, *Section 2, Ecosystems – Community Connections.*

Procedure:
1. Ask students to think about things that are thrown away in our homes and schools everyday. Generate a class list of categories that make up our garbage at school or at home (*i.e. food waste, paper waste, plastics, aluminum, etc.*). Ask students to predict the percentage of their home garbage that falls into each category.

2. Ask students to inventory the waste materials produced by the class or the school, their households or community:

- ***At home***, students and their families separate their waste by category for a day or a week, weighing each on a bathroom scale. Students can record their daily waste production by category. These data can be presented in a chart, with category percentages.

- ***At school,*** classes monitor waste produced by the lunchroom or office as well as in a classroom.

- ***In the community***, a study of waste produced by the town could include a trip to the dump or to the sewage treatment plant.

3. As a class, evaluate the origin of the largest percentage of household or school trash. Choose a

common item from this category and follow its cycle from its basic elements to its eventual disposal. Where does this item go after we use it? What is it made from? Is that material recyclable? See if your item is a part of a cycle, or reaches a dead end for years at a landfill.

4. To set the stage for the discussion stage of this activity, show "The Rotten Truth" or "Its Gotten Rotten" or share a resource book with students from the list of references to focus students on the need to reduce dead-end waste.

5. How does your community deal with waste? How long will waste materials last? Will they ever decay? Are any recycled? Which waste materials will decompose quickly in nature?

6. Discuss the concept of **limited resources** and list some examples that students or others in the community frequently use (*old-growth timber, fresh water, and products that rely on a lot of agricultural land*).

7. Contrast these with **nonrenewable resources** such as oil and metals such as gold and aluminum. Nonrenewable resources are also limited. *They will only be replaced naturally within geologic time, not human time.*

8. What changes can people make to become less reliant on nonrenewable resources and conserve them for the future? Focus the discussion on ideas relating to reducing use, reusing old materials, recycling, or rethinking ways to conserve our limited resources.

9. You might want to incorporate a discussion of **renewable resources** here. (*Resources that replace themselves over time such as trees or that are inexhaustible such as sunshine and wind*). Discuss what might make Alaska unique in terms of waste disposal.

10. Working in small groups, students design a plan to recycle either all or one of the waste elements that currently are discarded by their home, school, or community. Encourage them to think of ways to recycle both the organic and inorganic wastes.

11. Each student (or group of students) writes up a proposal that includes how the plan would work, what would be recycled (also what could not be recycled), and how much implementation of the plan would cost. Include a statement of advantages and disadvantages of each plan.

12. If possible, set up a compost box either in the classroom or at the lunchroom. *See Section 2 activity "Create a Classroom Compost Box" for instructions and suggestions.*

Evaluation:

1. Present recycling and waste reduction ideas to others in the class. The class decides the best system considering feasibility, costs, and effectiveness. Present ideas to the appropriate administrators and building support staff.

2. Represent data collected on a household or school waste survey in a table or graph. From this information, students can write summary statements and draw conclusions.

EXTENSIONS:

A. **Create skits or big books.** Students create skits or plays to present to the class or to other classrooms that deal with reduction of waste. Big books could also be created by older students to share with those at younger grade levels.

B. **Send a community message.** Students create an illustrated pamphlet, radio message, or video for the community, incorporating ideas on diminishing waste. (*One idea might be using popcorn instead of Styrofoam when mailing items Outside.*)

C. **Research hazardous waste disposal.** Older students research hazardous waste products, determining which of these products exist in the home. Students research the "life cycle" of these products, discovering how these products are usually disposed of in their community. A plan could be developed toward educating community members on the least harmful disposal of hazardous waste items.

Credit:

This activity was modified by Val Chabot, Eagle River, Alaska.

Curriculum Connections:
(See appendix for full citations)

Books:

50 Simple Things Kids Can Do to Recycle (EarthWorks Group)

Chattanooga Sludge (Bang)

Compost Critters (Lavies)

Just a Dream (Van Allsburg)

Kid's Guide to Social Action (Lewis)

The Lorax (Seuss)

The Paper Bag Prince (Thompson)

Reducing, Reusing and Recycling (Kalman)

The Worm Cafe: Mid-Scale Vermicomposting of Lunchroom Waste (Payne)

Worms Eat My Garbage (Appelhof)

Wump World (Peet)

Media:

It's Gotten Rotten (Video) (Gr. 9-12)

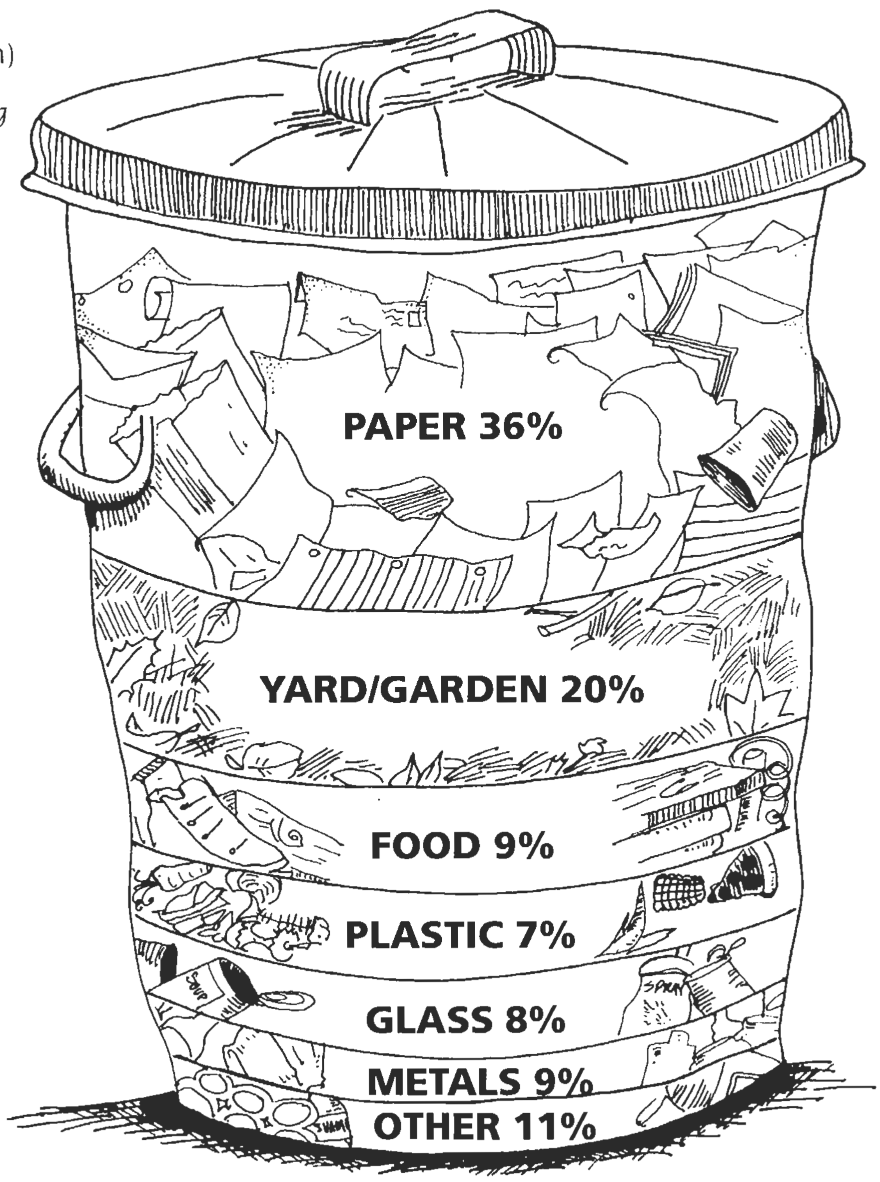
The Rotten Truth (Video) (Children's Television Workshop)

Website:

EPA Office of Solid Waste. *Students' and Teachers' Page* <www.epa.gov/epaoswer/osw/students.htm>

School Resources for Waste Prevention and Recycling <www.deq.state.ok.us/waste/education/resources2.html>

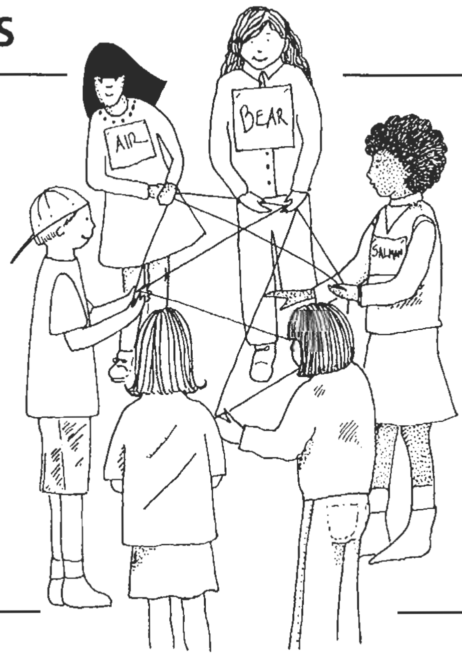
Teacher Resources:
(See appendix)



Solid Waste in Anchorage, Alaska
Statistics reported by Anchorage Recycling Center, Anchorage, Alaska

Spinning a Yarn about Ecosystems

4 EXTENSIONS



Section 4
ECOLOGY ACTIVITIES

Grade level: K - 12

State Standard: S A-14

Subjects: Science, art, language arts

Skills: Analyzing, applying

Duration: 30 minutes

Group Size: Groups and whole class

Setting: Outdoors or indoors

Vocabulary: Carnivore, consumers, detritivore, ecosystem, herbivore, omnivores, producer

Objective:
Students will be able to describe why changes in one part of an ecosystem can affect other, seemingly unrelated parts.

Teaching Strategy:
Students standing in a large circle represent an ecosystem. Each student represents a different part of an ecosystem. Yarn connects all of the students in an intricate web.

Complementary Activities:
This is a good synthesis, so all activities in this book apply.

Materials:
One large ball of yarn, scissors, name cards representing living and nonliving parts of an ecosystem (pre-made or students can make them), a list of Alaska organisms from "Alaska Food Chains and Webs" from INSIGHTS *Section* 2.

Background:
See INSIGHTS, *Section 1*, *Elements of Ecosystems*; INSIGHTS, *Section 2*, *Ecosystems – Community Connections*; INSIGHTS, *Section 3*, *Living Things in their Habitats*; and INSIGHTS, *Section 4*, *Human Impacts*.

Procedure:
1. Divide the class into five groups: nonliving things (*sun, water, minerals*), producers, herbivores, carnivores, and detritivores.

2. Using a list of Alaskan organisms and nonliving things, assign or have each student choose a different organism or nonliving thing that they will represent from their group.

3. Each student should create a name tag for his choice (*for example, the nonliving groups can choose to be sun, water, air, soil*). The name tag should include the name of the organism or nonliving element in large letters. Students may also draw what they want to represent on the nametags.

4. Students should work in groups combining their knowledge or using reference materials to determine how their organism or element relates to other parts of the food web. Each student should be aware of what their element needs to survive, and what other elements rely on it for survival.

(*For example, a mosquito could eat nectar from plants or blood from warm-blooded animals and, in turn, they are eaten by bats and birds. Mosquitoes also need warmth from the sun, air for flying, and fresh water for eggs and larvae.*) Have students include this type of information on the back of the card, if appropriate.

5. After students have donned their name tags, have the groups break apart and mingle randomly with the other students. Students "introduce themselves" as the organisms or elements represented on their cards. Following introductions, arrange the students in a large circle, arms distance apart.

6. Hand the ball of yarn to the sun and instruct the sun to say "I am the sun and plants need me in order to live." Holding on to the end, the sun then should pass the ball of yarn to a plant. For example, the sun might hand the ball of yarn to a willow.

7. As the web begins, be very explicit that no one is to throw the yarn or pass it without the complete attention of the other class members. Explain that one organism (or nonliving thing) must "interact" with another by first stating the relationship between the two, and then by passing the ball of yarn to the next person in the food chain. *For example, the willow would say, "I am a willow, (a producer) and I am eaten by a moose."*

8. The receiving organism (or nonliving thing) should then wrap the ball of yarn **loosely** around a finger and continue the chain. **Remind students not to pull on the yarn!**

9. Review the rules of the game until each student understands the procedure.

10. Continue until all the students are holding the yarn at least once. Get as many "interactions" as possible so that there will be a net of yarn connecting the students.

11. Reinforce the concept that all living and nonliving things are connected, as has just been demonstrated. Ask the students to predict what would happen if one organism or nonliving thing was removed from the web.

12. Pick one member of the web, (*for example, a salmon*) and ask students to identify other web members that would be affected if this animal disappeared. Reinforce that each member of the web is connected and cannot leave without affecting every other part of the ecosystem.

13. Have pairs of scissors ready and cut students free of the yarn when the activity has demonstrated the connections in ecosystems. Collect the yarn and cards and ask students to reproduce their webs in a bulletin board or mural display.

Evaluation:

1. Students draw a food web from their own local ecosystem or from another area. They explain the relationships between the elements in the web.

2. Students list all possible relationships for their web element. *For example, a willow* needs *sun, soil, water, air, and detritivores to break down organic material for minerals. A willow is* needed *by moose, hares, birds (for nesting), carnivores (for cover), and detritivores (after the willow leaves fall or the plant dies).*

EXTENSIONS:

A. **Reflect on activity in words or drawings.** Students describe in words or pictures the interconnections depicted by the web, including what happens if the web is broken or one of the web members is missing.

B. **Experiment with "What Ifs" in the yarn web.** After the web has been established, instruct one of the migratory animals (bird, salmon, or caribou) to move. The entire web will need to move or be modified in order to survive. What are the closest connecting elements to the migratory animals?

While the class is still attached in the web, discuss what happens in a real ecosystem when migratory animals move away. What about animals that hibernate in the winter? How are other members of the ecosystem affected? What happens if pollution occurs in a part of the ecosystem? What if the population of one element grows too large for the ecosystem to support?

C. **Describe their living kingdom.** If students have studied the five kingdoms of life, have each web element describe their kingdom.

D. **Trace pollution through the food web.** Simulate an environmental disaster once the web has been set up. Show how toxins, like oil or lead, can be passed by consumers through an ecosystem until almost all members have been affected.

Credits:

Activity contributed by Steve Kemper, Anchorage, and modified by Val Chabot, Eagle River.

Curriculum Connections:

(See appendix for full citations)

Books:

One Small Square Series (Silver)

Webs of Life Series (Fleisher)

What are Food Chains and Webs? (Kalman)

Who Eats What? Food Chains and Food Webs (Lauber)

What is a Biome? (Kalman)

Media:

Into the Forest, Krill, Onto the Desert, Predator (Nature's Food Chain Games) (Ampersand Press)

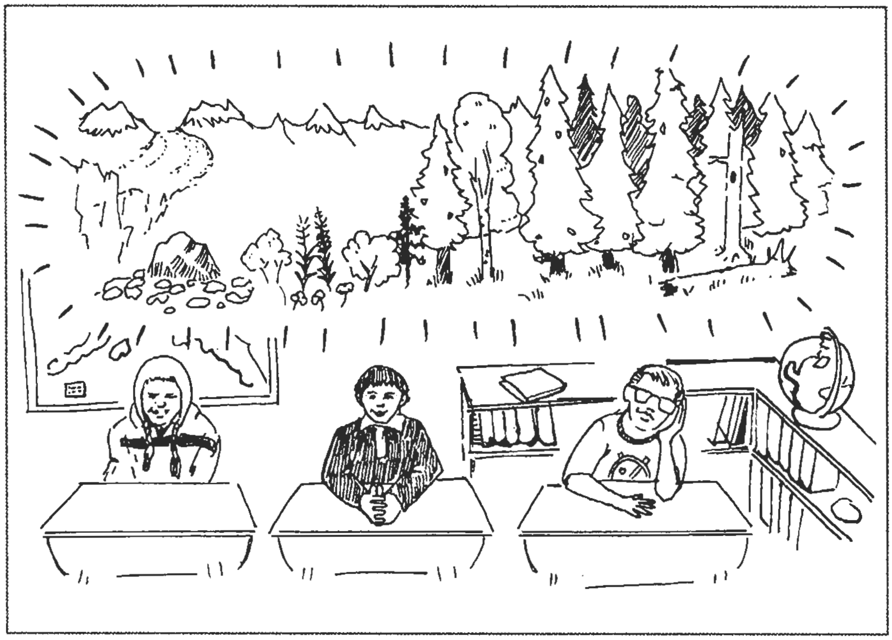
Teacher Resources:

(See appendix)

Alaska’s Forests

Trees to Imagine

3 EXTENSIONS



Grade Level: K - 5

Subjects: Science, language arts, dramatic arts

Skills: Listening, visualizing, identifying, describing

Duration: 20-30 minutes

Group Size: Individual

Setting: Indoors or outdoors

Vocabulary: Broadleaf, cone, conifer, crown, deciduous, evergreen, roots, sap, seeds, trunk

Objectives:

1. Students will name the parts of a tree and describe the function of each.

2. Students will describe the seasonal cycle in the life of a tree.

Teaching Strategy:

Students imagine themselves to be trees in the forest.

Complementary Activity:

OUTDOOR/INDOOR: "Role-Play a Tree" *in this section*.

Materials:

Copy of a guided imagery (*following page or story of your own*)

Background:

See INSIGHTS *Section 1, Elements that Create Forests.*

Procedure:

1. Outdoors: Students stand against the trunk of a tree, close their eyes, and imagine that they are the tree. Indoors: Students draw each part of the tree as it is discussed in the guided imagery.

2. Guide the students through a year of a tree as you review the roles of the various parts of a tree by reading the story.

3. If you want to change this guided imagery or repeat it with a **deciduous broadleaf** tree, change the shape of the crown and add details about leaves changing, falling in autumn, and growing again in the spring.

4. In summary, ask students to name the parts of a tree and their jobs. Ask students to name changes that take place in the annual cycle of tree life.

Evaluation:

1. Students name the parts of a tree and describe their functions.

2. Students describe changes in the life of a tree over a year.

GUIDED IMAGERY:

You are a **conifer** tree. Your **crown** is shaped like a cone and stretches far up into the sky. Your **trunk** is straight and strong, so strong that winds don't blow you over. Your trunk holds up all your branches and needle-like leaves.

Your **roots** are planted solidly in the cool soil. They grow only a few inches below the ground and stretch outward from your trunk as far as your trunk reaches skyward. They mingle with the roots of other trees of your forest. Your roots are soaking up water and minerals from the soil Those nutrients (called **sap**) are slowly drawn upward through the inner layers of your trunk. You feel the cool moisture traveling upward, then out to your branches and into your leaves.

Your **leaves** look pretty just hanging there, but they are really busy working. Leaves are the kitchens of trees. They are soaking up warm sunshine and the cool air. They mix sunshine and carbon dioxide from the air and add water sent up from your roots. This makes a feast of sugars.

These sugars move from your leaves and slowly seep through the outer layers of your branches and trunk to reach all parts of you. These sugars are food for your trunk so it can grow taller and stronger. These sugars are food for your cones and the seeds that are forming inside. And these sugars are food for your roots so they can grow longer and find more water and minerals.

Day in and day out, your **sap** flows through your trunk. Your leaves are busy capturing the energy of sunlight. You grow taller. You grow new leaves at the tips of your branches. And you form new **seeds** and **cones** to protect the seeds..

Soon summer is ending. The cool air dries your leaves and the wind shakes some needles from your branches. Just as the thick bark on your trunk and branches protected you from the insects and sun of summer, now that bark protects you from cold, dry winds. Some mornings there is frost creeping over your roots, making your sap flow more slowly.

By the time the winter snows fall, you have stopped growing for a while. You keep your needles so you are called **evergreen**. Your roots hold you solidly to the ground as the winter winds howl and toss your branches. When the wind stops, your branches fill with heavy snow, bending them to the ground. You sleep and wait for warmer weather, more sunshine, and another season to grow.

You have lived through 100 winters. Months of cold and darkness move slowly before you feel spring arriving. Then, one day, cold meltwater begins to seep through the soil; your roots wake to the icy cold water. You begin growing again as the sunlight shines on you for longer hours.

A bird perches in your branches and sings a song. It's spring and time to get busy. You begin adding another ring of cells to your trunk, more branches and leaves to your crown, and you begin making more seed cones. Life continues.

EXTENSIONS:

A. **Adopt a tree.** For an ongoing extension, each student adopts a tree in the area. Students can keep daily or weekly observation logs on their trees throughout the year. Encourage students to draw conclusions from their observations. Measure each tree's girth and height during the year. *To measure height by triangulation, see "Champion Tree" in Section* 5. In multi-grade classes, students can measure their tree from year-to-year.

B. **Build a classroom tree with "found" parts.** Build a classroom tree using real, "found" tree parts. Draw the shape of a tree on a large piece of butcher paper. Glue on small branches, bark, leaves, cones, and others that the children bring to class. Caution them about not tearing off living plants.

C. **Build a classroom tree with paper.** Build a model of a tree in the classroom. If you use long cardboard tubes from wrapping paper, you have a way to make "winter trees" or tree silhouettes.

(1) Collect as many wrapping paper tubes, paper towel tubes, toilet tissue tubes, and drinking straws as you can, to represent trunks and long branches, shorter branches, and twigs.

(2) Stand the long tubes in a 5-gallon bucket filled with sand.

(3) Cut slits along the long tubes and attach long and shorter tubes for branches and twigs. Try to make a pattern resulting in silhouettes of various Alaska tree species.

Credits:

Adapted from Susan. Quinlan, "Alaska's Forests: More Than Just Trees." *Alaska Wildlife Week*, Alaska Department of Fish & Game, 1987.

Extensions contributed by Jean Ward, Chugach Optional School, and Patrick Ryan, Northwood Elementary, Anchorage, Alaska.

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Just a Dream (Van Allsburg)

Old Elm Speaks (O'Connell) (Poetry)

Owl Moon (Yolen)

Tree of Life, The World of the African Baobab (Bash)

Media:

Billy B Sings About Trees (Billy B)

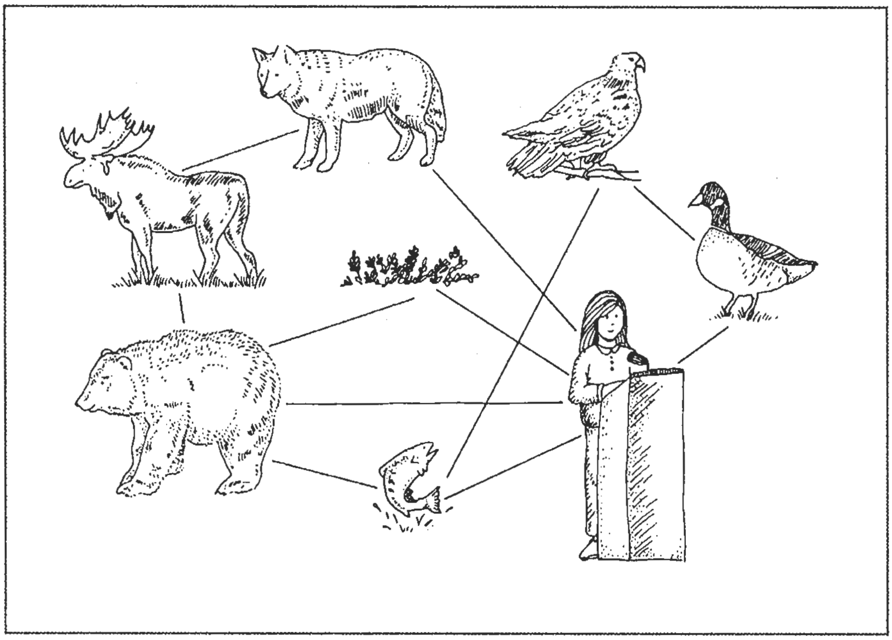
Teacher Resources:

(See appendix)

Forest Food Web Game

1 EXTENSION

ALERT: ALASKA ECOLOGY CARDS REQUIRED



Grade Level: 5 - 12

State Standard: S A-14

Subjects: Science

Skills: Classifying, predicting

Duration: 60 minutes

Group Size: Whole class

Setting: Indoors

Vocabulary: Carnivores, consumers, detritivores; ecosystem, energy, food chain, food web, fungi, habitat, herbivores, minerals, omnivores, producer

Objective:

Using pictures, students will construct and describe food webs that include the nonliving elements of a forest ecosystem.

Teaching Strategy:

Students introduce themselves as elements of a forest ecosystem and link with the other elements they need to form a forest food web.

Complementary Activities:

OUTDOOR: "Fungi," "Detritivores," and "Forest Ecosystem Scavenger Hunt," *all in this section.*

Materials:

Selected *Alaska Ecology Cards* (list follows) or other pictures of coastal and boreal forest plants and animals, lengths of yarn 6 inches to 3 feet long, chalkboard and chalk.

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Procedure:

1. Separate the *Alaska Ecology Cards* for either the boreal or coastal forest (list follows).

2. Review your students' prior knowledge about **food webs**.

3. Brainstorm the components of an Alaska forest. Encourage students to name a mixture of **nonliving things**, kingdoms of **living things** (*plants, animals, fungi, etc.*), specific organisms (*flying squirrels, woodpeckers, insects, etc.*) and roles of living things (***producers***, ***consumers***, *etc.*). List whatever they mention on the board.

4. Students divide the list into living and nonliving things. Students then divide the living things into ecological roles (*producer, consumer,* ***herbivore***, ***carnivore***, ***omnivore***, *and* ***detritivore***).

5. Explain the classification of living things by their ecological roles is important in understanding how a forest **ecosystem** works. *If an ecosystem is to survive changes, then all of the ecological roles must be conserved. For*

example, if an herbivore disappears then the carnivore that eats it will be affected. Explain that the *Alaska Ecology Cards* represent a sample of some of the living things found in Alaska forests.

6. Depending on which forest you have chosen to study, distribute the following *Alaska Ecology Cards* in the following order (to assure that all organisms will interconnect):

BOREAL FOREST	**COASTAL FOREST**
Sunlight	Sunlight
Air	Air
Water	Water
Rocks and soil	Rocks and soil
White spruce tree	Sitka spruce
Red squirrel	Red squirrel
Goshawk	Goshawk
Carrion beetle	Carrion beetle
Bacteria	Bacteria
Gilled mushroom	Gilled mushroom
Bark beetle	Bark beetle
Hairy woodpecker	Red-breasted sapsucker
Sharp-shinned hawk	Sharp-shinned hawk
Birch tree	Hemlock tree
Moth	Sawfly wasp
Chickadee	Chickadee
Truffle	Truffle
Bacteria	Bacteria
Springtail	Springtail
Flying squirrel	Flying squirrel
Low-bush cranberry	Trailing raspberry
Vole	Moth
Great horned owl	White-footed deer mouse
Weasel	Marten
Polypore or shelf fungi	Polypore or shelf fungi
Protozoans	Protozoans
Lichen	Lichen
Moose	Deer
Grouse	Grouse
Hare	Crossbill
Lynx	Wolf
Algae	Algae

If few students are doing this activity, students hold more than one card from the same ecological role. For example, one student could hold all of the nonliving cards, or all the producer cards.

7. Students circulate around the room and introduce themselves to each other. They give the name of the item they represent, their type (nonliving, producer, consumer), and what they eat or use to survive. *For example, "I am the minerals in rocks and soil. I am nonliving. I do not eat;" or "I am a spruce tree. I am a producer. I make my own food using sunlight, water, minerals, and air;" or "I am a moose. I am an herbivore that eats twigs of birch, willow, and other plants."*

8. Whenever a student meets something that it eats, that eats it, that uses it (in the case of producers), or that is used by it (nonliving things), those students should join together by holding pieces of yarn. Students who are connected by yarn move together as a group. Students in groups can introduce themselves individually, or the top consumer in each group can do the introductions. Other students will join this group whenever appropriate. *Several separate groups will form at first, but eventually, the whole class should become interconnected.*

9. Congratulate the class on becoming a forest food web! Explain that a food web contains all the **food chains** of an ecosystem.

10. Ask what would happen to the ecosystem if one of the organisms in the food web was removed. Tug on one player as if to remove her. Tell her to pass the tug on to all the organisms she connects. Ask those who feel the tug to raise their hands. Discuss the effects. If desired, repeat this step by removing different kinds of organisms. Which causes the most effects – removal of a producer, herbivore, carnivore, or detritivore?

Evaluation:

1. Students describe the ecological role of producers, consumers, herbivores, carnivores, detritivores.

2. Students draw a food chain of at least 4 living things from the forest environment.

EXTENSION:

Color the posters and find the wildlife. Students color the boreal and coastal forest posters from the *Section 2* INSIGHTS, *Forest Ecosystems – Community Connections*. Can they find the following:
COASTAL FOREST: 14 animals? 9 plants? 3 fungi?
BOREAL FOREST: 12 animals? 7 plants? 3 fungi?
How are they connected in the ecosystem?

Curriculum Connections:
(See appendix for full citations)

Books:
Alaska Wildlife Notebook Series (ADF&G)

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Biomes of the World (*v.*1) (Allaby) 7-12

One Small Square: Woods (Silver)

Taiga (Kaplan)

Taiga (Sayre)

U-X-L *Encyclopedia of Biomes* (*v.*3) (Wigel) 7-12

What are Food Chains and Webs? (Kalman)

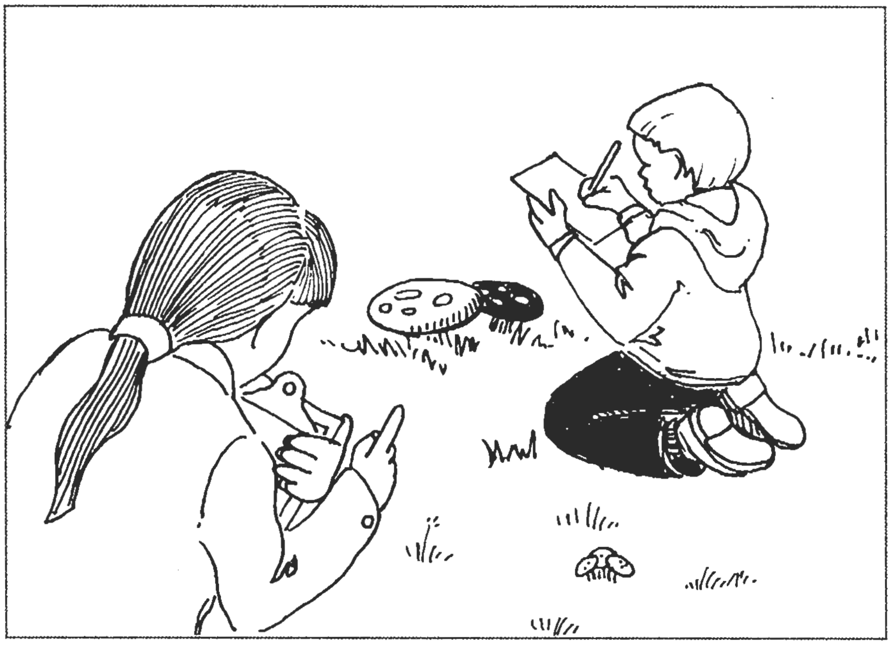
Who Eats What? (Lauber)

Website:
Alaska Science Forum
<www.gi.alaska.edu/ScienceForum>

Teacher Resources:
(See appendix)

Forest Ecosystem Scavenger Hunt

ALERT: ALASKA ECOLOGY CARDS OPTIONAL



Grade Level: 5 - 9
State Standards: AC E-2, S A-14, S B-1
Subjects: Science
Skills: Observation, inferring, application
Duration: 45 minutes or more
Group Size: 3-5
Setting: Outdoors
Vocabulary: Broadleaf, carbon dioxide, carnivore, commensalism, conifer, consumer, detritivore, ecosystem, erosion, fungus, herbivore, interdependence, invertebrate, mammal, microscopic organism, oxygen, mutualism, nonliving element, omnivore, parasitism, photosynthesis, predation, producer, recycle, respiration, symbiosis

Objective:

Students will identify concepts and components of a forest ecosystem.

Teaching Strategy:

Students participate in a scavenger hunt to identify and review roles of organisms in a forest ecosystem.

Complementary Activities:

OUTDOOR: "Insect Signs," "Mammal Signs," *and* "Bird Signs" *in this section. Also* "Track Casting" *in Section* 3, *Forest Learning Trail*; "Snag a Home" *in Section* 4, *Succession*.

Materials:

Copy of the scavenger hunt list for each group (*following pages*).
OPTIONAL: *Alaska Ecology Cards*.

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Procedure:

1. Before distributing the scavenger hunt list, add specific animals, plants or other items which represent your local area.

2. Review the list of items together. Help students define unfamiliar terms.

3. Explain that some items on the "Forest Scavenger Hunt List" require creative thinking. *For example, students may not see specific animals, but they could find animal signs such as droppings, browse marks or tracks. Similarly, students will not see* ***carbon dioxide****, but they can deduce its presence by their own presence or the presence of animals that breathe it out, or by plants which use it in* ***photosynthesis*** *and* ***respiration***.

Evidence of ***symbiosis*** *might include a* ***parasitic*** *growth on a plant, a deer or moose (which requires* ***microscopic organisms*** *to digest its food), a swallow (which must have holes in trees made by woodpeckers or fungi to survive), or seeds that stick to someone's socks.*

4. Explain the rules:
- Although students can review the *Alaska Ecology Cards* or the Glossary, they may not write anything down until the hunt begins. (b) When students find an item, they are to **write each "find" on their list rather than collecting it**.
- Students can use the same item more than once on the list as long as the item fits more than one category.
- The search ends when any team finds one example of each item on the list, or at the end of a specified time.

5. Once the class is outside, set clear boundaries for the hunt. Remind students to respect wildlife and the forest ecosystem by leaving plants as they find them.

6. When the search ends, the first team finished reads aloud its list, explaining why their items are examples or evidence. Other teams follow with items that they found which were different from the first team's list.

7. All teams cross from their list anything that another team also listed. Any incorrect answers must also be crossed off. Each team then adds the number of allowed items remaining on its list and scores one point per item. The team with the most points wins.

Evaluation:
Students write a description of the forest ecosystem using the scavenger hunt list. Students explain the interconnections.

Curriculum Connections:
(See appendix for full citations)

Books:

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Dead Log Alive (Kittinger)

A *Dead Log* (Green)

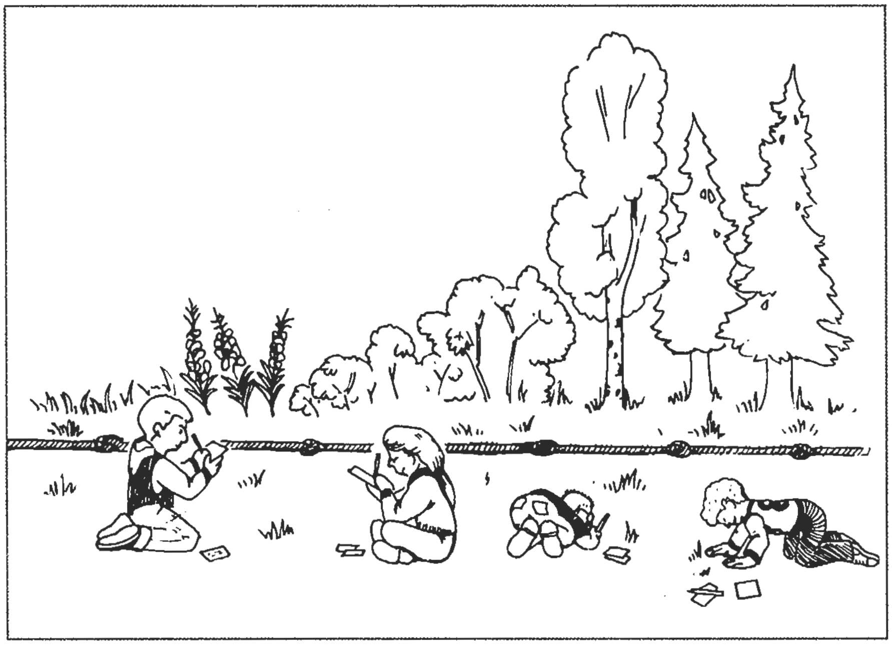
One Small Square: Woods (Silver)

Shrinking Forests (Tesar)

Teacher Resources:
(See appendix)

Flipbook Succession

1 EXTENSION <u>*ALERT: ALASKA ECOLOGY CARDS OPTIONAL*</u>



Grade Level: 4 - 8

State Standard: S A-15

Subjects: Science, social studies, art

Skills: Observing, recording, drawing

Duration: 50-100 minutes

Group Size: 1-3

Setting: Outdoors and indoors

Vocabulary: Herbs, pioneer, sere, shrubs, succession, successional stage, transect

Objective:

Students will identify and record the successional stages of a local forest.

Teaching Strategy:

As students walk (or crawl) along a transect line, they will observe differences in the types and abundance of plants, draw these changes, and make a flipbook to show stages of succession along a transect.

Materials:

Enough 3 x 5 cards (or 5 x 7) for each student to have at least 10 cards, two brass fasteners per student, one clipboard or cardboard for drawing surface per student, pencils, hole punch, rope long enough to signify a transect from pioneer stage to climax forest (several hundred feet maximum).

OPTIONAL: *Alaska Ecology Cards*, separate cards or construction paper for booklet covers.

Note: This activity works well if you familiarize yourself with local plants prior to doing the activity with students. You may also invite a botanist, forester, naturalist, knowledgeable community member, or elder into class to assist you with this activity.

Background:

See INSIGHTS, *Section 4, Succession.*

Procedure:

IN ADVANCE, locate an area with plants ranging from **pioneer** stage through as many **successional stages** as possible to **climax** forest. Spring, summer, or fall will give more successional clues. *Look for such areas where gravel pits, dirt parking lots, or abandoned fields meet a forest.*

1. IN CLASS, review your forest's (coastal or boreal) **succession charts** (*see* INSIGHTS, *Section* 4) with students before making a visit to the site. Explain that students have new jobs as foresters, botanists, or biologists. Their first assignment is to describe the **successional stages** at a nearby site.

2. AT THE OUTDOOR SITE, students number the cards to match the number of knots/markers on the transect line.

3. Set up the **transect** by laying the rope along the ground across the area. *For example, start one end of a 100-foot trope on the edge of an abandoned dirt parking lot and stretch it into the adjacent woods.* The rope becomes a visual cross-section.

4. Make knots in the rope at spots where you want students to draw a picture of the successional stage, OR put flagging tape or other marker at the observation spots.

5. Students draw as much as they can on an index card at each station. Encourage students to observe all the kinds of herbs, shrubs, and trees at each spot, and to make their drawings in profile, as if they were lying on the ground looking head-on at the plants (*as in the succession charts*).

6. As *students move along the rope, they will notice that the numbers and kinds of low growing annual plants like fireweed decrease. As they move into the forest, small trees may begin to appear. By the time they reach the forest, they might find tall spruce, hemlock, or birch with thick sphagnum moss on the ground.*

7. BACK IN CLASS, give students time to complete the details in their drawings.

8. Students arrange the cards in successional order, punch holes in the cards, and fasten them with the brass fasteners. Covers are optional. Students may work in groups of 2 or 3.

9. Students refer to their succession charts to l
the various stages or **seres** they observed.

10. Practice flipping through the stages of success
and watch the forest grow!

Evaluation:

1. Students put a new set of pictures in successi
order and label the stages.

2. Students arrange a set of written fo
descriptions in successional order, adding a draw
and label to each one.

EXTENSION:

Make puzzles out of the succession cards. Stud
cut their succession cards into puzzle pieces
classmates to reassemble.

Curriculum Connections:

(See appendix for full citations)

Books:

The Gift of a Tree (Tresselt)

How the Forest Grew (Jasperson)

Taiga (Kaplan)

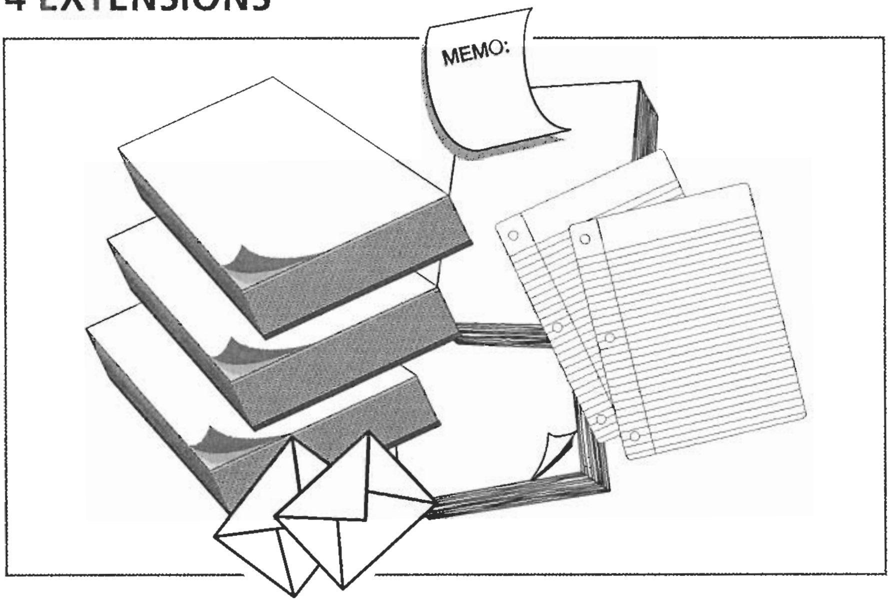
Teacher Resources:

(See appendix)

An ancient tree still lives in Alaska. Fossil records tell us that the plant, horsetail or *equisetum*, was once a mighty tree. It grows about a foot tall now and is no longer a true tree. You can see horsetail in many disturbed areas. (#25 of *Alaska Ecology Cards*)

How Much Paper Do We Use?

4 EXTENSIONS



Section 5
FOREST ACTIVITIES

Grade Level: K - 6

State Standards: M A-3, M A-4, M A-6, Geo E-1, Geo E-2, Gov E-6

Subjects: Social studies, math

Skills: Measuring, comparing, analyzing, graphing

Duration: 30-60 min.

Group Size: 1 and whole class

Setting: Indoors

Vocabulary: Recycle, reuse, reduce

Objectives:

1. Students will determine the amount of paper they use daily as individuals, as a classroom, as a school.

2. Students will understand that they can contribute to paper recycling.

3. Students will develop a plan for reducing the volume of paper waste in their classroom and/or school.

Teaching Strategy:

Students keep records of their paper use for one day and calculate the amounts used daily by their classroom and school. Students work in groups and as a class to make a plan for reducing paper use.

Complementary Activities:

INDOOR: "Paper Making" *and* "We All Use Forests" *in this section.*

Materials:

Large box for collecting paper from the classroom, a scale to weigh paper, pencil, paper.

Background:

See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems*: "How Much Paper Do We Use?" fact sheet.

Procedure:

1. List and discuss which classroom materials are made from trees.

2. Review daily class activities that use paper. Tell students that they will be keeping track of paper use for each day of one week. Ask them to deposit their paper in a central location such as a marked box. At the end of each day, weigh the paper. At the end of the week, calculate an average daily amount.

3. Divide the paper into two categories: "paper that can still be used," (*perhaps only one side has been used*) and "paper that has been used completely."

4. Discuss ideas for reusing paper. Ask the class to make a simple paper recycling plan and put it into action. Ask the children to determine at least three ways to reduce paper waste in the classroom.

5. After the plan has been in effect for a week, weigh the waste paper again to see if progress has been made.

VARIATION FOR OLDER STUDENTS
Use math to equate the percentage of paper saved over the course of the week. If the amount of paper saved were added up over the course of the year, how much paper, by weight, would be saved?

Evaluation:

1. Students name three ways to reduce paper waste in the classroom.

2. Students develop, carry out, and monitor a plan to reduce paper waste in the classroom or school.

EXTENSIONS:

A. **Research own paper use.** Students collect the paper individually at their own desks and determine their average personal use over a period of time.

B. **Estimate consumption of paper by school.** Estimate the amount of paper used by the school on a daily and weekly basis.

Alaska Recycling Sources

Citizens for Recycling Solutions (Anchorage, Alaska) <www.recyclingsolutions.org> (907) 566-2405

ALPAR (Alaskan's for Litter Prevention and Recycling), P.O. Box 200393, Anchorage, AK 99520 *or* (907) 274-3222

RurAL CAP (Rural Alaska Community Action Program), 731 E. 8 th Ave., Anchorage, AK 99501 *or* <www.ruralcap.com>

Alaska Inter-Tribal Council, 431 W. 7th Ave., Anchorage, AK 99501 *or* (907) 563-9334 <www.AITC.org>

Anchorage Recycling Center, 6161 Rosewood St., Anchorage, Alaska 99518 <www.anchoragerecycling.com/>

C. **Estimate how many trees supply school paper needs.** Estimate the number of trees used each year by the classroom and school (1 tree = about 300 lbs. of paper).

D. **Create and monitor plan for school paper reduction.** Create a waste reduction plan for the school and include ideas to help teachers and others who work in the school reduce their use. Monitor and follow the plan by weighing waste initially, and then periodically weighing after the plan has been in effect. The results can be recorded on a graph.

Credit:

This activity was originally contributed by the late Val Chalbot. Val taught elementary school in Eagle River, Alaska.

Curriculum Connections:

(See appendix for full citations)

Books:

Just a Dream (Van Allsburg)

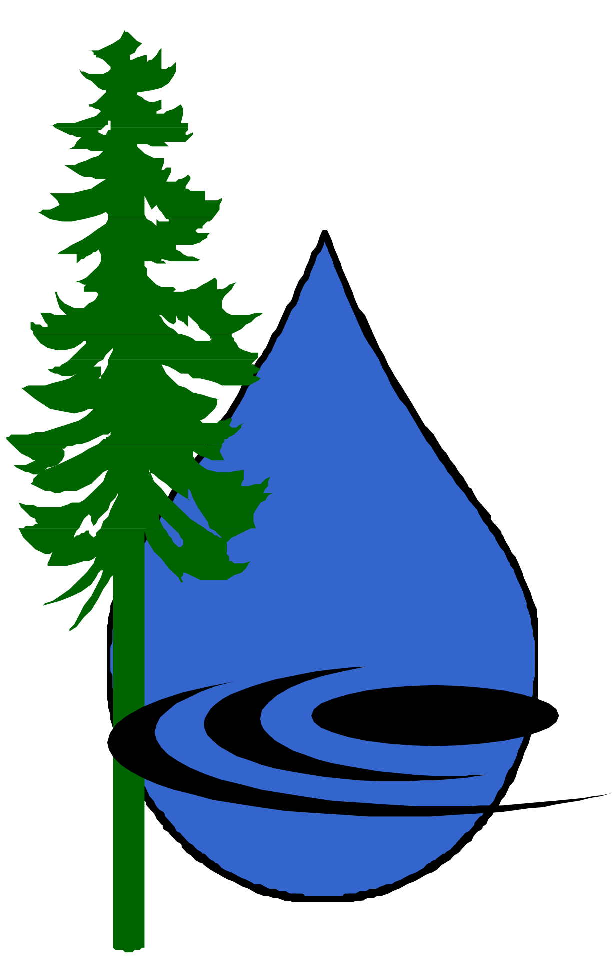
Lorax (Seuss)

Remake It! Alaska: Anchorage Businesses Remake, Recycle, Reuse (Citizens for Recycling Solutions)

Teacher Resources:

(See appendix)

The average American uses two trees worth of paper each year.



Alaska's Wildlife

Wildlife Conservation Conference

2 EXTENSIONS

Section 2
WILDLIFE ACTIVITIES

Grade level: 10 - 12

State Standards: L A-1, L A-3, L C-2, S A-14, CS B-2

Subjects: Science, geography, language arts, technology

Skills: Researching, writing, communication, oral presentations

Duration: 2 sessions

Group Size: 1-2

Setting: Indoors

Vocabulary: Wildlife names and terms

Objectives:

1. Students will give oral presentations on specific species of wildlife.

2. Students will provide the scientific, common and local name, life history, population and trend, range, predators and prey, and habitat requirement information for a specific species of Alaskan wildlife.

3. Students will present adaptation strategies, field sign and track information, local uses and stories relating to their chosen species.

Teaching Strategy:

Students will research Alaskan wildlife species and provide an oral presentation, using technology to create slides and charts.

Complementary Activities:

"Habitat Grid," "Schoolyard Habitat Map," *and* "The Habitat Times" *in Section* 1. "Gone Forever" *in Section* 3 *and* "Exploring Wildlife Issues" *in Section* 4.

Materials:

Access to research materials on the web, in the library, in the community. Computers and computer projector (*overheads can be used if equipment is unavailable*). Track casting materials, skulls and hides from loan collections, samples gathered from local community members.

Background:

See INSIGHTS Section 2, Biodiversity and Populations – Alaska's Dynamic Wildlife.

Procedure:

1. Introduce the activity by reminding students that mysteries still surround some Alaskan wildlife. Until recently, where Spectacled Eiders wintered or how far polar bears traveled were unknown. Many more questions about wildlife remain unanswered.

2. Tell students they will become experts specializing in one species of wildlife. They will research their animal in-depth and present this information in a professional manner, as conservation professionals.

3. Brainstorm or provide a list of Alaska wildlife species in your area from which to select the species for specialization. Each pair will have a different species.

4. Students gather information including:
- scientific, common, and local names
- life history
- population, population trends, and management practices
- seasonal ranges (gather and/or create maps)
- predators and prey
- habitat adaptation strategies
- field sign and track information
- behavioral information (calls, territory, mating, parenting, etc.)
- local, regional, statewide, global uses of the species
- stories relating to their chosen species

4. Students create oral presentations including computer presentations, hand-on collections (photographs, track castings, scat, etc). *When applicable, the presentations can follow an order that represents a food chain. For example, students presenting lynx will follow students providing presentations on snowshoe hare.*

VARIATION
Require students to take notes from other presentations and test them on the information to enhance listening and note taking skills.

Evaluation:
Students will demonstrate knowledge in each of the concept areas mentioned above relating to the species of their choice.

EXTENSIONS:
A. **Dramatize research for others.** Students write stories about their chosen animal and perform these stories to younger students after practicing and critiquing them for their class. Stories may include traditional myth, personal experience, and information gathered in the above activity.

B. **Archive research for future users.** Students can store computerized presentations on a school library computer, post them to the school web page, or make CD-ROMs for future reference by other students and teachers.

Curriculum Connections:
(See appendix for full citations)

Books:
Alaska Wildlife Notebook Series (ADF&G)

Alaska's Bears (Sherwonit)

Alaska's Birds (Armstrong)

Alaska's Fish (Armstrong)

Alaska's Mammals (Smith)

Encyclopedia of the Animal Kingdom (Kerrod)

Facts on File Wildlife Atlas (Kerrod)

Mammals of Alaska (Alaska Geographic)

Media:
Alaska Wild! Free video clips for multimedia repo

Websites:
Alaska Biological Science Center
<www.absc.usgs.gov>

Alaska Natural Heritage Program
<www.uaa.alaska.edu/enri/aknhp_web>

Alaska Statewide Databases, accessed through your local library website or <sled.alaska.edu>

Alaska Wildlife Notebook Series <www.state.ak.us/ac

Animal Diversity Web
<animaldiversity.ummz.umich.edu>

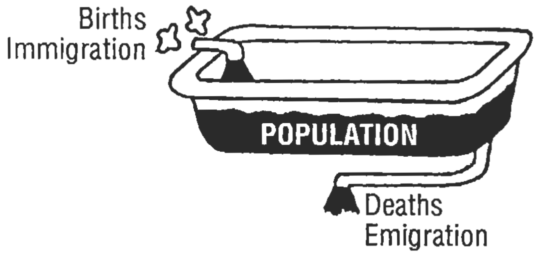
Animals of the Arctic <tqjunior.thinkquest.org/3500

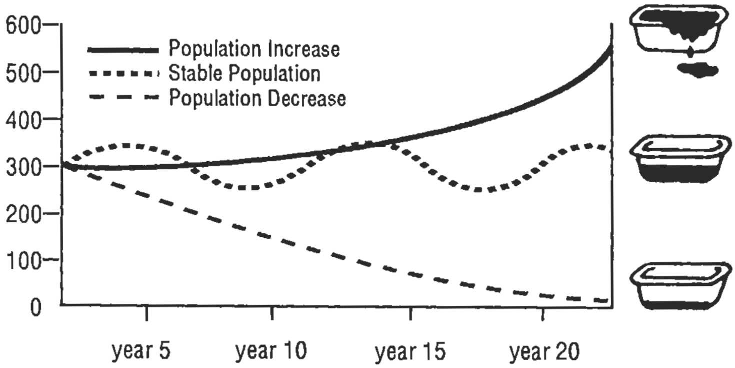
Staff-written Alaska newspaper articles: Anchora *Daily News* Archives <www.adnsearch.com> or Fairbanks *Daily News-Miner* <www.newsminer.co

Teacher Resources:
(See appendix)

Graphic Populations
7 EXTENSIONS

Carrying Capacity





Section 2
WILDLIFE ACTIVITIES

Grade level: 6 - 8

State Standards: M A-4

Subjects: Science, math, language arts

Skills: Analysis, communication, graphing, inference, prediction, reading, synthesis

Duration: 2-3 periods

Group size: 4-8

Setting: Indoors

Vocabulary: Conservation, extinction, graph, population decline, population recovery, stable population

Objectives:
1. Students will compare population trends.

2. Students will determine factors that may cause population declines or increases.

3. Students will discover ways that human actions have contributed to or reversed population declines.

Teaching Strategy:
Students compare graphs for several wildlife populations.

Complementary Activities:
"Population Explosions" *and* "How Many Bears Can Live in this Forest?" *in this section*. "Science, Technology, Society, and Wildlife" *and* "Exploring Wildlife Issues" *in Section* 4.

Materials:
Copies from INSIGHTS Section 2 of *Steller Sea Lion, Northern Pintail, California Condor, and Western Arctic Caribou Herd* — "Wildlife Facts," "What Happened," and "Population Graphs." Graph paper.

OPTIONAL: computer graphing program, overhead projector, overhead graph paper.

Background:
See INSIGHTS *Section* 2, *Biodiversity and Populations – Alaska's Dynamic Wildlife*. Also INSIGHTS *Section* 3, *When Populations Decline* and INSIGHTS *Section* 4, *Wildlife Conservation is Up to Us!*

Procedure:
1. Draw a hypothetical **population** graph on the board or on overhead graph paper to show how a population can grow, stabilize, and **decline**. Discuss the relationship of births and deaths in a population that is growing, **stable**, or declining.

2. Brainstorm the causes of wildlife declines (*see* INSIGHTS *Section 3 for more information*). Categorize the causes of declines under two separate headings, "human-related factors" and "other environmental factors."

3. Use jigsaw grouping (*see description included with this activity*). Divide the class into the lettered groups and

pass out the "Wildlife Population" Fact Sheets (*from* INSIGHTS *Section* 2). Pass out graph paper if you want the groups to graph the data. If not, pass out the corresponding "Population Graphs" at the same time.

4. Encourage students to read the fact sheets, extract the data, and make graphs.

5. Review the graphs to determine the trend of the population (*increasing, declining, or stable*).

6. Students should discuss what factors might have caused the trends in their population. **If a population is declining**, students may predict when their wildlife population would drop to zero (***extinction*** *would occur*) assuming that all factors causing the decline continue.

7. Discuss how human effort through **conservation** management can change a downward trend. *The Cackling Canada goose of the Yukon-Kuskokwim Delta is an example of effective conservation management in Alaska <www.r7.fws.gov>*

8. **If the population is increasing**, discuss how many animals in a population may be too many for the **habitat** to support – if the animals exceed the **carrying capacity** of the habitat.

9. Ask students to predict what will happen if the population grows too large. Discuss how human effort through hunting and other conservation management can contain this population explosion. *The Canada goose population in the Anchorage Bowl is an example <www.r7.fws.gov>*

10. Distribute the "What Happened?" handouts that match each group's wildlife population fact sheet. Ask the groups to make a list of the factors that affected the population trends for their animals. Each student will need a copy of the group's results.

7. After letter groups complete their work, students meet in numbered groups to share the graphs and lists from the lettered groups. Discuss the questions asked about what scientists need to know.

(For example, answers to Sea Lion Population questions: Scientists would need to know whether the populations being counted represented the entire species or if other populations still survived after some populations dropped to zero. They would also need to know the life history, where young are born and raised, and any migratory movements.)

8. For each graph, make a list of human actions that contributed to population declines and a list of human actions that helped reverse population declines. If the population has increased, list what human actions have contributed to the increase and determine if the increase is healthy or cause for concern.

Evaluation:

1. Ask students the relationship between the number of births and the number of deaths in a population at the following points on a population graph:
   (a) Upward graph (*number of births exceeds the number of deaths*)
   (b) Straight line graph (*number of births equals the number of deaths*)
   (c) Downward graph (*number of deaths exceeds the number of births*)

2. Students research wildlife management success stories in Alaska (*Aleutian Canada geese, sea otters, mallards, bowhead whales, muskox, trumpeter swans, or arctic nesting geese*) or elsewhere in the world. List the ways population declines were reversed.

3. Each group presents a skit or play of what they have learned. Perform for the class and end with at least three recommendations how humans can help declining species.

EXTENSIONS:

A. **Computer graphing.** Use a computer program that generates graphs based on population data or present graphs and conclusions to another class through a computer network.

B. **Research and write about other populations.** Research and develop population story examples and "What Happened?" sheets for other Alaskan animals.

Chose a variety of animals that are: (a) healthy, (b) threatened or endangered animals and (c) rapidly increasing.

C. **Discuss wildlife news stories.** Students bring in and discuss news articles on animal populations and how they are changing.

D. **Guest wildlife manager.** Invite wildlife managers to the classroom to discuss population graphs. If the biologist is unable to come to class, ask for sample population graphs of animals in your area, or animals of particular interest to your students.

E. **Guest Native elder.** Invite knowledgeable long-term residents and Native elders to describe changes in local wildlife populations that they have observed over their lifetime. Discuss possible human influences on the changes in local populations.

F. **Graph other animal populations.** Obtain scientific data about local animal populations. Graph the data to see if they are declining, increasing, or stable. Predict what action wildlife managers might take after getting the data.

G. **Peregrine falcon case study.** Study the "Population Graph" of American peregrine falcons from the Upper Yukon River (*in* INSIGHTS *Section* 2). In the late 1960s, populations of the American peregrine falcon populations had declined throughout the United States and the bird was recommended for listing on the federal Endangered Species List.

- *Raptor Kit*. Available on loan from ADF&G in Fairbanks and Douglas or ARLIS in Anchorage. Other Raptor kits are being developed by the Pratt Museum and the Alaska Raptor Rehabilitation Center. For further information check *Guide to Educational Science Kits in Alaska* <www.col-ed.org/ak/kitwebpage.html>

- Between 1968 and 1977, the number of pairs of peregrines that nested each year in the upper Yukon River changed very little. Female falcons were laying the same number of eggs that they did before the population declined. Why didn't the population grow? (*All young birds were not surviving and being added to the population.*) What was the trend of the population after 1977? (*rapid increase*).

- To develop scientific questioning skills, ask students to think of reasons why the peregrine population may have increased.

- (*Scientists learned that the cause of death of young birds was thin eggshells. When the adults sat on the eggs, the eggs were crushed and didn't hatch. Scientists later learned that pesticides such as* DDT *caused the thinning of eggshells. Adult birds ingested* DDT *when they ate smaller birds that had fed on crops sprayed with* DDT.

  In 1972, the United States banned the use of DDT and similar pesticides. It took time for the population to recover, however, because the pesticide is slow to break down in the environment to the point where it is no longer toxic to peregrines and other birds.)

- (*To demonstrate the effect of accumulating toxic substances at the top of a food chain, do the* Project WILD *activity "Deadly Links." See Teacher Resources.*)

Curriculum Connections:

(See appendix for full citations)

Books:

California Condor (Silverstein)

Endangered Animals: 140 Species in Full Color (Kest)

The Peregrine Falcon – Endangered No More (Priebe)

Media:

Steller Sea Lions (Video) (ADF&G)

Websites:

Alaska Biological Science Center <www.absc.usgs.gov>

Alaska Science Forum <www.gi.alaska.edu/ScienceForum>

California Condor <www.dfg.ca.gov/hcpb/condor.html> (California Department of Fish and Game, Habitat Conservation Planning Branch)

Ducks Unlimited <www.ducks.org> For information on the Pintail Duck.

Endangered Species <endangered.fws.gov> (US Fish and Wildlife Service)

Steller Sea Lions <www.fakr.noaa.gov/protectedresources/stellers.htm> (National Marine Fisheries Service)

Tundra Peregrine Falcons in the North Yukon <www.taiga.net/coop/indics/peregrin.html>

US Fish and Wildlife Service Alaska region <www.r7.fws.gov>.

US Fish and Wildlife Service Alaska region, Arctic National Wildlife Refuge <www.r7.fws.gov/nwr/arctic> For information on the Western Arctic Caribou herd.

Wildcam: Steller Sea Lion, Chiswell Island <www.nationalgeographic.com/stellercam> Live video camera on Chiswell Island, Alaska.

Teacher Resources:
(See appendix)

Jigsaw groupings

Each student meets with 2 groups: **first**, with other students assigned the same **letter** to gather information; second, with other students assigned the same **number** to share the information.

Class Size	*W-group*	*X-group*	*Y-group*	*Z-group*	
	W-1	X-1	Y-1	Z-1	Ones
	W-2	X-2	Y-2	Z-2	Twos
	W-3	X-3	Y-3	Z-3	Threes
16 students	W-4	X-4	Y-4	Z-4	Fours
20 students	W-5	X-5	Y-5	Z-5	Fives
24 students	W-6	X-6	Y-6	Z-6	Sixes
28 students	W-7	X-7	Y-7	Z-7	Sevens
32 students	W-8	X-8	Y-8	Z-8	Eights

Steller Sea Lion

Steller sea lions are marine mammals that live in Alaska's coastal waters from Southeast to the Bering Strait. In 1958, scientists counted 140,000 sea lions in the area between the western Aleutian Islands and the Kenai Peninsula. In just over 30 years, the population fell to 27,754!

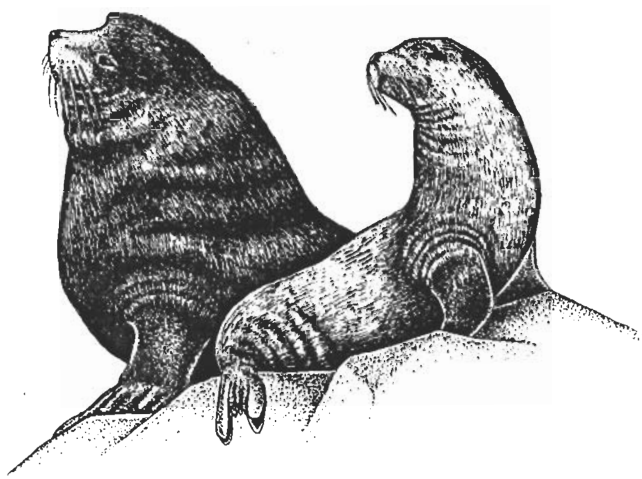
WHERE TO CENSUS? Sea lions are difficult to count accurately much of the year because they spend so much time in and under water and scatter widely. In spring and summer, however, the sea lions gather on **rookery** beaches and rocks where they rest, mate, and raise pups. Non-breeding sea lions gather on nearby **haulouts**.

FLYING RESEARCHERS. Scientists count the sea lion population by flying over the haulouts and rookeries in June when the pups are born. The scientists fly along the coast and count each haulout area separately. While they never see all of the sea lions because some are in the water, scientists can check the population **trend** from the number of sea lions they see. When the groups are too large to count quickly, scientists take photographs and count the animals later using the photos.

DOWNWARD SLIDE. Let's look at the curent population trends of Stellar sea lions in the same area that originally had 140,000. In 1990, the population was 22,754. In 1991, it was 21,737 and for 1992 it fell to 20,629. Studies were then set at two year intervals. In 1994, the population was down to 18,713 and in 1996 there were 17,900 Steller sea lions in that area. In 1998, the population count was 16,315 and in 2000, it was 15,228.

Graph challenge: Graph the population trend. *What percentage of the population have we lost between 1958 and 2000? When would this population of sea lions drop to zero if the trend continued? What questions do biologists need to answer to help the population return to safer levels.*

What Happened? Steller Sea Lion



Since 1958, about 90% of the Steller sea lion population from Kiska to the Kenai Penninsula has disappeared. The population is continuing to decline. Biologists do not know the *precise* cause of decline, but believe food is a factor.

Alaska Natives traditionally hunted sea lions for subsistence (food, clothing, boat coverings, art, tools, etc.). A subsistence harvest continues under provisions of the Marine Mammal Protection Act. Subsistence harvests are not considered to be a major factor in the population decline. Sea lion pups were harvested commercially for their fur until this law was passed in 1972.

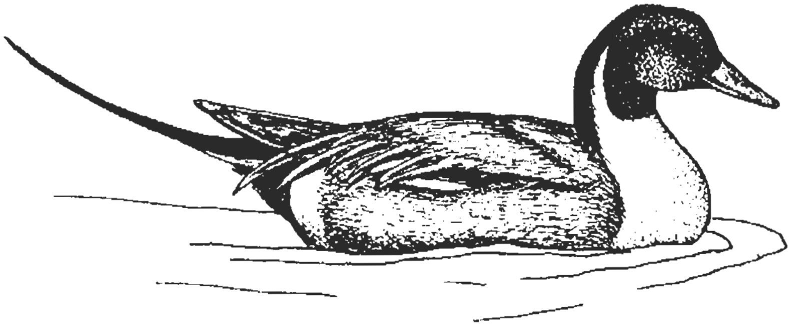
Scientists are trying to find out why young sea lions are not surviving to adulthood. Biologists suspect there is a shortage of food. Commercial fishermen harvest some of the same types of fish that sea lions eat. Fishermen also have shot and killed sea lions in the past because the sea lions feed on fish caught in their nets and hooks. Scientists have detected major changes in prey available for Steller sea lions in the Northern Pacific Ocean. The ocean has been warmer for the past 25 years.

Killer whales prey on sea lions, but scientists have no data showing an increase in killer whale populations. Sea lions also may be threatened by disturbance from development along the coastline (increased boat traffic and water pollution, for example). Also, diseases have not been ruled out as a contributing factor to the decline.

Steller sea lion populations were listed as threatened in 1989. In 1996, the western stock (north of Cordova) were moved to the endangered list. With the exception of subsistence harvest, people are prohibited from shooting sea lions, or disturbing rookeries and haulout areas occupied by sea lions. People cannot come within three miles of these areas. In 1999, the western stock was only 40,000.

Scientists have attached radio transmitters to sea lions to find out where they feed. The signal from the radio is transmitted to a satellite and then sent to a computer. This allows scientists to plot sea lions' movements. When scientists find feeding areas, they attempt to reduce any activities that would disturb feeding sea lions. Scientists are also trying to learn more about the marine ecosystem that supports sea lion populations to pinpoint cause of food shortages. (*For additional information on Steller Sea Lions, check out the video,* Steller Sea Lions In Jeopardy *from your school library.*)

Northern Pintail



The northern pintail is one of the most abundant ducks nesting in Alaska. In 1955, national biologists estimated that 9.2 million pintails nested on the North American continent. They nest in many places, but Alaska and the prairie grasslands of north-central North America are the two most important breeding areas for the pintails.

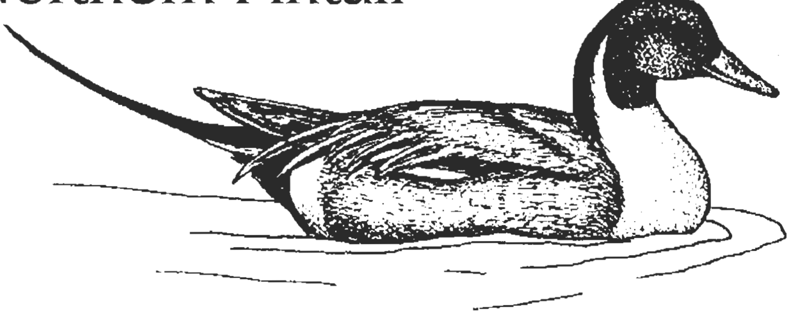
FLYING RESEARCHERS. Wildlife biologists fly over nesting areas and count pintails at the beginning of summer. The biologists return later in summer to count the number of ducklings. This gives them a measure of how successful the nesting ducks are each year.

ESTIMATED POPULATIONS. In 1960 wildlife biologists estimated 5.2 million pintails on the breeding grounds. In 1965, they estimated 3.8 million. In 1970, the pintail duck population rose to 6.2 million.

In 1975, biologists counted an estimated 6.0 million pintails. In 1980, 4.5 million; in 1985, 2.3 million; in 1990, 2.1 million; in 1995, 2.4 million. In 1999, biologists counted 2.5 million pintails.

Graph challenge: Graph the population trend. When did the pintail population get into trouble? Why? What is the trend in recent years? *Is this population decreasing, stable, or increasing?*

What Happened? Northern Pintail



Overall, pintail populations in the United States remain low. In 1999, the population was estimated at 2.5 million – down 6.7 million in 39 years. Wildlife managers believe many pintails from nesting areas in the "prairie potholes" (*midwestern states and Canadian provinces*) fly to Alaska because their normal habitat is currently unsuitable for nesting. After their long trip, the ducks do not nest or breed successfully.

LOSS OF NEST SITES. One reason for declining pintail numbers is the loss of nesting habitat south of Alaska. This loss follows (1) drought and (2) conversion of land to agriculture. In the Midwest, 10 years of drought dried up many small wetlands used by pintails for nesting. When the wetlands are dry, farmers often plow and plant them. Other wetlands are filled for homes or for industrial development, taking away wetland habitat permanently.

LOSS OF WINTER WETLANDS. More than half the continent's pintail population winters in California where wetlands have been reduced drastically. Only 10 percent of California's original wetlands remain. Many acres have been filled for homes, towns, roads, and industries. Water that would flow into these wetlands has been diverted for city water supplies and farming.

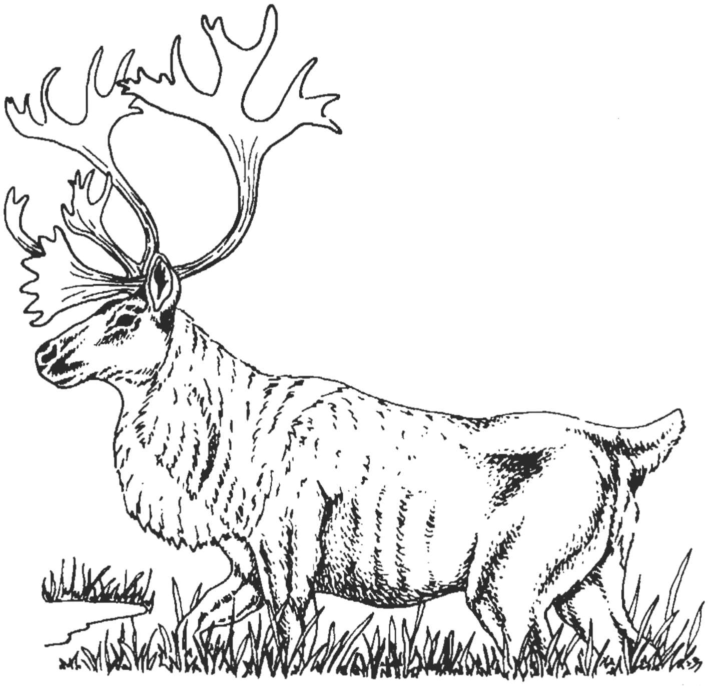
HELP FOR PINTAILS. Rice fields are being restored. They provide food and resting areas for pintails in winter. Other restoration projects have returned important wetland areas for pintails and other migrating waterfowl (*ducks and geese*).

PESTICIDE PROBLEM. Pesticides and other toxic substances used on some of the farms pollute runoff water that drains into California wetlands. The future balance between human development and pintail conservation is still unclear. Wildlife managers are watching pintail populations closely.

HUNTERS' MONEY HELPS PINTAILS. The number of pintails taken by hunters is regulated. Hunters buy hunting licenses and "duck stamps" in order to hunt ducks. The money they pay is then used to study duck populations and to protect wetland habitat.

For more information on pintail restoration, see <www.ducks.org> (Ducks Unlimited), <www.r7.fws.gov> (US Fish and Wildlife Service), or <www.state.ak.us/adfg> (Alaska Department of Fish and Game).

Western Arctic Caribou Herd



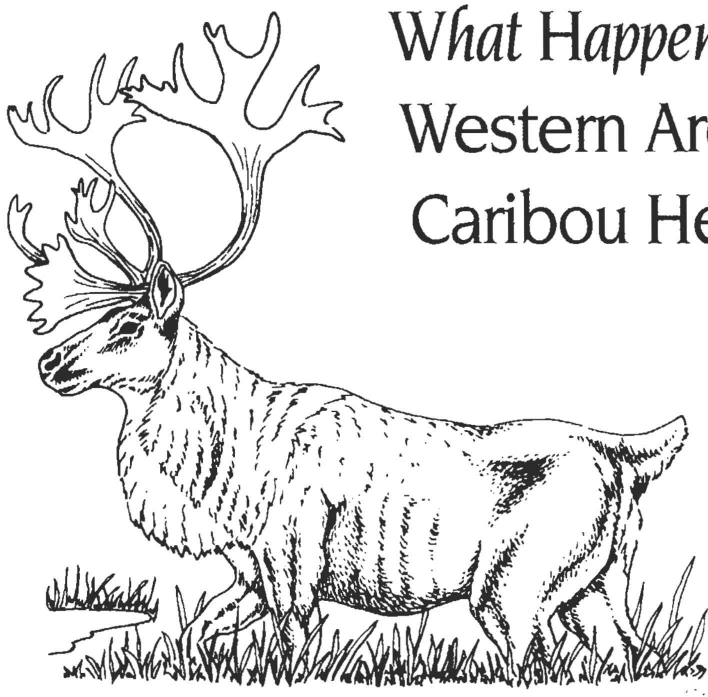
Caribou in Alaska separate themselves geographically into more than 30 herds. The Western Arctic herd is the largest herd that stays in Alaska all year. These animals migrate over 140,000 square miles that includes many communities where people traditionally hunt caribou.

GATHER AFTER CALVING. While the caribou scatter over a very large area for much of the year, the herd migrates toward one calving area where the cows give birth to their calves in late June or early July.

PHOTOGRAPHING THE CENSUS. Wildlife biologists take advantage of this gathering to photograph the herd from the air and count the animals later using the photos. This technique is called photo-censusing.

POPULATION COUNTS. Wildlife managers and the people who live in the herd's territory became very concerned when photocensus counts dropped from 243,000 caribou in 1970 to 75,000 caribou in 1976. Historical estimates of the size of the herd were 240,000 caribou in 1950, and 280,000 caribou in 1965.

Graph challenge: Graph the population trend. *What do you predict will happen to the Western Arctic Caribou Herd population based on this data?*



What Happened? Western Arctic Caribou Herd

Additional photo-censuses in 1978, 1980, 1982, 1986, and 1988 resulted in the following population counts: 107,000 caribou, 138,000 caribou, 172,000 caribou, 229,000 caribou, and 343,000 caribou. In 1990 the herd numbered about 416,000 animals. By 1993 there were 450,000 caribou and in 1996 reached a peak count of 463,000. Biologists counted 430,000 in 1999.

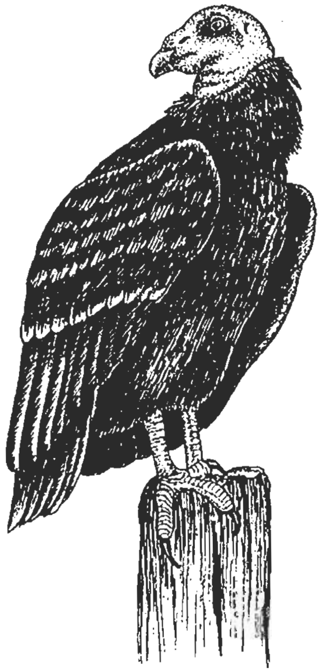
EMERGENCY ACTIONS. When the herd declined in the 1970s, the Alaska Board of Game reduced the harvest of caribou. Wildlife managers asked hunters to take fewer caribou so the population could recover. They also removed some of the caribou's natural predators, wolves and bears.

HEALTHY HERD. Now that the Western Arctic herd is healthy, hunting regulations are more liberal. Even with large numbers of bears and wolves, predators will not have a significant effect on this herd, given its large size. This herd is a very important source of food and cultural identity for the local communities. As with predation, hunting is having little effect on the current size of this herd.

HI-TECH RESEARCH. Wildlife managers census the population every three years. Some caribou have been radio collared and some have been fitted with collars that beam information to satellites. That technology lets biologists follow the movements of the herd and collect data such as the number of calves born every year and the number of adults dying.

WINTER WATCH. Such remote data collection is particularly helpful in monitoring the herds movements during the dark, stormy winter months. Wildlife managers also study the body condition of the animals, how many calves survive the winter, and test for the presence of disease. The Western Arctic herd currently appears stable.

California Condor



The California condor is one of the ancient animals. It survived from the Ice Age when many animals were very large.

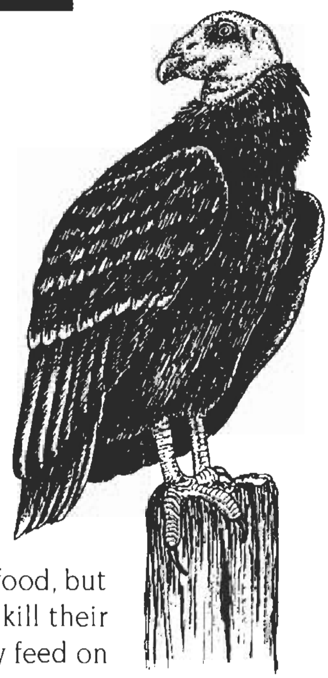
ANCIENT SCAVENGER. The condors is a scavenger that eats dead animals. The condor itself is large so it has a big appetite and must eat a lot in order to survive. Condors probably scavenged on woolly mammoths as the mammoths became extinct 11,000 years ago.

HABITAT SHRINKS. California condors ranged widely until the early 1900s when their habitat shrank to the mountainous and rugged terrain of California and Baja California.

POPULATION SHRINKS. The rugged habitat that protected the condors created challenges when biologists tried to count them. When they finally succeeded, the news wasn't good. In 1940 they estimated there were 65 wild condors. In 1963 they counted 40 condors. In 1978, 30 condors: in 1982, 23 condors: in 1984, 16 condors: and in 1986 there were 3 condors.

Graph challenge: Graph the population trend. *Predict when this species would become extinct.*

What Happened? California Condor



The California condor's habitat became smaller and smaller as towns, farms, industries, and other human habitat grew. The number of dead, large animals – the condors' favorite food – decreased. A few condors were able to survive in California near large ranches because they could feed on dead sheep, cattle, and deer.

HUMAN FEAR IS MISTAKEN. Humans never hunted condors for food, but many condors were killed because people were afraid they might kill their livestock. Condors do not kill animals; they are **scavengers** – they feed on animals once they are dead.

CONDORS DIE. To protect livestock from predators such as coyotes and wolves, people put poisons in the bodies of dead livestock. That killed condors that fed on the carcasses. Scientists also contributed to the population decline. They killed some condors to put in museum displays.

SLOW GROWTH OF FAMILIES. As with many large animals, it takes several years before a condor is old enough to nest. Adult condors do not nest every year. This means that a small condor population would take many years to grow and recover.

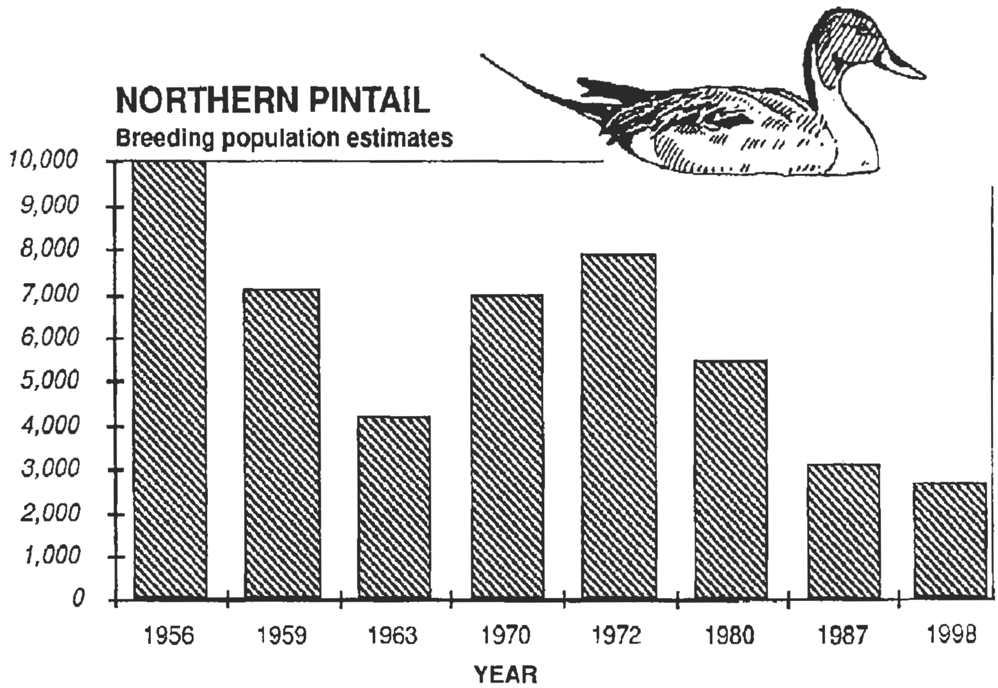
STATE & NATIONAL PROTECTION. In 1953 condors were given special protection under California law. In 1967 they were placed on the first national list of animals likely to go **extinct**. Condors are still on the Endangered Species List.

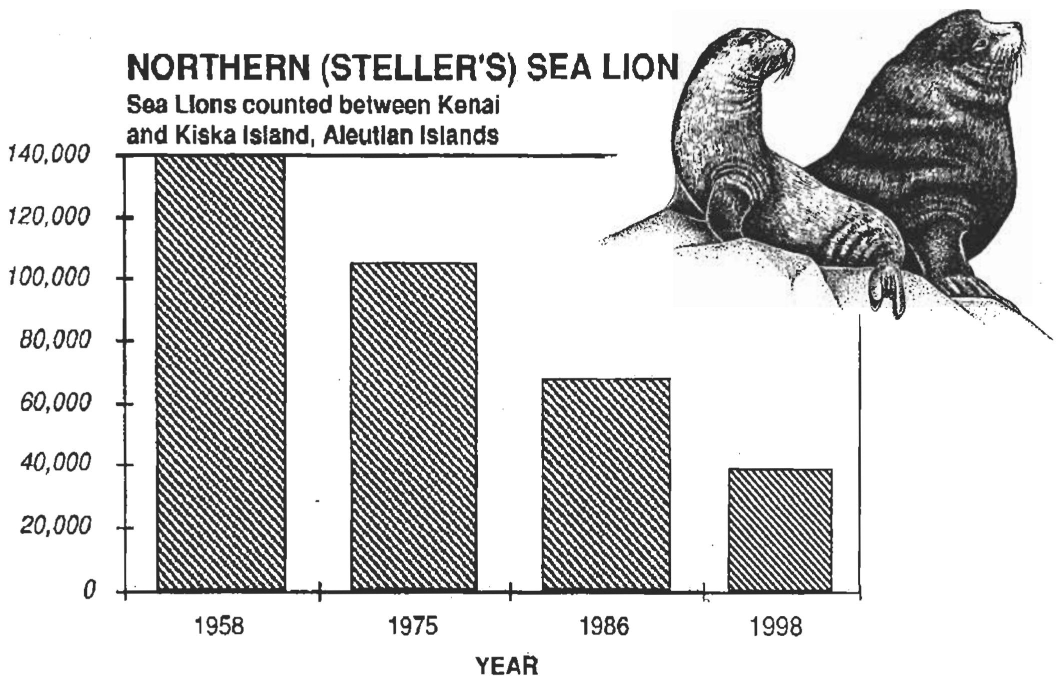
POPULATION SAVED IN ZOOS. The population of California condors living in their natural habitat dropped to 0 in 1987. Fortunately, the species has been saved from extinction – so far. People captured the last 3 condors and put them in zoos with the 21 captured earlier. Under a special program, they helped them survive and raise their young.

SOME BACK IN THE WILD. In January 1992, enough condor chicks had been raised that two young birds were released to the wild. The total population of captive and released birds in January 1992 was 54. In 2000, the total population was up to 169. The majority remain in captivity, but 36 are living in the wild.

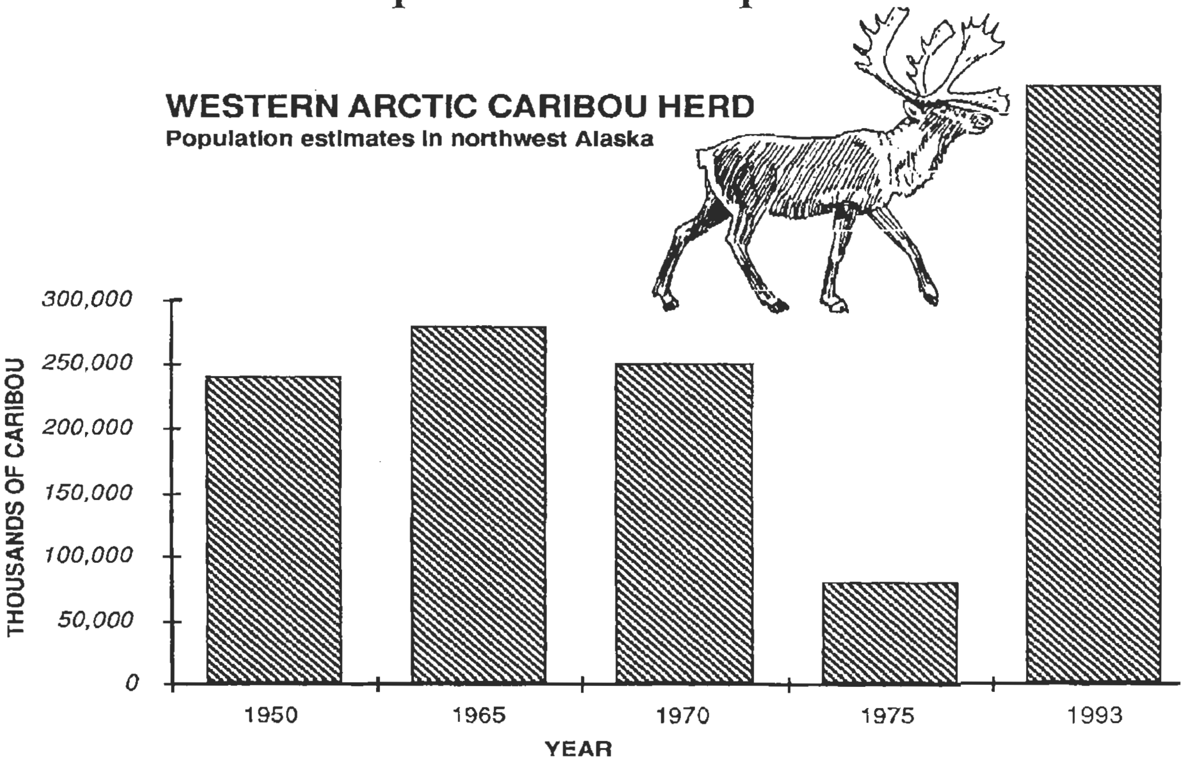
For current information, see <www.dfg.ca.gov/hcpb/condor.html> (*California Department of Fish and Game*).

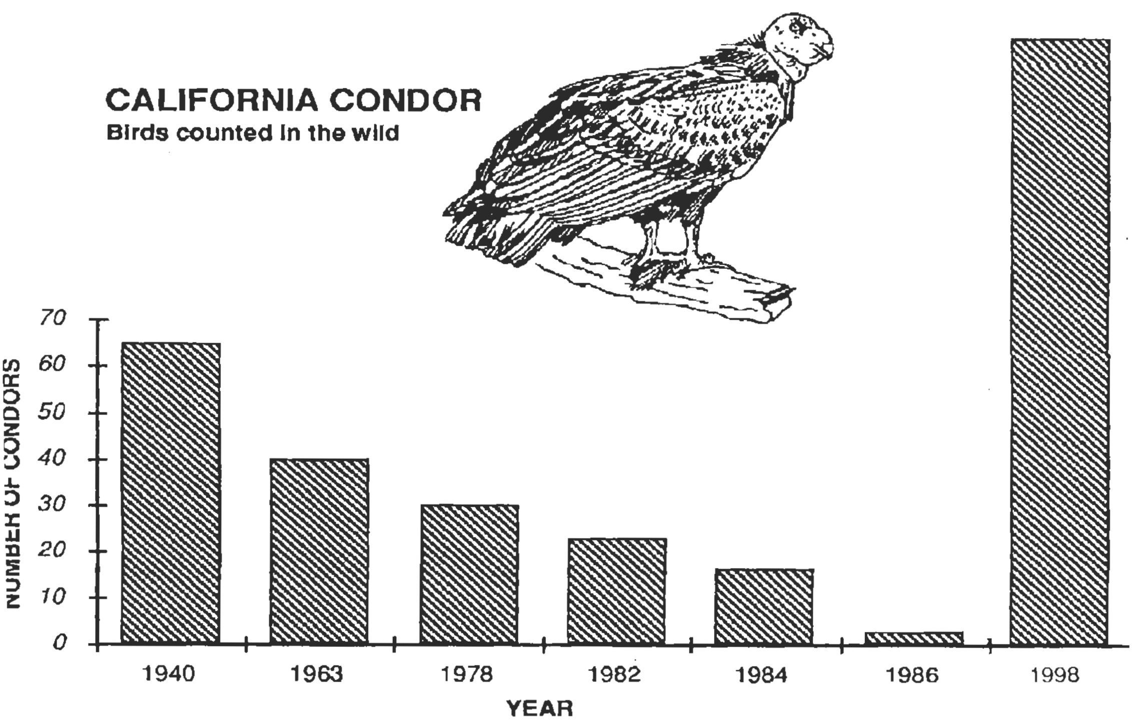
Population Graphs



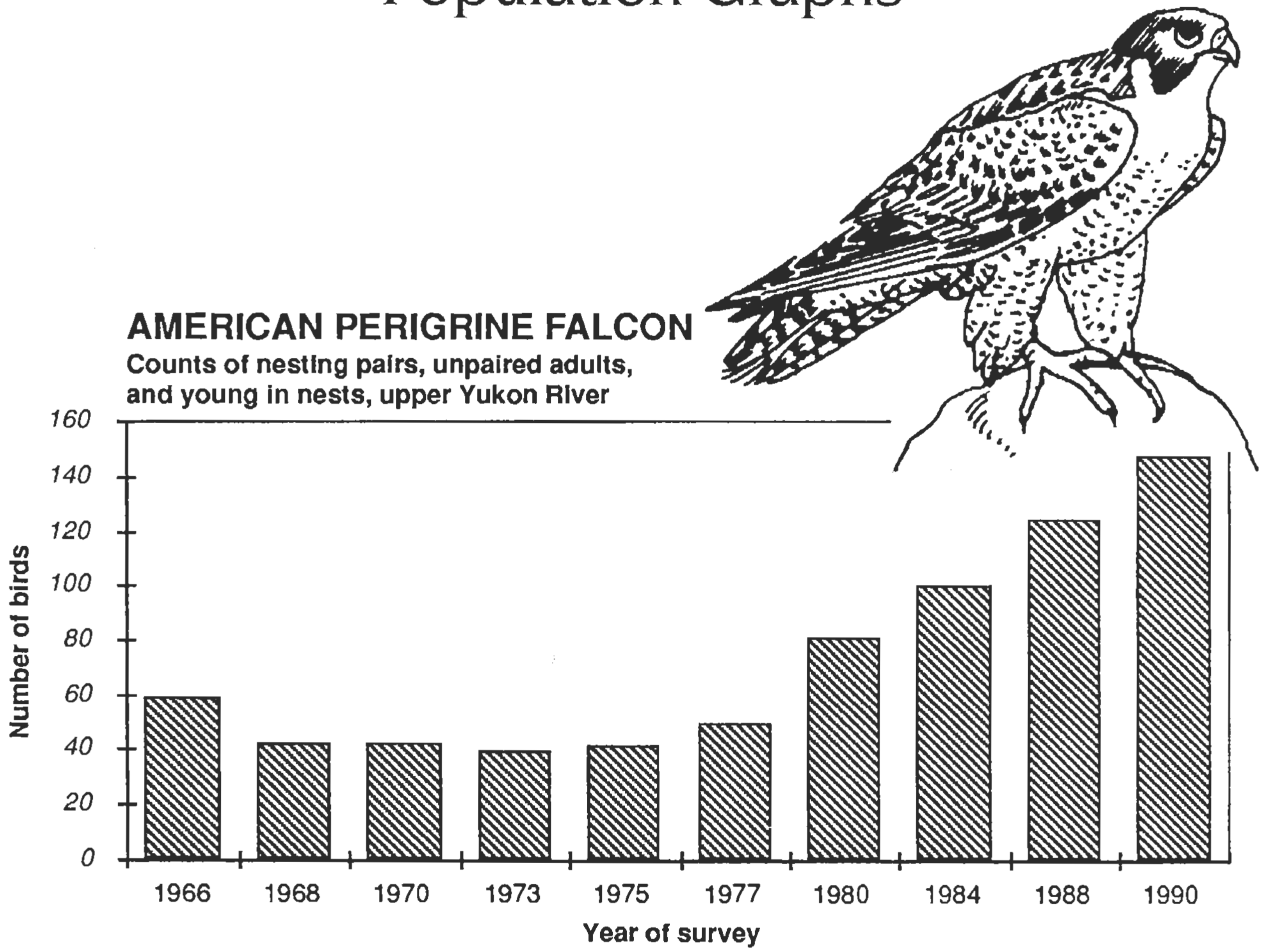


Population Graphs



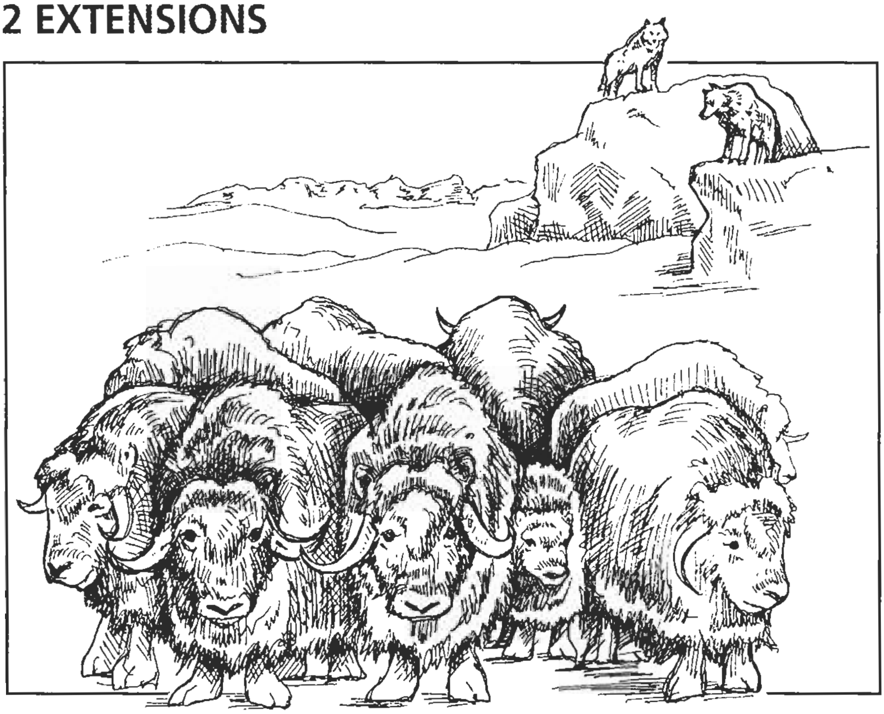


Population Graphs



Muskox Returns to Alaska

2 EXTENSIONS



Section 4
WILDLIFE ACTIVITIES

Grade Level: 4 - 9
State Standards: S A-14
Subjects: Science, physical education
Skills: Analysis, description, discussion, evaluation, generalization, kinesthetic concept development, observation, psychomotor development
Duration: 20-35 minutes
Group Size: 15-50 (following based on 33)
Setting: Outdoors
Vocabulary: Adaptation, bag limit, defense, game, limiting factors, management, predator, prey, sustain

Objectives:

1. Students will evaluate the effectiveness of some adaptations in predator/prey relationships.

2. Students will describe the importance of predator/prey relationships as limiting factors in wildlife populations.

3. Students will understand the need for wildlife management.

Teaching Strategy:

Students simulate muskoxen and wolves in a physical activity and then add humans to game.

Complementary Activities:

"Wildlife Use Interview "*and* "Eye of the Beholder" *in this section.* "Habitat Grid" *and* "Interview a Muskox" *in Section* 1. "Graphic Populations," "Predator-Prey Predicaments" *and* "How Many Bears Can Live in this Forest?" *in Section* 2

Materials:

Two colors of flags/flagging tape/or colorful rags – as many as there are wolves and calves.

Background:

See INSIGHTS *Section 4, Wildlife Conservation Is Up to Us!* "*Muskox Returns to Alaska*" *Fact Sheet* and "*Teacher's Guide for Dealing with Differing Viewpoints.*"

NOTE: This activity does not illustrate all the complexities of predator/prey relationships; however, it does illustrate broad concepts and (in step 6 and beyond) the need for hunting regulations.

Procedure:

IN ADVANCE, decide on a location for the game. This is a highly involved activity! It is best done outdoors, in an open, grassy area. It is possible to do the activity indoors – even in a classroom if tables, chairs, and desks can be moved to create a large space for movements including "tag-like" running.

1. Using the table as a guide, divide your students into the four animal roles. (*For example, a group of 33 students would break down into three wolves, six bulls, 12 cows and 12 calves.*) Each will have a distinctive behavior.

Total Players	Wolves	Bulls	Cows Calves
15-18	2	3	Equal number or one more cow than calf
19-28	2	4	" "
29-35	3	6	" "
36-45	4	8	" "
46-50	5	10	" "

Cows:

The cows should choose a lead cow to watch for **predators**. The cows should pick a signal that the lead cow will use to warn the herd of the approach of predators.

- When the lead cow signals that predators are near, all the cows move to form a circle around the calves to protect the calves. With the calves in the center of a circle, the cows stand with their backs to the calves, facing outward to watch the wolves.
- The cows can move very little. Mostly, they stay firmly in one place, moving their upper bodies to block the wolves from reaching the calves.
- The cows cannot touch the wolves with their hands or feet.

Calves:

Calves typically stay close to their mothers, but the animals do not always stay clustered – except when predators appear!

- The calves depend on the cows for protection. Each calf holds onto a cow with both hands around the cow's waist.
- They only follow the cow's lead. Calves cannot influence the cows' movement.

Bulls:

In this game (*for classroom management and safety*), the bulls are the active defenders of the cows and the calves. (*In nature, both sexes vigorously defend the young.*)

- As the predators near, the bulls form a circle around the cows (who in turn are forming a circle around the calves). The bulls form as tight a circle as they can around the cows and calves, never any farther than one step in front of the circle of cows.
- The bulls can move – but only in a clock
direction around the circle of cows.
- The bulls can use their hands. As the wolves a
the herd, the bulls try to "kill" them by pullin
flag out of their back pocket, or wherever the fl
attached to the wolf.
- When a bull kills a wolf, the wolf moves off t
side, "dead," to watch the remainder of the act

Wolves:

Wolves begin the activity out of sight of the
They try to get as close as possible to the herd wit
being detected.

- Wolves typically work as a unit so they can p
strategy for surprising the herd in order to ki
calves for food.
- The wolves are mobile, able to move at any ti
any direction.

They can use any maneuver (*except pushing and sho*
to break the herd's defenses.

- Once a wolf kills a calf – by pulling the calf's
out of its pocket – temporarily stop the game
move the calf's carcass to the side, where i
can watch the remainder of the activity.

Sound Effects: This is not a quiet activity mu
the time. Wolves should be howling – communic
– with each other in predetermined ways as si
and as part of their tactics to startle and confus
muskoxen. The muskoxen grunt and snort loud

SUMMARY OF THE GAME:

2. Start the game with the muskox herd sprea
and grazing quietly. Wolves are out of sight of
Wolves move in to attack herd. When lead cow s
wolves, the herd begins **defense**. A circle is for
with calves in the center, cows facing out in a
around the calves, and bulls in an outer circle,
facing the wolves. Each should behave appropri
as described above.

3. A round can end in several ways:

Several wolves are injured or killed.

The wolves give up in frustration with no succe
killing a calf.

The wolves could kill one or more calves and s
down to eat as the herd moves away.

4. After the excitement and enthusiasm have peaked, sit down with the students to discuss what happened and what the game represents in terms of (a) animal **adaptation**, (b) predator/**prey** relationships, and (c) **limiting factors**.

5. Ask the students to describe and evaluate the predatory behavior of the wolves and the various defense behaviors of the muskoxen. What would happen if the wolves could not get into the herd? What would happen if the wolves always got into the herd? Ask the students to distinguish between what would be actual behaviors of muskoxen contrasted with their behaviors in this activity.

6. Play the game again (*this round will be very short*) introducing **hunters** with guns.

- Hunters are given no restrictions on their **bag limit.**
- All muskox have flags for this activity.
- Hunters approach the herd, which moves into formation when alerted.
- Hunters kill muskoxen by calling out their names.
- When a muskox hears its name, it drops its flag and dies.
- This round ends when all the muskoxen are dead.

7. Discuss the history of muskoxen in Alaska (*from* INSIGHTS *Section* 4). Explain that over-hunting, while not the sole source of population decline, was a major factor. The **adaptation** muskoxen have against natural predators does not work against a rifle. What then is the human responsibility towards muskoxen now that reintroduction of these animals has been successful?

NOTE: *Create a discussion atmosphere where students with differing viewpoints can talk about their views regarding hunting. Discuss what is currently allowed by law* (hunting by limited permits, determined by the Board of Game).

FOR OLDER STUDENTS

8. Explain the Alaska Board of Game process, hunting regulations, bag limits, and hunting permits.

9. Play another round where the class sets an appropriate number of hunters. If each hunter's bag limit is one bull muskox, how many bulls can hunters remove from this herd while **sustaining** the population?

10. On a chart, take note of the population (number) of male muskox, female muskox, wolves, and hunters.

11. Play another round with hunters harvesting their allowed bag limit of muskox. Wolves continue their role as before.

12. After that round, count the number of wolves and mark this on your population chart. Count the number of male muskox, female muskox and hunters. Has the muskox population declined? Were male or female muskox killed? Explain that if female muskoxen were killed, the herd has lost future calves.

13. Next, for each surviving female, add one more muskox to your population count to represent next year's offspring. Did the bag limit allow hunters and wolves to hunt while keeping the herds' population **sustainable**? Explain that if too many muskox are killed, their population will decline and require additional wildlife management.

Evaluation:

1. Name a prey species and its predator species. Describe how each is adapted to the other. How does the prey protect itself? How does the predator overcome this protection? Describe the overall effectiveness of each animal's adaptations.

2. Discuss the responsibility of people towards wildlife populations. What role do bag limits and hunting regulations play in maintaining wildlife for the future?

EXTENSIONS:

A. **Research local wildlife management.** Following the last step, lead the class in a brief discussion about wildlife management. Instruct students to select and investigate management issues related to a specific, local **game** population, answering the following questions:

- What has been the population trend?
- How is population information gathered?
- What is this population's typical reproduction rate?

- How does weather affect these animals and what have been the weather trends in relation to the population trends?
- What other natural factors impact this population?
- What human factors affect these animals?
- What have wildlife managers done to maintain a healthy population?
- How large can this population grow without forcing a rapid decline (due to starvation, disease, etc)?
- What current regulations impact this population?
- When students have gathered this information, ask the class to determine what is needed to sustain the population they are investigating. What are the implications of their ideas?
- Invite a biologist into your class to discuss this topic. If that is not possible, write a class letter to a local/regional biologist stating the class' findings and asking for feedback.

B. **Research muskox history and display on map.** Students research more details about the life and history of muskoxen, wolves, and humans – acquiring information about survival needs, habitat, behaviors, and population numbers. As a class or individually, students make a large range map showing the populations of muskox in Alaska. Add their research in text, drawings, and photographs about these amazing animals. Display this map in the class, hall, or library.

Credits:

Adapted from "Muskox Maneuvers," *Project* WILI 12 *Activity Guide*, Council for Environme Education, Boulder, CO, 1992. Modified by Rc Dublin, Alaska Department of Fish and Ga Anchorage, Alaska.

Curriculum Connections:

(See appendix for full citations)

Books:

A is for Arctic (Lynch)

Alaska Wildlife Notebook Series (ADF&G)

Arctic Animals (Kalman)

Moose, Caribou and Musk Ox (Alaska Geogra Society)

Websites:

Alaska Hunting Regulations <www.state.ak.us/adfg

Alaska Science Forum <www.gi.alaska.e ScienceForum>

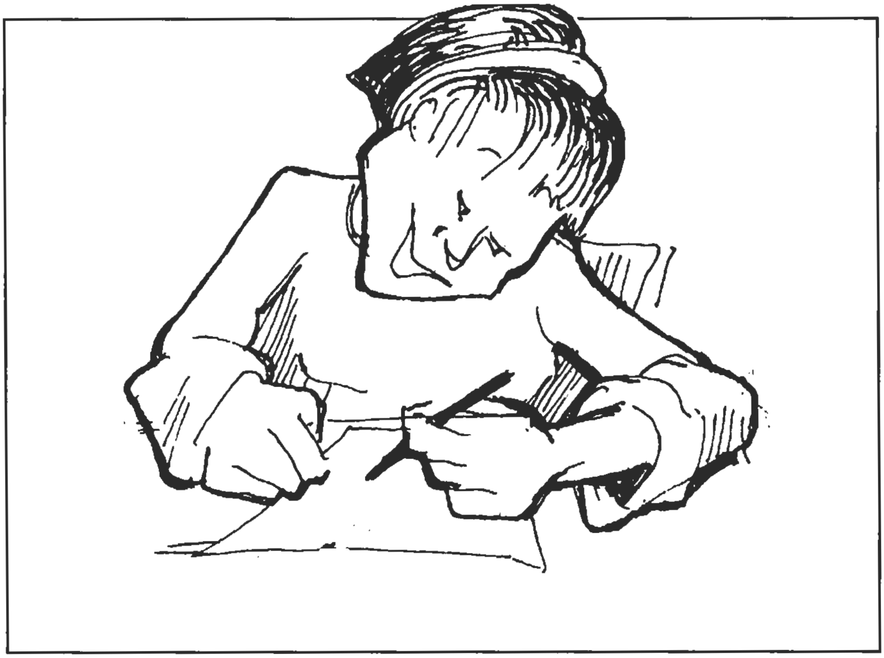
Alaska Wildlife Notebook Series <www.state.ak.us/ac

Muskox Natural History <www.muskoxfarm.org>

Teacher Resources:

(See appendix)

I Propose ...!
3 EXTENSIONS



Section 4
WILDLIFE ACTIVITIES

Grade Level: 9 - 12
State Standards: Gov A-1, Gov C-1, Gov C-2, Gov E-2, Gov E-3, Gov E-4, Gov G-2, Gov G-3, Gov G-4, L A-1, L A-4
Subjects: Government & citizenship, social studies, language arts
Skills: Reading, writing, problem-solving, and researching an issue
Duration: 3-4 sessions
Group Size: Small groups/ whole class
Setting: Indoors
Vocabulary: Board of Game, Fish and Game Advisory Committees, game, permit, regulations, season, statutes, wildlife

Objectives:
Students will explain how regulations are created through the Board of Game process.

Teaching Strategy:
Students study a wildlife management issue in depth, study the wildlife regulatory process, and present a mock (or real) proposal to the Board of Game.

Complementary Activities:
"Eye of the Beholder," "Science, Technology, Society, and Wildlife," *and* "Can Do!" *in this section*.

Materials:
Information provided on the Alaska Department of Fish and Game website <www.state.ak.us/adfg> (regarding regulations, Board of Game proposals, wildlife populations, and issues. Paper, pens, chalk board, copies of *Regulation Proposal Form (following)*.

Background:
See INSIGHTS *Section 4, Wildlife Conservation Is Up to Us!* "*Hunting Regulation Vocabulary,*" "*Tracking Wildlife Regulations*" and "*Check & Balances for Wildlife Regulations*" *Fact Sheets*; and "*Teacher's Guide for Dealing with Differing Viewpoints.*"

Procedure:
IN ADVANCE, If possible, invite a member of the Fish and Game Advisory Committee to explain to students the Board of Game (or Board of Fish) process and discuss locally pertinent wildlife concerns.

If you are planning this activity concurrently with the actual Board of Game meeting, begin once the "***Call for Proposals***" is available (contact your local Fish and Game office or search the Department's website). Use the current "*Call for Proposals.*" If you are not conducting this activity concurrently, access old proposals on the same website.

IN ADVANCE, review the "Teachers Guide for Dealing with Differing Viewpoints."

DAY ONE:
1. Brainstorm fish and wildlife related issues, recording these on butcher paper or the chalk board. (If students focus on fish, rather than game, this

activity can be adapted for fish regulations and the Board of Fish.)

2. Discuss the role of hunting (and/or fishing) in Alaska as it relates to managing wildlife populations.

3. Present background information (*from* INSIGHTS *and the website*).

4. Once students are clear about the Board of Game process, provide information about their local Fish and Game Advisory Committee.

5. Give the following assignment: Identify a local or regional wildlife issue or issues that each student wants to research and address.

DAY TWO:
1. On the chalk board, list all issues identified by students.

2. Divide into interest groups that will work together for the remainder of the project.

3. Using the following resources, students research the issue in depth, making sure to include their scientific and social influences:
- newspapers and other media
- the Internet
- the school library
- phone contacts/e-mails with Fish and Game Advisory Committee members, ADFG biologists, community members, etc.
- other sources identified by the students.

4. From that research, each student drafts a proposal for her or his group's issue.

5. Ask each group to integrate its drafts into one proposal. If there are distinctly different proposals, let the groups splinter into smaller groups. *As with the actual Board of Game, there may be many approaches to a specific issue.*

DAY THREE:
1. Students present their finished proposals to the class. If there are several proposals relating to one issue, clump these together and conduct a discussion when all have been presented.

2. As a class, discuss the strengths and weaknesses of each proposal, both in presentation and content.

3. If possible, come to resolution on those solutions the class deems acceptable.

Evaluation:
1. Describe the process by which Alaska wildlife regulations are created and changed.

2. Write a strong regulation proposal with scientific and accurate background information.

EXTENSIONS:
A. **Submit proposals to the Board.** If student-generated proposals are deemed feasible by the class AND if students have permission from their parents (*and you from your administration*), students submit their proposals to the Board of Game and follow them through the process.

B. **Attend meetings and take notes.** Attend Fish and Game Advisory Committee and/or Board of Game meetings. Students record meeting notes and their observations of people providing testimony as well as the committee/ board members. Back in class, students share their observations and discuss their views on the process.

C. **Civic lesson.** Introduce the concept of "checks and balances" in the democratic process. Using the "Checks & Balances for Wildlife Regulations" chart (*from* INSIGHTS *Section* 4), ask students to find places within the Board of Game process where checks and balances exist. Ask students to identify areas where they think the process is effective or problematic. Compare this public process to other public processes to further identify strengths and weaknesses.

Credit:
Contributed by Robin Dublin, Alaska Department of Fish and Game, Anchorage, Alaska.

Curriculum Connections:
(See appendix for full citations)

Books:
Guardians of Wildlife (Chandler)

Websites:
Alaska Board of Game <www.state.ak.us/adfg>

Alaska Hunting Regulations and other related materials <www.state.ak.us/adfg>

Alaska Native Heritage Center <www.alaskanative.net> Links to Native Organizations and subsistence articles. Select Education, then Resources for links.

Alaska Outdoor Council <www.alaskaoutdoorcouncil.org> Official state affiliate of the NRA.

Alaska Science Forum <www.gi.alaska.edu/ScienceForum>

Alaska Statewide Databases, accessed through you local library website or <sled.alaska.edu>

Alaska Wildlife Alliance <www.akwildlife.org> F current wildlife issues.

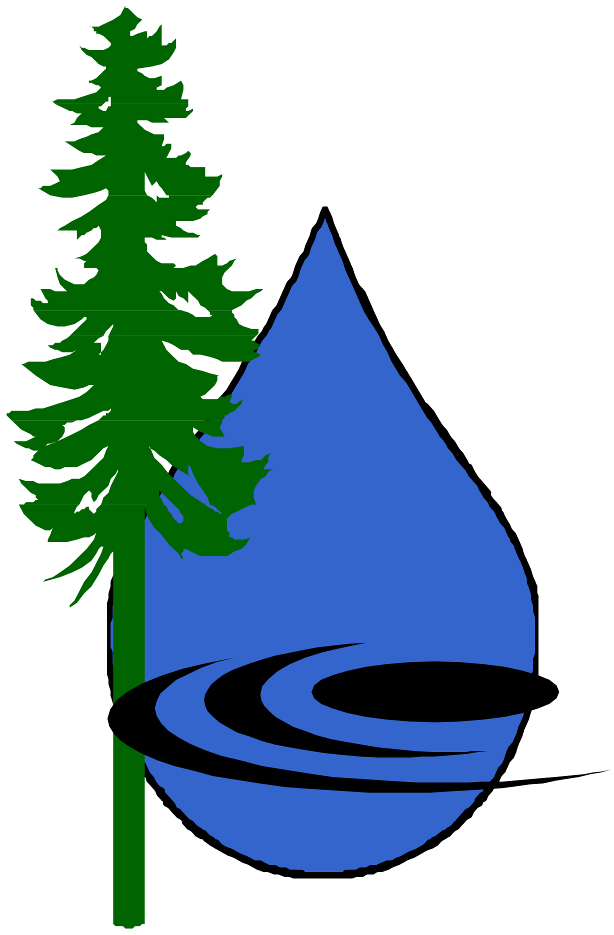
Current wildlife issues information <www.state.ak.us/adfg> and <www.r7.fws.gov>

Office of Subsistence Management, Alaska Reg <www.r7.fws.gov/asm/home.html>

Staff-written Alaska newspaper articles: Anchor *Daily News* Archives <www.adnsearch.com> or Fairbanks *Daily News-Miner* <www.newsminer.co

University of Alaska Justice Center <www.uaa.alaska.edu/just/links/natives.html> Links and information on the subsistence issue

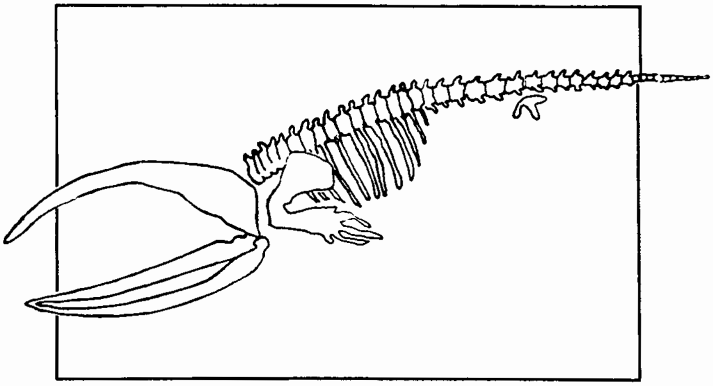
Teacher Resources:
(See appendix)



Sea Week

Animals of the Sea and Marrine Mamals

Activity 3
Whale Adaptations



Background:

Adaptations are structures or behaviors that allow an organism to be well-suited to the conditions of its environment. Whales probably descended from land animals long ago, as is evident from their skeletal similarities with land mammals. Whales are probably the largest animals that ever have lived on earth. Their huge size makes it impossible for them to live on land, but enables them to keep warm in cold waters. As an animal increases in size, there is proportionately less skin area exposed, and therefore, less heat loss to the environment. Whales also have a thick layer of blubber under the skin to insulate themselves against the cold. They have:

- glands that oil the eye to protect against salt water;
- young born tail first because of their need to be brought to the surface immediately to breathe;
- blowhole on the top of the head so they do not have to bring their whole body out of the water to breathe;
- an echolocation system that is more efficient than sight in a dark environment, especially since water is a better conductor of sound than air;
- streamlined bodies;
- forelimbs modified into flippers;
- external hindlimbs that have disappeared completely;
- a tail that has been modified into a fluke, providing propulsion by up-and-down movements;
- decreased respiration and heart rates for deep dives; and
- an ability to vary their body shapes as they move through the water, reducing resistance and drag.

(This information and the activity were adapted from the ORCA Whales curriculum developed by the Pacific Science Center and Washington Sea Grant.)

Vocabulary:

- echolocation
- forelimbs
- hindlimbs
- adaptation

Materials:

- 100-foot tape measure or measuring sticks
- pencils
- butcher paper
- old newspapers or scrap paper
- stapler
- large felt-tip markers
- worksheet:
  ...Whale in the Water! (2G)

Procedure:

1. Discuss the meaning of adaptation, then pass out the worksheet Whale in the Water! to the students. (Answers: 1. These bones would be hip bones if the whale had legs,

but through years of evolution have decreased in size; 2a. 3, 3; 2b. 5, 5; 2c. they are closely related, the same bones have come to be used for different purposes in humans and whales; 3a. 1 cubic inch; 3b. 8 cubic inches; 3c. 8; 3d. Alaska is filled with examples--think of the large mammals such as moose and caribou that roam around during winter while lemmings and voles hide under the snow; 4a. yes, to protect against salt water; 4b. no, fur would increase friction and slow down the whale in the water; 4c. no, the young need to get to the surface to breathe right away, and it might take a while for the tail to come out; 4d. no, too much heat would be lost; 4e. yes, they can move through the water faster; 4f. yes, to insulate and protect them from the cold; 4g. no, would slow down their speed; 4h. yes, retain fresh water in bodies; 4i. no, other methods can be used to keep warm; 4j. yes, the blood will be able to conserve what oxygen is there; 4k. yes, more efficient than sight when it's dark, and water is a better conductor of sound than air; 4l. no, saltwater tears don't help much when an animal is already in salt water; 4m. yes, help with swimming; 4n. yes, prevent bends, which is common in human deep sea divers, when nitrogen bubbles get into their bloodstream and cause paralysis and death if they ascend too rapidly; 4o. yes, then they can breathe effortlessly without taking their whole head or body out of the water.)

2. Take a hundred-foot tape measure or use measuring sticks to mark the size of a blue whale in the school hallway, side of the building, or on the playground. Mark the measurements with a sign so other classes can see, too!

3. Then make a smaller blue whale for the classroom out of butcher paper. Stuff the insides with old newspaper and staple it together. Label the adaptations on your whale. Make sure it's ready for the water!

Materials:

- pictures: from Alaskan maga-
- zines, calendars or photos
- pencils
- crayons
- paper
- worksheet:
  ... Animal and Human Habitats (9-A)

Procedure:

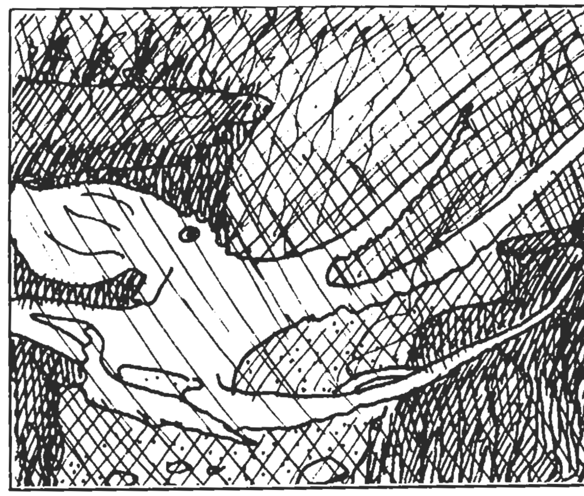
1. Ask students what they like best about the seas, rivers, or wetlands around them.

2. Show pictures of different Alaskan aquatic environments from magazines, calendars, or photos. Explain that these are called "habitats." What animals live in these places, and what do they need for life? (food, water, cover).

3. Use the worksheet Animal and Human Habitats to compare walrus, beaver, and human habitats. What does each species eat? Where does each live? Color water blue, food yellow, and cover (space or shelter) red in each of the three worksheets. Which animal needs the most water, the most food and the most cover? Which animal makes the most changes in its habitat? List the good things and the bad things that result from these changes.

5. Have the class choose another aquatic animal and draw its habitat.

Activity 2 Swimming in an Underwater World



Background:

Seals, sea lions, walrus, beavers, mink and muskrats breathe through mouths and noses as we do, and must come to the water's surface for air. Whales and porpoises breathe through a special blowhole on the top of their heads. The blowhole opens when the animal surfaces; old air is expelled and fresh breath is drawn in. Fish, however, use their gills to "breathe" oxygen out of the water that is constantly moving over their gills.

Movement in the water is quite varied:

- Fish move through the water by flexing their tails from side to side. Fins help them to keep their balance and sometimes to move in special ways.

- Whales and porpoises flex their bodies and move their flukes (tails) up and down when they swim.

Sea lions, otters and seals flex their bodies or use their powerful forelimbs to propel themselves.

Beavers, otters, muskrats, frogs and toads use webs between their feet to help them swim.

Crabs walk over the sea floor as if on tiptoe. The pointed tips of their legs help keep them poised and yet ready to run and escape if the need arises.

Sponges, anemones, mussels and barnacles anchor themselves firmly to the sea floor. Water currents cannot dislodge them, but instead bring the animals a steady supply of plankton and drifting organic debris for food.

Clams and worms may burrow deep into the sea floor. This gives them protection and keeps them from being moved about by currents.

Scallops, jellyfish, octopi and leeches use various techniques to move through the water:
Scallops clap the valves of their shells together.
Jellyfish cause their bells to pulsate.
Octopi can spread the webs located between their arms for gliding, or they can jet away by expelling water from their siphons. Like sea stars or urchins, they also use suction discs to move over the sea floor. These discs let them hold on tight so that they won't be dislodged by strong currents.
Leeches loop through the open water by alternately stretching and shortening their segmented bodies. They also have head suckers that they use to move along in inchworm style.

Vocabulary:

- breathe
- gill
- move
- blowhole
- fluke
- webbed feet

Materials:

Large space indoors or outdoors where students can move freely.

Procedure:

1. Prepare the children for an undersea voyage. Ask them to imagine water moving around them and to imagine what they would see underwater.

2. Pretend that you are various undersea animals. Pretend to breathe, move and eat like those animals. What are your needs? What is your habitat like?

   Use the teacher background material for ideas. This activity should be a good review of animals studied in previous units. If students have further questions about the animals, have them look up the answers in the library, or ask their parents.

3. Have each student pick a sea animal to imitate and see if the others can guess its identity.