Volume #3 Grades 5-6

STOP, LOOK and LEARN

About Our Natural World

Nebraska Natural Resources Elementary Education Guide

STOP, LOOK and LEARN
About Our Natural World

Nebraska Natural Resources Elementary Education Guide
Volume Three, Grades: Fifth – Sixth

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Questions, Comments or Requests Concerning
STOP, LOOK and LEARN About Our Natural World
Should be Directed to:

Nebraska Natural Resources Commission
Stop, Look and Learn
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Lincoln, Nebraska 68509
(402) 471–2081

STATE OF NEBRASKA

E. BENJAMIN NELSON, GOVERNOR

STOP, LOOK and LEARN
About Our Natural World

Nebraska Natural Resources Elementary Education Guide

Volume 1: Kindergarten – Second Grade
Volume 2: Third – Fourth Grade
Volume 3: Fifth – Sixth Grade

Developed as part of the
Nebraska Natural Resources Commission's
State Water Planning and Review Process

SOIL AND WATER CONSERVATION STRATEGY

——— In cooperation with ———

Nebraska Department of Education
U.S.D.A. Soil Conservation Service
Nebraska Natural Resources Districts
Nebraska Department of Agriculture – Ag In the Classroom Program
University of Nebraska, Institute of Agriculture and Natural Resources

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This activity notebook is suggested for the fifth and sixth grade levels.

It has been developed to promote conservation awareness and understanding for Nebraska elementary school children. This project was developed by a cooperative effort of the 23 Nebraska Natural Resources Districts, U.S.D.A. Soil Conservation Service, Nebraska Natural Resources Commission, Nebraska's Ag in the Classroom Program, Nebraska Department of Education, Nebraska Department of Agriculture and the University of Nebraska-Lincoln Institute of Agriculture and Natural Resources.

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   San Jose, California 95129
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2. Minnesota's Ag-Stravaganza
   Protecting Agricultural Land
   Minnesota Environmental Education Board
   Box #5, DNR Building
   500 Lafayette Road
   St. Paul, Minnesota 55155-4005

3. Soil--We Can't Grow Without It
   1985 Educator's Guide
   National Wildlife Federation
   1412 Sixteenth Street, N.W.
   Washington, D.C. 20036-2266

4. The Growing Classroom
   3 volume garden-based science and nutrition curriculum
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    4-H Members Manual
    Published by:
    National 4-H Council
    7100 Connecticut Avenue
    Chevy Chase, Maryland 20815

11. Conservation Education
    South Platte Natural Resources District
    Box 294
    Sidney, Nebraska 69162
    and
    Educational Service Unit #14
    Sidney, Nebraska 69162

12. Ecology and Energy Action Pack
McDonald's Corporation
One McDonald Plaza
Oak Brook, Illinois 60521

13. Nebraska's Ag in the Classroom
Learning Activities Notebook
Nebraska's Ag in the Classroom Program
310A Ag Hall
University of Nebraska
Lincoln, Nebraska 68583-0709

14. Conserving Soil
United States Department of Agriculture Soil Conservation Service

15. Soil -- Use and Improvement
United States Department of Agriculture Soil Conservation Service

16. Soil Conservation Topics Education Kit
United States Department of Agriculture Soil Conservation Service

17. Teaching Soil and Water Conservation
United States Department of Agriculture Soil Conservation Service

18. Nebraska's Guide to Environmental Resources
Nebraska Department of Education
301 Centennial Mall South
Lincoln, Nebraska 68509

19. What on Earth is Soil?
UCCE Publication
317 University Hall
University of California
Berkeley, California 94720

20. Soil – Our Most Valuable Resource
Project PLUM
Gifford Educational Farm and Woodlands
700 Camp Gifford Road
Bellevue, Nebraska 68005

21. Exploring the World of Plants and Soils
4-H Member's Manual Published by:
National 4-H Council
7100 Connecticut Avenue
Chevy Chase, Maryland 20815

22. Plant Reproduction
4-H Member's Manual Published by:
National 4-H Council
7100 Connecticut Avenue
Chevy Chase, Maryland 20815

23. Arizona Teachers Resource Guide for Environmental Education
Arizona Department of Education
1535 West Jefferson
Phoenix, Arizona 85007

24. Using Nebraska's Range
4-H Study Guide 30 Published by:
National 4-H Council
7100 Connecticut Avenue
Chevy Chase, Maryland 20815

25. Renewable Resources Extension Act Report
United States Department of Agriculture

26. Green America #28
American Forest Council
1250 Connecticut Avenue, N.W. Suite 320
Washington D.C. 20036

27. Urban Forestry
4-H Member's Manual Published by:
National 4-H Council
7100 Connecticut Avenue
Chevy Chase, Maryland 20815

28. Plant Characteristics
Unit IID, 4-H Member's Manual Published by:
National 4-H Council
7100 Connecticut Avenue
Chevy Chase, Maryland 20815

29. Groundwater: A Vital Resource
Tennessee Valley Authority
Knoxvill, Tennesse 37902

30. Discover Wildlife in Your Yard
1986 Educator's Guide
National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington D.C. 20036-2266

31. Wildlife Conservation
    4-H Member's Manual Published by:
    National 4-H Council
    7100 Connecticut Avenue
    Chevy Chase, Maryland 20815

32. Agricilture in Montana Schools
    Box 167
    Wolf Creek, Montana 59648

33. The Energy Challenge
    U.S. Department of Energy

34. Energy Learning Center
    Communications and Education Group
    Dayton, Ohio

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Introduction

This activities notebook was developed to help teachers provide relevant conservation information for students in an easy and practical manner.

These materials are designed for the teacher to adapt to his/her individual style and teaching needs. The materials can be taught in 5 units; activities can be pulled and use to enrich a core curriculum, or worksheets can be used in skill review.

The Unit Guide lists unit concepts and daily lesson plans enabling a teacher to implement these materials in a unit form.

Each activity lists objectives, subject area, background information (if needed), materials, additional activities, supplemental worksheets to reinforce concepts of each activity, and suggested procedures to provide your students with a hands on experience in conservation. Refer to the Activity Guide to identify topics and basic skills for each activity.

The Worksheet Guide can be used to identify basic skills for each worksheet.

The activities provide needed background information. If you would like more background information, contact one of the following resources in the appropriate area:

Soil and Water

Contact your local Soil Conservation Service or
Natural Resources District offices.

Wildlife

National Wildlife Federation
1412 Sixteenth Street N.W.
Washington, D.C. 20036-2266

Nebraska Game and Parks Commission
2200 N. 33rd Street
Lincoln, Nebraska 68683
(402)464-0641

Forest , Trees

Nebraska State Forest Service
101 Plant Industry Building
Lincoln, Nebraska 68583
(402)472-2944

USDA Forest Service
Regional Forester
11177 West 8th Avenue
Box 25127
Lakewood, Colorado 80225

There are a few slide/tape shows available on loan from:

USDA Soil Conservation Service
Nebraska Office
100 Centennial Mall North
Lincoln, Nebraska 68508
(402)437-5300

Ask for: "Soil - We Can't Grow Without It"

15 minutes, discusses the significance of soil to plants, animals and people.

or:

"Water - We Can't Live Without It"

14 minutes, shows how freshwater habitats support wildlife, what threatens our water supply, and how we can conserve this vital resource for future generations.

Unit Guide

This unit guide list 6 units, the concepts for each unit and suggested daily activities. For example in Unit 1, Day 2 it is suggested to use "Soil Texture" activity 2 and Additional Activity 1 to reinforce the objective. "Soil Texture" is the first activity found in the notebook. Additional Activity 1 is found after the procedure of "Soil Texture", it is part of "Soil Texture" activity.

Unit 1 Soil Conservation

Concepts

The student will

- understand the soil formation process
- understand that soil textures affect erosion and it's productive capability
- understand soil compaction and permeability and it's affects on plant growth
- discover differences between topsoil and subsoil
- recognize the small percentage of the earth's surface used for food production
- examine soil conservation practices used to reduce soil erosion
- evaluate the importance of planning land use

Suggested Daily Lesson Plan (Activities 1-9)

Day 1
"Making Soil" Activity 1

Day 2
"Soil Texture" Activity 2
Additional Activity 1, to reinforce the objective

Day 3
"Soil Compaction and Permeability" Activity 3
Additional Activity 1, to show compaction and permeability with different soil types

Day 4
"Profile" Activity 4

Day 5
"Eat the Earth" Activity 5
Additional Activity 1, to reinforce the concept

Day 6
"Slope" Activity 6 to introduce activity 7 on Day 7

Day 7
"Contouring" Activity 7

Day 8
"Soil Roots" Activity 8

Day 9
"Who's Responsible" Activity 9

Unit 2 Plants And Conservation

Concepts

The student will

- examine the effects of plant populations in varying conditions
- examine the process of photosynthesis
- discover dominate and recessive genes
- determine the importance of farmland and rangeland
- examine the importance of leaves to plants
- examine limiting factors of various populations
- examine plant reproduction from perfect and imperfect flowers
- use plant materials to create with

Suggested Daily Lesson Plan (Activities 10 - 18)

Some of these activities need to be started and will continue for several weeks with periodic observation and information collecting.

Day 1
"The Flower" Activity 10 to introduce activities 11 and 12
Additional Activity 1 to reinforce the objective

Day 2
"Plant Crosses" Activity 11

Day 3
"Selfing" Activity 12

Day 4
"Propagation" Activity 13

Day 5
"Photosynthesis and Transpiration" Activity 14

Day 6
"Productive Plants" Activity 15

Day 7
"Wise Acres" Activity 16

Day 8
"The Sky is not the Limit" Activity 17
Additional Activity 1, to reinforce the concept

Day 9
"Plant Dyes" Activity 18

Unit 3 Tree Conservation

Concepts

The student will

- research and discover Arbor Day, Nebraska National Forests, and important Nebraska "tree planters"
- plant a tree
- identify common Nebraska trees
- realize the importance of recycling paper

- make recycled paper
  - examine causes of range and forest fires
  - examine efficient ways to use our natural resources
  - examine the age and size of trees

Suggested Daily Lesson Plan (Activities 19 - 25)

Day 1
"Plant a Tree" Activity 19

Day 2
"Trees of Nebraska" Activity 20

Day 3
"Fire!" Activity 21

Day 4
"An Aluminum Pencil?" Activity 22
Additional Activity 1 to reinforce the concept

Day 5
"Making Recycled Paper" Activity 23
Additional Activities 2 and 3 to reinforce the concept

Day 6
"How Big" Activity 24

Day 7
"Tree Rings" Activity 25

Unit 4 Water Conservation

Concepts

The student will

- examine irrigation methods and purposes
- realize the amount of water on the earth
- realize how much water they use and how measured
- realize the impurities in water
- examine the importance of water in everyday life
- examine underground water and the water table
- discover the hydrologic cycle

Suggested Daily Lesson Plan (Activities 26 - 34)

Day 1
"Wanted: Water" Activity 26
Additional Activities 2 and 3 for a broader view on the concept

Day 2
"Water's Going On?!" Activity 27

Day 3
"Water Meter" Activity 28
Additional Activity 2 to reinforce the concept

Day 4
"Life on Dune" Activity 29

Day 5
"Surface Water - Groundwater Quality" Activity 29a
Day 6
"Water and Agriculture" Activity 30
Day 7
"Simple Water Filter" Activity 31
Day 8
"Nature's Waterwheel" Activity 32
Additional Activity 1 for a hands on experience
Day 9
"Illustrating the Water Table" Activity 33
Day 10
"Wells and Groundwater" Activity 34

Unit 5 Wildlife Conservation

Concepts
The student will
- identify ways litter can endanger wildlife
- examine the pro's and con's of hunting
- examine the varying values of people towards wildlife
- be exposed to a variety of careers dealing with wildlife and natural resources
- examine wildlife populations and what affects theirnumbers (including carrying capacity and predator/prey relationships)

Suggested Daily Lesson Plan (Activities 35-43)
Day 1
"Stormy Weather" Activity 35
Day 2
"The Value of Wildlife" Activity 36
Day 3
"The Hunter" Activity 37
Additional Activity 1. to familiarize students with regulations in their immediate area
Day 4
"Oh Deer!" Activity 38
Additional Activity 1. for more information about changing wildlife populations.
Day 5
"Quick Frozen Critters" Activity 39
Day 6
"Manage a Moose" Activity 40
Additional Activity 1. to reinforce the concept
Day 7
"Wildlife on the Farm" Activity 41
Day 8

"Litter" Activity 42

Day 9

"Wildwork" Activity 43

Additional Activity 1

Unit 6 Conserving Our Energy

Concepts

The student will

- learn about alternate energy sources
- realize the value of solar energy
- learn the history and uses of wind power
- recognize the hydroelectric function
- research and campaign the pro's and con's of nuclear energy
- discover how nuclear energy is formed

Suggested Daily Lesson Plan (Activities 44-46)

Day 1

"Nuclear Energy" Activity 44

Day 2

"Solar Energy" Activity 45

Day 3

"Energy of the Future" Activity 46

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Activity Guide

This activity guide lists each of 47 activities under the appropriate section of Science/Social Studies, Language Arts, Math or Art. Some activities are listed under more than one section. This guide shows basic skills and the conservation topic found in each activity.

Science/Social Studies

Activity#	Page#	Skill	Conservation Topic
1	1	infer, observation	soil formation
2	7	infer, observation	soil texture
3	13	infer, observation	soil characteristics
4	15	infer, observation	soil profile
5	19	observation	soil use
6	23	infer	soil erosion
7	25	infer, observation	soil erosion
8	29	infer, observation	soil erosion
9	31	role playing	land use
10	41	identification	parts of a flower
11	45	infer, observation	plant reproduction
12	49	infer, observation	plant reproduction
13	53	infer, observation	growing conditions
14	55	infer, observation	transpiration, photosynthesis
15	57	infer, observation	plant vigor
16	61	comprehension	vegetation types
17	63	problem solving	limiting factors
18	65	observation	plant use

Science/Social Studies (con't)

Activity#	Page#	Skill	Conservation Topic
19	67	research, observation	tree plant/history
20	69	identification, observation	tree identification
21	73	problem solving, infer	forest fires
22	79	research	recycling, tree uses
23	83	infer, observation	recycling, tree conservation
24	87	calculation, observation	tree sizes
25	89	infer, observation	tree ages
26	91	observation	water conservation
27	95	research, record keeping	daily water usage
28	99	research	water meters
29	105	brainstorming	water conservation
30	111	categorizing	water quality
31	117	research	irrigation
32	123	infer,	clean water
33	125	observation observation	water cycle
34	131	observation	water tables
35	133	observation	underground wells
36	135	listening, imagining	wildlife conservation
37	141	research, categorizing	wildlife value
38	145	listening	wildlife hunting

Science/Social Studies (con't)

Activity#	Page#	Skill	Conservation Topic
39	155	role playing	wildlife habitat
40	161	role playing	wildlife adaptations, predator/prey relationships
41	165	role playing	wildlife management
42	177	listening, infer	wildlife management
43	185	observation, critical thinking	litter
44	187	research	careers
45	189	observation	nuclear energy
46	195	application, observation	solar energy
47	201	problem solving	energy conservation

Language Arts

1	1	comprehension, vocabulary	soil formation
16	61	comprehension, listening for detail	vegetation types
17	63	problem solving	limiting factors
19	67	research	tree history
20	69	reading for information	tree identification
22	79	research	recycling, tree uses
26	91	observation	water conservation
29	105	creative writing	water conservation
36	135	listening, imagining	wildlife conservation

Language Arts(con't)

Activity#	Page#	Skill	Conservation Topic
38	145	listening, creative writing	wildlife hunting
43	185	critical thinking	litter
44	187	letter writing	careers
45	189	persuasive writing	nuclear energy

Math

2	7	flow chart	soil texture
3	13	graphing	soil characteristics
5	19	graphing, percentages	soil use
6	23	determine slope	soil erosion
21	73	graphing	forest fires
24	87	diameter, height	tree sizes
25	89	circumference	tree sizes
27	95	record keeping	daily water usage
28	99	reading meters	water meters
31	117	graphing	irrigation
39	155	graphing	wildlife habitat
41	165	problem solving	wildlife management
42	177	problem solving	wildlife management
43	185	observation	litter

Art

Activity#	Page#	Skill	Conservation Topic
16	61	sketching	vegetation types
18	65	colors	plant use
42	177	collage	litter

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Worksheet Guide

This worksheet guide lists each worksheet under page number and activity number. For example, the first worksheet listed in Science is page 10, Activity 2. You can then discover the Skill used and Conservation topic covered on this worksheet by going across the page. Science, Language Arts and Math are the subjects used in this guide.

Science

Page#	Activity#	Skill	Conservation Topic
10	2	flow charts	soil texture
11	2	map reading	Nebraska soils
59	15	record keeping	plant productivity
64	17	infer, role visualizing	limiting factors
71	20	crossword puzzle	trees of Nebraska
85	23	comprehension	recycling
101	28	reading water meters	water conservation
102	28	reading water meters	water conservation
103	28	reading water meters	water conservation
110	30	crossword puzzle	water facts
113	31	pollution rating chart	surface water quality
119	31	reading graphs for information	irrigation
120	31	graph reading	irrigation
121	31	map reading	irrigation
128	33	reading for information	water cycle
129	33	labeling a diagram	water cycle
138	36	crossword puzzle	wildlife conservation

Science (con't)

Page#	Activity#	Skill	Conservation Topic
139	36	crossword puzzle	wildlife conservation
199	46	labeling a diagram	solar energy
202	47	reading for information	energy resources

Language Arts

6	1	symbol matching	soil conservation
64	17	creative writing	limiting factors
172	41	comprehension	wildlife refuges
173	41	reading,	wildlife habitats
174	41	decoding context meaning	conservation
175	41	context meaning	endangered animals
191	45	reading for detail	nuclear energy
192	45	viewpoint, decision making	nuclear energy
193	45	comprehension	nuclear energy
194	45	syllables	nuclear energy
197	46	comprehension	solar energy
198	46	listening for details	solar energy
203	47	comprehension	energy resources
204	47	comprehension	energy conservation
205	47	problem solving	energy conservation

Math

Page#	Activity#	Skill	Conservation Topic
59	15	tables, measuring	plant productivity
86	23	word problems	recycling
94	26	word problems	water conservation
101	28	reading water meters	water conservation
102	28	reading water meters	water conservation
103	28	averages-application	water conservation
183	42	word problem matching shapes	carrying capacity
205	47	problem solving	energy conservation

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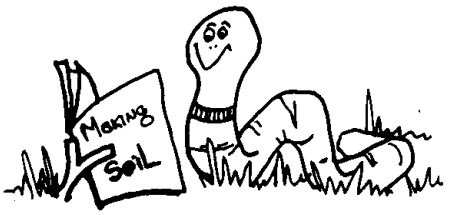
Activity 1
Soil Conservation
Making Soil



Subject Area: Science, Language Arts

Objectives:
1. The students will understand the soil formation process through experiments.
2. The students will use new vocabulary to complete sentences in a letter.

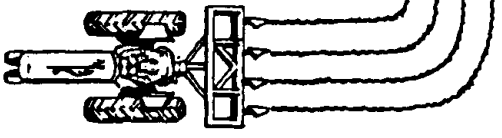
Suggested Grade Level: 5-6

Background: Soil is formed from rocks very, very slowly. When you rub two rocks together, small particles rub off. It takes a long time to accumulate even a spoonful. When large sheets of ice (glaciers) moved over the land thousands of years ago, rocks were ground together,rubbing off tremendous quantities of rock particles of all sizes. Much of the North Central United States is made up of soils that were formed by the action of these glaciers. Changes in temperature also help to make soil. The sun warms the rocks during the day. At night the rocks cool. The expansion and contraction chips off particles of rock. Freezing water expands with tremendous force. Water that finds its way into cracks in the rocks freezes and breaks the rocks into smaller and smaller pieces.

When you put limestone in the vinegar, you duplicate in a small way what plants do. Plant roots take in oxygen from the soil air and give off carbon dioxide gas. This gas is one of the important end products in the decay of organic matter.

Carbon dioxide gas dissolves in the soil moisture, forming weak carbonic acid. This acid reacts just as acetic acid in vinegar does with limestone rock and will decompose limestone and marble. The dissolving effect of this carbonated water is several times that of pure water. Since the lime in limestone is soluble, it gradually washes away leaving only the other materials as soil. It takes 40 to 50 feet of limestone to make only a few inches of soil.

There are other physical and chemical factors that also aid in soil formation. For example, wind blows small rock particles against larger ones, wearing both down.

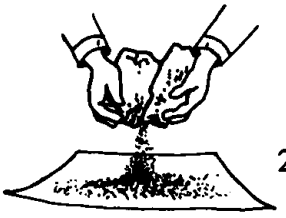


Most of the soils we see today developed from rock material that was moved by water or wind.Soil is made up of many different things; worn rocks, decayed plant and animal life (organic matter), air and water.

Materials:

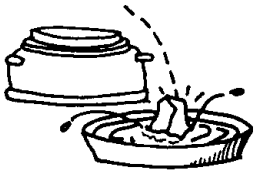
1. Pieces of limestone or fine sandstone
2. Hot plate
3. Ice water
4. Tin pie plates
5. Small discarded glass jar with lid
6. Refrigerator freezer
7. Vinegar
8. Thermometer
9. Attached letter
10. Eye protection (for limestone dust)

Procedure:

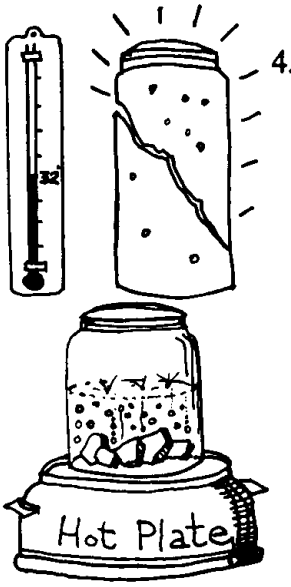


1. Rub two pieces of limestone or fine sandstone together. If you do not have natural stone, pieces of building bricks or concrete will do. Notice how long it takes to rub off even a few fine particles. Discuss how soil is made by glaciers.

2. Heat a small piece of limestone over a flame or on a hot plate. Drop it quickly into a pan of ice water. The rock should break or crack as it contracts after its expansion by heating. Discuss how change in temperature makes soil.



3. Fill a small discarded glass jar with water and cap it tightly. Let it freeze outdoors or in the freezing compartment of a refrigerator. Discuss what happens to the jar.



4. Put some small pieces of limestone in a little vinegar. Heat the vinegar on a hot plate or over a burner and notice how bubbles form on the pieces of stone. These bubbles are carbon dioxide gas made from carbon and oxygen released from the limestone by a chemical change in the rock caused by the acid in the vinegar. If you continued this process long enough, all the limestone would gradually break down. Discuss.

5. Duplicate copies of the attached letter. Write these words on the board and have the students use them to complete the letter.

ice water	four	water
soil	limestone	cracked
glaciers	particles	lid
rocks	heated	vinegar
100	break	bubbles
sun	600	heat
night	freezer	conserve
soil conservation jar	expanded	
North Central United States		

6. Pass out copies of "Weathering Away". Have students work independently.

Additional Activities:

1. Have students make enough soil to plant a seed in. You will have to add organic matter to your soil so the seed has enough nutrients to grow.

Adapted From:

1. Conservation Education
2. Teaching Soil Water Conservation

Dear Family;

Today at school we experimented to see how soil is formed. We did four experiments. The first experiment required us to rub two pieces of limestone together. From that we got a few particles of soil. Thousands of years ago large sheets of ice called glaciers moved over the land grinding rocks together. Much of the soil in the North Central United States was made from the action of the glaciers.

In the second experiment we heated a small piece of limestone and then dropped it into a pan of ice water. The rock cracked because it contracted; it got smaller when it hit the ice water after being expanded by the heat. During the day the sun heats up the rocks. Then at night the rocks cool off. This expansion and contraction action causes pieces of rock to chip off from larger rocks.

In the third experiment we filled a jar with water and then put the lid on tight. We put the jar in the freezer. After awhile the jar cracked. This meant the water needed more space so it expanded. Since the lid was on, the water had no place to go so the jar broke open and the freezing water had more space. Water that gets into cracks in the ground and then freezes, causes the rock to break into smaller pieces.

In the fourth experiment we heated limestone in some vinegar. Bubbles formed on the limestone. The vinegar was breaking down the limestone to represent how plant roots break down the soil.

It takes about 100 years to produce one inch of soil. This means it would take 600 years to produce 6 inches of soil. Since it takes so long to make soil, soil conservation is really important. We don't want our soil eroding into our rivers and streams. We need to keep our soil in the fields where it belongs. It takes a long time for new soil to form so we need to conserve the soil we have.

Love,

_____

Name_____

Dear Family:

Today at school we experimented to see how _____is formed. We did _____ experiments. The first experiment required us to rub two pieces of _____ together. From that we got a few _____ of _____. Thousands of years ago large sheets of ice called _____moved over the land grinding _____to-gether. Much of the soil in the _____was made up of the action of the _____.

In the second experiment we _____a small piece of _____ and then dropped it into a pan of _____ _____. The rock broke/cracked because it contracted; it got smaller when it hit the _____ _____ after being expanded by the heat. During the day the _____ heats up the rocks. Then at _____ the rocks cool off. This expansion and contraction action causes pieces of rock to chip off form larger rocks.

In the third experiment we filled a _____ with _____ and then put the lid on tight. We put the jar in the _____. After awhile the jar _____. This meant the water needed more space so it _____. Since the _____was on, the water had no place to go so the jar broke open and the freezing water had more space. Water that gets into cracks in the ground and then freezes causes the _____ to _____into smaller pieces.

In the fourth experiment we heated _____in some vinegar. _____formed on the _____. The vinegar was breaking down the limestone to represent how plant roots break down the soil.

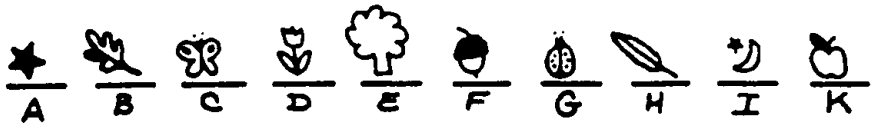
It takes about _____years to produce one inch of soil. This means it would take _____years to produce 6 inches of soil. Since it takes so long to make soil. _____ _____ is really important. We don't want our _____ eroding into our rivers and streams. We need to keep our soil in the fields where it belongs. It takes a long time for new soil to form so we need to _____the _____ we have.

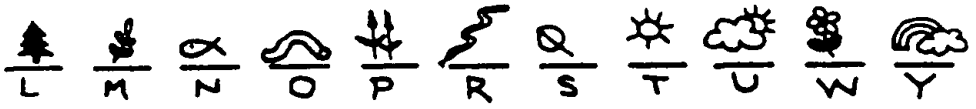
Love,_____

Name _____

Weathering Away

In the coded message below, find out what helps make soil. Write the letter of each picture under the same picture in the puzzle.





_____ _____ _____

_____ _____ _____

_____ _____ _____.

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____.

Activity 2
Soil Conservation
Soil Texture

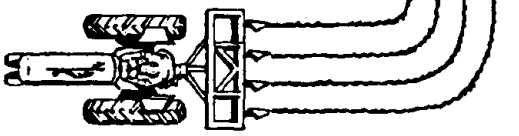
Subject Area: Science, Math

Objectives:
1. The students will understand that soil has many different structures, which affect erosion and it's productive capability.
2. The students will follow a flow chart to determine soil structure and type.

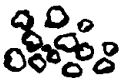
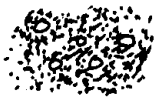
Suggested Grade Level: 5-6

Background: One soil characteristic is it's texture. Individual soil particles are grouped together to form larger pieces of soil called structural groups, known as "peds", "aggregates", or "clods". Soil texture is classified by the size of the soil particles measured in millimeters (mm). A soil's texture affects it's stability and susceptibility to erosion and water absorbing and holding capabilities.

To simplify the description of the mineral portion of the soil mixture, three sizes of particles have been defined. These are called (in order of decreasing size; sand, silt, and clay). All soils are mixtures, in one proportion or another, of these three types of particles. The proportion of each particle type in any particular soil can be estimated by rubbing the moist soil between the thumb and fingers to determine its "feel." Sandy soils are scratchy or gritty. Silty soils are smooth and slippery, but not sticky. Soils high in clay are both slippery and sticky. In addition to influencing the feel of the soil, each of the particle sizes contributes somewhat different properties to the total soil. The properties affected by particle size are: water seepage, water retention for plant roots, aeration, nutrient supply, and soil strength. In general, sandy soils have faster water percolation and better aeration than finer textured soils, but their ability to retain water and supply nutrients is lower. They also have less strength and are therefore easier to cultivate.



General Soil Structures

Type		Description
Platy		Flat,thin plates lying horizontally in soil.
Prismatic		Columns vertical in soil may be several inches long and 1 1/2 to 3" in diameter.
Blocky		Angular blocks 1/2 to 2" in diameter.
* Granular or Crumb		Resembles crumbs or grains. Usually less than 1/4" in diameter.
Gravel or Sand		Soil particles do not stick together. Single grains.
Heavy Soil		Soil in very large clods. No visible structure. Hard to break apart.

* Best structure, will crumble easily to particles the size of wheat grains. This type of structure is most easily tilled and is best for plants.

Materials:

1. Microscopes
2. Several large clumps of soil from different locations (must be different colors and textures of soil) Contact your local Natural Resources District, Soil Conservation Service, Extension Agent, or Vo-Ag Instructor for soil samples.
3. Worksheet 1

Procedure:

1. Break large lumps of moist soils apart with your hands and note the way the soil breaks up.
2. Note type of structure such as blocky, prismatic, crumb or granular and platy.
3. Soils that have large lumps, no visible structure and are hard to break apart are usually fine texture clay soils. Excessive tillage, working the soil too wet, or heavy traffic may also produce large lumps or a lack of visible structure.
4. Look for the different soil structures first by just eyesight and then by using a microscope.
5. Handout worksheet 1. Students should complete the experiment.

Additional Activity:

1. Have students research their soil type, describing its characteristics and where it is found in Nebraska. (Refer to Worksheet 2).

Adapted From:

1. Soils Unit IIB
   4-H Members Manual
2. What on Earth is Soil?

Soil Texture

Name _____

START

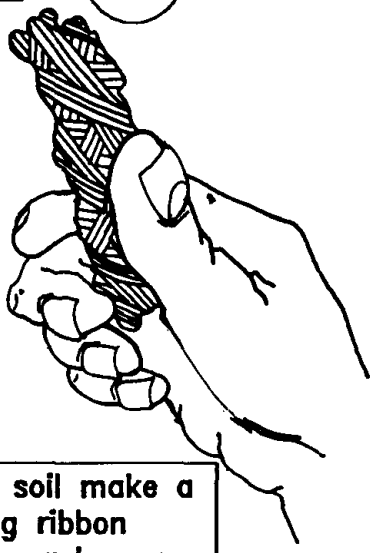
Place approximately 25 grams of soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.

Add dry soil to soak up water.

Does soil remain in a ball when squeezed? no → Is soil too dry? yes → Add dry soil to soak up water. no → Is soil too wet? yes → SAND

yes

Place ball of soil between thumb and forefinger gently pushing the soil with the thumb, sqeezing it upwards into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.



Does soil form a ribbon? no → LOAMY SAND

yes

Does soil make a weak ribbon less than 2.5 cm long before breaking? no → Does soil make a medium ribbon 2.5 to 5 cm long before breaking? no → Does soil make a strong ribbon 5 cm or longer before breaking?

yes

Excessively wet a small pinch of soil in palm and rub with forefinger.

yes

Does soil feel very gritty? yes → SANDY LOAM

no → Does soil feel very smooth? yes → SILT LOAM

no → Soil is neither very gritty nor very smooth. yes → LOAM

Does soil feel very gritty? yes → SANDY CLAY LOAM

no → Does soil feel very smooth? yes → SILTY CLAY LOAM

no → Soil is neither very gritty nor very smooth. yes → CLAY LOAM

Does soil feel very gritty? yes → SANDY CLAY

no → Does soil feel very smooth? yes → SILTY CLAY

no → Soil is neither very gritty nor very smooth. yes → CLAY

Worksheet 1

Taken from "A Flow Diagram for Teaching Texture-by-Feel Analysis" by Steve J. Thien, Journal of Agronomic Education, Vol. 8, 1979, pp. 54-55.

Soils of Nebraska

Name _____

Worksheet 2

Directions: Using ten different colors, color the map.

1. Sandy and loamy upland soils formed in loess, eolian sand and alluvium.
2. Sandy and loamy upland soils and rock escarpments formed from sandstone.
3. Sandy, loamy and clayey bottom land soils formed in alluvium.
4. Silty and clayey upland soils formed from galacial till and loess.
5. Loamy and silty upland soils formed from loess and sandstone.
6. Sandy upland soils in the Sandhills.
7. Silty upland soils formed from loess.
8. Silty upland soils formed from siltstone.
9. Clayey upland soils formed from shale.
10. Loamy and clayey upland soils formed in loess, eolian material and shale.

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Activity 3
Soil Conservation
Soil Compaction and Permeability

Subject Area: Math, Science

Objective: 1. The students will understand how soil compaction and permeability affects plant growth.

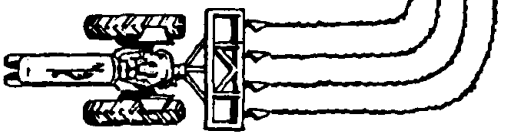
Suggested Grade Level: 5-6

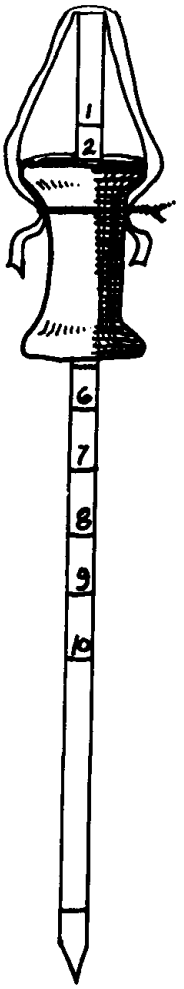
Background: When soil is compacted too much it has several effects on plant growth. It hinders seedling emergence, leading to uneven plant stands, which may lead to losses at harvest time. Compaction in the soil also stunts root growth, reducing the plants ability to absorb water and nutrients. Another effect compaction of the soil has on plant growth is the reduced rate that water can infiltrate into the soil (permeability). More water soaking into the soil means less water running off. Excessive water running off can lead to erosion, which can carry away young plants or seeds and nutrients. The degree to which soil becomes compacted is based on several factors. These factors include the amount of sand, silt, and organic matter, in soil which increase permeability, and the amount of clay in the soil which reduces permeability. Also affecting soil compaction are moisture of soil when it is worked, the rate of rainfall, and the number of times you drive over the land with a tractor. Greater soil compaction leads to decreased soil permeability.

Materials:
1. A 1/4 inch diameter dowel, 10 inches long
2. Large thread spool with a 1/4 inch diameter hole
3. Heavy thumb tack
4. Wide, heavy rubber band
5. Wire
6. Two No. 10 cans
7. Ruler
8. Graph paper

Procedure:
1. Select at least four areas around the school ground--lawn, path, field, woods, flower bed, etc.

2. Sharpen one end of the dowel to a point. Measure and mark a line 1/2 inch from the point. Measure and mark one inch from the top of the dowel and make 10 more marks, one-half inch apart going down. Number each





mark. Cut the rubber band and place the mid-section of the band over the top of the dowel, fastening with the thumb tack. Attach the band to the spool with the wire. Slip the spool over the dowel and adjust so the top of the spool is at the first line. Holding the spool, push the pointed end of the dowel into the soil until it reaches the line nearest the point. Record the number revealed at the top of the spool. Repeat the compaction test at each site selected. Make a graph to show the difference at the different sites.

3. Cut both ends from a can. At one of the selected sites, drive the can into the ground about 2 inches. Place the rule inside the edge of the can. Fill the other can with a measured amount of water and pour it into the can in the ground. Record the number of seconds it takes for the soil to absorb the water. Repeat at each site and record the results on a graph.

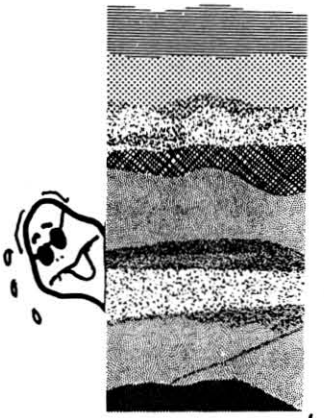
4. Discuss the following questions. How does soil compaction on the path compare with that on the lawn? What is the relationship between soil compaction and soil permeability? What effect might heavily compacted soil have upon plant growth? Which soil absorbs water at a faster rate? Why?

Additional Activity:

1. Fill up a paper cup to an inch from the top with a sandy soil, one with silty soil, and one with a clay type soil. Pack lightly. Punch a hole in the bottom of the cups. Place something under the cups to catch water. Pour an even amount of water into each cup and time how long it takes for the first 20 drops of water to come out. Record. Repeat above procedure,only pack the soil tightly into the cups this time. Discuss which soil is more susceptible to compaction.

Adapted From: 1 Soil Conservation Topics Education Kit
USDA Soil Conservation Service

Activity 4
Soil Conservation
Profile



Subject Area: Science

Objectives:
1. The students will understand the differences in soil profiles, topsoil, and subsoil.
2. They will understand the importance of conserving our valuable topsoil.
3. The students will reinforce the concept that plants get nutrients from the soil by observing plants in different types of soils.

Suggested Grade Level: 5-6

Background: A soil profile is a slice of earth several feet deep. By studying soil profiles, scientists learn about the soil, its characteristics, and how to use and protect it.

The primary kinds of soil are designated by layers called horizons. The O horizon consists of leaf litter or other organic material lying on the soil's surface (such as in forests). This includes some decomposed organic matter. The next layer is the A horizon. This is considered the topsoil. It is accumulated decomposed organic matter and mineral materials, usually dark in color.

The B horizon is the next layer, also called subsoil. This horizon is finer in texture and is lighter in color than the topsoil. It is mineral materials which accumulate organic matter, clay, iron, aluminum, and others from the layer above.

Nutrients needed by plants are usually in topsoil. Topsoil is the most fertile because it contains organic matter (decayed and decaying plants, animals, fungi and bacteria). Organic matter improves soil in many ways. It increases its water-holding capacity; it serves as a store- house for plant nutrients such as nitrogen; and it provides food for the countless bacteria and other living things in the soil. Some of these organisms produce acids that in turn help break down soil minerals. Plants take their nutrients from the soil. Mineral nutrients are made available for plant use through weathering and other soil forming processes.

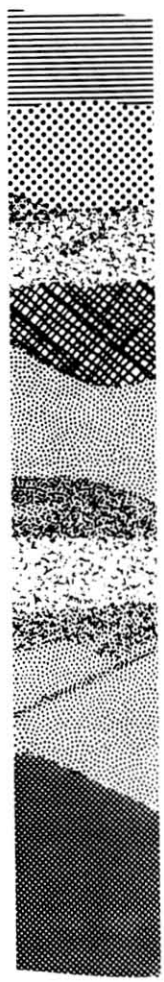
We need to use conservation practices to protect our important topsoil. A few centimeters of topsoil taking a hundred years or more to form can be washed

away during a single rainfall on an unprotected, sloping field. Most of the soil that erodes away into streams, lakes, and oceans is topsoil.

Materials:

1. A soil profile (refer to procedure 1)
2. Topsoil (Potting soil can be substituted for top soil).
3. Subsoil, from a depth of three feet from a cut road bank, creek bank, or excavation area.
4. Sand, from a beach or sandbox.
5. Three small pots per group.
6. 3-5 seeds per pot

Procedure:



1. To obtain a soil profile contact your local Soil Conservation Service or Natural Resources District or you can make one. You will need white tagboard, glue, and a soil probe or a shovel. Fold a large piece of white tagboard in half. Open it and place a 6" band of glue down the middle. Take a core of soil using either a soil probe or shovel or post hole digger. Be careful not to disturb the layers. Carefully place the soil on the glue in the order of digging. Look at the soil for difference in color, texture, structure, and animal life. After the glue has dried throughly shake off the excess soil. On each side of the soil make labels for description. This will became a permanent profile. Stand it up in your classroom.

2. Discuss the soil profile. What differences are there in the horizons? Have students point out color, texture, and appearance changes in the horizon depths. Measure horizon depths. Sketch the profiles studied.

3. Discuss the importance of top soil and remind the students that plants take all their mineral nutrients from the soil.

4. Divide the students into small groups. Give each student or group 3 soil containers and have them fill one with topsoil, one with subsoil, and one with sand.

5. Plant 3-5 seeds in each container. (Soaking seeds overnight in water will speed up germination.)

6. Keep the plants watered and in a warm, well- lighted place.

7. Have students record growth, leaves, color changes, waterings, etc. They are to treat all 3 pots exactly the same. Eventually, they will see topsoil produces the best plant. This is why we need to protect our topsoil. Discuss

the findings. Possible questions: What have you learned? How is topsoil different than subsoil? What do you think erosion does to topsoil? Who is responsible for protecting topsoil?

Adapted From:

1. Soil-Our Most Valuable Resource
2. Conserving Soil
3. Minnesota's Ag-Stravaganza
   Protecting Agricultural Land

Soil Profile

01 Undecomposed organic matter

02 Decomposed organic matter

A Horizon

Accumulated decomposed organic matter and mineral materials - usually dark in color.

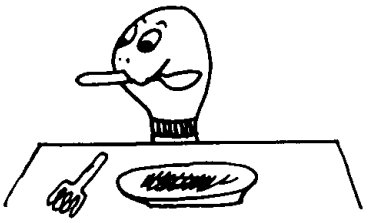
B Horizon

Mineral materials which accumulate organic matter, clay, iron, aluminum, etc. from layer above.

C Horizon

Mineral material of weathered rock or other unconsolidated material.

Activity 5
Soil Conservation
Eat the Earth



Subject Area: Science, Math

Objective:
1. The student will recognize the percentages of the earth used for food production as compared to the amount of oceans, deserts, mountains, etc. on the earth.

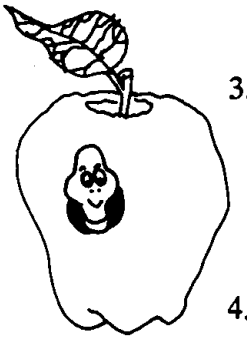
Suggested Grade Level: 5-6

Background: The most important natural resource is soil. **All** living things depend on it as a source of food. Our food producing land is a limited resource. In fact, we lose many acres each year through urban growth, industry, and erosion. Yet, the world's population continues to grow. Consequently, each person's food producing portion of land is becoming smaller and smaller. It is the responsibility of all generations to use the soil wisely; to insure a bright future.

Materials:
1. Large apple
2. Paring knife
3. Answer Key A

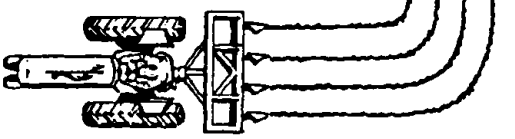
Procedure:
1. Cut the apple into four equal parts. Three parts represent the oceans of the world. The fourth part represents the land area.

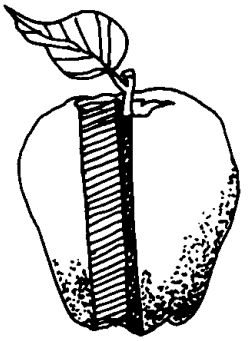
2. Cut the land section in half lengthwise. Now you have two one-eighth pieces. One section represents land such as deserts, swamps, antarctic, arctic, and mountain regions. These regions are not suitable for humans to live.



3. The other one-eighth section represents land where humans can live. Slice this one-eighth section lengthwise into four equal parts. Three of these one-thirty second sections represent the areas of the world which are too rocky, too wet, too hot, or where soils are too poor for food production, as well as areas developed by humans. People can live in these areas.

4. Carefully peel the last one-thirty second section. This small bit of peeling represents the soil of our earth on which mankind depends for food production!





5. Discuss what this soil is used for. Possible questions:
   - What if this valuable top soil upon which we depend should suddenly disappear?
   - What will happen if the world's population continues to grow while our earth's top soil remains the same?
   - What ways can you and your family help conserve precious soil in your own backyard?

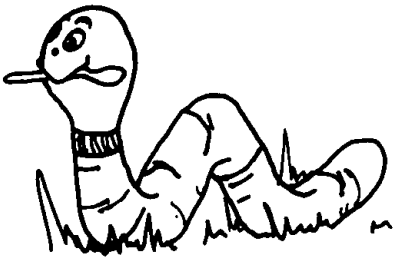
6. Have the students make a pie-graph depicting the portion of land used to grow our food versus all the other areas of the world such as water or land regions. (Refer to Answer Key A).

Additional Activities:

1. Invite a local soil conservation person into your classroom to discuss what special things are being done to save the soil.

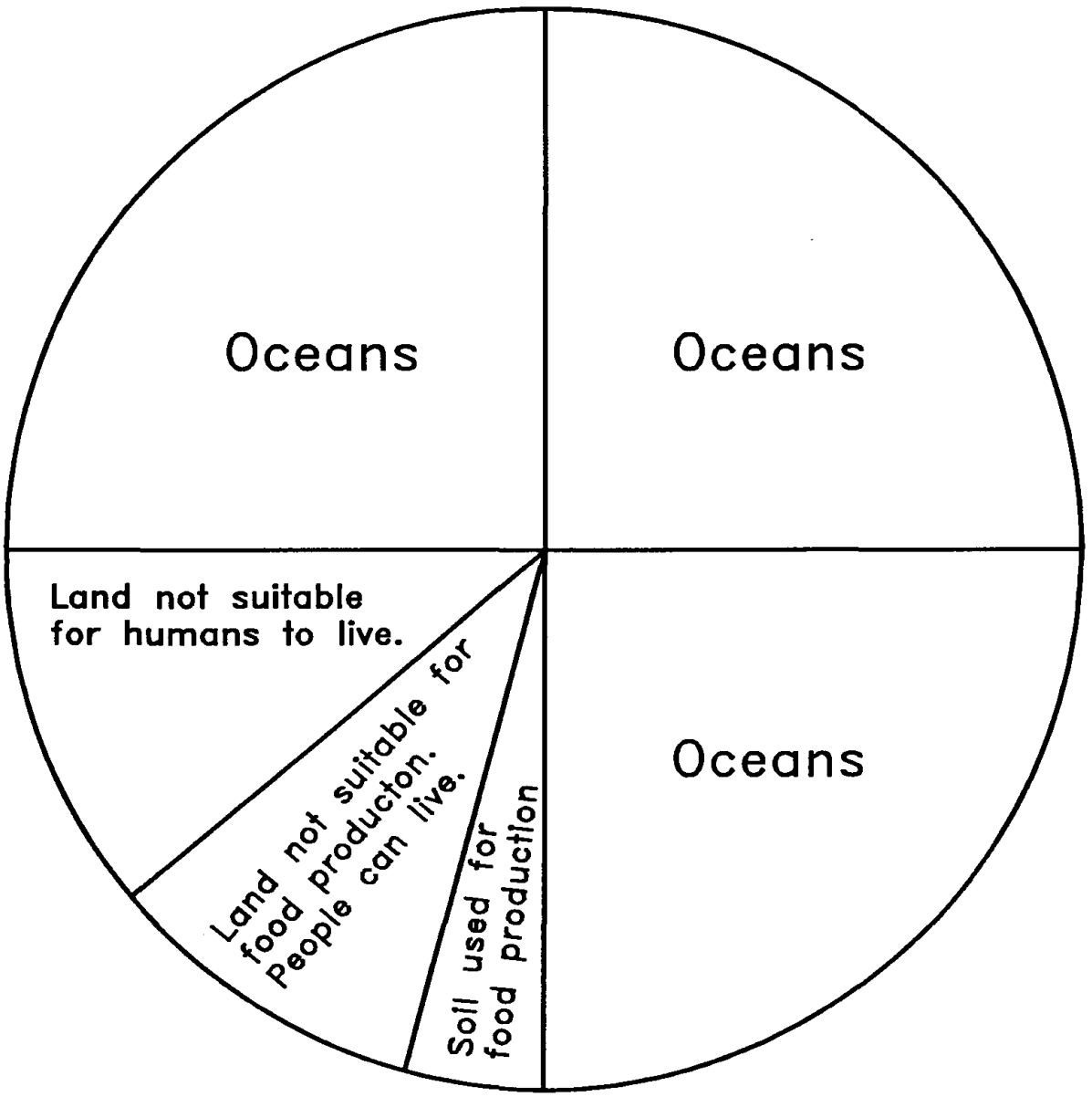
Adapted From:

1. Protecting Agricultural Land, Minnesota's Ag-Stravaganza
2. The Growing Classroom
3. Nebraska's Ag in the Classroom Learning Activities Notebook



Getting to the Core

Areas of the Earth's Surface



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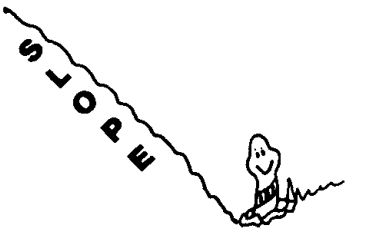
Activity 6
Soil Conservation
Slope



Subject Area: Math

Objective: 1. The student will determine slope of a hill side.

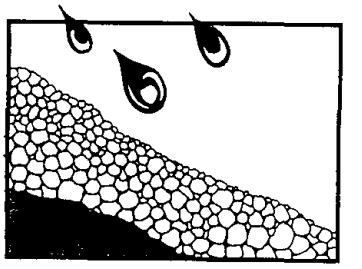
Suggested Grade Level: 5-6

Background: To conserve their soil, farmers figure the slope of their land. They then decide on a conservation practice to protect their soil from erosion. The greater the slope, the greater the chances of water erosion. This is because the degree of erosion caused by water is determined by **how fast** the water is traveling. The key to controlling water erosion is **slowing it down.** As water runs down the side of a hill, the faster it flows, the more soil it will take with it. Therefore, the greater the slope, the greater the potential for soil erosion. Terraces are often recommended as erosion control practice for fields with a slope over 3%.

$$\% \text{ Slope} = \frac{\text{Vertical Drop in 100"}}{100} \times 100$$

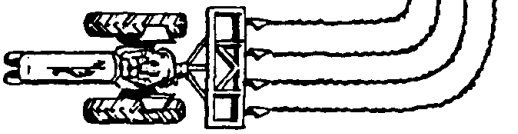
*Example: $\frac{7"}{100} \times 100 = 7\%$ slope

* Usually done in feet.



Materials:
1. 2 small flags or stakes
2. 100" piece of string
3. Jar of water or a level
4. Yardstick

Procedure:
1. Select a place that represents the average slope of the land being studied or take several measurements and average them.
2. Place one end of a 100" string on the slope you want to measure. Pull tight and hold outright to level.



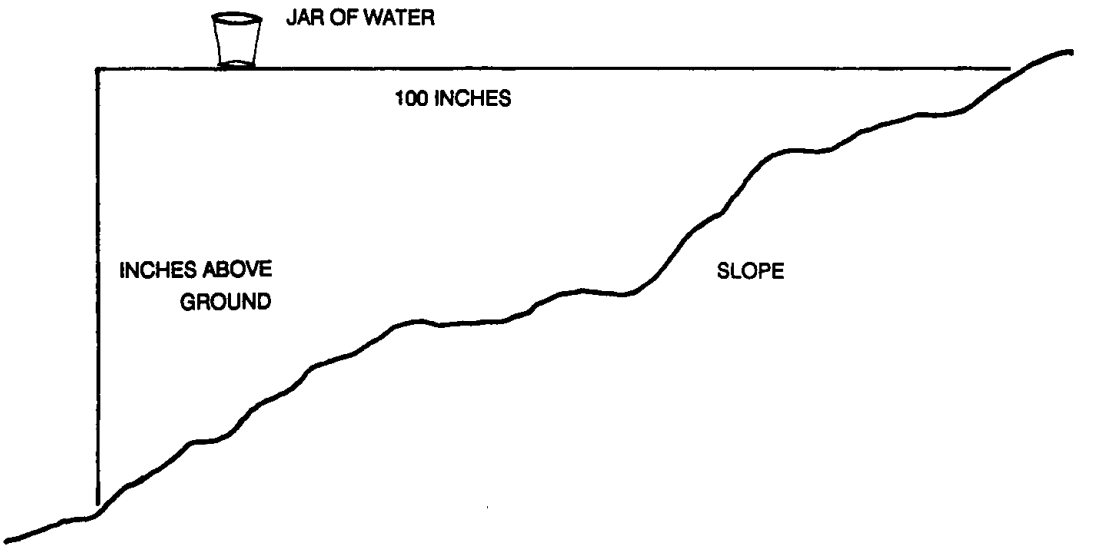
3. To be sure your string is level, hold a level or jar with some liquid in it on the outright string. Raise or lower the string until level.

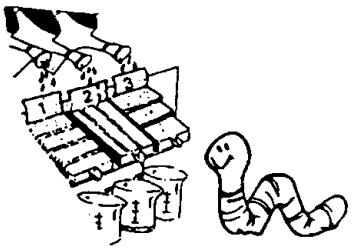
4. Measure the number of inches the free end of the string is off the ground.

5. The number of inches is the slope of the land in percent. (7" = 7%) If you use a different length string, then correct by using the conversion table below.

Conversion Table

Length	No. inches the end of the string is above the ground	Multiply by converision factor = % slope		
100"	_____	X	1	=
50"	_____	X	2	=
25"	_____	X	4	=





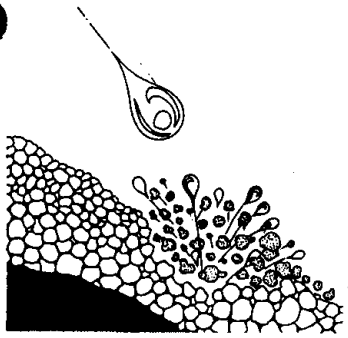
Activity 7
Soil Conservation
Contouring

Subject Area: Science

Objectives:
1. The students will demonstrate how contour farming reduces erosion and will be aware of other techniques used to conserve the soil.
2. The students will realize and explore the value of terracing as a land-management technique.

Suggested Grade Level: 5-6

Background: Rainfall is dispersed in two ways: By absorption into the ground or by runoff on the surface. The amount of rain that soaks in or runs off is determined by the intensity of the rainfall, slope of the land, character of the local soils and rocks, and kind and amount of vegetation. Hard, severe rains produce much runoff. Steep slopes, especially those bare of vegetation, accelerate the runoff even more.

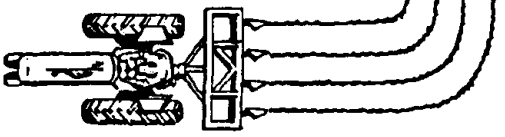


Whenever rain falls faster than it can soak in, a sheet of water collects on the surface and moves downhill. The rain dislodges soil and keeps it suspended in the moving sheet of water or feeds it into little streams along crop rows.

If water in the little streams moves fast enough, it dislodges soil and carries it along with that splashed up by raindrops. This scouring action carves out channels that join farther down the slope. As channels become large, they are called gullies. Heavy rainfall, erodible soil, sloping land, soil that absorbs water slowly and poorly managed vegetative cover contribute to gully erosion.

Erosion is slowed when soil is covered with grass and other plants. When farmers plow a field that has a gentle slope, erosion from running water may be 120 times greater than on the same slope covered with grass. Many farmers are discovering that they can plant a new crop without plowing the field first. They use a practice called conservation tillage. Seeds are planted in the soil under stubble and residue from the old crop. The old vegetation holds the soil in place even during heavy rains.

If the farmer plants grass in places where gullies might form, water flows through these grassy paths, called waterways, without carrying the soil with it.



Erosion is of great concern to humans because it may remove the fertile topsoil and threaten production of our food supply. It is important that we recognize the erosion processes and have a knowledge of what is called conservation tillage. With this method, farmers leave the residue of last years crop on the field, instead of plowing it into the soil. The crop stubble helps hold soil in place and catches water, allowing it to soak into the ground instead of running off. Each year new seeds are planted in the past years stubble. Less tilling is needed saving the farmer fuel and money and helping to save the soil structure.

Farmers avoid letting water concentrate and run directly downhill carrying soil with it. They construct terraces or hills that run around a hill, with gentle grades to carry the runoff water around the hill at slow speeds. These terraces should empty onto grassed waterways or on meadowland to prevent creation of gullies. The grades are gentle enough that a farmer can still plant on the terraces. The farmers also plant crops and till the soil along the contours or across hills, not up and down hills.

Materials:

1. Shoe boxes - trimmed to five centimeters deep, v-notched on one end, and lined with (plastic should extend several centimeters beyond notched end)
2. Sprinkling cans
3. Measuring cups
4. Soil
5. Water
6. Ruler

Procedure:

1. Divide the class into three groups and distribute the materials. Each group will follow these instructions to prepare their box of soil:
   Group 1. Fill box with moist soil and using your finger make packed furrows across the slope (contouring);
   Group 2. Fill box with moist soil and using your finger make furrows up and down the slope;
   Group 3. Fill box with soil and using a ruler make ridges across the slope to simulate the terracing of a hill.

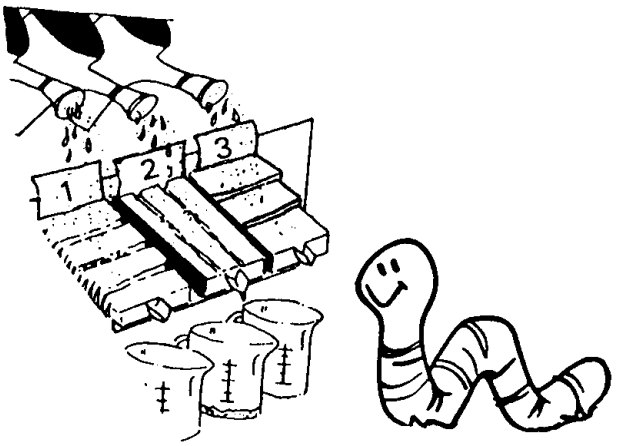
2. Line up each group's box on an incline, and place measuring cups beneath the v-notches to catch the water that drains off (close enough to prevent splashing).

3. Have one student from each group simultaneously sprinkle a measured amount of water from about thirty centimeters (twelve inches) above each box. Pour steadily for five seconds.

4. Record how long water continues to flow out of the v-notch. Let the water in the jars settle and measure the sediment in each.

5. Discuss which box lost the most soil. Which methods were most effective in controlling erosion in this experiment? What other methods might help conserve the soil? (i.e. stripcropping and conservation tillage)

Adapted From: Soil: We Can't Grow Without It



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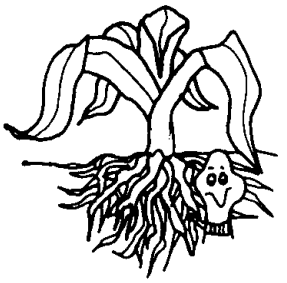
Activity 8
Soil Conservation
Soil Roots



Subject Area: Science

Objectives:
1. The student will investigate the soil holding quality of roots.
2. The student will understand how roots help fight erosion.

Suggested Grade Level: 5-6

Background: Organic matter, and plant roots, allows water to enter the soil rapidly and helps to hold the water, thereby decreasing the amount of water that runs off the surface. Organic matter improves aeration, especially in the finer textured soils, makes the soil easier to work and adds nutrients for plants such as nitrogen which is needed by growing plants. During heavy rains, the binding effect of organic matter and plant roots help hold the soil particles together so that they are not loosened and moved by water.

Materials:
1. Clump of sod consisting of well-compacted grass roots and soil
2. Clump of hard soil containing few or no roots
3. Two large glass containers of water
4. Two screen strainers or chicken wire

Procedure:

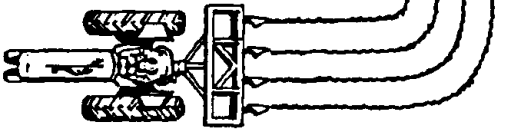
* Only one laboratory demonstration needs to be set up for the whole class to observe, although more can be set up if desired. It takes days to do the observing so other lessons can go on while the class glances from time to time at the experiment to see how the dissolving process is getting on.

1. Set up two large-mouth glass containers (gallon jars or equivalent).

2. Hang a large-mesh strainer from the rim into each jar. An alternative is to press a piece of chicken wire down into the jar to form a basket below the rim.

3. Fill both jars with water to the brim.

4. The most difficult part of this experiment is obtaining suitable clumps of soil. One must be a chunk of well-compacted lawn having roots of grass firmly knit into the sod. Select a size to fit in the top of the glass jar. The other must be a lump of soil containing few or no roots. Compacted



playground clay is good. It should be dug up with a shovel to obtain one small but whole, solid piece. Loose soil packed together by hand is not a natural clump and does not give a valid comparison.

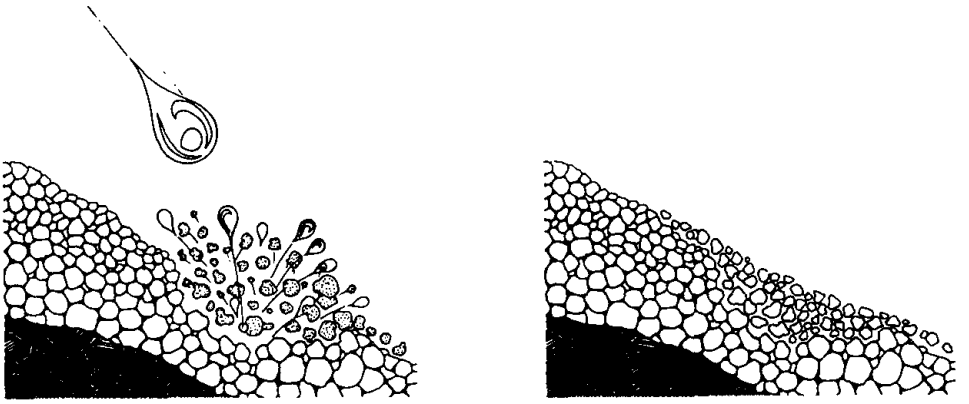
5. Lower the two clods very carefully, one into each jar, bringing them to rest on the screen cradles. Make sure water covers at least most of the clumps.

   DO NOT SHAKE OR DISTURB THE JARS AT ANY TIME

6. Have students observe and record how long it takes soil from both clumps to dissolve in water. Rootless clay usually begins to disintegrate within ten minutes. Within hours, water under the rootless clump is usually opaque. The grass clod holds together much better and the water beneath remains relatively clear. A well-knit grass clod can hold together for days before gradually dissolving. Consider the effects in nature of the tendency of roots and soil particles. Besides ideas put forth by the students, discussion can be directed to include a consideration of roots, especially fibrous (grass) roots, as soil holders on hillsides.

7. As a classtime excursion, take a walk around the schoolyard and look at areas at the bottoms of slopes or slanting ground. Is there evidence of soil being washed down to a lower level? Sometimes a "fan" of mud settles at the base of a hillside rivulet after a heavy rain. What kind of groundcover, if any, grows on such hillsides or slopes? Look for effects at the bottoms of both grassy and bare slopes. The washing downhill of top soil is called **soil erosion.**

8. Ask the following questions: If you had a slope or hillside next to your house, would you cover the soil? If so, with what? Cement? Stone masonry? Grass? Bushes? Vines? What do most people seem to do?



Activity 9
Soil Conservation
Who's Responsibility

Subject Area: Social Studies, Language Arts, Science

Objectives:
1. The students will understand how two communities operate and plan for their future, by role playing.
2. The students will understand and demonstrate the importance of protecting agricultural land, by giving a presentation on how they would use the given area of land.

Suggested Grade Level: 5-6

Background: In this simulation, students interact with each other in the decision-making process.

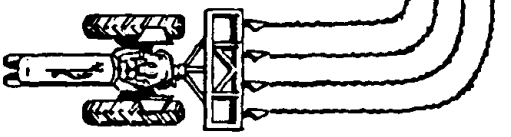
Where there is a planning commission, land is designated for use through zoning. The zones include: agricultural, forestry, recreation, residential, lakeshore, industrial, commercial, flood plain, and special purpose (airports, parks, etc.).

A planning commission, through public hearings, can recommend to a higher authority, usually a Board of County Commissioners or a City Council, to change or maintain a zoning ordinance for a specific piece of land.

Work Plan of a Planning Commission:
1. Identify problems.
2. Listing the goals.
3. Preparing work tasks.

Since the function of a planning commission is to make recommendations, interested parties can meet with the planning commission to present their case and try to influence a decision. A planning commission can recommend to change or maintain the zoning ordinance for a specific piece of land if they feel it is in the best interest of the community.

Soil is basic to all life. Soil may be considered a factory where everything is made to feed plants, animals and human beings. It is our main source of food supply because it supports and nourishes the plants we eat. All animals, including ourselves, depend upon plants. Plants depend upon soil. Only lichen



and primitive plants such as silver sword in Hawaii, can get nutrition directly from rock without soil.

Soil helps protect us from cold, heat and rain. Bricks and concrete for our homes are made from soil, and lumber is made from trees that grow in soil.

Our clothing originates with the soil. Clothes come from wool, flax, cotton, silk, leather, or synthetics. Synthetics are made from petroleum. All these products depend in some way upon soil. Soil grows the plants that sheep eat; flax and cotton are plants; silk comes from silkworms and leather comes from livestock that live on plants; and our petroleum, which also originates from plants, comes from deep within the earth.

Although soil has many uses, it's most important use is in helping plants grow. Plants mean food, shelter and clothing, a support system human beings cannot live without. But plants cannot contain adequate minerals if they aren't in the soil, and animals suffer from lack of minerals when fed such forage.

Activity Sheets 4 and 5 provide some information on land use in Nebraska.

Materials:

1. Activity sheets 1-3

Procedure:

1. Write LAND USE across the chalkboard and ask for a definition.

2. Distribute Activity Sheet 1, "Centerplace City Land Use Problem."

3. After they have read the case study, ask them to list the possible uses of the land on Activity Sheet 1.

   - Who would want this land?
   - What would they do with the land?
   - What might be some concerns the owner would have about the land? (good price, pollution, neighbors, zoning)
   - Who should be responsible for determining the best use of the land? (owner, buyer, government, neighbors, all tax payers)

4. Using the background information, introduce the function of a planning commission.

5. Bring in a member of your local planning commission to discuss the process the commission goes thru (optional).

6. Prepare for role-playing by dividing the class into groups (4-6 students).

7. Designate one group as the planning commission. Tell them they will be responsible to hear presentations and decide upon the best one. The planning commission should first review the problems and goals of Centerplace (as set up in class), and write up a list of questions to ask prospective land buyers. They should then:
   a. Develop the criteria they will use in evaluating the proposals.
   b. Develop a system to record and evaluate their assessment of each presentation. (Activity Sheet 2 "Planning Commission" will aid in these activities).

8. Assign the other groups to one of the land use citizen's group. (One group could represent a nuclear power plant, one group could represent a farmer*, one group could represent a shopping mall owner, etc.)
   *The farmer would want to maintain the present zoning ordinance for agricultural use.

9. To these groups, pass out Activity Sheet 3, "Presentation Preparation." Have the students list and analyze the advantages and disadvantages for their proposed land use. (Allow about 10 minutes.)

10. After compiling a list, each groups task is to develop a three minute presentation for the planning commission. They should include:
    a. reasons for wanting the land
    b. how it would benefit the community
    c. the price they would pay
    (Remind them to consider such things as proper use of land, sewage, water, electricity, health, safety, taxes, economics, needs of the community, roads, etc.) More than one person in each group must participate in making the presentation.

11. When all groups are ready, have the planning commission sit at the front. Appoint a time- keeper.

12. While the planning commission is meeting, the class could develop a list of criteria which they think should be used by the commission in making their decision.

13. After deliberating, the planning commission should read their criteria aloud and announce their **decision** as to what recommendation will be given to the Board of County Commissioners. Their **reasons** for the decision should also be given.

Follow-up Discussion Questions

1. What additional information would you like to have had for planning your group's presentation? List on the board (e.g., topography, vegetation, economy of area, railroad, shopping center, adjacent land, climate, soil survey, historical information, flood plain, wildlife, interest of Board of County Commissioners, money available, educational needs, regulations by State, political climate).

2. Where would you go to collect information on these topic? Point out to the group that this is one of the most important parts of the activity, because it emphasizes that we need a variety of information and data before we can intelligently make a land management or environmental decision to BEST meet the needs of people and their environment.

Optional Follow-Up Discussion Questions

1. Did new leadership emerge during this session? What factors enabled this to happen?

2. Did your group work as a team? What did your group do to insure participation by all members of the group?

3. Were you assigned to a group or interest you didn't want to represent? How did you feel? Point out that many times we overlook that other people have different needs and ideas and this might be a way to identify them.

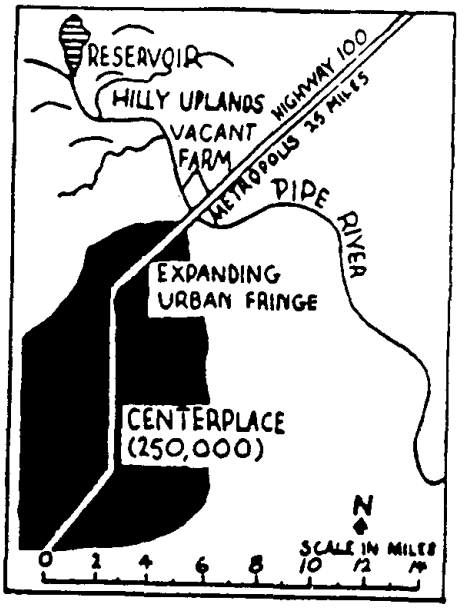
Adapted From:

1. Protecting Agricultural Land
   Minnesota's Ag-Stravaganza

Centerplace City
Land Use Problem

Case Study

160 acres of unused county farmland, four miles northeast of the city is expected to be sold soon. Some of the interested buyers have indicated their desire to use the land for a purpose other than agriculture. The land is presently zoned for agricultural use. The current price for prime farmland is $2,000.00 an acre.



Background Information Sheet: Centerplace City

The population is 250,000 and rapidly increasing.

The city's boundaries are being extended, but the suburban fringe is expanding even more rapidly.

The rapid population growth is accompanied by demands for more housing, more jobs, additional city services and recreational areas.

The power for industrial uses, adequate public trasprotation and a skilled labor force are available.

The city is located near forests, which are to the north.

The land to the east is devoted mainly to farming.

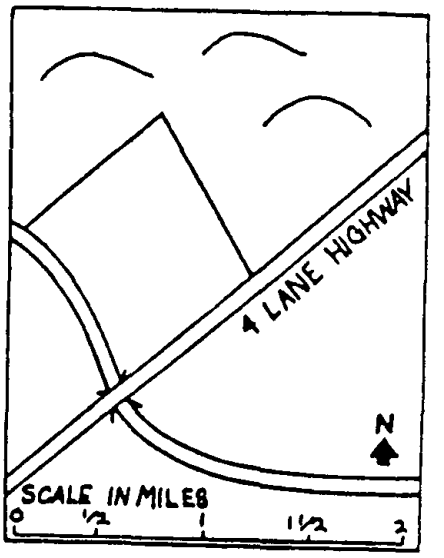
The Pipe River is unpolluted and is the source of irrigation water as well as the municipal water supply.

The river is too small for freight transportation, but logs could be floated on it. The gravel bed of the river is appropriate new material for concrete manufacture.

The present sewage treatment plant and garbage disposal area are at maximum capacity.

The citizens of Centerplace are concerned about the maintenance of a scenic regional environment.

The board of County Commissioners is the authority for land zoning, and many citizen's groups are developing to influence zoning decisions.



List possible uses of the land below:

_____	_____
_____	_____
_____	_____

Adapted from: Minnesota's Ag-Stravaganza

Activity Sheet 1

Planning Commission

Case Study

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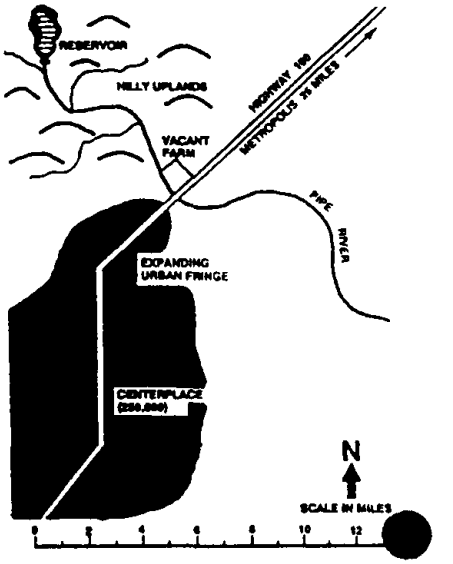


Group making presentation (use category)	Criteria to assess presentation rating					
	1	2	3	4	5	6

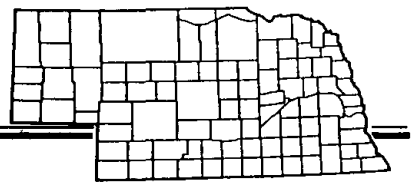
Elect a chairperson to preside during the group presentaions and to run the meeting in an orderly manner. (5 minutes)

Announcements to be made by the chairperson.

- –Because of time constraints there will be no rebuttal after presentations.
- –The Board may ask 2 or 3 clarifying questions of each group after the presentations.
- –You have 3 minutes to give your presentation. You will be given a warning when you have 1 minute left, by our time.

Adapted from: Minnesota's Ag-Stravaganza

Presentation Preperation



Learner Objective:
Students will be able to discover the need for trade-offs in using land and identify the need for zoning procedures to protect agricultural land.

Assigned Category of Land Use:	
Advantages to Land and Community	**Disadvantages to Land and Community**

Now, as a group, develop a 3 minute presentation to the Planning Commission.

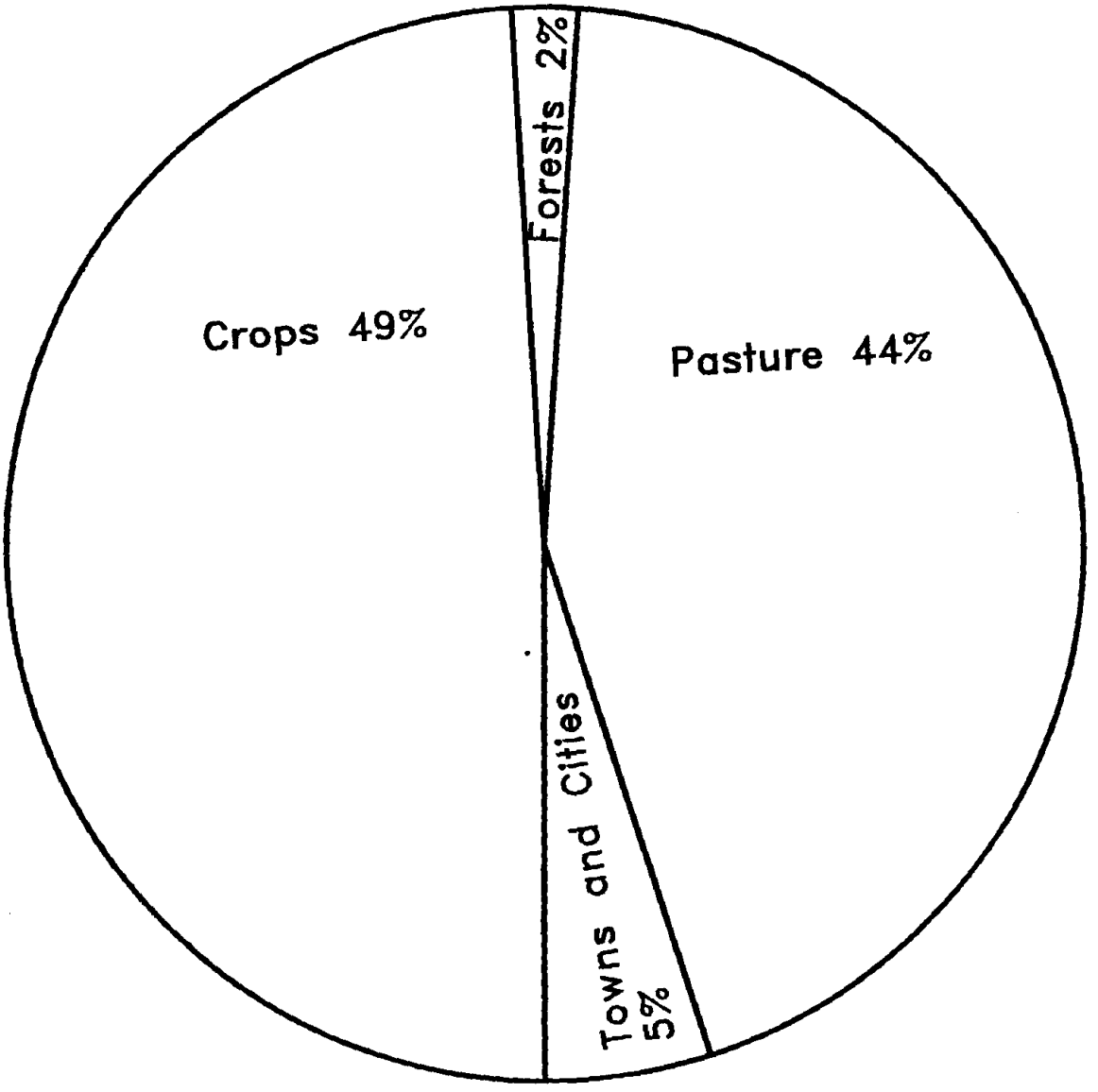
Include:

1. Reasons for wanting the land.
2. How it would benefit the community.
3. What price you would pay.

Consider such things as proper use of the land, sewage, water, electricty, health, safety, taxes, economics, community needs, roads etc., as you prepare your presentation.

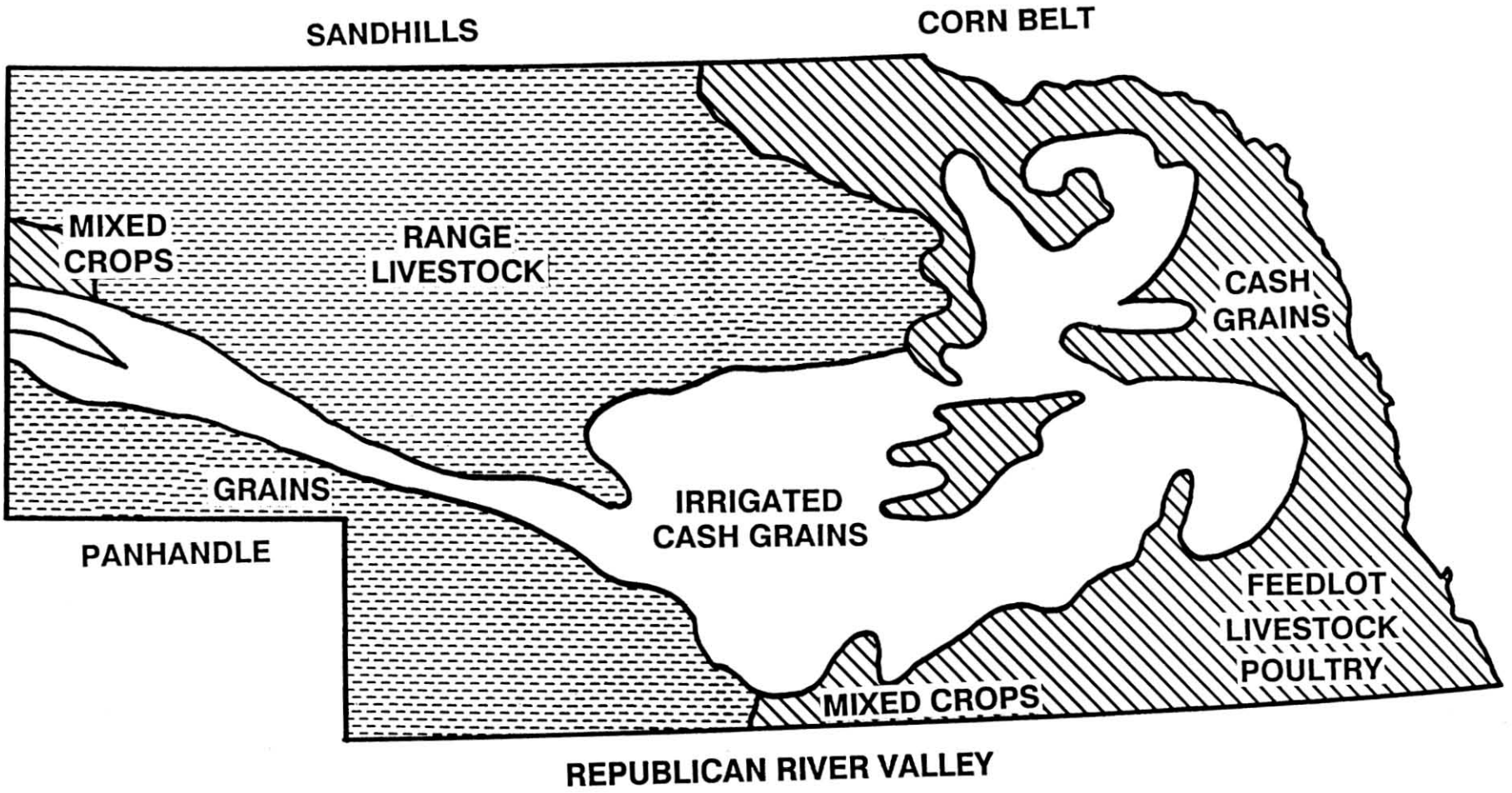
*More than one person in each group must participate in making the presentation.

Nebraskans Use Their Land



Activity Sheet 4

Nebraska's Farming Regions



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Activity 10
Plant Conservation
The Flower

Subject Area: Science

Objectives:
1. The students will identify the parts of a flower.
2. The students will name the parts of the flower and their role in reproduction.

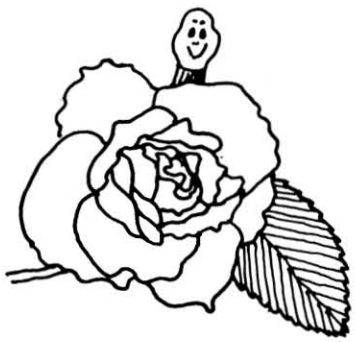
Suggested Grade Level: 5-6

Background: The parts of the flower and their roles are described in the procedure.

Materials:
1. A variety of fresh flowers
2. Activity Sheet 1

Procedure:
1. Discuss with students the parts of the flower, pointing them out on the Activity Sheet. Parts of a flower are somewhat different from plant to plant. Many flowers consist of:

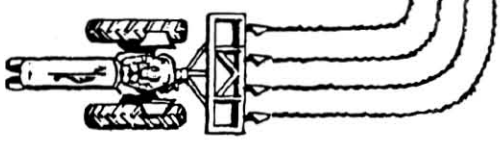
   a. Petals - that form the flower
   b. Filament - that supports the anther
   c. Anther - where pollen is produced
   d. Stigma - pollen is received by the stigma
   e. Style - pollen passes through the style to the ovary
   f. Ovary - where the seed develops



Some plants have separate male and female flowers. Others have male and female flowers on different plants. Pollen is produced on the anther of the flower. This pollen is transferred to the stigma by wind, insects (bees) or close contact. It germinates and sends a tube down the style to the ovules (female). Here fertilization takes place and seeds develop in the ovary.

2. In pairs, have students examine different fresh flowers to identify the parts discussed earlier. Look for pollen on the stamen.

3. After all students have examined the flowers, cut open the pistil and observe the seeds that are forming.

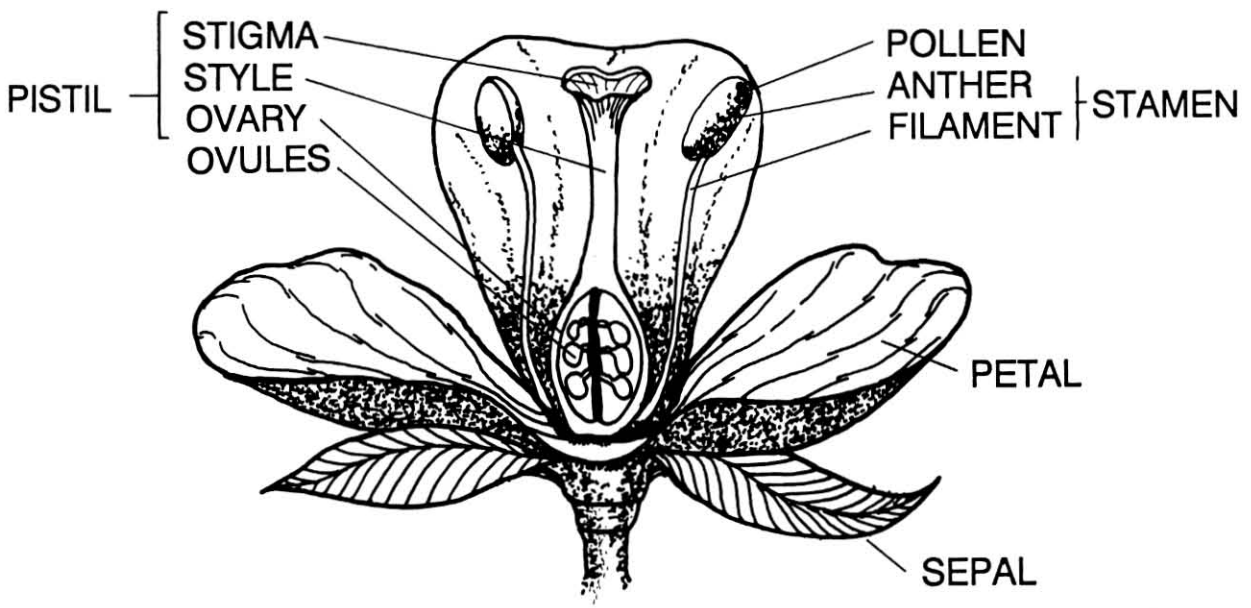


Additional Activity:

1. Press mount and label the different parts of one or more flowers.

Adapted From:

1. Exploring the World of Plants and Soils
   Plant and Soil 4-H Members Manual



A COMPLETE FLOWER

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Activity 11
Plant Conservation
Plant Crosses

Subject Area: Science

Objective: 1. The students will be able to understand how plants reproduce from an imperfect flower.

Suggested Grade Level: 5-6

Background: Every plant has a group of features that make up its "personality". Some are desirable, some undesirable. These characteristics include yield capacity, disease and insect resistance, early or late maturity, tall or short stem, color of flower or fruit, and others. The plant breeder selects a plant with as many desirable characteristics as possible. He then fertilizes the female flower with pollen from another plant having a specific needed quality. This might be a high-yielding plant crossed with a disease resistant plant to combine the good features of both.

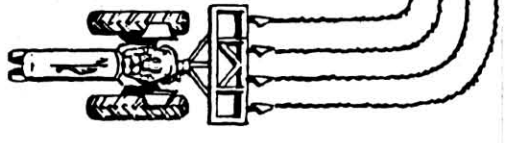
Parts of a flower are somewhat different from plant to plant. Many flowers consist of:

1. Petals - that form the flower
2. Filament - that supports the anther
3. Anther - where the pollen is produced
4. Stigma - part that receives the pollen
5. Style - pollen passes through the tube like style to the ovary
6. Ovary - where the seed develops

Plants differ with respect to their reproductive parts, such as:

1. Male and female parts in the same flower (perfect flower).
2. Male flowers and female flowers on the same plants (imperfect flowers)
3. Only male flowers on one plant and only female on another (imperfect flowers)

How are seeds produced? Pollen (male) is produced in the anther and is transferred to the stigma (female) by wind, insects (bees) or contact. In controlled plant breeding, pollination is done by hand. The pollen germinates



and sends a tube down the style to the ovules. Here fertilization takes place and seeds develop in the ovary.

Materials:

1. Two varieties of cucumber seeds; one white- spined fruit and one with black-spined fruit. Some suggestions are:

Black-spined fruit	White-spined fruit
Burpee Pickler	A and C
Chicago Pickling	Ashley
National Pickling	Marketer
Ohio MR 17	Model

2. Four containers for growing; 10" or 12" clay pots, gallon cans or boxes, (be sure it has drainage holes).
3. Gravel
4. Potting soil
5. Fertilizer; 8-8-8 or 10-10-10 (1 tablespoon)
6. Water
7. Trays or plates
8. Four jars
9. Paper bags
10. Knife
11. Spoon
12. Plastic glasses
13. Twist ties or pipe cleaners

Procedure:

1. Select two varieties of cucumber seeds, one with white-spined fruit and one with black- spined fruit as suggested in Materials. Label the black-spined variety parent #1 and the white-spined variety parent #2.

2. Label two pots parent #1 and two pots parent #2. Add a layer of gravel in the bottom of each pot.

3. In a large tray or box, mix one tablespoon fertilizer with enough soil for all four pots. Moisten the soil.

4. Fill each pot with the moistened soil, 1/2" from the top. Press lightly with your hand.

5. Make two furrows with your finger in a "X" shape, 1/4" deep. Plant the correct seeds in the correct pot, 1" apart. Cover with loose, damp soil and firm lightly. Store the leftover seeds in a sealed jar in a cool place. You can use them in the next activity "Selfing".

6. Set pots in trays or plates to catch drainage water. Slowly add water until it begins to drip from the bottom of the pot.

7. To germinate the seeds, set pots in a place where the temperature holds near 70 to 75 degrees day and night.

8. After the seeds sprout, set the pots in a south or west window, if possible. The ideal place is one with full sunlight, day temperature of 70-75 degrees and night temperature of 60-65 degrees.

9. Check plants daily. Water as needed to keep soil damp but not wet.

10. When the first pair of true leaves appear (after the cotyledons), thin to one strong plant per pot.

11. Watch for flowers 6-8 weeks after planting. The first are usually the male flowers. Watch closely for the first female flowers. Remember the male flower has only the stamen and the female flower has only the pistil.

12. To prevent unwanted crossing seal a few female flowers the day before they open, by holding the petals closed, near the tip, with "twist- em"or pipe cleaners. Be careful, do not damage the stigma. In the same manner seal several male flowers at the same stage of development.

13. Pollinate the female flower the day it would normally have fully opened (expanded like a balloon), if it had not been held shut. To do this:
    a. Take a sealed male flower at the same stage from a plant chosen for the male parent from pot 2.
    b. Carefully pinch off the yellow petals of the male flower that surrounds the stamens.
    c. Expose the stigma by carefully removing the "twist-ems" of pipe cleaner from the female flower from pot 1.
    d. Brush the stigma of the female flower gently with the anthers leaving some pollen grains.
    e. Reseal the female flower using the "twist- ems"or pipe cleaner. Attach a small tag to its stem, showing the date and the parents thus: 1x2 - 5/27. Always list the female parent first.

14. Make crosses in both directions (1x2) and (2x1). Note: When the flower's petals dry, they will fall off with the "twist-ems" or pipe cleaner.

15. Remove the tagged fruit (cucumber) when it has fully matured (turned deep orange or yellow - approximately 5 weeks). Place the fruit and the

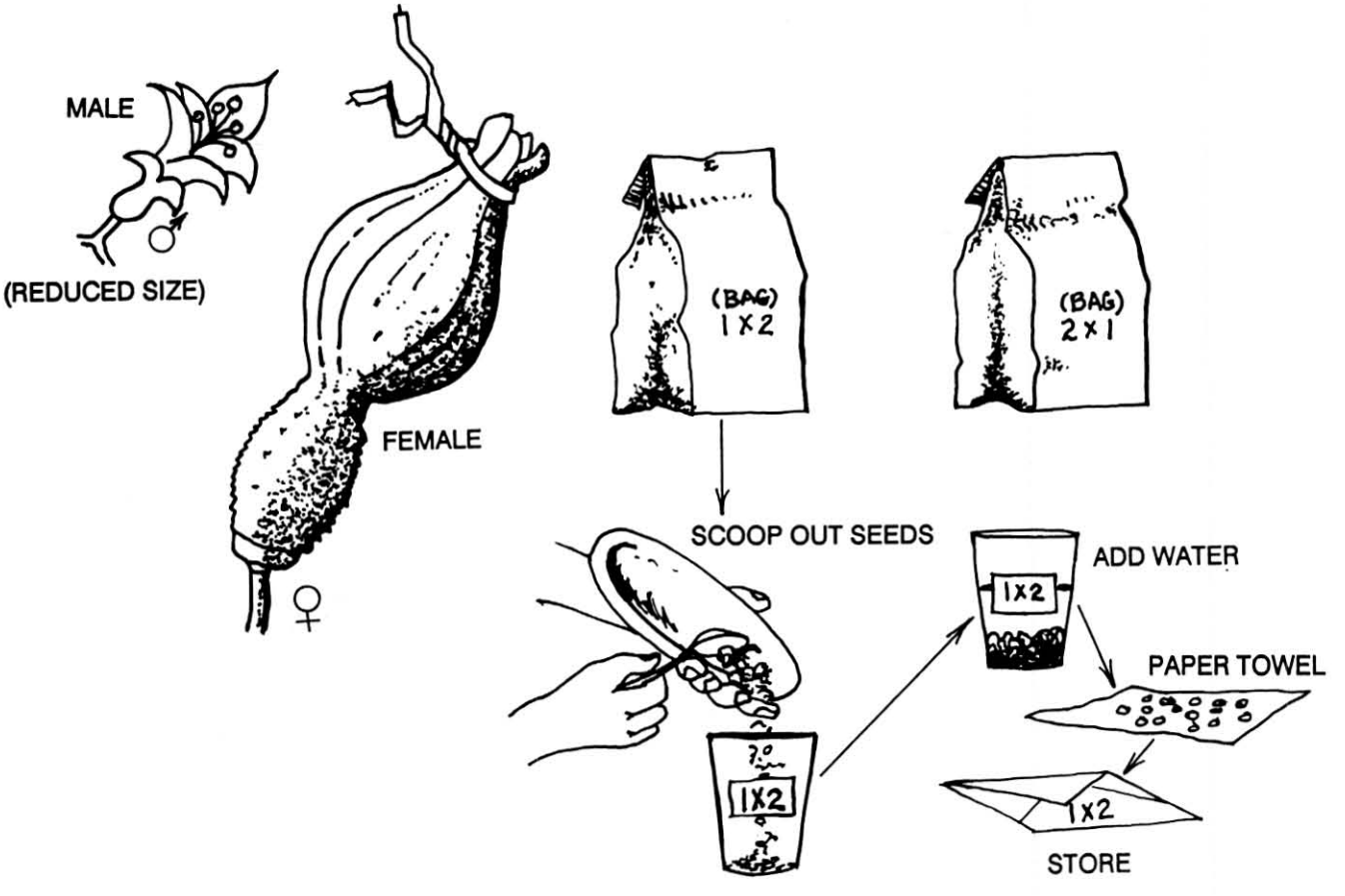
tag in a paper bag. Keep each fruit in a separate bag. Note the color of the fruits and write it down.

16. About 2 weeks after harvesting, cut the fruit lengthwise -one at a time - and scoop out the seeds. Put seeds from each cucumber in a separate glass. Be sure to keep the label with the seeds - tape it to the glass. Fill the glass half full of water - allow to ferment for one day. Pour off the water and pulp. Place the seeds on a paper towel and allow to dry thoroughly. Put the seeds from each cucumber in a separate envelope and label it like the tag. You now have cucumber crosses.

17. Discuss what has happened.

Adapted From:

1. Plant Reproduction
   4-H Members Manual



Activity 12
Plant Conservation
Selfing

Subject Area: Science

Objectives:
1. The students will be able to define "selfing".
2. The students will be introduced to dominate and recessive genes.

Suggested Grade Level: 5-6

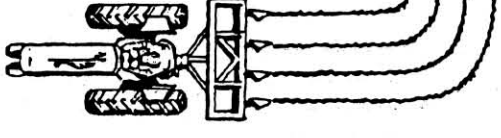
Background: Gene - The element that transmits characteristics of parent to offspring. In people, animals and plants, genes are present. Some genes are dominant and some are recessive. For example in people, brown eyes might be more dominant than green eyes. so when a parent with brown eyes and a parent with green eyes has an offspring together it is more probable the child will have brown eyes, because brown eye color is a trait with dominant genes and green eye color is a trait with recessive genes. In this activity, students will cross cucumber plants to discover what spine color is dominant.

Materials:
1. Seeds from Activity "Plant Crosses"
2. Four pots from Activity "Plant Crosses" with Parent 1 and Parent 2 plants still growing in them. Be sure they are labeled as such.
3. Four pots, 10" or 12" clay pots, gallon cans or boxes. (Be sure it has drainage holes).
4. Gravel
5. Potting soil
6. Fertilizer;8-8-8 or 10-10-10 (1 tablespoon)
7. Water
8. Trays or plates

Procedure:
1. Label the four empty pots. Two of the pots should be labeled Parent 1x2 and two pots should be labeled Parent 2x1. Now you should have eight pots. Four pots should already have a plant growing in them. Two of these are labeled Parent 1 and two are labeled Parent 2.

2. To prepare the four empty pots, place gravel in the bottom of each.

3. In a large tray or box, mix one tablespoon fertilizer with enough soil for all four pots. Moisten the soil.



4. Fill each pot with the moistened soil, 1/2" from the top. Press lightly with your hand.

5. Make two furrows with your finger in an "X" shape, 1/4" deep. Plant the correct seeds in the correct pot, 1" apart. Cover with loose, damp soil.

6. Set pots in trays or plates to catch drainage water. Slowly add water until it begins to drip from the bottom of the pot.

7. To germinate the seeds, set pots in a place where the temperature holds near 70 to 75 degrees day and night.

8. After the seeds sprout, set the pots in a south or west window, if possible. The ideal place is one with full sunlight, day temperature of 70 - 75 degrees and night temperature of 60 to 65 degrees.

9. Check plants daily. Water as needed to keep soil damp but not wet.

10. When the first pair of true leaves appear (after the cotyledons), thin to one strong plant per pot.

11. Watch for flowers 6-8 weeks after planting. The first are usually the male flowers. Watch closely for the first female flowers. Remember the male flower has only the stamen and the female flower has only the pistil.

12. To prevent unwanted crossing seal a few female flowers the day before they open, by holding the petals closed, near the tip, with "twist- ems" or pieces of pipe cleaners. Be careful. Do not damage the stigma. In the same manner seal several male flowers at the same stage of development.

13. Pollinate the female flower the day it would normally have fully opened (expanded like a balloon), if it had not been held shut.

    To do this:
    a. Take a sealed male flower at the same stage from a plant chosen for the male parent.
    b. Carefully pinch off the yellow petals of the male flower that surround the stamens.
    c. Expose the stigma by carefully removing the "twist-ems" or pipe cleaner from the female flower of the same plant.
    d. Brush the stigma of the female flower gently with the anthers leaving some pollen grains.

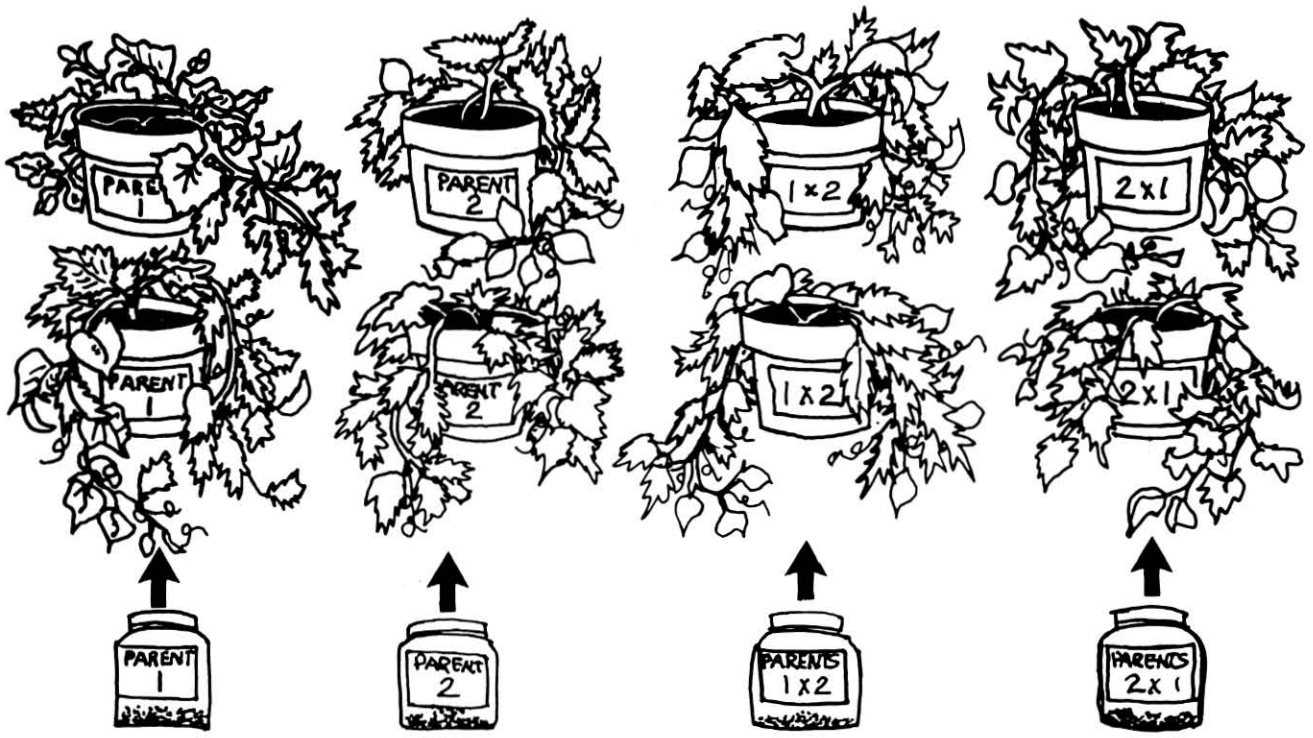
e. Reseal the female flower using the "twist- ems" or pipe cleaner. Attach a small tag to its stem, showing the date and the parents thus: "1x2 - 5/27". Always list the female parent first. This is called selfing.

14. Observe the plants (all eight pots together). When fruit appears record the following information: Record the pot number and the color of spines for each plant. Which color dominates? Note the color of the mature fruit. Were the color of the spines and color of the fruit related?

15. Discuss what happened and what was observed.

Adapted From:

1. Plant Reproduction
   4-H Members Manual



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Activity 13
Plant Conservation
"Propagation"

Subject Area: Science

Objectives:
1. The students will discover the effects of plant populations by growing plants under different conditions.
2. The students will determine if plants can adapt to their environment in a new situation.

Suggested Grade Level: 5-6

Materials:
1. Several small containers (paper cups work well)
2. Potting soil
3. Radish seeds
4. Journal

Procedure:

1. Assemble students in a **close** bunch. (sitting preferred)

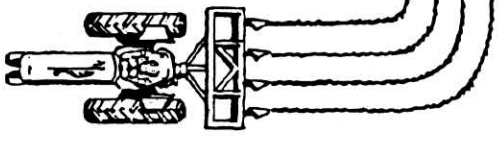
2. Read or explain the following:

"How much room do you need to live? If you grew up in a room 3 feet high by 3 feet wide, do you think it would be easy for you to grow up to be a basketball player? Plants also need room to grow. Their roots need room to spread out and soak up nutrients and their leaves need room to spread out and soak up the sun. Let's learn how crowding affects their growth."

3. Divide class into small groups.

4. Have each group fill 5 containers with soil and number them 1 to 5. (can use more if desired)

5. Have them plant the following number of seeds in each container, equally spaced, at about 3/4" deep.
   - Pot 1: 2 seeds
   - Pot 2: 4 seeds
   - Pot 3: 8 seeds
   - Pot 4: 16 seeds
   - Pot 5: 32 seeds



6. Place pots in a sunny place , water each pot with the same amount of water. Observe them to see if radishes are growing better in some pots. Note if some are tall and spindly, stunted, yellow, etc. Have students write down observations of each pot every few days in a journal.

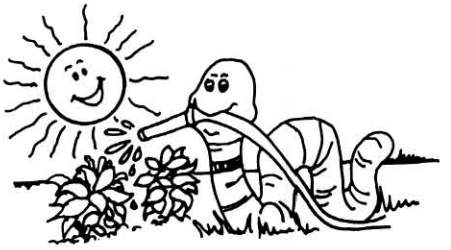
7. When radishes are fully grown, carefully pull them out of pots. Be sure to keep radishes with their original pot. Measure the length of each radish plant. Record information about which pot had the healthiest radishes.

8. Decide if crowding seemed to affect their growth.

9. Could these plants adapt to this situation?

Adapted From:

1. The Growing Classroom



Activity 14
Plant Conservation

Photosynthesis And Transpiration

Subject Area: Science

Objectives:
1. The students will be able to observe the effect of light on plants (photosynthesis).
2. The students will be able to illustrate the exchange of gases between the atmosphere and the plant.

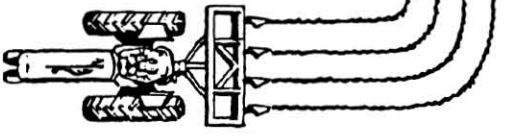
Suggested Grade Level: 5-6

Background: Life of all organisms (including people) depends on the unique ability of green plants to convert the sun's energy in to food. Photosynthesis is one of the most important chemical reactions on earth. We are totally dependent on plants for our food. No other living organism can make the sun's energy available to us as chemical energy. Photosynthesis takes place within the chloroplasts of plant cells. There the raw materials, water and carbon dioxide, are combined chemically in the presence of sunlight and chlorophyll. Some of the resulting sugar is immediately transported to other parts of the plant. Some of the sugar is changed to starch and stored temporarily in leaves. Oxygen is released into the air as a by-product of this process. The release of this oxygen is called respiration. We could neither breathe nor eat without green plants.

Materials:
1. Two or more six-inch pots with drainage holes
2. 20 or more soybean seeds or pea seeds
3. Potting soil
4. Sprinkling can or similar
5. Dark area (a large cardboard box or a cabinet that can remain closed for one week)
6. Glass bottle or jar
7. Paper, pencil and crayons

Procedure:
1. Divide the class into small groups. Each student will keep a log of their group's plant from germination of seedlings to the end of the experiment.

2. Germinate the seeds by placing them between moist paper towels in a tray. Place in indirect sunlight. The seeds should germinate within a few days. As soon as a "hook" appears, the seedlings are ready to plant.



3. Place potting soil in each pot. Leave 2 1/2 inches at the top. Place six to ten seedlings carefully on top of the soil and cover with 1/4 to 1/2 inch of soil.

4. Water the soil until well saturated (not flooded). Place one pot in a well lit place (direct sunlight if possible). Place the other pot in a dark area and leave it in complete darkness for one week to ten days.

5. After ten days, remove the pot from the dark area. Compare it with the seedlings that were grown in the light.

6. Discuss your findings and relate them to the concept of photosynthesis. Have the class make a drawing to illustrate the differences between the two sets of seedlings.

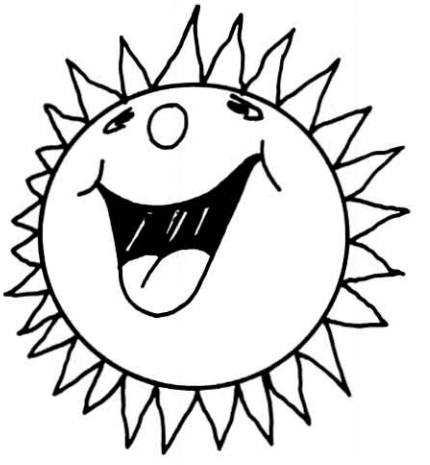
7. Place a glass jar over one of the pots and place it in the sunlight.

8. Notice the condensation that occurs on the inside of the bottle. The condensation is water vapor being given off by the plant when it exchanges oxygen for carbon dioxide (respiration).

Adapted From:

1. The Growing Classroom

2. Arizona Teachers Resource Guide for Environmental Education



Activity 15
Plant Conservation
Productive Plants

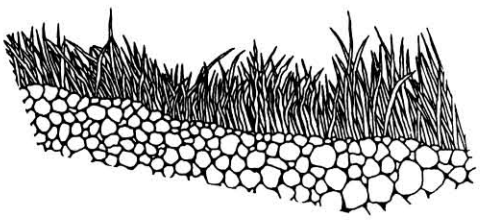
Subject Area: Science

Objectives:
1. The students will discover how removing leaf area from the plant will affect the plant's vigor and strength.
2. The students will recognize the importance of range management.

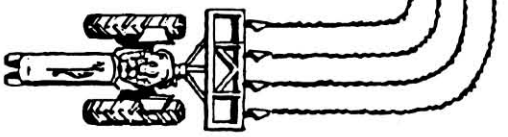
Suggested Grade Level: 5-6

Background: A productive rangeland has strong and vigorous plants which provide the greatest amount and best quality of forage possible for grazing. How range plants are used affect their strength and vigor. Plants which become weak are replaced by stronger plants. If the replacement plants are weeds or less desirable grasses, the rangeland becomes less productive. Plants make their own energy for growth through the process of photosynthesis. Sunlight is used by the plant in the green portion of the leaf to manufacture simple carbohydrates which can be stored and used the following year for regrowth. Plants low in reserve carbohydrates (stored foods) regrow slowly, yield less and may die if the plant is stressed. Low quality plants do not really "take over" a pasture. They replace more desirable plants that are weak or have died. Keeping desirable plants vigorous should be the aim of the range manager so as to have a productive range for the cattle and horses.

Materials: **This Activity Works Best If Done In The Spring.**
1. Six large flower pots or 1-gallon coffee cans (Be sure there are drainage holes)
2. Soil (a mixture of soil and sand)
3. Sudan grass seed - available at garden centers, grain elevators, and coop feed stores.
4. Scissors
5. Worksheet 1
6. Plant food



Procedure:
1. Divide the class into six groups.
2. Have each group manage one pot.



3. In each pot, plant the sudan grass. Label each pot according to the group number.

4. After plants have started, thin plants to six plants per pot. Be sure each pot receives equal sunlight, water and plant food.

5. After the plants reach six inches in height, make the following treatments for the next 12 weeks.
   Pot 1: clip to 2 inches - clip to this same height every two weeks.
   Pot 2: clip to 2 inches - clip to this same height every three weeks
   Pot 3: clip to 2 inches - clip to this same height every four weeks
   Pot 4: clip to the height of 6 inches every two weeks
   Pot 5: clip to the height of 6 inches every three weeks
   Pot 6: clip to the height of 6 inches every four weeks.
   Be sure the entire class is aware of the activities in the other groups.

6. Save the harvested material from each pot and allow it to air dry and then weigh each. Record on worksheet 1. You can have one sheet for the entire class or give each student a worksheet to record information, so that each student is aware of the progress of the experiment.

7. At the end of the 12 week period, clip all the plants at the surface, and compare the harvested material. Are there any differences at all?

8. Remove the plants from the pot, being careful not to damage the root system.

9. Gently wash the soil from the roots. Allow the roots to air dry and then weigh all the roots and measure the longest root from each pot.

10. Record all data on worksheet 1 and answer the questions. Discuss the experiment and your results. Why would it be important to be a good range manager?

Adapted From:

1. Using Nebraska's Range
   4-H study guide 30

Name_____

PLANTS

Be sure to keep material from each pot seperate.

	Treatment			
	Top Growth			
Pot Number	Height	Frequency	Total Yeild (oz. or g)	Root Length (in or cm)
1	2 inches	2 weeks		
2	2 inches	3 weeks		
3	2 inches	4 weeks		
4	6 inches	2 weeks		
5	6 inches	3 weeks		
6	6 inches	4 weeks		

		Top Growth Yield (oz or g)	Root Length (in or cm)		Top Growth Yield (oz or g)	Root Lenght (in or cm)
Average	2 in.			2 weeks		
	6 in.			3 weeks		
				4 weeks		

Questions:

1. Which plants yielded the most and why?

2. Which plants had teh greatest root length and weight and why?

3. Which plants obviously had the greatest vigor?

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Activity 16
Plant Conservation
Wise Acres

Subject Area: Art, Science, Social Studies, Language Arts

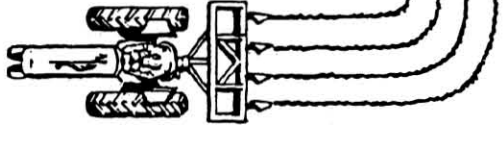
Objectives:
1. The students will be able to visualize differences between two vegetation types.
2. The students will be able to determine uses and benefits of each vegetation type.
3. The students will write about a vegetation type discussing uses and benefits.

Materials:
1. Drawing paper
2. Crayons or markers
3. Worksheets

Procedure:
1. Have students pretend they each own 100 acres of land in Nebraska.
   a. The first fifty acres is grassland. It is a rolling plain covered with grass, wildflowers and a variety of weeds. There is a windmill that a rancher built many years ago. It pumps water out of the ground and stores it in a big tank. Animals can drink from this tank. As far as you can see is rolling plains and blue skies. Strong winds blow across the grassland. Snow falls in the winter, and it gets cold.
   b. The other fifty acres is farmland. You have planted corn on the land this past spring. In the fall you will harvest your corn. You apply herbicides and pesticides to keep insects and weeds from destroying your crop. Along the fence rows grow tall grasses and shrubs.

2. After reading the two paragraphs to the students, have them divide their paper in half. On one half draw what they think the grassland looks like, on the other half draw what they think the farmland looks like. Remember specific details and think about what types of animals would live in each area.

3. Have the students look at their pictures of just the grassland. What are you going to do with your fifty acres of grassland? What animals can live here? What is there in terms of water, food, and shelter? What could humans do here in terms of recreation? What usable products could be grown here? What do you like about this place (aesthetics)? What area of Nebraska would this fifty acres most likely be found in? (Western Ne-



braska). Students might answer: raise cattle, sheep, horses, leave it for wildlife to use, let people use it to hunt in or ride horses, etc.

4. Now look just at the farmland. What are you going to do with your fifty acres of farmland? What will you do with the corn you harvested? What animals can live here? (In fence rows). Could humans do anything here in terms of recreation? Are the plants grown here usable? Are there any other usable products grown here? What do you like about this place (aesthetics)? What area of Nebraska would this fifty acres most likely be found in ? (Eastern Nebraska).

5. Have the students pick one of their fifty acres (grassland or farmland), and write about it, addressing the questions discussed earlier. Student could also compare the two areas addressing the topics discussed earlier.

Adapted From:

1. Renewable Resources Extension Act Report

Activity 17
Plant Conservation
The Sky is Not The Limit

Subject Area: Science, Language Arts

Objectives:
1. The students will be able to state three limiting factors affecting any given population.
2. The students will be able to list three limiting factors for humans in a given situation of a sub-optimal environment.
3. The students will be able to identify the importance of limiting factors to the distribution of certain animals.

Suggested Grade Level: 5-6

Background: Limiting factors are physical factors that limit the distribution of species; examples include temperature, type of vegetation, moisture and light intensity.

Materials:
1. Worksheet 1

Procedure:
1. Ask the students the following questions:
   a. Why does a cactus grow in the desert and not in a swamp?
   b. Why aren't there more people living in the desert?
   c. Why don't you find polar bears in prairies?
2. All of the questions relate to the fact that plants and animals need a specific environment to survive. These are considered "LIMITING FACTORS".
3. Divide the class into small groups. Give each student a worksheet. Have each group work through the worksheet.
4. Have each group present their ideas to the rest of the class.

Additional Activity:
1. Have the students list the limiting factors of their community. Have them discuss why certain plants and animals live in or near their community while others do not. Have them suggest things that would limit people from settling in a certain area.

Adapted From:
1. Learning with Otis

Name _____

The Sky is Not the Limit

The year is 112,140 A.D. You live in Nebraska which has the following characteristics.

Average Temperature	40° below zero
Rainfall	100 inches
"Soil" Type	Concrete
Natural Waters	Lakes
Plants	Low growing; short growing season
Animals	Large elephant-type creatures; horses; dogs
Light	No sunlight
Atmosphere	No oxygen
Homes	Made of concrete
Communitation	Use of toes

Design a human that could live in such an environment. Fill in the following squares.

Adaptations: How will humans adapt to this limiting environment? How will plants and animals adapt?

Dangers: What changes might you confront that will limit the size of the human population?

Nebraska in 112,124 A.D.

Resources: What might be some of the resources that will help humans survive in this envoronment?

Food: What will humans eat? What will the animals eat? Draw or write your ideas.

On the back of the page draw your human and label the things that have changed to allow humans to live in this environment.

Activity 18
Plant Conservation

Plant Dyes

Subject Area: Art, Science

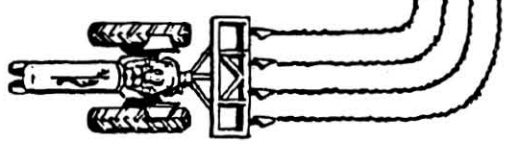
Objectives:
1. The students will be able to use plant materials to create various colored dyes.
2. The students will be able to use plant dyes they created to dye cloth.

Suggested Grade Level: 5-6

Materials: **This Activity is Suggested for Early Fall or Late Spring When Temperatures are Warmer.**
1. Plant Materials (students may be able to find these around their home or in the schoolyard, check procedure step one for a list of possible materials).
2. Alum (found in a pharmacy, not cooking alum)
3. Cream of tartar
4. Water
5. Pots
6. Stove or hot plate
7. Heavy art paper
8. Cloth or white t-shirts (optional)
9. Knife or blender
10. Measuring spoons and cups
11. Strainer

Procedure:
1. Ask students to look around their home and neighborhood for plant materials listed in the chart. Gather materials around the school yard.

Color	Plant Source
Blue-violet	Cherry roots
Purple	Elderberries, black raspberries
Reddish-purple	Pokeweed berries
Red-pink	Dandelion roots, cherries, strawberries, red raspberries, cardinal flowers, sorrel roots and bark, red oak bark
Blue	Blueberries (boiled)
Dark Brown	Black walnut husks (boiled)
Reddish Brown	Buckeye husks



Color	Plant Source
Yellow	Goldenrod (boiled), willow leaves, March marigolds, ash (inner bark), St. Johnswort flowers (boiled), onion skin, tulip tree leaves, ragweed, burdock, Osage orange roots and bark (boiled)
Rose Tan	Birck bark, willow bark, sassafras roots
Green	Plaintain leaves and roots (boiled), lily of the valley leaves
Yellow-orange	Bloodroot (boiled)
Salmon	Cherry bark
Black	Black walnut husks, Sumac leaves

NOTE: WARN STUDENTS TO BE AWARE OF POISONOUS PLANTS AND NOT TO TASTE ANY PLANTS OR BERRIES THEY HAVE COLLECTED. Do not pick flowers or plants from other people's yards without permission. Also remember to use conservation practices in collecting. The materials collected should not noticeably change the environment of the area in which they were found. In some areas and in national parks, it is against the law to pick wild flowers and plants. Find out if this is the case in your area. Many of these dyes are of low quality and may fade or change color. Check with your local weaver's guild or museum to determine the best local plant materials for dyes.

2. Chop all the materials. Boil each kind of material separately. Strain.
3. Add alum - 1/4 to 1/2 teaspoon (1 to 2 milliliters) to 2 cups (473 milliliters) of liquid plant material. (Alum helps to make the dye colorfast.) If curdling occurs, add cream of tartar in the same amount.
4. Your fabric should be simmered in the dye for at least 30 minutes. Occasionally, stir gently. Then let it cool completely in the dye solution to room temperature or cooler.
5. Wash repeatedly in baths of water the same temperature as the dye solution. (Check temperature with your hand). Repeat until the water is clear. Hang the fabric to dry.

Additional Activities

1. Have each student make a color wheel using dyed material and indicating the plant sources of the colors represented.
2. Use this activity as part of a unit on early life in the United States.

Adapted From:

1. Project Learning Tree

Activity 19
Tree Conservation
Plant a Tree

Subject Area: Science, Language Arts, Social Studies

Objectives:
1. The students will be able to research and gather information about Arbor Day and important "tree planters" in Nebraska.
2. The students will be able to plant a tree and observe it grow.

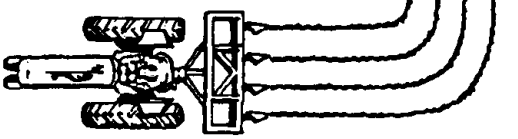
Suggested Grade Level: 5-6

Background: When the settlers first arrived, Nebraska had few trees. Prairie grass fires started by lightning and pushed by strong Nebraska winds would burn for miles. Grass would grow again but trees could compete with grass only in wet places protected from fire. The only trees were found on the banks of creeks and rivers. Pioneer explorers, farmers, ranchers and railroad engineers needed wood for building, cooking or heating but found very little. As a result the early pioneers planted trees. This practice was continued by their children and their children's children. Since Nebraska people have such a strong tradition for planting trees, Nebraska has become known as the "Tree Planter State".

Materials:
1. Reference material; encyclopedias, dictionary, etc.
2. One or more tree seedlings -from Natural Resources District, Arbor Lodge Foundation, or from seedlings already growing as volunteers
3. Shovel
4. Water and bucket
5. A place to plant a tree

Procedure:
1. To understand more about the history of trees in Nebraska have students research well known "tree planters" of Nebraska such a Jules Sandoz, Dr. Charles Edwin Bessey, J. Sterling Morton, and J. J. Lydick, Also have students research the history of Arbor Day, and the National Forests in Nebraska (especially Nebraska National Forest near Halsey, Nebraska). The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410 might have some information for you also.

2. Give the students time to report their findings about the rich heritage of trees in Nebraska to the class.



3. To continue this heritage of tree planters in Nebraska, plant a class tree.

4. Choose a good spot to plant your tree, with permission from school officials.

5. Dig a hole **large enough** to receive the entire root system without crowding or bending. A shallow hole that causes roots to be turned up at the bottom may result in the death of the tree.

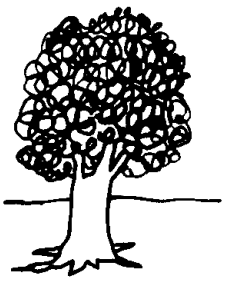
6. Keep the tree roots moist at all times, but do not leave them standing in water.

7. Set the seedling in the hole and carefully put some soil around the roots. Make sure the tree stands straight. Fill the rest of the hole with more soil.

8. Mulch around the tree with seasoned sawdust or ground corn cobs.

9. Water the tree well. Remember to keep watering the rest of the year (even in the summer).

10. Label the tree by attaching small signs to a wooden spike and sticking into the ground at the base of the tree.



Activity 20
Tree Conservation
Trees of Nebraska

Subject Area: Science, Language Arts

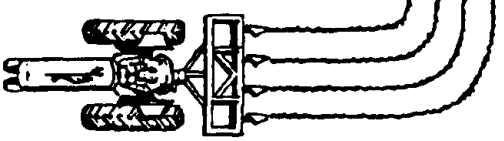
Objectives:
1. The students will be able to name at least ten trees common to Nebraska.
2. The students will be able to identify five common trees of Nebraska by their leaf shape.
3. The students will design a simple classification key.

Suggested Grade Levels: 5-6

Background: Refer to 43 Trees of Nebraska booklet. (Found at the back of this volume.)

Materials:
1. Six sets (or more) of 5-6 different leaves.
2. 43 Trees of Nebraska booklet.
3. Worksheet 1.

Procedure:
1. Divide the students into groups. Give each group a set of leaves.
2. Have the students place the leaves into two piles based on a specific characteristic (e.g. shiny or not shiny, etc.).
3. Have the group write the criteria used on the top of a horizontal piece of paper.
4. Have the student continue to separate the piles based on specific characteristics until each leaf is in a category by itself.
5. Have the groups exchange leaves and classification keys. See if they can decipher the other group's classification scheme.
6. Have student's return to their own classification scheme. Give each group a new leaf and see if they can fit it into their key without revising it (at least extensively).
7. Have each student select one leaf from their group's pile. Write a description of the leaf in complete sentences using the words in their key.



8. After each student has read their description to the class, explain that students have described the leaves in such a way that everyone knows which leaf they are talking about, however, this description is long. We give names to specific living things so we may identify them readily.

9. Identify the trees these leaves came from using the 43 Trees of Nebraska booklet.

10. Using the 43 Trees of Nebraska booklet, identify the trees around your school. You could even take a walk to a nearby park and identify the trees you see on your way.

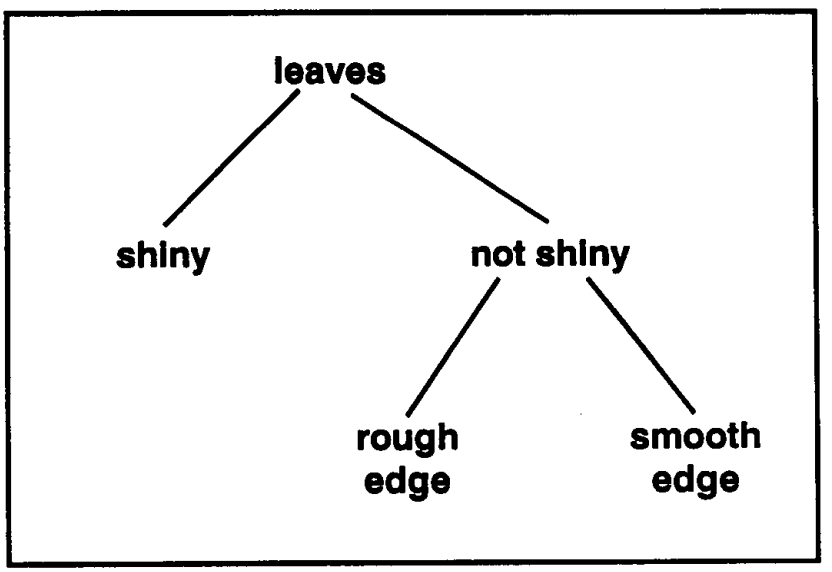
11. Using information from 43 Trees of Nebraska booklet, complete Worksheet 1.

Additional Activity:

1. In order to preserve the leaves you find, you may laminate them on to posterboard. Make sure all of the air is out of the mount. You can iron the leaves to dry them before mounting.

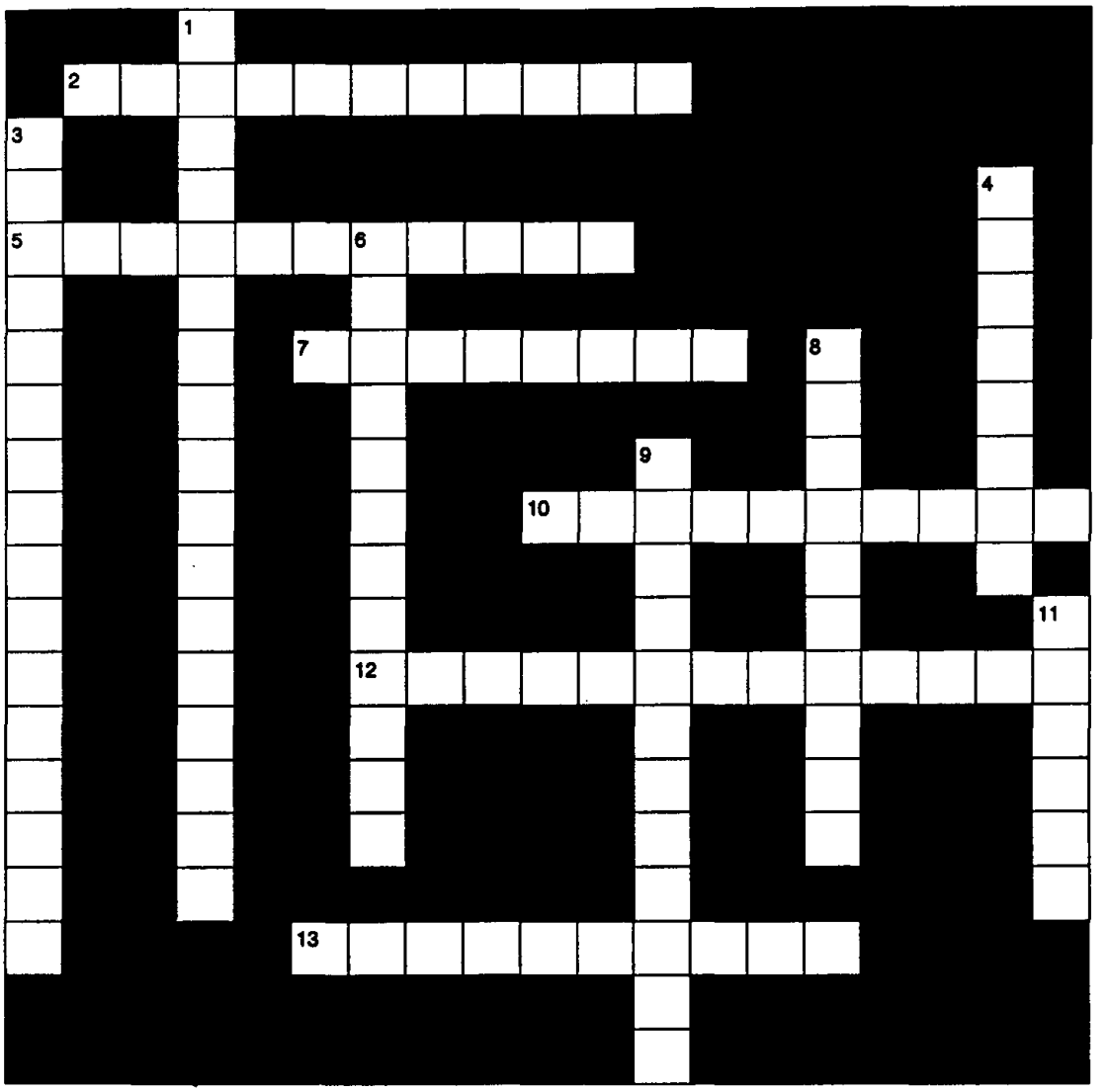
Adapted From:

1. Learning with Otis



Name _____

Trees of Nebraska



Across Clues

2. A very high valued hardwood, a native found near Nebraska rivers.
5. Some people incorrectly call this tree Chinese Elm, what is its correct name.
7. The wood of this tree is brittle and decays readily.
10. Comprises 50% of the standing timber of western forests, not native to Nebraska.
12. Slow growing but important lumber producing western pine.
13. This tree fits its name, it is found along streams. (Hint: rivers and streams)

Down Clues

1. This is the state tree, it fits its name because its fruit contains a cottony material.
3. The fruit of this tree is about 5" long, narrow, stalked, with thin scales and unarmed.
4. A prized ornamental, not native to Nebraska.
6. The scintific name for this tree is Prunus Americana, what is its common name?
8. This tree is noted for the maple syrup made from its sap.
9. Similar in size and habit to the native ponderosa pine.
11. This tree has beautiful flowers that bloom before leaves appear in April.

Worksheet 1

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Activity 21
Tree Conservation
Fire!

Subject Area: Social Studies, Math, Science

Objectives:
1. The students will be able to identify causes of range and forest fires in Nebraska.
2. The students will be able to determine the potential environmental and economic costs of fires.
3. The students will use given information to construct a variety of graphs.

Suggested Grade Level: 5-6

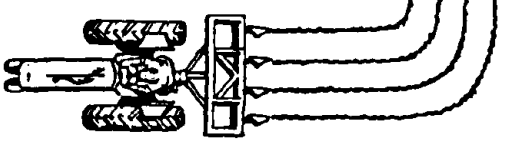
Materials:
1. Activity Sheets (The information is for Nebraska)
2. Graph paper
3. Calculators, if needed

Procedure:
1. Discuss fires. What are some causes of fires? What kind of damage does it do, especially to farmland and forests?

2. Using the Activity Sheets create graphs that can easily relay the information, figure percentages from the information to create circle graphs, etc. This can be done in small groups or as a class project. (Answer Key A is a good example).

3. From your graphs:
   * Determine which cause was responsible for the most large fires in each year; for the fewest.
   * Compare numbers of fires caused by each category in each year, noting increases or decreases.
   * Give reasons why these increases or decreases might have occurred.
   * Compare the number of fires in each county to the population in the county (you will have to get this information from the Census Bureau).

4. Discuss your findings and how students feel about these.



Additional Activity:

1. The students can research the effects of fire on the environment, both detrimental and beneficial. They could find about:

   * Financial costs involved in the loss of natural resources.
   * Other kinds of costs to humans and other living things.
   * Whether there are, under any circumstances, benefits to humans or the environment from forest fires.
   * How various government agencies and forest industries both use fire and handle fire prevention.
   * What happens after a large fire - naturally and with human intervention.

Adapted From:

1. Project Learning Tree

Average Annual Number of Fires per County 1980-1984

County License Number	County	Population	Fires	County Licnese Number	County	Population	Fires
1	Douglas	397,038	54	48	Red Willow	12,615	17
2	Lancaster	192,884	55	49	Howard	6,773	16
3	Gage	24,456	22	50	Franklin	4,377	17
4	Custer	13,877	49	51	Harlan	4,292	24
5	Dodge	35,847	46	52	Kearney	7,053	14
6	Saunders	18,716	41	53	Stanton	6,549	12
7	Madison	31,382	31	54	Pawnee	3,937	6
8	Hall	47,690	42	55	Thurston	7,186	17
9	Buffalo	34,797	22	56	Sherman	4,226	8
10	Platte	28,852	17	57	Johnson	5,285	6
11	Otoe	15,183	35	58	Nance	4,740	5
12	Knox	11,457	17	59	Sarpy	86,015	26
13	Cedar	11,375	15	60	Frontier	3,647	6
14	Adams	30,656	29	61	Sheridan	7,544	23
15	Lincoln	36,455	45	62	Greeley	3,462	8
16	Seward	15,789	29	63	Boyd	3,331	5
17	York	14,798	25	64	Morrill	6,085	26
18	Dawson	22,304	17	65	Box Butte	13,696	61
19	Richardson	11,315	21	66	Cherry	6,758	29
20	Cass	20,297	30	67	Hitchcock	4,079	19
21	Scotts Bluff	38,344	51	68	Keith	9,364	41
22	Saline	13,131	36	69	Dawes	9,609	8
23	Boone	7,391	5	70	Dakota	16,573	13
24	Cuming	11,664	13	71	Kimball	4,882	8
25	Butler	9,330	12	72	Chase	4,758	18
26	Antelope	8,675	10	73	Gosper	2,140	4
27	Wayne	9,858	8	74	Perkins	3,637	5
28	Hamilton	9,301	12	75	Brown	4,377	16
29	Washington	15,508	26	76	Dundy	2,861	10
30	Clay	8,106	19	77	Garden	2,802	16
31	Burt	8,813	19	78	Deuel	2,462	6
32	Thayer	7,582	13	79	Hayes	1,356	4
33	Jefferson	9,817	30	80	Sioux	1,845	3
34	Fillmore	7,920	17	81	Rock	2,383	14
35	Dixon	7,137	12	82	Keya Paha	1,301	1
36	Holt	13,552	21	83	Garfield	2,363	6
37	Phelps	9,769	22	84	Wheeler	1,060	2
38	Furnas	6,486	16	85	Banner	918	3
39	Cheyenne	10,057	11	86	Blaine	867	13
40	Pierce	8,481	23	87	Logan	983	2
41	Polk	6,320	3	88	Loup	859	1
42	Nuckolls	8,367	15	89	Thomas	973	5
43	Colfax	9,890	8	90	McPherson	593	1
44	Nemaha	8,367	15	91	Arthur	513	5
45	Webster	4,858	16	92	Grant	877	1
46	Merrick	8,945	8	93	Hooker	990	10
47	Valley	5,633	10				

Activity Sheet 1

Total Acreage Burned / Number of Wildfires by Cause 1980 – 1984

Cause	1980		1981		1982		1983		1984		Average Year 1980-1984	
	Fires	Acres	Fires	Acres	Fires	Acres	Fires	Acres	Fires	Acres	Fires	Acres
Railroads	581	6,599	411	3,957	221	2,224	317	3,139	287	879	363	3,360
Burning Debris	772	7,265	874	9,355	392	13,265	309	2,295	259	2,032	521	6,842
Equipment Use	308	3,774	222	2,138	173	11,304	174	3,121	126	2,910	201	4,649
Lightning	328	18,201	78	2,891	54	1,689	90	9,478	92	26,331	128	11,718
Smoking	150	4,272	185	706	59	118	64	208	47	1,290	101	1,319
Electric Fences	26	79	21	234	15	62	15	96	7	152	17	125
Children	61	64	51	198	18	8	28	18	14	17	34	61
Incendiary	54	181	70	494	13	74	12	157	5	42	31	190
Campfires	11	55	8	5	3	6	0	0	0	0	4	13
Miscellaneous	338	8,775	407	3,698	171	2,569	175	1.069	133	1,536	245	3,529
Total	2,629	49,265	2,327	23,676	1,119	32,319	1,184	19,581	970	35,189	1,645	31,806

Fires Burning 100 Acres or More Number of Fires, Acres Burned 1980 – 1984

Cause	Number of Fires	Acres Burned
Lightning	71	53,884
Burning Debris	43	24,930
Equipment Use	28	18,024
Miscellaneous	36	13,870
Railroads	22	11,200
Smoking	6	5,300
Electrice Fences	2	200
Incendiary	1	150
Children	1	150

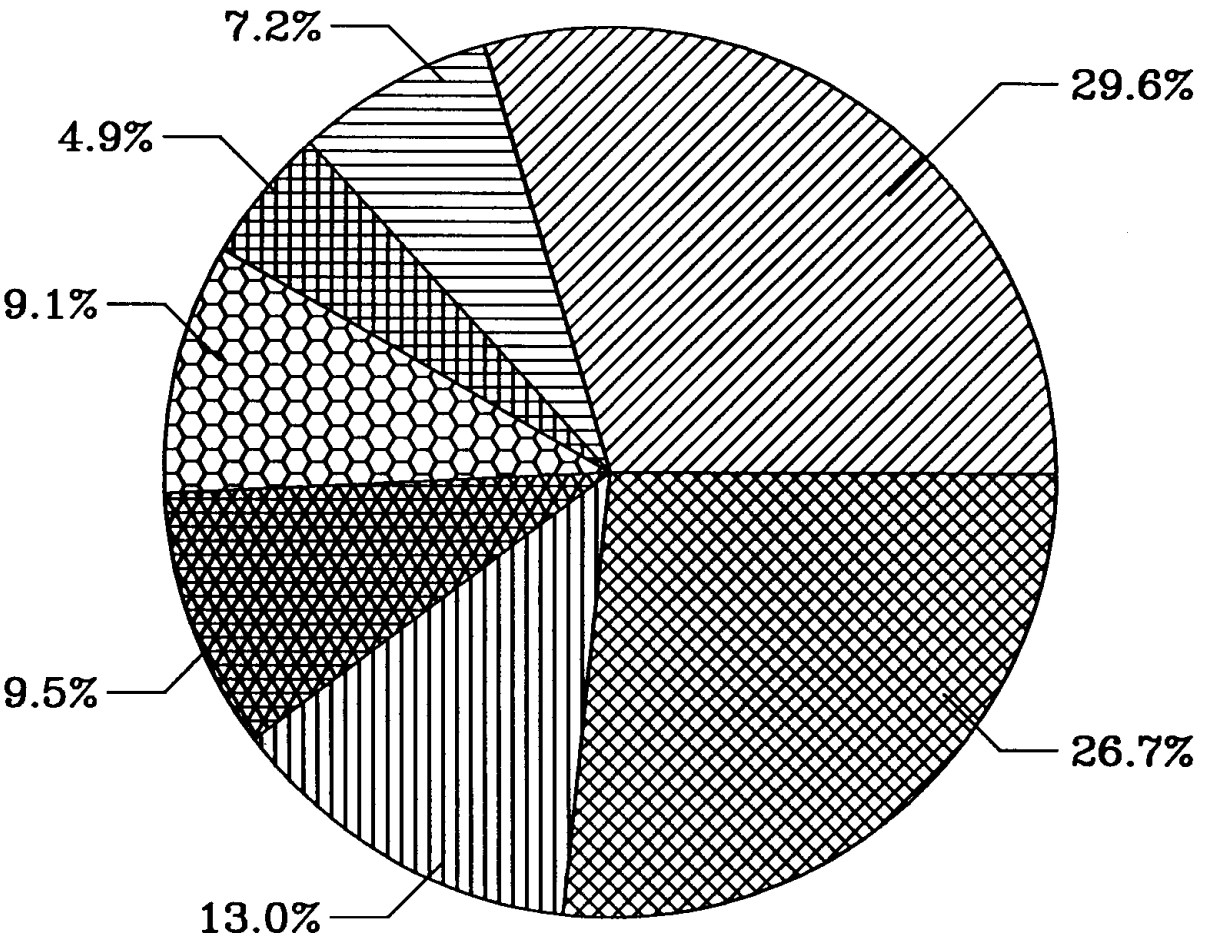
The greatest number of large fires are caused by lightning. In terms of number of fires and acres burned, large fires caused by debris burning rank well ahead of all other types of man-caused fires.

The average fire size is decreasing, but large fires still occur. Fires which reach 100 acres in size are so difficult to control that they often grow to be very large. In the past five years, only 3% of Nebraska's fires have been larger than 100 acres, but these fires burned 80% of the acreage. Certain Nebraska counties tend to have more large fires due to their sparsity of settlement or the nature of the land use. As a result, fire suppression equipment is often not in close proximity to the fire scene. Long response times usually mean larger fires which are more difficult to suppress.

The Cost of Wildfires – by Cause, 1984

Cause	Damage to Crops and Improvements	Value of Firefighters Time	Equipment Operation	Total
Debris Burning	$ 100,588.00	$ 25,725.92	$ 136,300.06	$ 262,613.98
Railroads	9,471.00	18,120.56	108,183.15	135,774.71
Equipment Use	215,411.00	28,339.42	127,484.83	371,235.25
Miscellaneous	40,652.00	12,816.47	74,316.05	127,784.52
Lightning	472,201.00	20,445.26	146,783.96	639,430.22
Smoking	3,793.00	3,827.63	17,364.26	24,984.89
Electric Fences	588.00	1,498.39	11,065.75	13,152.14
Incendiary	400.00	237.38	1,497.22	3,134.60
Children	2,280.00	1,236.06	5,692.37	9,208.43
Campfires	0.00	0.00	0.00	0.00
Total	$845,384.00	$112,247.09	$628,687.65	$1,568,318.74

Percent of Total Wildfires in 1984



Railroads 29.6%

Miscellaneous 7.2%

Smoking 4.9%

Unknown 9.1%

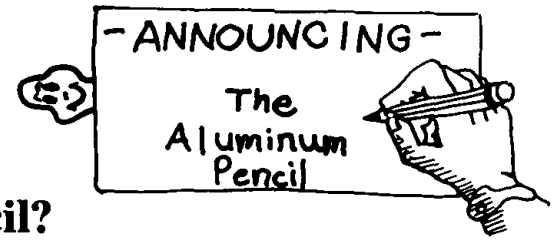
Lightning 9.5%

Equipment Use 13.0%

Debris Burning 26.7%

Answer Key A

Compiled by Don Westoyer
Nebraska Forest Service
101 Plant Industry, UN-L, (402) 472-5629



Activity 22
Tree Conservation
An Aluminum Pencil?

Subject Area: Social Studies, Science, Language Arts

Objectives:
1. The students will describe the suitability of materials manufactured for certain consumer products.
2. The students will identify recyclable items and ways to efficiently use materials to conserve our natural resources.

Suggested Grade Level: 5-6

Background: What do bee keepers, Maine lobstermen, chicken ranchers, photographers and Texas wildcatters all have in common? The work they do, the products they sell all depend on by-products from trees.

Trees are renewable. There are no "dry holes", no "exhausted veins", no "bottom of the barrel" in a forest, **if** we practice good forest management. But for centuries people saw trees only as lumber, or firewood. In the process of making lumber, however, there was a tremendous amount of waste. Sawdust, bark, wood scraps all had to be hauled away or burned - and that created more complications. Finally, scientists came along and peered into the very structure of trees. They found a brew of chemicals, the stuff of energy, and new ways of taking a tree apart, and shaping it to human needs. They perceived, in short, that the molecular latticework of a tree had a potential beyond their wildest dreams. The lights burned late at research centers all over the country.

The story of how the forest industry used this research to create new products, new markets, new ways of doing things and even new energy is too big a story to be told here. But we'll outline some of the products that depend on the exotic chemistry of a tree. We'll start with:

Bark - Up to 21 percent of a cord of wood may be bark. Much of it is used as fuel in forest industry mills. It is also a source of chemicals, resins, waxes, vitamins, plywood adhesives, plastic fillers, lacquers and oil spill control agents. Bark is also used for mulches and soil conditioners.

Wood Flour, Resins - Wood flour and melamine resins using cellulose filler are principal components of dinnerware, electrical receptacles and

parts, toys, handles for cooking utensils, telephone housings, camera cases and appliance housings.

Cellulose - Ethyl cellulose and other chemical based cellulose are used in making tool handles, photographic films, sausage casings and football helmets. Acetate filament yarns make textile products such as clothing, drapes and rugs. Nitrocellulose is used in making solid rocket propellants and other explosives.

Tortula Yeast - Tortula yeast is a high protein product made from wood sugars as a by- product of the pulping process in papermaking. Type S Tortula is used in baby food and cereals. Type F Tortula is used in feed supplements for cattle, fish and chickens. Type FP goes into pet foods. Tortula has been found to make bees and lobsters grow faster!

Turpentine, Tall Oil - Turpentine and tall oil are resinous materials that are also reclaimed from the paper-pulping process. They are important ingredients in paint, varnish, adhesives, asphalt, printing inks, rubber products, soaps and polishes. Synthesized essential oils are used in chewing gum, toothpaste, detergents and shampoos.

Spent Pulping Liquids - Lignosulfonates from spent sulphite pulping liquor are used in cleaning compounds, insecticides, cement, ceramics, fertilizers, oil well drilling muds, cosmetics, gummed tape and certain pharmaceutical (Aldomet and Aldoril for hypertension and L-Dopa for Parkinson's disease are examples).

Energy - Bark, ground wood and spent pulping liquors provide an important source of the pulp and paper industry's total energy requirements. Nationally over half of the industry's energy use is self-generated from these residues.

Lobsters and bees grow faster, chickens prosper, photographers have film for their cameras, and mud additives make drilling easier for Texas oilmen. All because of chemicals and by products from trees. Now that you have a hint, you can make a list of tree products. Here's a suggestion that might help. Inventory just about everything in sight, in the next room and out on the street. That'll give you a good start - but remember, splinters don't count.

Materials:

1. Writing paper
2. Reference materials

Procedure:

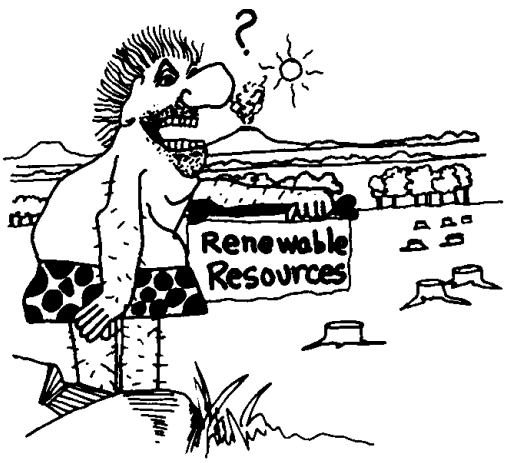
1. Divide students into five groups.
2. Assign each group one of the following materials: wood, plastic, steel, aluminum and iron.
3. Each group will create a list of products used in the school which are made from their assigned material.
4. Combine the lists. Each student will pick two items (each made from differing materials; i.e. one from the wood list and one from the plastic list) and write reasons why each item was made from the material it is made of. Why wasn't it made from a different material? What properties do materials have that makes them suitable or non-suitable for certain uses? How plentiful is this material? Is it renewable? Is the item recyclable? Are there other uses for the item? Is the item currently being wastefully used? Why?
5. Have the students share their ideas with the class.

Additional Activity:

1. Have students name 2500 products that come from trees. But don't count lumber, plywood, paper, or splinters. Refer to the Background information to get you started.

Adapted From:

1. Project Learning Tree
2. Green America #28



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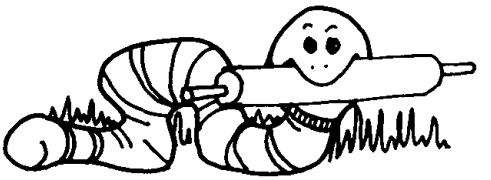


Activity 23
Tree Conservation

Making Recycled Paper

Subject Area: Math, Science

Objectives:
1. The students will recognize the importance of recycling.
2. The students will recycle paper.

Suggested Grade Level: 5-6

Background: Making Paper: Trees are cut down, hauled to the mill and the wood chips are processed into paper. This process takes lots of energy. Paper can also be made from used or recycled paper. This process saves energy and our natural resources.

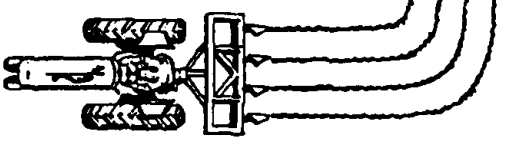
People make choices every day that affect our environment. We waste food and materials which deplete our natural resources. Only by learning to use our resources wisely will we be able to truly practice conservation.

Other things that can be recycled--cans, glass, rubber, egg cartons, milk jugs, styrofoam cups and packing, old clothes, etc.

Materials:
1. Used paper (paper bags work well)
2. A piece of flat screen, about six inches square.
3. A flat pan that is a little larger than the screens
4. 8 quarts of water
5. Newspaper for blotting
6. A bowl for mixing
7. An egg beater or blender
8. A rolling pin or wooden dowel
9. Hot water
10. Worksheets 1 & 2

Procedure:
1. Tear used paper into little pieces. Add two cups of hot water. Beat with beater or blender to make pulp.

2. Pour pulp into the flat pan. Slide the screen into the bottom of the pan and move it around until it is evenly covered with pulp. Lift screen carefully. Hold it level above the pan and let it drain for a minute.



3. Put the screen, pulp side up, on the newspaper. Move the screen with the pulp to some dry newspaper to let dry. When almost dry, peel your paper off the screen, gently. Let dry thoroughly.

4. You have a piece of recycled paper.

Additional Activities:

1. Have the students assess and compute the amount of paper they use everyday. Work out an average of paper per student per day. Multiply this by the number of students in school. Two thousand pounds of paper equal 17 trees. Calculate the number of trees used by the students per year. Start a recycling program in the school. For help in this endeavor contact any of the environmental groups or the Game and Parks Commission.

2. "Recycling Newspapers" Worksheet.

3. Math Word Problems Worksheet.

Adapted From:

1. Agriculture In Montana Schools

Name _____

Recycling Newspapers

Old newspapers can be **recycled**. That means they can be used again instead of being thrown away or burned. You should save your old newspapers and take them to a recycling center or a paper mill. They will pay you money for bringing in old newspapers.

The paper mills have their own ways of making the old newspapers into new paper. They soak the newspapers with water and beat the pulp with paddles. Then the wet pulp is put through heated drying rollers. These rollers squeeze the water out of the pulp and dry it, making new paper and cardboard

When we use paper which has been recycled, we are saving trees. It takes about seventeen trees to make one ton (2,000 pounds) of paper.

Directions: Answer the questions.

1. What can you do with old newspapers besides throwing them away, making paper hats or burning them?

_____

2. What does **recycle** mean?

_____

3. When the paper mills make paper from trees, they use wood chips from trees and cook them with water to make pulp. To make recycled paper, what do the paper mills mix with water to get pulp?

_____

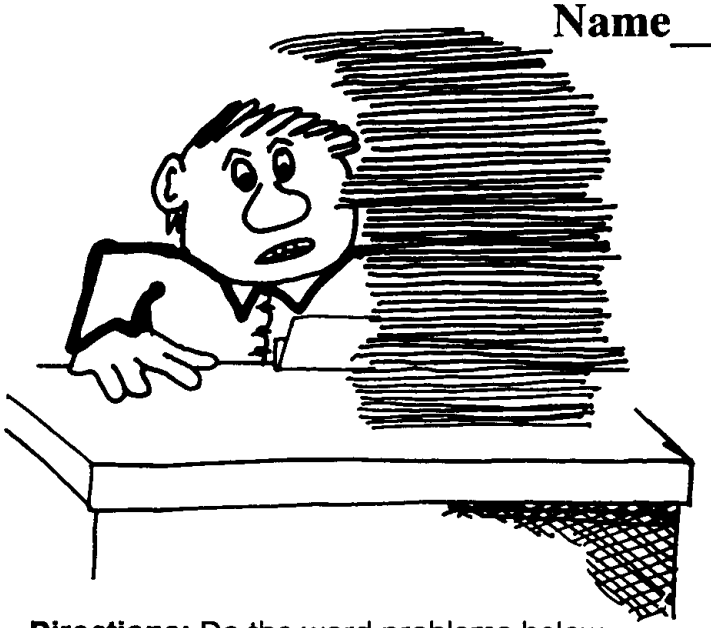
4. How many trees does it take to make one ton of paper?

_____

5. What do you think is one of the most important reasons for recycling newspapers?

_____

Name _____



The National Wildlife Federation has started a paper recycling progam in their company offices. Each employee has a tray on their desk to hold used papers. The used papers go from the trays to boxes instead of into the wastebasket.

Their goal is to save four tons of used paper for recycling.

Directions: Do the word problems below.

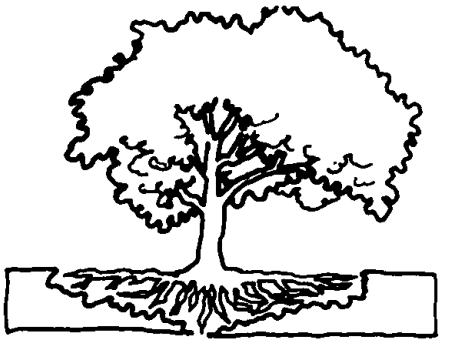
1. The NWF goal is to save four tons of used paper. Each box of used paper weighs 50 pounds when it is full. How many boxes will they need to make four tons?

2. Each 1000 pounds of paper that they collect will save 8.5 trees. If they reach their goal of four tons, how many trees will be saved?

3. The four tons of used paper will be recycled and made into copier paper. Recycling one ton of waste paper uses 22,000 kilowatt hours of energy. Producing the same amount of paper from trees takes 67,000 kilowatt hours. How many kilowatt hours of energy will be saved by recycling four tons of waste paper?

(This is enough to air condition and heat two average houses in Washington, D.C. for an entire year.)

Adapted from: Conservation for Children



Activity 24
Tree Conservation
How Big?

Subject Area: Math, Science

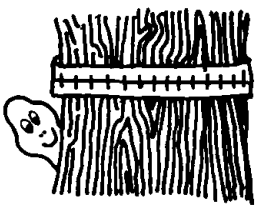
Objectives:
1. The students will be able to realize how extensive a tree's root system actually is.
2. The students will measure a tree's diameter and height using a diameter tape and cruising stick.

Suggested Grade Level: 5-6

Materials:
1. A large tree to observe
2. A strip of flexible paper or cardboard, 1/2 inch wide and 45 inches long
3. Ruler
4. Yardstick
5. A strip of hard paper or cardboard the length of the yardstick
6. Shovel

Procedure:

1. Foresters use cruising sticks to measure a tree's diameter and height. These facts are essential in figuring the amount of wood in a tree. Take the flexible paper strip (1/2" X 45") and begin at one end of the strip and make ink marks 3.14 inches apart (do your best to estimate).



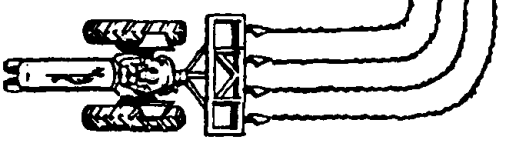
2. Number these marks consecutively starting with NO. 1 on the left end of the tape. A measurement of 3.14 actual inches on your tape is equal to 1 inch in tree diameter.

3. Wrap this strip around the tree at chest height, about 4 1/2 feet above the ground. The diameter of the tree in inches will be at the mark nearest where the tape overlaps the zero end.

4. To measure tree height, glue a strip of hard paper on one side of a yardstick.

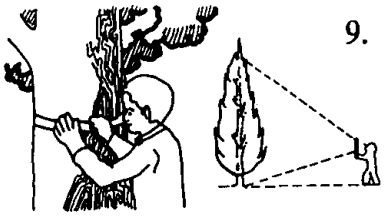
5. Using black ink, begin at one end and make marks 6.15 inches apart.

6. Label the first mark No. 1, the second 2, etc.



7. To measure the tree, stand 66 feet from the tree; hold your arm out horizontally and the stick vertically at arm's reach.

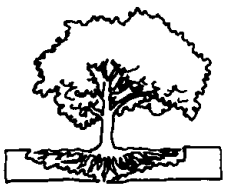
8. Slide stick up or down until the top of the stick is in line with the top of the tree.



9. Without moving your head, sight the bottom of the tree (be sure stick is still vertical), see the place on the stick where line of sight crosses it. The nearest figure is the number of 16 foot lengths in the tree. If the figure is 2, there are two 16-foot lengths in the tree. The tree is 32 feet high (2 X 16 feet).

10. Now that we know how big the tree is above the ground let's find out how big the tree is below the ground.

11. To see how extensive a tree's root system is, walk away from the tree trunk and stop at the crown spread's outer edge (the end of the outer branches).



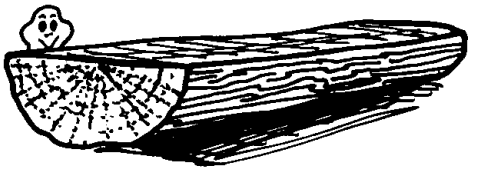
12. Dig a shallow hole or two, which you will fill again when you are finished. Look for tree roots as you dig. If you use a shovel, face the bough of the tree as you insert it so you can easily detect the roots as the soil is removed. If you find extensive roots, back up a few steps and check again. If you do not find any, move closer to the trunk of the tree and dig another hole. Once you discover the radius of the root system, you might consider the harmful consequences of digging a ditch under the canopy of a tree.

13. If you think that a tree's root system is formed like its crown spread in reverse, you are mistaken. Even taking into account the fact that root systems do vary according to tree species and soil conditions, most "feeder roots" are actually near the soil surface, where there is more fertility, moisture and aeration. Roots used for anchoring the tree are larger and deeper, but not nearly as massive as the feeder root system. Visit a freshly-cut ditch near a tree. Observe the level of the roots. With some nails for anchor points and some string, stretch a line every six inches of depth and count all of the roots at each level. Find out what percentage of the roots are in the first six inches, the first foot, and so on.

Adapted From:

1. Urban Forestry
4-H Member Manual

Activity 25
Tree Conservation
Tree Rings



Subject Area: Science, Math

Objectives:
1. The students will measure the circumference of a tree using a string or tape measure.
2. The students will count the number of rings on a log or stump to determine its age.

Suggested Grade Level: 5-6

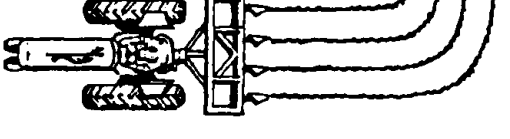
Background: Tree rings can tell us many things. You probably already know that you can tell how old a tree was by counting the rings in a cross section of the tree. This is because the tree grows new wood and makes a new ring each year. A tree with nine circles of sapwood (rings) is nine years old. You can also tell something about what the weather was like when the tree was alive. In a year when there is a lot of rain, the tree grows more. The tree rings are wider. When there is only a little rain, the tree does not grow as much and the tree rings are closer together.

The soft rings were formed in spring and early summer when the tree grew fast: the hard rings appeared late in the season when growth was slow. Therefore, the number of hard rings in the stump or lowermost log tells you the age of the tree. Rings in a limb indicate the age of that branch.

Growth results from the multiplication and development of cells. We are more aware of growth occurring in buds, tips of branches and roots. This exercise with growth rings reminds us that the cambium is an area of active cell division and, hence, growth.

Materials:
1. Logs, stumps or a cross section of a tree to show all of it's rings
2. String or tape measure

Procedure:
1. Divide the class into small groups.
2. Have each group measure the circumference of the tree samples with a string or a tape measure. If using a string, use a ruler to measure the length of the string.



3. Have each group guess the age of their trees.

4. Tell students that the tree's growth rings are about 1/4" thick. Have them determine the age of their tree by counting the growth rings. See who has the oldest and the youngest tree.

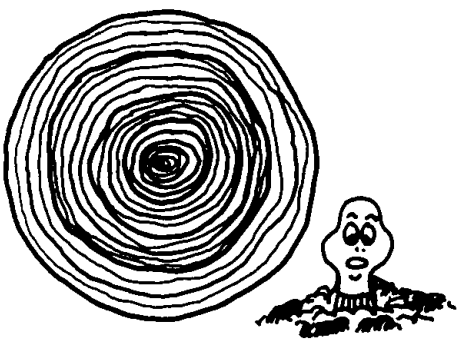
5. Next, have each group examine the face of a log or stump.

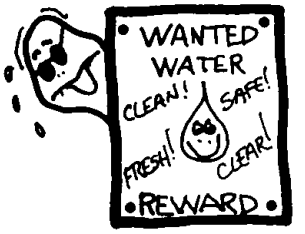
6. Have them test the growth rings for hardness by sticking a pin in them.

Adapted From:

1. Plant Characteristics, Unit IID 4-H Members Manual

2. Learning With Otis





Activity 26
Water Conservation
Wanted: Water!

Subject Area: Science, Language Arts, Math

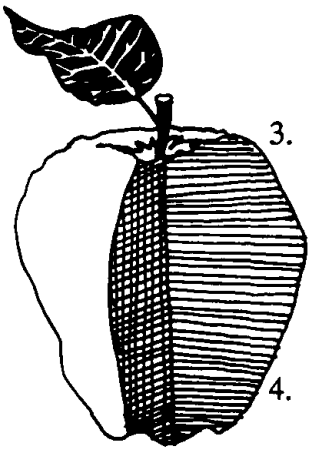
Objectives:
1. The students will realize the amount of water on the earth.
2. The students will compare and contrast the amount of water present on the earth with the amount of water usable by plants, animals and people.

Suggested Grade Level: 5-6

Materials:
1. Three glass jars
2. One teaspoon measuring spoon
3. Liquid measuring cup
4. Apple
5. Paring knife
6. 1/2 teaspoon measuring spoon

Procedure:

1. Cut the apple into four equal parts. Three of the parts represents the area of the earth that oceans (or salt water bodies) cover. The fourth part represents the area of the earth that is land.

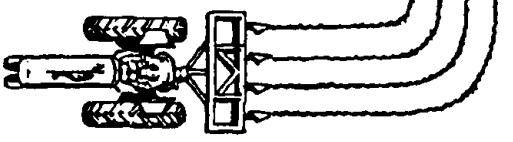


2. Cut the land section in half lengthwise, creating two one-eighth pieces. One of these pieces represents land such as desert, swamp, antarctic, arctic and mountain areas that are not suitable for man to live.

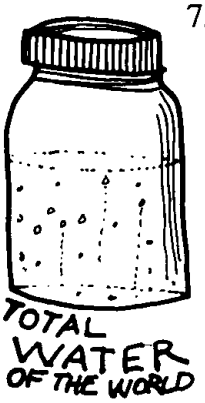
3. Take the other one-eighth section (which represents the areas that man can live on, but may not grow food) and slice it lengthwise into four equal parts (they will be thin). Three of these one-thirty second sections represent the areas of the earth which are too rocky, too wet, or too hot, for the production of food or are occupied by cities, factories and highways. Man can live in these areas.

4. Carefully peel the last one-thirty second section. This bit of peeling represents the amount of soil which is used for the production of food that feeds the world.

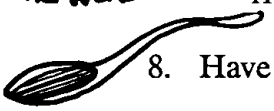
5. Explain that first you are going to study the water. 99.4% of the worlds' water is in the oceans and polar ice caps, and the remaining 0.6% is the water on land.



6. Demonstrate by placing 100 teaspoons of water into a glass container labeled "TOTAL WATER OF THE WORLD". Remove 1/2 teaspoon of water and put it into a second container labeled "TOTAL LAND WATER".



7. Demonstrate a similar situation by displaying the total amount of land water used by people:
   a. Pour all water in the "TOTAL LAND WATER" container and remove the "TOTAL WATER OF THE WORLD" container.
   b. Remove 1 teaspoon of water and put it into a third glass container labeled "FRESHWATER LAKES AND RIVERS".
   c. After the pupils compare the amounts, tell them that most of the people in the world get their water from rivers. Where is the rest of the total land water? (1% in salt lakes, almost 98% in the water tables, the remainder in soil and air moisture and rain.) What happens if the rivers are polluted?



8. Have students write their reactions to the demonstrations.

9. Discuss the following:
   a. Can all plants and animals live in salty water? (No, only those adapted to salt water.)
   b. Where do other wild animals and aquatic plants get their water? (Lakes, ponds, streams and other surface land water.)
   c. Where do plants on land get water? (Ground water, rain.)
   d. Does rain make new water? (No, recycles it.)

Additional Activities:

1. Have students write and deliver a speech entitled "Can We Afford to Pollute Our Water?"

2. Have students complete Worksheet #1. Discuss the answers in class. Focus on why people need water for health purposes, (prevent dehydration: perform many bodily functions).

3. Have students bring news items about water shortages, dam building, water flooding, water pollution, etc.

4. Have students do library research on how people, animals and plants need water for health and life. Have them report their findings using charts, maps, graphs, diagrams, posters or other audio/visual materials.

Adapted From:

1. Learning with Otis

2. Soil Conservation Topics Education Kit
   United States Department of Agriculture, Soil Conservation Service

3. Nebraska Ag in the Classroom Learning Activities Notebook

Name_____

Wanted: Water!

Calculate the answer of each of the following problems. Show your work.

Background Information

Babies weight = 3/4 water
Grown person's weight = 1/2 water
1 liter of water weighs 1 kilogram

1. Charlie is Sally's baby brother. He weighs 8 kilograms. What percentage of his weight is water? _____
   How many kilograms is water?

2. Sally's father said, "My body has 40 liters of water according to my weight." How much does he weigh?

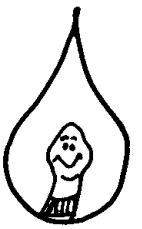
3. a. The school nurse told 11-year-old Sally that she weighs 30 kilograms, and that 18 kilograms of that is water. How many kilograms are **not** water?

   b. Why isn't Sally's total number of kilograms in water, 18 kilograms?

4. If Laura has 10 kilograms of water in her body, then . . .
   a. What is her total weight if she is a baby?

   b. What is her total weight if she is a full grown woman?

Adapted from: Soil Conservation Topics Ecucation Kit



Activity 27
Water Conservation
Water's Going On?!

Subject Area: Math, Science, Health,

Objectives:
1. The students will record and calculate how much water they use in a day at school.
2. The students will make recommendations how they can save a significant percentage of that water.

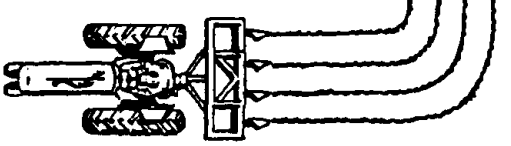
Suggested Grade Level: 5-6

Background: Every molecule of water that was present when the earth's oceans were formed is still present today in one of water's three forms--as a gas, a liquid, or solid ice. In the United States, approximately half of the water used is drawn from groundwater sources. This amounts to approximately 82 billion gallons a day of groundwater. This causes an ever-increasing drain on the groundwater supply. As groundwater dries up, stream flows are reduced. Ponds and marshes dry up and plant species die out. The groundwater remaining may also become contaminated by saltwater intrusion or by pollution, rendering it unfit to drink. All these results have obvious effects on wildlife, people, and the environment. Some of the world's fresh water is also used for irrigation, but if a majority of Americans practiced personal water conservation and water quality practices, it would make a real difference.

Materials:
1. Chalkboard
2. Paper
3. Pencils

Procedure:
1. Ask the students to estimate how much water each student uses each day in school. Have containers of different volumes for students to use for reference. Write their estimates on the chalkboard or on a chart. A chart may be made showing the class's estimates as follows:

Gallons	2	4	6	8	10	12
	X	X	XXX	XXX	XXX	XXX
		X	XXX	XXX	XX	
		X	XXX			



2. Ask the students to monitor their use of water for a day. They can record their drinks of water. Ask them to do the same for handwashing. They should also record the number of times they use the restroom, etc.

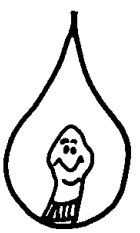
3. As a class, calculate the amount of water used: e.g., run water from the fountain to a container for ten seconds and see how much water was used. Use this amount to calculate the amount in seconds. Do the same for the sink faucets. Multiply the number of gallons used per flush by the number of trips to the restroom. Have each student come up with an individual number of gallons used.

4. Compare the estimates of water use to the actual water used.

5. Add all the individual gallons of water used to arrive at a total for the entire class. Divide this amount by the number of students in the class. In this way, individual students can compare their individual usage against a class average to see if they are above or below average in their water use.

6. Ask the students if it would be possible to reduce the amount of water used, and if so, how? For example, cups could be used at the drinking fountain to reduce the amount of water that goes down the drain. The trade-off here would be more paper trash waste in exchange for conservation of water.

7. Put the students' suggestions into practice for a day or two. Then ask the students how water conservation practices changed what they did. What materials did they use or buy? Did their attitude change? How? Which changes in their behavior will they keep, as part of their personal lifestyles?



8. Ask the following: Where does our water come from? How does it get here? Does our finding, transporting, and using water affect wildlife in any way? If so, how? After a discussion of the effects of water depletion and conservation on wildlife, ask students to draw two murals--one showing the effects of depletion and another the effects of conservation.

Additional Activities:

1. Monitor water use at home (showers, dishes, clothes washing, lawn watering, etc).

2. Use this activity for paper and energy use and conservation.

3. Incorporate use of elementary statistics in this activity.

4. Estimate what activity of yours requires the most water per year?

5. Describe and explain three ways you can decrease your use of water.

6. Describe and evaluate the seriousness of water problems you can identify which affect people and wildlife, now and in the future.

Adapted From:

1. Project WILD

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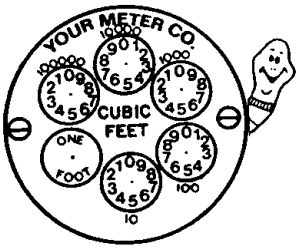
Activity 28
Water Conservation
Water Meter



Subject Area: Math, Science

Objectives:
1. The students will be able to read a water meter.
2. The students will realize how much water they use and how it is measured.

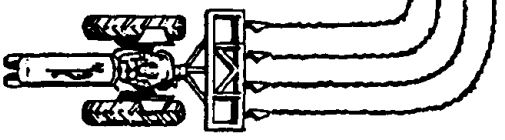
Suggested Grade Level: 5-6

Background: Some water systems don't use meters and some don't allow residents to open their meters. If this is true in your area, you may want to skip this activity. Call your water system to learn more.

Materials:
1. Water Meter Worksheets

Procedure:
1. Read Worksheet 1 together.
2. Have the students complete the page.
3. Complete Worksheet 2.
4. Have them take a reading of their home meter for a week. Worksheet 3.
5. If your class has experience at averaging, have them find the class average water use per student. Have each student calculate if they are using more/less than the class average.
6. Discussion Questions: Do you think there is a lot of water wasted in our world? How? How do you waste water? How can you reduce this waste of our very valuable natural resource, water?

Additional Activities:
1. Have the school custodian show the class the school's water meter in small groups.
2. Contact the local water system to have a technician bring meters to your class for a demonstration on how to read them.
3. Make a graph showing student water use.



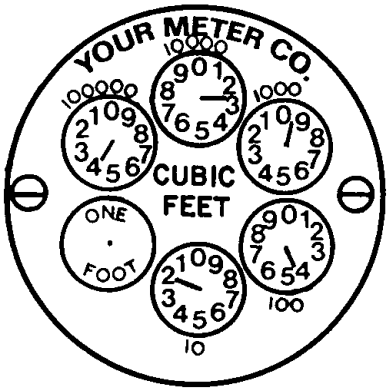
Adapted From:

1. The Story of Drinking Water
2. Water Education Activity Guide

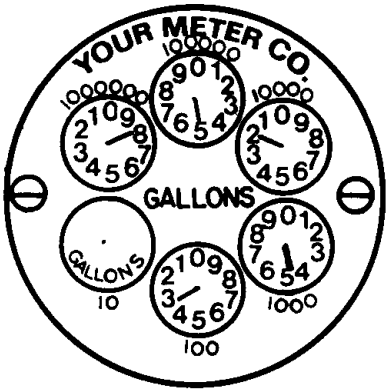
Name_____

Reading a Water Meter

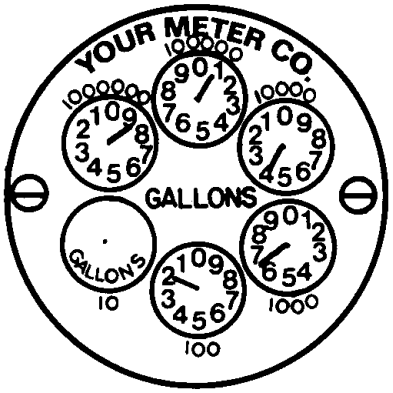
Some meters with dials record in cubic feet, some record in gallons. If the dial points directly to a number, record that number. If the dial points between two numbers, record the lower number. Read the following dial meters and record their readings below them. The first two are done for you to show how.



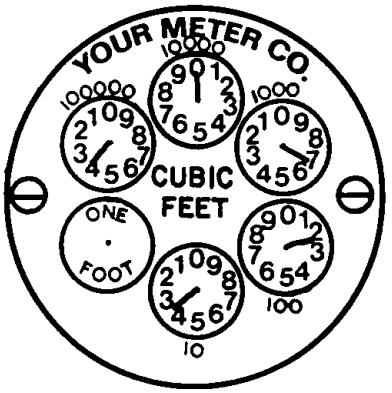
Example: 42,942



Example: 852,430



1._____



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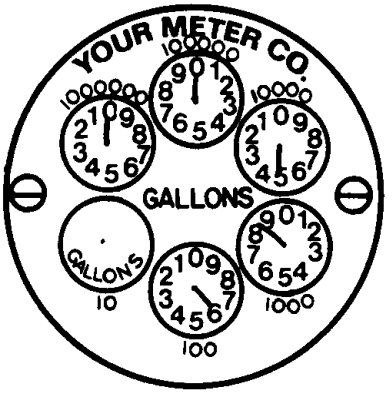

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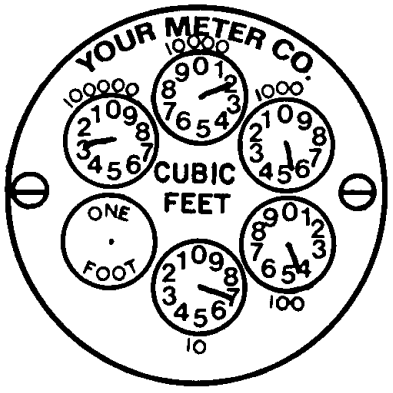

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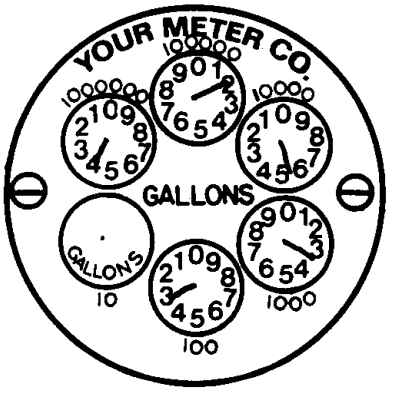

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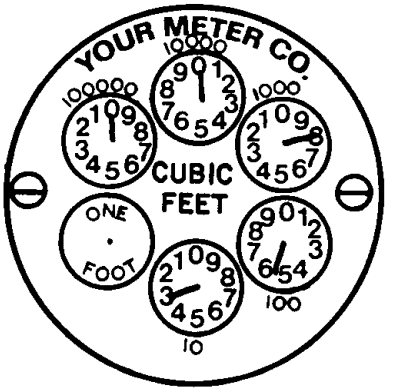


6._____

Adapted from: The Story of Drinking Water

Worksheet 1

Name _____

Most water meters record gallons just as a car's odometer records mileage. However, some water meters show the usage in cubic feet. For these, you must multiply by 7.5 (the approximate number of gallons in one cubic foot) to find how many gallons are used.

Directions: Use the meter readings below to find out how much water is being used. Be sure to label you answers as gallons or cubic feet.

1. How much water is used in taking a shower?

Before

After

196942
-196872
gallons

2. How many gallons were used to wash the car?

Before

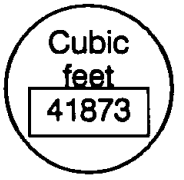
After

3. How many gallons are used for one load of wash in the washing machine?

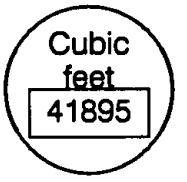
Before

After

4. How much water was used to clean the sidewalk with the hose?



Before



After

How many gallons of water is that? (Remember to multiply by 7.5)

Tips to save water:

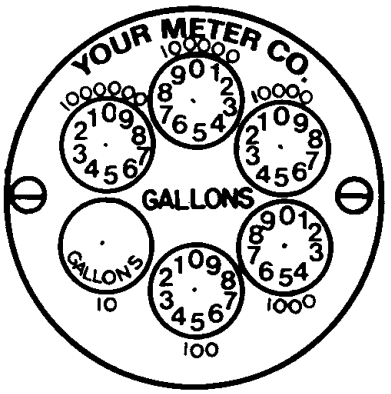
1. Take shorter showers.
2. When washing the car, use a bucket for soapy water and use the hose to rinse only.
3. Be sure to wash full loads when using the washing machine.
4. Use a rake or broom to clean the sidewalk, not the hose.

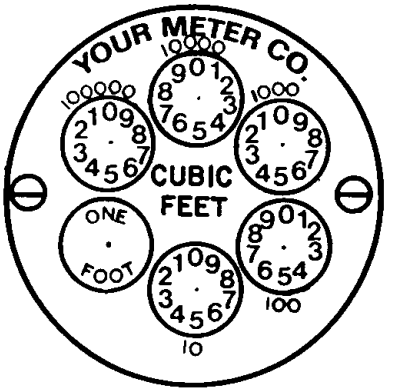
Worksheet 2

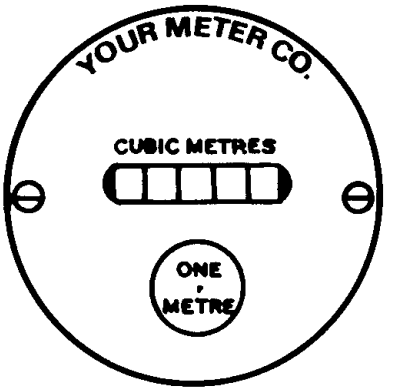
Adapted from: Conservation for Children

Name _____

Reading a Water Meter







Your water meter probably looks like one of these. Now find your own meter in or near your home and read your water meter every day for the next week. (If your water meter is outside, you may have to check with the water department to be sure it is all right to open and read the meter.) Record the data on the chart.

Date							
Reading							
Daily Units							
						Weekly Total	

To find the Average Daily Use, divide your weekly total by the total number of readings. Compare the average with the daily units. (Sometimes your use more, sometimes less. Why?)

To find the amount used by each person in your household, divide your weekly total by the number of people in your family. That will tell you the amount used per person in a week.

To find the daily amount used per person, divide your daily average number by the number of people in your household.

Why do you need a meter? What is the money you pay to the water company used for?

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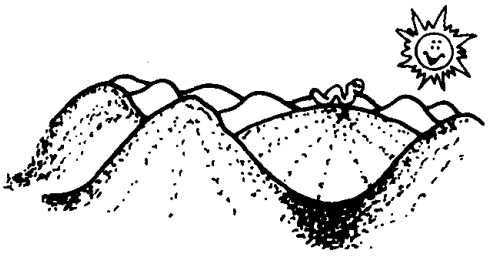
Activity 29
Water Conservation
Life on Dune



Subject Area: Science, Language Arts

Objectives:
1. The student will list uses of water in order of importance to life.
2. The student will use creative writing to describe what life would be like without water.

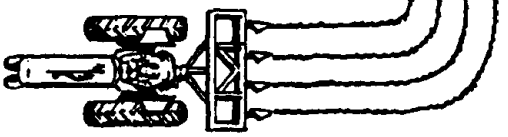
Suggested Grade Level: 5-6

Background: Suggested Water Use List: (Not Ranked)

Recreation --	Swimming
	Boating
	Fishing
	Water Skiing
	Ice Skating
Industrial --	Cleaning Agent
	Cooling Equipment
	Using water as a base (Herbicides, Paint, Pesticides)
	Irrigation for crops
	Fighting Fires
	Generate Electricity
	Cool Engines
Personal --	Ice
	Drinking Water
	Showers
	Wash Clothes
	Wash the car
	Dish Washing
	Sewage
	Irrigating lawn and garden
	Uses by Wildlife

Water Use List Adapted From:
1. Learning with Otis

Materials:
1. Life on Dune Worksheet



Procedure:

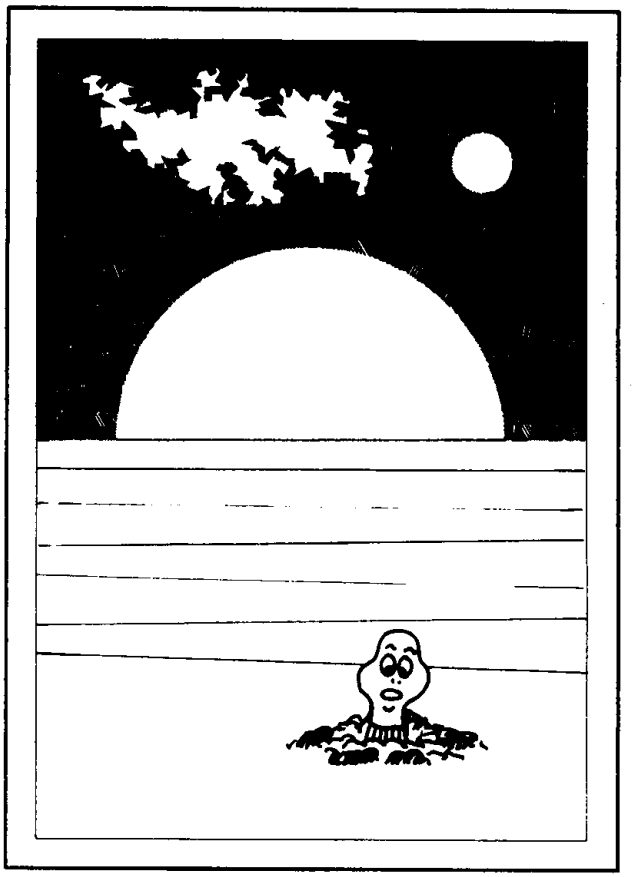
1. Ask students to brainstorm the many uses of water. List them on the chalkboard, (Don't forget irrigation for farming).
2. Have the students rank the uses from step 1, in order of importance (their opinion). This could be done in small groups or as an entire class.
3. Discuss why some uses are more important than others, so students again realize how important water is in our lives. How important is it that we take care of our water?
4. Handout Life on Dune questions and have students complete them.
5. Discuss student answers. Continually remind them of how important it is that we conserve and protect our water.

Additional Activity:

1. Worksheet 2 "Water Puzzle"

Water Puzzle Adapted From

1. Learning with Otis

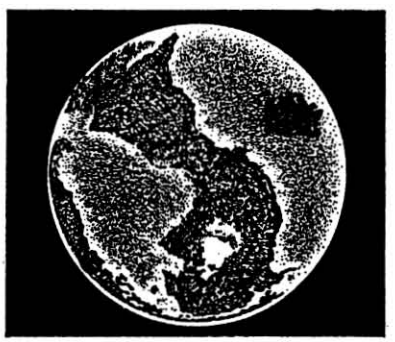


Worksheet 1

Life on Dune

Here is your chance to be a science fiction author. Imagine that you are the author and have to create Dune, the water deficient planet. Describe the following aspects of Dune. When finished, your descriptions will be compared to the real author's, Frank Herbert. Good luck and use your imagination. Remember there is a water shortage on Dune.

1. Describe what the people on Dune would be like. How would they look and how would they be different from people on Earth?

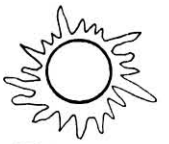


2. How would you have them dress?

3. Describe the vegetation and animal life on your planet.

4. Describe the methods you are going to use on this planet to save water.

5. Describe how the rich could use water to show their wealth.



Suggestions for Answers*

Life on Dune

1. Describe what the people on Dune would be like. How would they look and how would they be different from people on Earth?

   "The woman looked as wrinkled and desiccated as any member of the mob that had greeted them along the way from the landing field that morning. Every native she had seen looked prune dry and undernourished."

2. How would you have them dress?

   "The people on the planet wore "stillsuits" a body-enclosing garment invented on the planet. Its fabric is a micro-sandwich performing the functions of heat dissipation and for bodily wastes. Reclaimed moisture is made available by a tube from catchpockets."

   "**Catchpocket**: Any stillsuit pocket where filtered water is caught and stored."

3. Describe the vegetation and animal life on your planet.

   "She glanced out to the right at a slope humped with a wind troubled gray-green of bushes--dusty leaves and dry claw branches."

   "Paul's mind, each with its picture imprinted by the book's mnemonic pulse: saguaro, burro bush, date palm, sand verbena, evening primrose, barrel cactus, incense bush, smoke tree, creosote bush.... kit fox, desert hawk, kangaroomouse...."

4. Describe the methods you are going to use on this planet to save water.

   "**Dew Collectors or Dew Precipitators:** Egg-shaped devices about four centimeters on the long axis. They are made of chromo plastic that turns a reflecting white when subjected to light, and reverts to transparency in darkness. The collector forms a markedly cold surface upon which dawn dew will precipitate. They are used by Fremen to time concave planting depressions where they provide a small but reliable source of water."

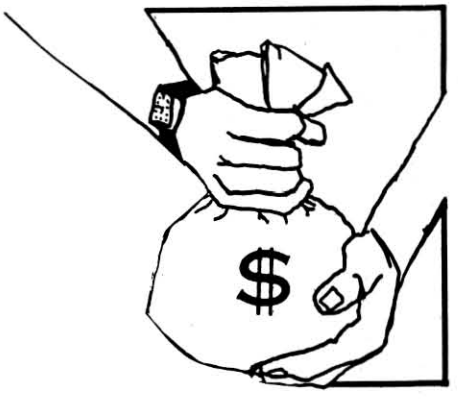
   "**Windtrap:** A device placed in the path of prevailing wind and capable of precipitating moisture from the air caught within it."

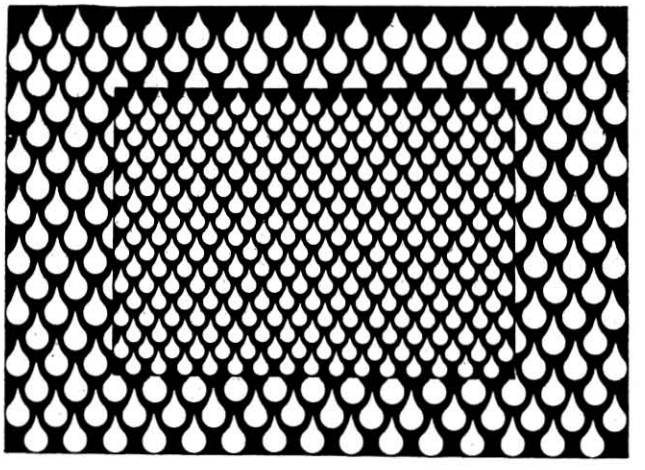
5. Describe how the rich could use water to show their wealth.

Growing date trees outside their castles: "Those are date palms" he said. "One date palm requires forty liters of water a day. A man requires but eight liters. A palm, then, equals five men."

"Beside each plate on the dining table stood a flagon of water. There was enough water along the table, the Duke estimated, to keep a poor family alive for more than one year."

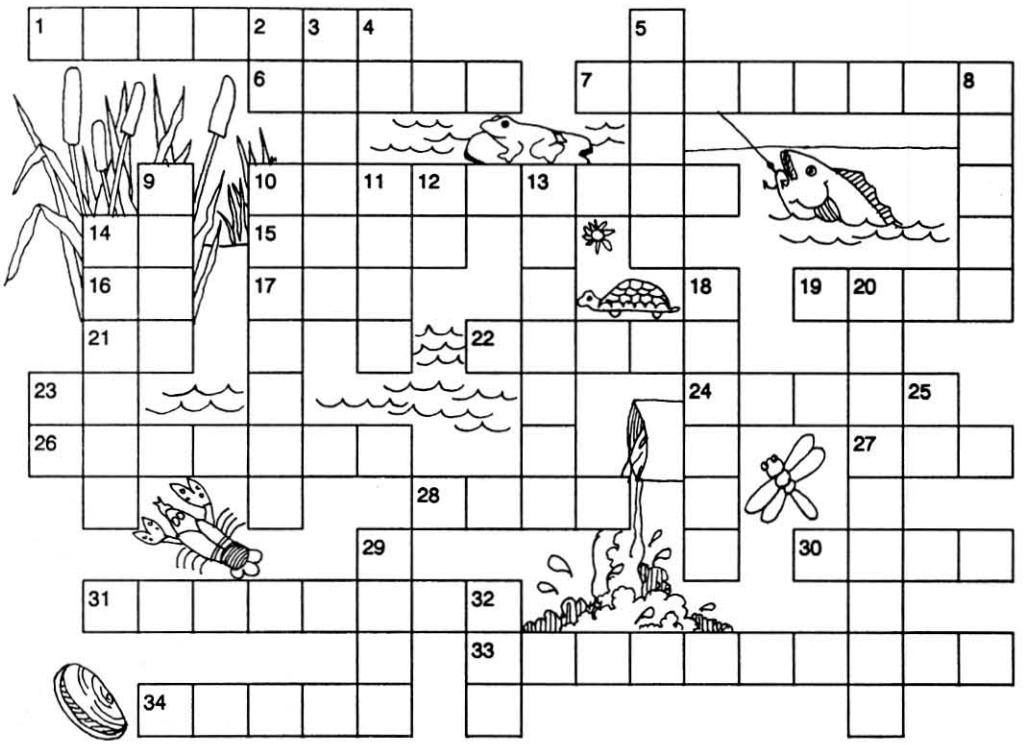
* quotes from Dune, Copyright 1965 by Frank Herbert.





Name _____

Water Puzzle



Across

1. Immature frog.
6. Most important liquid
7. Tall plants at water's edge
10. Contamination of nature.
14. Abbreviation for Michigan
15. Well traveled path.
16. Who is responsible for pollution.
17. Writing fluid.
19. Part of the pond where water meets land.
21. Slang for "be quiet".
22. Missouri is one.
23. Lives, exists.
24. Not dirty.
26. National government.
27. Long-nosed armored fish.
28. Large-mouth or small-mouth game fish.
30. Winter precipitation.
31. Micorscopic decomposers.
33. Fruit that is 97% water.
34. Single-celled water plants.

Down

2. Ouch!
3. A small pond or waste-water lake.
4. Extraterrestrial (abbr.)
5. Short for "alligator".
8. Reptile with no arms or legs.
9. Finned animal in water.
10. The first three grades.
11. Large body of fresh water.
12. Abbreviation for learning disability.
13. Reptiles with hard shells.
14. Clam-like invertebrate.
18. Runner-up, _____ place.
20. Large insect found near water.
23. Supposing that.
25. North America (abbr.)
29. One of the Great Lakes.
32. Feeling inspired by a waterfall.

Adapted from: Conservation for Children

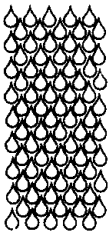
Activity 30
Water Conservation
Surface Water - Groundwater Quality

Subject Area: Science, Language Arts

Objectives:
1. Students will learn how water quality can impact various uses of surface water and how surface water can be protected from various pollutants.
2. The students will rate the pollutants that often get into water and limit its uses.

Suggested Grade Level: 5-6

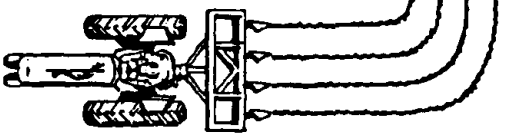
Background: Water Source Definitions.



1. **Surface Water Supplies:** Water that is on the earth's surface that is available for us to use for many purposes. Examples are water in streams, rivers, ponds and lakes. Streams and rivers get water from storm and snow melt runoff and from springs that release water from groundwater sources. Ponds and lakes receive water from streams, rivers and spring flows.
2. **Groundwater Supplies:** Water that seeps or percolates into the soil and is stored in an aquifer (water bearing material like gravel) where we can pump it out to use.

Water Quality Definitions -- Here are definitions of six classes of pollutants that could get in our lakes and stream water.

1. **Sediment:** Soil that has been washed off a field by water or blown off by the wind. It often damages streams, ponds and lakes.
2. **Debris:** Loose materials that can be washed or blown into a water supply. Examples are paper, cans, bottles, dead plants, dead animals, plastic containers, etc.
3. **Nutrients:** Substances that are necessary for plant growth. Nutrients in the soil are taken up by plant roots and used to produce plant growth. Fertilizers are nutrients that are applied by people to increase plant growth and crop production. Two common nutrients that are a problem in water supplies are nitrates and phosphates.
4. **Pesticides:** Man made materials that are used to kill pests. Examples are: Herbicides are used to kill certain plants. Insecticides are used to kill insects. Rodenticides are used to kill rodents.
5. **Algae:** Plants that grow excessively in water when the water contains a rich supply of nutrients. Too much algae in lakes can reduce the numbers of fish and other aquatic life.



6. **Soaps and Detergents:** Materials used for cleaning that can get in water supplies. Examples are hand soap, dish soap, clothing soap, degreasers and paint thinners. These are difficult to remove at sewage treatment plants.

Materials: None needed.

Procedure:

1. Discuss and identify local surface water supplies and groundwater supplies. How important are they to people and wildlife?
2. Refer to Water Quality Definitions to lead a brief discussion on surface water pollutants.
3. Make a transparency and one copy of the pollution rating chart and have class suggest answers for the projected chart. Have one student keep score. Color the "P.M." blocks red and the "Y" blocks blue for a visual aid.
4. Discuss how surface water could be protected from these pollutants. Refer to the Waste Disposal Guide for disposal information.

Sediment: Maintain cover on the soil--either growing crops or crop residue. Use other conservation practices such as terraces, contour farming, waterways, and grass strips around ponds and lakes. These practices reduce runoff, store water in soil and increase spring flow.
Fertilizer or Nutrients: Test soil to determine amount of fertilizer needed. Apply only enough for the current years crop. Excess fertilizer could be washed into surface water supplies or find its way into the groundwater.
Pesticides: Apply chemicals only when necessary and according to the directions on the label. Use management controls such as rotating crops instead of using pesticides. (Example: Corn rootworm and corn borer larvae must feed on corn plants. When corn crop is alternated with small grains such as oats or wheat in a field, most of the larvae will die during the year of the small grain. Weeds can be controlled by mowing without herbicides during the year of the small grain or alfalfa.
Algae: Will be controlled when you control sediment and nutrient.
Soaps and Detergents: Treat by running through city sewage treatment plants or farm septic systems.
Debris: Do not leave debris (paper, cans, junk, tree limbs) in water courses where it can be washed into a water supply. Dispose of waste according to attached disposal guide. Students could begin managing debris by properly disposing of gum and candy wrappers and school papers.

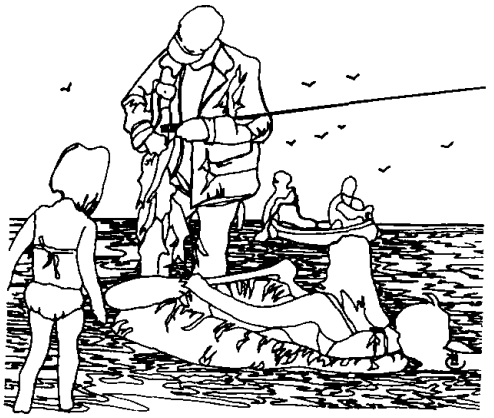
Pollution Rating Chart for Surface Water

Could you tolerate some of the pollutants in the water uses listed in the chart below? Place a "Y" for Yes and an "P.M." for proper management needed to explain whether you could tolerate the pollutants in the diagram with the listed water uses.

Y = Yes this pollutant is okay in this water use.

P.M. = Proper management is needed to keep these pollutants out of the listed water use.

		Sediment	Nutrients: Nitrogen and Phosphorus	Pesticides	Algae	Soaps and Detergents	Debris
Recreation:	Swimming						
	Boating						
	Fishing						
	Water Skiing						
Industrial:	Cleaning Agent						
	Cooling Engines						
	Irrigation						
	Firefighting						
	Electricity Generation						
Personal:	Drinking Water						
	Showers						
	Washing Dishes						
	Sewage Transport						
	Irrigation						



Worksheet 1

Additional Activity
Groundwater Quality

Objectives: Students will learn how water is stored in groundwater aquifers and how pollutants enter the water.

Materials:
1. Two quart glass jars - one 3/4 full of soil and the other 3/4 full of gravel.
2. one orange
3. one measuring cup
4. Red food coloring

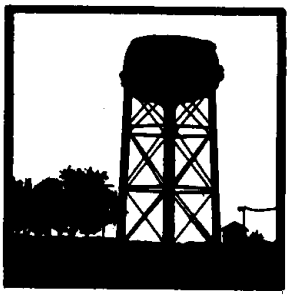
Background:

Nebraska has one of the best supplies of groundwater in the United States. It is contained in different types of aquifers (water bearing materials) beneath the soil surface. The best aquifers are gravel or coarse sand and gravel mixtures. In some areas water is just beneath the surface while in others, it may be up to several hundred feet deep. There are still other areas where groundwater is either too deep to feasibly pump or of too poor a quality to be of value. In some areas, groundwater may be non-existent.

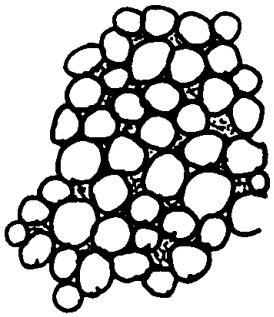
Aquifers can be recharged by water percolating downward from streams, lakes and even from rainfall on the soil surface. Water percolating through the soil and through the geologic formations can carry pollutants into the groundwater supply. Good quality water can be polluted by this process.

Some of the pollutants that can get into groundwater through mismanagement are fertilizers, pesticides, soaps or detergents, sewage wastes and fuels. Proper management of these will usually keep them out of the groundwater.

Procedures:



1. Ask the students where they get their drinking water, (groundwater or surface water source). Only two cities in Nebraska get part of their drinking water from surface water sources (Omaha and Crawford) A few others have the potential to if necessary. Ask where the local irrigation water or manufacturing water comes from--surface or ground.
2. Have the students demonstrate an aquifer. Fill two quart glass jars three-fourths full, one with gravel and the other with medium texture soil. Pack the materials lightly and pour one cup of water into each. Compare the rate that the water moves through the two materials. Notice that the water moves faster through the gravel because the particles are more coarse (larger). The saturated zone represents a water bearing aquifer and the top of the water represents the water table. This is the way groundwater lies beneath the soil. Wells are drilled into the aquifer and pipes are inserted to pump the water out.
   Now, put a lid on the jars and gently tip them to a horizontal position. Notice that the gravel gives up the water and it easily flows out. Notice



also that the soil does not give up the water and it is held around the soil particles.

The small soil particles have more surface area than the gravel. Water in the soil is held as a thin film around the individual soil particles so tightly that it can't be poured off. Gravel has less surface area so some of the water is held in the pore space between the gravel particles. Demonstrate this by cutting an orange in four pieces. Before, there is enough peeling to cover the whole orange. After cutting, there is more surface area and not enough peeling to cover it. Soil is a good median to grow plants because it holds more moisture in the root zone that can be used by the plants. Gravel is poor for growing plants, but is a good aquifer to store water in.

3. Now have the students add one half cup of water with red food coloring to each of the jars. The food coloring is to represent a pollutant. Again, compare the rate that the pollutant moves to the groundwater. Are people placing pollutants where it can be washed into a groundwater aquifer? Could management practices be used to eliminate the threat to the groundwater? Remember, some pollutants in drinking water can be injurious to your health.
4. Discuss management techniques for the pollutants that have been mentioned.
   a. For fertilizers (especially nitrogen and phosphorus), one should apply only the amount that the current crop will use in one growing season. Irrigate properly so the water does not go below the crop root zone. When irrigation water goes below the root zone of plants, it carries some nutrients out of the reach of plants and the nutrients are wasted.
   b. Pesticides should be applied according to the directions on the package. Excessive application of pesticides can cause pollution. On the soil, some chemicals decay faster than others. The ones that decay the fastest pose the least threat to groundwater.
   c. Water containing soaps and detergents should be disposed of through the cities sewage disposal system or through a farm septic system. These allow micro-organisms to digest them or filters to remove them in the sludge. Make a trip to the treatment plant and get an explanation from the operator.
   d. Sewage wastes should be run through the treatment systems. Livestock manures should be spread on the cropland soil in the summertime to increase a biologic breakdown by micro-organisms.
   e. Care should be taken to see that fuels (gas or diesel fuel) are not spilled on the soil. Waste hydrocarbons should be recycled. Contact a local oil company for recycling information.
   f. Consult the waste disposal guide for improving waste management. Make a copy for the students to take home.

Waste Disposal Guide

The following chart will help you dispose of many common materials that could become pollutants. The letters S, L, H, and R as defined below will help you decide how to dispose of the following potential pollutants. Ask your city officials for names of hazardous waste collectors and recyclers. Note! There is always the possibility of eliminating waste materials by transferring them to another responsible person to use for the purpose for which they were intended.

Legend

S - Those that can be poured down a sewer system.
L - Those that can be placed in a land fill dump.
H - Those that should be delivered to a hazardous waste collector.
R - Those materials that can be recycled.

Type of Waste	S	L	H	R
Household				
Aerosol cans (empty)		L		
Alcohol based lotions (aftershaves, perfumes etc.)	S			
Aluminum cleaners	S			
Ammonia based cleaners	S			
Bathroom cleaners	S			
Bug sprays			H	
Disinfectants	S			
Drain cleaners	S			
Floor care products			H	
Furniture polish			H	
Hair relaxers	S			
Medicine (expired)	S			
Metal polish with solvent			H	
Nail polish (solidified)		L		
Nail polish remover (evaporated)		L		
Oven cleaner (lye based)		L		
Permanent lotions	S			
Toilet bowl cleaner	S			
Tub and tile cleaners	S			
Window cleanter	S			
Garage and Construction				
Aerosol cans (empty)		L		
Anitfreeze	S			
Auto body repair products (non-lead)		L		
Automatic Transmission fluid			H	R
Battery acid (or battery)			H	R
Brake fluid			H	
Car Wax with solvent			H	
Cutting oil			H	
Diesel fuel			H	
Gasoline			H	R
Glue (solvent based)			H	
Glue (water based)	S			
Kerosene			H	R
Metal polish (with solvent)			H	
Motor oil			H	R
Other oils			H	
Paint - latex (dried out)		L		R
Paint thinner and stripper			H	
Paint - oil based			H	R
Paint stripper (lye based)	S			
Paint brush cleaner with TSP	S			
Paint brush cleaner with solvent			H	R
Rust remover (with phosphoric acid)	S			
Turpentine			H	R
Varnish			H	
Windshield washer solution	S			
Wood preservative			H	
Farm and Miscellaneous				
Ammunition			H	
Dry cleaning solvents			H	R
Fertilizer		L		
Fiberglass epoxy			H	
Gun cleaning solvents			H	R
Mercury batteries			H	
Old fire alarms		L		
Pesticides			H	
Photographic chemicals (mixed and properly diluted)	S			
Shoe polish		L		

Activity 31
Water Conservation
Water And Agriculture

Subject Area: Science, Social Studies

Objectives:
1. The students will be able to discover the need for irrigation.
2. The students will discover the different methods of irrigation in Nebraska.
3. The students will be able to describe where the majority of irrigation water comes from.
4. The students will read a bar graph to answer questions.

Suggested Grade Level: 5-6

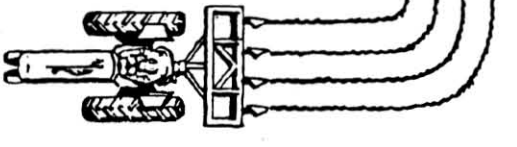
Background: Nebraska ranks second, behind California, in total irrigated acres, with Texas being third. About 73% of water used for irrigation is pumped from wells. "Every dollar worth of irrigated crop production adds $8.00 to other parts of Nebraska's economy." The main types of irrigation systems in Nebraska are sprinkler irrigation and surface irrigation. Sprinkler irrigation is water that is sprayed through the air and falls to the ground like rain. This includes center pivot systems and portable handling systems. Surface irrigation is water applied on the ground, (at ground level) it flows by gravity over the surface of the fields. These systems include ditches or furrows and gated pipe that is laid on the surface of the soil.

Materials:
1. Worksheets 1,2, and 3
2. Reference Materials (dictionaries, encyclopedias, etc.)

Procedure:
1. Ask students to define irrigation in their own words. Write a class definition on the chalkboard.

2. Separate in to small groups. Each group can research a type of irrigation (surface, sprinkler, drip, sub-surface, etc.) and give a brief report about their topic. How does it work? Where is it used? What is the usual source of water?

3. Invite a local farmer to the classroom, or visit his fields. Have the farmer explain how irrigation works on his farm.



4. Handout worksheets 1 and 2. Read the information and answer the questions. Worksheet 3 can be discussed to give students an idea of where irrigation wells are located in Nebraska.

Adapted From:

1. Nebraska Curriculum Guide for Nebraska Vocational Agriculture Instructors

2. Water and Its Conservation

Name _____

Irrigation

Irrigation has become one of the most important factores in making Nebraska a leading state known for its agricultural productivity. During the last two decades, tapping groundwater resources to help meet agricultural demand for water has increased at such a rapid pace that now more than 73 percent of the water used for irrigation is pumped from wells. Using Worksheet 2, answer the following questions.

1. Approximately how many irrigation wells were installed by 1936? _____

2. How many irrigation wells were registered by January 1, 1984? _____

3. How large of an increase in the number of irrigation wells is this? _____

4. In the year 1956 there was a sharp increase in the number of irrigation wells. Using the graph, find another year with a sharp increase. Write that year. _____
   Why do you suppose this happened? _____
   _____

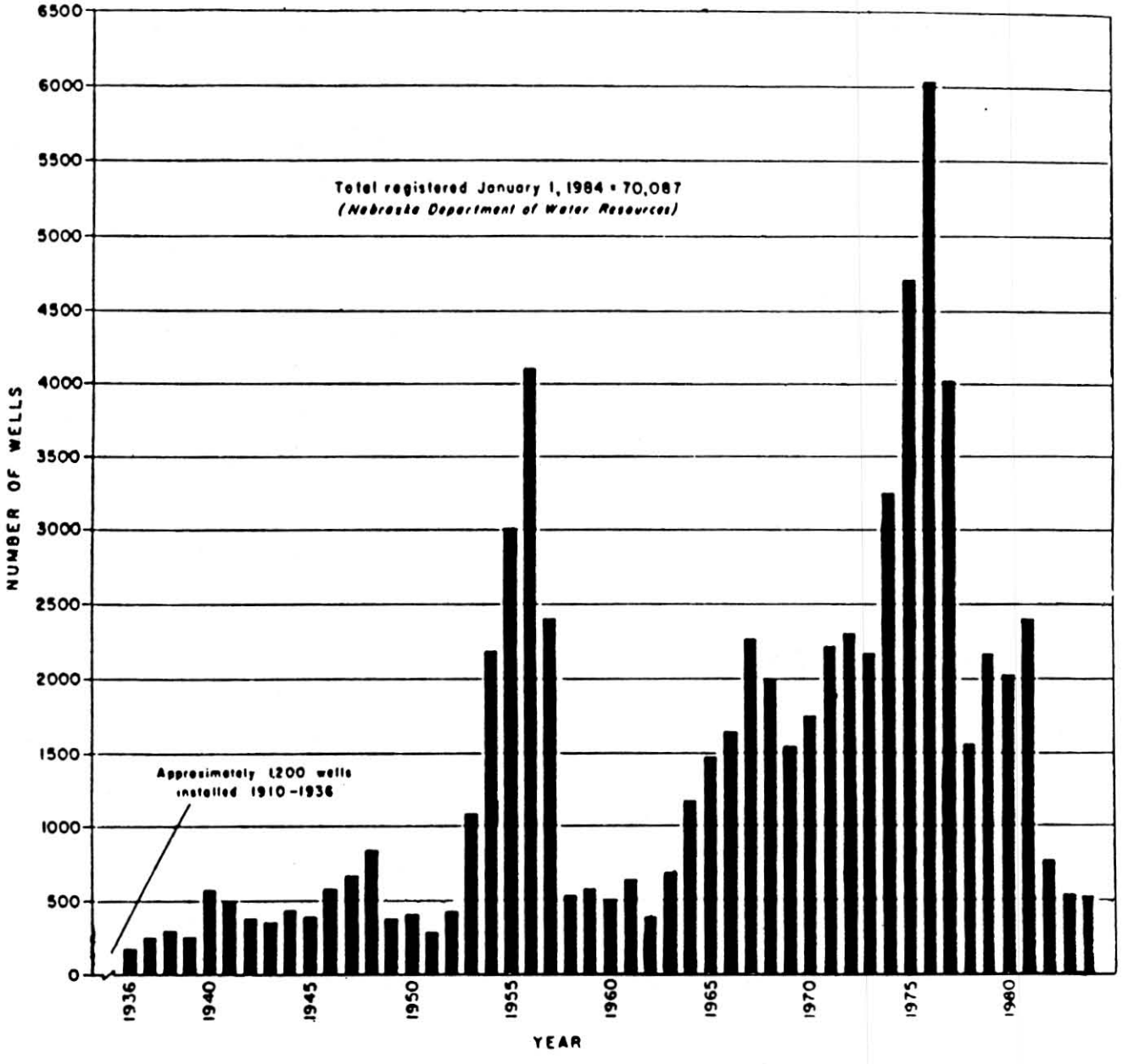
5. In what year were there 2000 irrigation wells registered? _____

6. What might be the reason for such a sharp dropoff of new irrigation well installation in recent years? _____
   _____

7. Between 1936 and 1984, which year had the lowest number of irrigation wells installed? Which had the highest?
   Lowest _____ Highest _____

Name_____

ANNUAL INSTALLATION OF IRRIGATION WELLS IN NEBRASKA THROUGH 1983



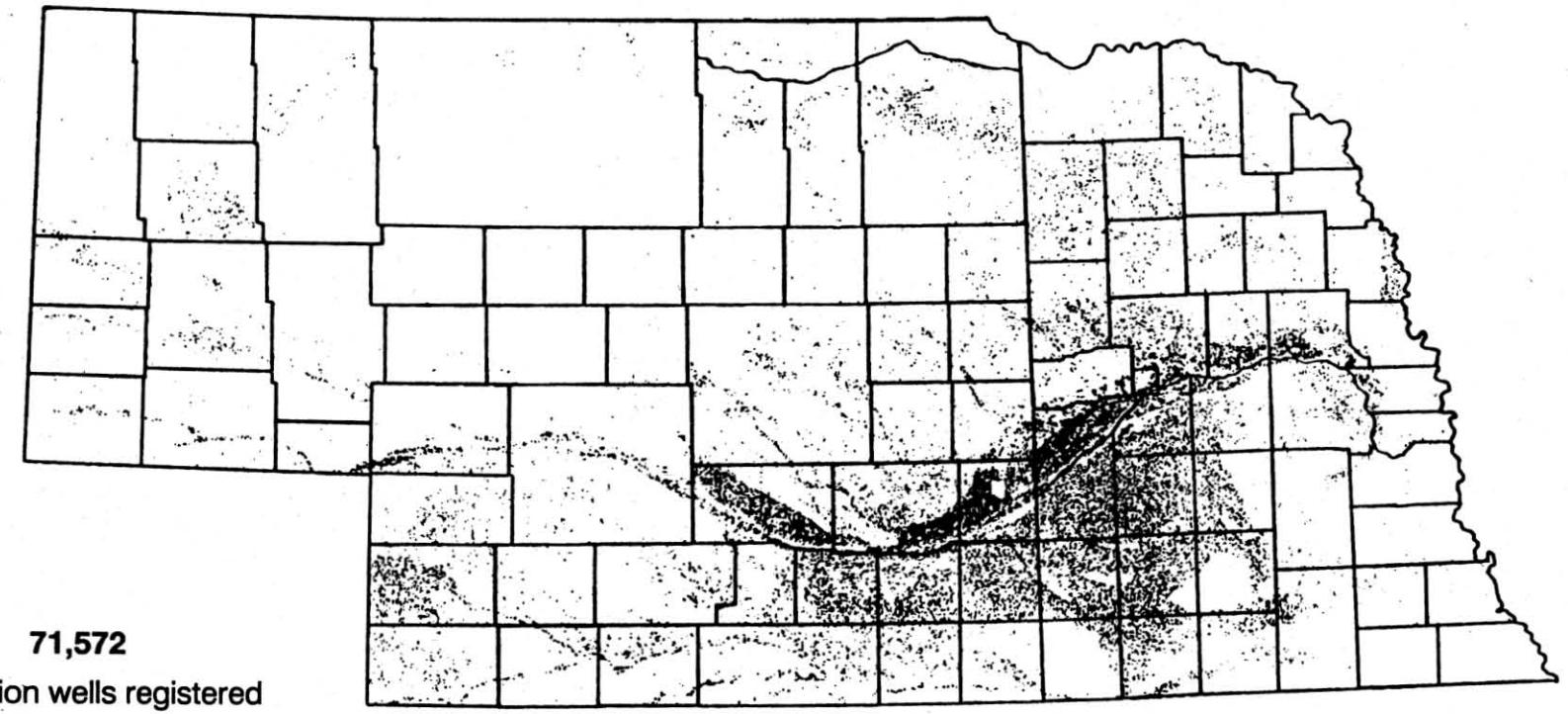
(estimated from historical surveys and irrigation well registration data)

Conservation and Survey Division
Institute of Agriculture and Natural Resources
The University of Nebraska–Lincoln

Worksheet 2

Registered Irrigation Wells in Nebraska

(as of January 1, 1988)



71,572

Total irrigation wells registered January 1, 1988 (Nebraska Department of Water Resources)

Prepared cooperatively by U.S. Geological Survey and Conservation and Survey Division, IANR, The University of Nebraska – Lincoln.

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Activity 32
Water Conservation Activities
Simple Water Filter

Subject Area: Science

Objectives:
1. The students will build and use a simple water filter.
2. The students will realize the impurities in water.

Suggested Grade Level: 5-6

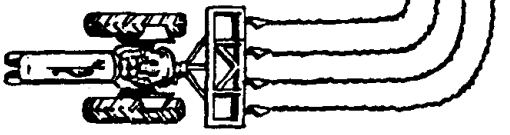
Background: Water going through the filter should be cleaner than what was poured in. Although it appears clean, it is **not** pure enough to drink.

Materials:
1. 1 qt. plastic bottle (w/ bottom cut off)
2. Small piece of wire screen
3. Pebbles
4. Course sand
5. Fine sand
6. Dirty water (pond water or puddle water would be good)

Procedure:
1. Cut the bottom out of the bottle, invert the bottle, and place the screen in the neck.
2. Place a layer of pebbles, then a layer of course sand, then fine sand.
3. Pour tap water through to remove dust and clean the filter.
4. Slowly pour the dirty water through the filter.
5. Notice the difference in water. Which would you prefer to use? What about animals, if we dirty their water, what happens to them?

Additional Activity:
1. Have a guest speaker, about water purification and cleaning.

Adapted From:
1. The Story of Drinking Water



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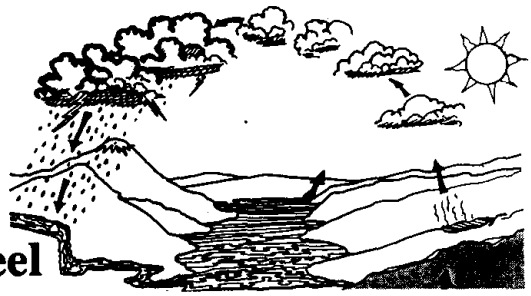


Activity 33
Water Conservation
Nature's Waterwheel

Subject Area: Science

Objectives:
1. The students will be able to identify and describe what groundwater is.
2. The students will be able to identify and describe how the hydrologic cycle operates.

Suggested Grade Level: 5-6

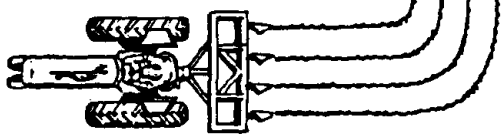
Background: Hydrology is the study of the movement and distribution of the waters of the earth. In nature, water circulates through a system called the water cycle or hydrologic cycle. This cycle begins when heat from the sun causes ocean water to evaporate and become water vapor. The atmosphere holds the water vapor while the vapor gradually cools and forms clouds. The water eventually falls as rain or snow. Most rain and snow falls back into the oceans. But some falls on the land and flows back to the seas or soaks into the land (groundwater) which eventually is used by nature and transpires or evaporates into the air completing the cycle.

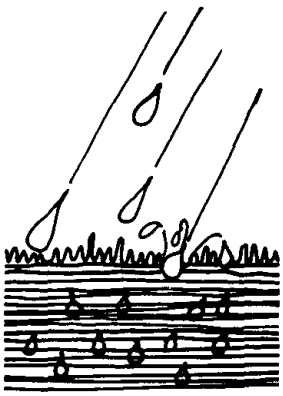
There are two main sources of fresh water: surface water and groundwater. Surface water flows over the land in lakes, rivers, and streams. Groundwater seeps through the soil or through cracks and cavities in rock.

Groundwater is water beneath the surface of the earth. It is the source of water for wells and springs. Groundwater provides much of the fresh water in the United States. Most rural areas and some cities depend heavily on groundwater for their needs.

Groundwater accumulates chiefly from rain that filters through the soil. It also forms from water that seeps into the ground from lakes and ponds. The water settles into the pores and cracks of underground rocks and into the spaces between grains of sand and pieces of gravel. A layer or bed of such porous materials that yields useful amounts of groundwater is called an aquifer. Wells are drilled down to an aquifer to draw groundwater to the surface.

The surface of groundwater, called the water table, drops when more water is withdrawn that can be replaced naturally. In some areas that have large





population or little rainfall, the groundwater supply may have to be recharged artificially. However, many regions of the world are using up the groundwater faster than aquifers are being recharged. This lowering of the water table caused special problems in coastal areas, because salt water from the ocean enters reservoirs of groundwater.

Pollution of groundwater is a serious problem, especially near cities and industrial sites. Pollutants that seep into the ground can come from contaminated surface water, leaks from sewer pipes and septic tanks, and gasoline and chemical spills. Groundwater may also be polluted by chemical fertilizers and buried radioactive wastes.

Materials:

1. Water
2. Hot Plate
3. Pie Pan (tin or aluminum, smaller would be better)
4. Ice cubes
5. Worksheets 1 and 2
6. Glass jar (such as a mayonnaise jar)

Procedure:

1. Place ice cubes in pie pan, to begin cooling pan.
2. Place jar of water on hot plate and wait for it to boil.
3. While waiting for water to boil, pass out Worksheet 1. Read together and discuss.
4. Hold the pan of ice cubes over the steam from the boiling water. Steam from the boiling water condenses when it hits the cold ice cube pan. The condensed water then falls back to be changed to steam again, creating a water or hydrologic cycle.
5. Discuss the demonstration relating to Worksheet 1. Discuss how water seeps or infiltrates into the soil creating (and adding to) groundwater.
6. Have students turn Worksheet 1 over. Pass out Worksheet 2. Ask students to complete Worksheet 2 from memory.

Additional Activity:

1. Construct a classroom water cycle that can last all school year. In the bottom of a fish bowl, aquarium or large glass jar, place an 1- inch layer of gravel for drainage. Add a layer of peat moss and a layer of soil (potting soil will work). Plant ferns, mosses or other plants in the terrarium. Water lightly and cover. You should not have to add more water. The plants

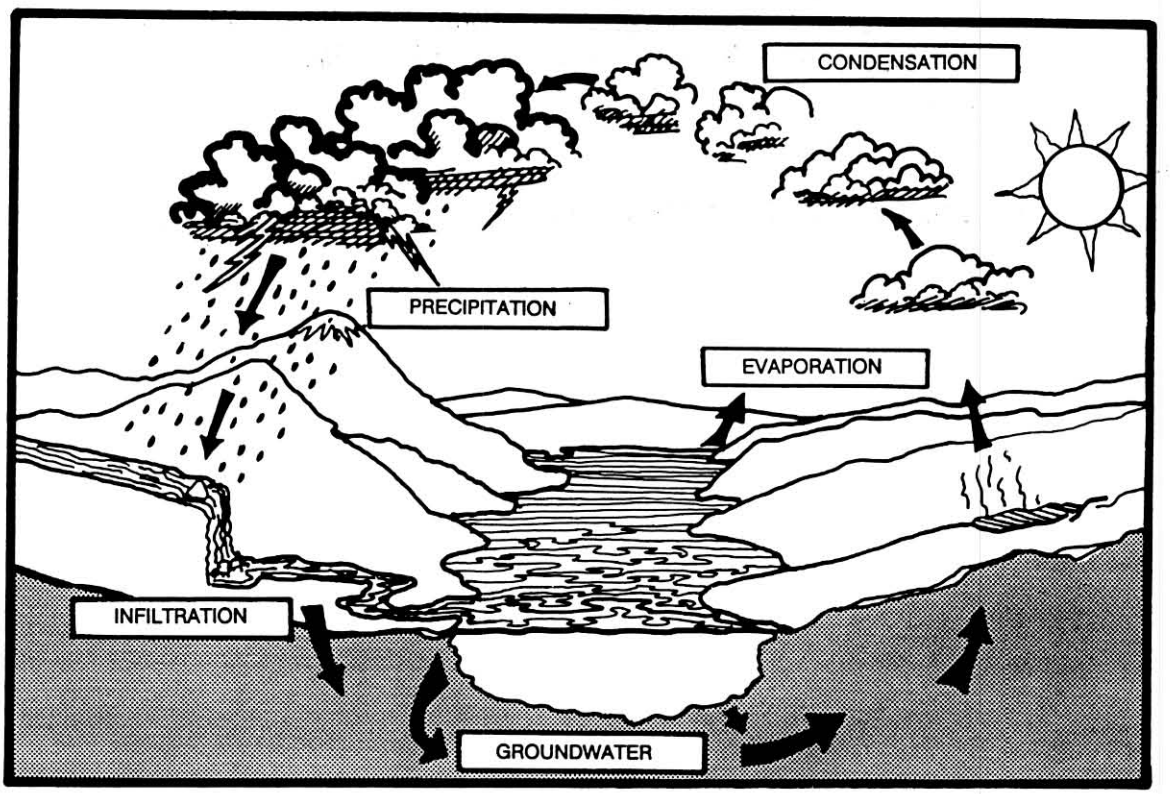
will take the moisture from the soil and release it through their leaves. The water will condense on the terrarium and fall back into the soil. The terrarium works in the same way as the hydrologic cycle works on the earth.

Adapted From:

1. Groundwater: A Vital Resource

Name_____

Nature's Waterwheel



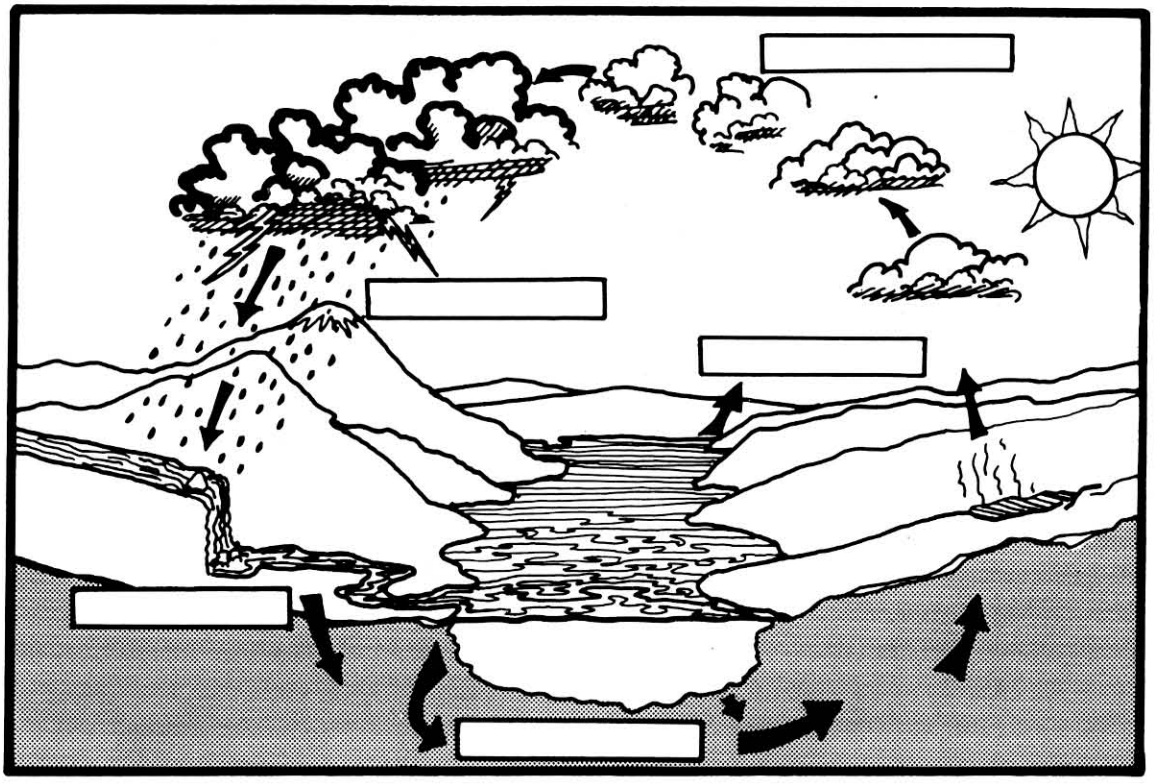
Water Cycle (Hydrologic Cycle)

Think about the water on the ground. The water on the ground evaporates when the ground gets warm. Think about the warm air rising. The air and water vapor expand and rise high. The air is cooled when it rises. When the air is cooled, the water vapor condenses. The water vapor condenses to make clouds. Cloud drops come together to make bigger and bigger water drops. The bigger drops are rain. Rain falls on the ground. The water evaporates again. The whole cycle starts again. Water vapor condenses. Rain falls to the ground. This is the water cycle.

Adapted from: Groundwater: A Vital Resource

Name _____

Nature's Waterwheel



Water Cycle _____

Condensation – The changing of water vapor to liquid.

Evaporation – The changing of water into water vapor

Groundwater – Water found below the surface of the earth.

Hydrologic Cycle – Process involving the circulation and distribution of water on the earth.

Inflitration – The process by which water seeps into the soil.

Precipitation – Forms of condensed water vapor that are heavy enough to fall to the earth's surface, such as rain, snow, sleet, hail and fog.

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Activity 34
Water Conservation
Illustrating the Water Table

Subject Area: Science

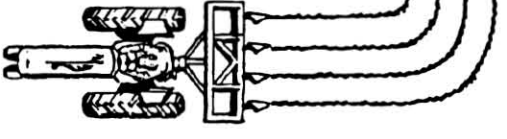
Objectives:
1. The students will be able to understand and describe the water table.
2. The students will be able to recognize and illustrate that the water table is a contributing factor in the existence of streams, swamps, and lakes.

Suggested Grade Level: 5-6

Background: Groundwater is the water that has accumulated and been stored beneath the surface of the earth. Groundwater originates as precipitation, either rain or snow, which filters through the soil. Water shares with air the space between soil grains and rocks. Water will not go below clay or impervious rock. Contrary to popular myths, groundwater doesn't flow through mysterious underground rivers, nor is it stored in underground lakes. It moves from place to place by migrating through pores and fractures in bedrock and through voids in unconsolidated sands and gravels. As more water sinks into the ground, it begins to collect above the bedrock or dense soil. When the ground has as much water as it can hold, it is said to be saturated. The ground becomes saturated from the rock or dense soil up, and the top level of this water rises towards the surface. This uppermost level is called the water table. The area of dry ground above the water table is called the zone of aeration. After heavy rains, the table is nearer the surface (it rises), and in dry weather it drops again. Wherever land surfaces dip below the water table, groundwater flows out the surface. This forms springs, swamps, or lakes.

Materials:
1. Wide-mouth glass jar
2. A glass
3. Crayons
4. Water
5. A mixture of sand and gravel

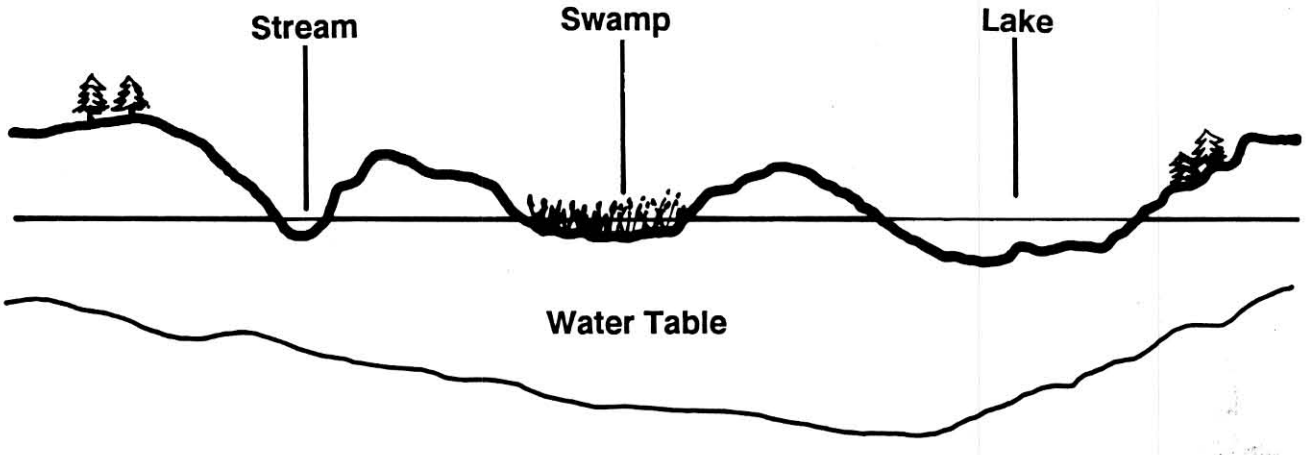
Procedure:
1. Fill a wide-mouth glass jar three-fourths full of sand and gravel mix. Use a glass to pour water down the side of the jar until the water level rises about half way up the side of the jar. This water level should represent the level of the water table. Use a marking instrument of some kind to mark the present level. Show the students that as you add more water, the water table will rise.

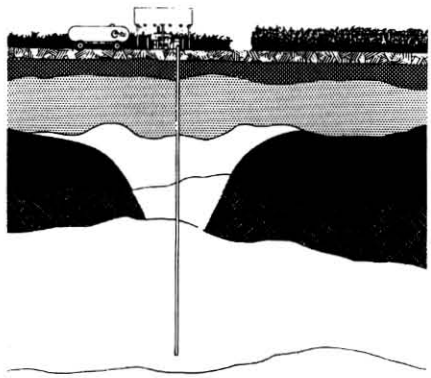


2. On the chalkboard show that wherever the land surface dips below the water table, groundwater flows out to the surface. This forms springs, swamps or lakes.

Adapted From:

1. Groundwater: A Vital Resource





Activity 35
Water Conservation
Wells and Groundwater

Subject Area: Science

Objective:
1. The students will be able to describe how an underground well works and how it relates to groundwater level.

Suggested Grade Level: 5-6

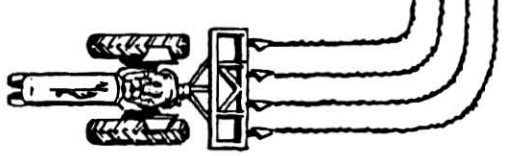
Background: Groundwater makes up 96% of the world's total fresh water resources. Approximately 118 million Americans, half of the country, depend on ground water for their drinking water.

Materials:
1. Pencil
2. Fine wire screening
3. Small wire for fastening
4. Medicine dropper or straw
5. Drinking glass
6. Coarse sand
7. Water

Procedure:
1. Roll the wire screening around a pencil to make a cylinder. Enlarge the cylinder so it is about 1/2" in diameter and fasten a piece of wire around it to keep it from unrolling.

2. Place the cylinder upright in a glass and then fill the glass with sand, keeping the sand out of the cylinder.
3. Pour water into the sand. The sand will absorb the water but the water will also go into the cylinder ....your well.
4. Remove water from the cylinder with the eye dropper. Additional water should go into it from the sand, but the level of water in your well should be less than at first.
5. Raise the water level again by pouring more water into the sand and observe the water level in the well.

Adapted From:
1. Groundwater: a Vital Source



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Activity 36
Wildlife Conservation
Stormy Weather

Subject Area: Language Arts, Science, Social Studies

Objective:
1. The students will be able to generalize that people and wildlife share environments.

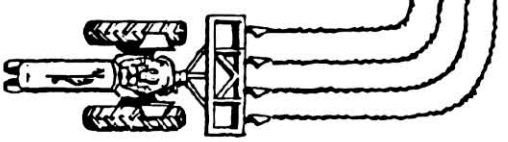
Suggested Grade Level: 5-6

Background: This activity is designed for students to experience feelings associated with the recognition that people and wildlife co-exist, and sometimes experience the same natural phenomena. During a storm, for example, most people, pets and wildlife need to seek shelter. This activity makes use of an instructional technique called visualization or guided imagery. To use this technique, read or describe, to your students, with their eyes closed to conjure in their minds. Leave time between the phrasing of your words for the students to visualize the images you are suggesting.

Procedure:
1. Tell the students they are going to try to imagine things that you will be describing. You will not be putting in all the details so the students must try to see and feel as clearly as they can the things you are describing.

2. Next have the students decide who they will be during this activity. They can be an animal of their choosing that is either a wild animal, a pet or a farm animal. The student will be visualizing things from the point of view of the animal they pick. You do not have to know what animal they choose but check to see that you have a variety of all three kinds of animals (pets, wild or farm). You may check on this by having the students write their choices on a piece of paper.

3. Read the following story, slowly with emphasis. "Now, we are ready to begin. Get yourselves in a comfortable place.Don't worry about who is sitting next to you. All of you will have your eyes closed. Just be comfortable, and do your best to imagine what you hear...It is late summer's night...there is a coolness in the air...You hear the sounds of summer...Somehow, you can feel some changes coming in the weather...In the distance, the dark sky is broken by bright flashes of lighting...The light is far away...After a long wait, a rolling rumble is heard...The lightning gets



closer...The rumbles are louder...Suddenly, the lightning flashes and lights up the whole sky...You need to find shelter, to find a safe place.

The brilliant flashes of lightning pop and crackle all around you. The noise of thunder is crashing so that the earth seems to shake...There are no longer times of quiet between the rumbles of thunder and flashes of lightning...it becomes still...You can notice scents in the air, things you can smell and feel...You begin to hear a new sound...You are not sure what it is...You again have to find shelter, if you had come out thinking the storm was gone...You need to find a place to stay dry...Suddenly, the rain is pouring down with a loud, rich sound...It rains, and rains...and rains...And then stillness...The storm has passed."

Wait a few seconds and then tell the students, "Open your eyes".

4. Ask students to describe what they saw and felt. Have them include who they were (what kind of animal), what shelter they found and what happened to them throughout the storm. How did they feel?

5. Turn the discussion to the idea that many creatures; people,pets and wildlife; share a common environment. No matter where we live in cities,country, desert, or mountains; we are not the only living creatures who live in these environments (even ants or a spider in the garden). Remind the students next time they see lightning, hear the thunder and feel the rain, to wonder where the birds, the spiders, the cats, the dogs, the fox, the cattle, the sheep, the horses, the raccoons and the bears are during the storm.

Additional Activities:

1. Use the following story instead of the rain storm story.
"It is a late winter's night. There is a stillness in the air...bright stars twinkle in the cold, crisp,winter sky...
Somehow, you can feel some changes coming in the weather...A gentle breeze begins to stir the leafless trees... A quiet snow begins to fall...The wind floats the snowflakes through the air...around and around and down...The snow touches you...The wind grows stronger...You can hear the rustle of the branches...You feel the snow pelt you as it swirls faster through the sky.
The snow falls heavier...The wind blows colder...Suddenly a gust of wind kicks up and blows a huge, dead tree down to the ground...It crashes down beside you with a loud BOOM!...and shakes the earth beneath your feet. The wind blows faster...You need to find shelter, a safe place.

Now the snow makes slapping sounds as the wind hurls it against the swaying trees...Branches creak and crackle all around you...Twigs and branches snap off...They strike the ground below...and are covered by the deepening snow...There is whiteness all around you as the blizzard fills the sky...It snows...and it snows...and it snows...And then there is stillness...The storm has passed."

2. Have the students draw pictures of what they imagined.

3. Pantomime the actions the animals took during the storm.

4. Worksheets 1 and 2, a challenging crossword puzzle.

Adapted From:

1. Project WILD

Name _____

Grades 6-8 Wildlife Federation

A Closer Look Crossword Puzzle

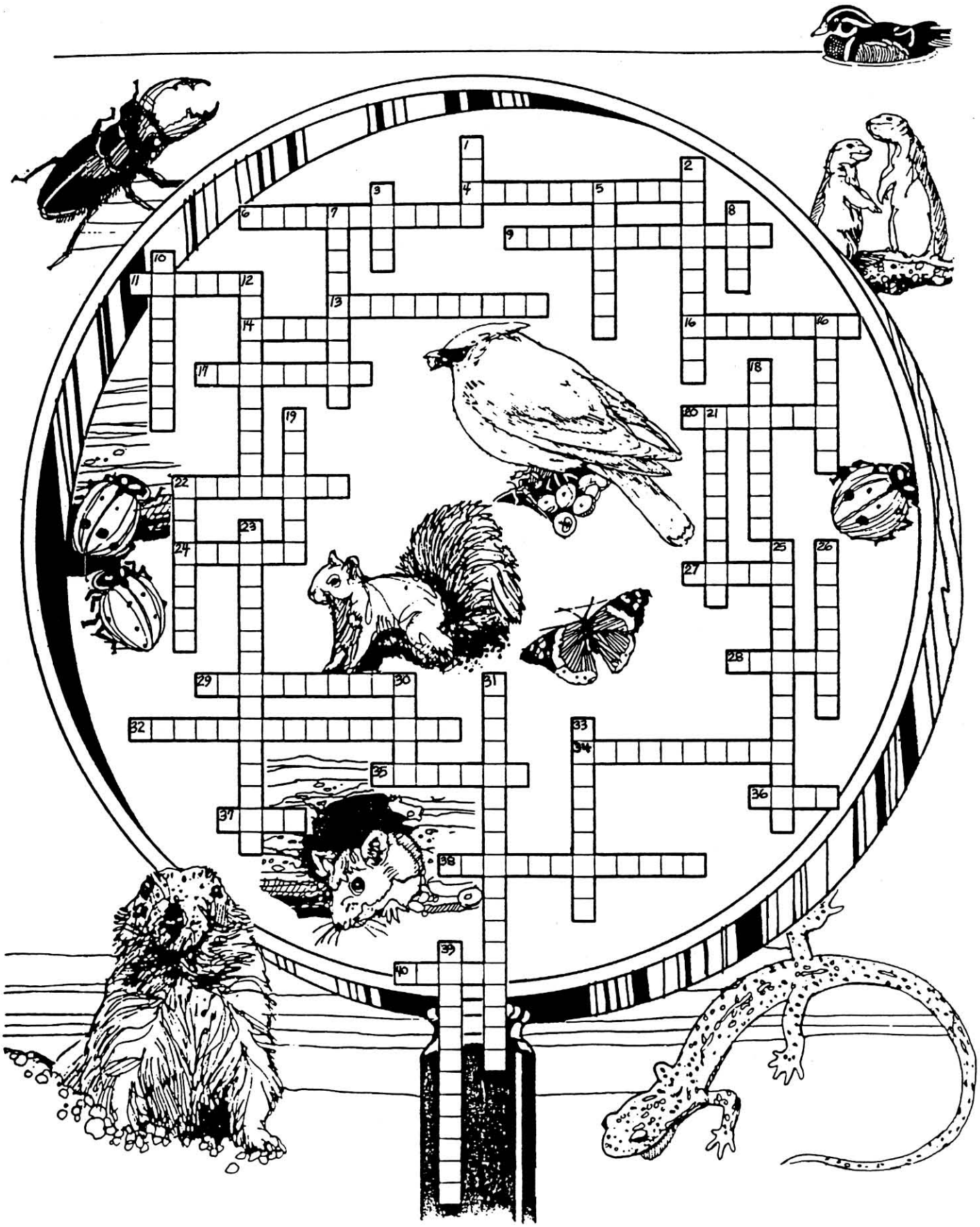
Across

4. A _____ is a reptile named for the sound it makes when threatened.
6. A mammal is a _____ animal with a backbone, hair and milk producing glands.
9. _____ is the care and protection of our natural resources.
11. If you are surrounded by tall trees you are probably in a _____.
14. An osprey often nests near a _____, so that is can catch fish.
15. If you stop, look and learn, you can _____ the world of wildlife outside your door.
17. A large mammal that communicates through whines, yelps and growls is a _____ _____.
20. A masked mammal increasingly common in suburbs and cities is a _____.
22. _____ are animals that are not tame or domesticated.
24. Gila monsters, trantulas and elf owls, live in the _____.
27. _____ is as important as food to wildlife, and is even stored in leaves and berries.
28. The _____ of the opossum includes the west coast and most of the eastern United States.
29. _____ make far away wildlife appear closer.
32. With a _____ _____, small objects appear much larger.
34. An _____ is a change in its body or the way it behaves that helps an animal or plant adjust to changes in its surroundings.
35. A _____ is a cold-blooded animal with a backbone and scales or horny plates.
36. A cold-blooded animal that spends its entire life underwater and has gills is a _____.
37. The favorite _____ of birds at feeders is black sunflower seeds.
38. Tiny birds that you can attract to your yard with bright red, tubular flowers are _____.
40. An insect has no backbone, a body that is divided into three parts and _____ pairs of legs.

Down

1. A _____ is a warm-blooded animal that lays eggs.
2. _____ are poisons used to kill pests. Some can weaken the shells of bird eggs.
3. The major threat to wildlife is _____ of habitat.
5. Nesting boxes and evergreens in your backyard can provide _____ for a variety of birds.
7. A _____ is a colorful flying insect. Males gather at puddles and drink by the hour.
8. Many _____ and research centers breed endangered animals to return them to the wild.
10. A flying insect that air-conditions its home by fanning the air with its wings is a _____ _____.
12. A _____ species is a type of plant or animal species that is likely to become endangered.
16. The passenger pigeon, a bird we will never see live again, is an example of an _____ animal.
18. You can attract wildlife to your own _____ by providing food, water and shelter.
19. A _____ is the place where a plant or animal lives.
21. An _____ is a cold-blooded back-boned animal with smooth moist skin. It spends its life both in water and on land.
22. A colorful bird with webbed feet, the _____ _____ eats plants and animals in and near water.
23. A bird of prey that can nab a meal at speeds of more than 200 mph is a _____ _____.
25. A _____ _____ is an insect named for how it holds its two front legs while waiting for a meal.
26. When a _____ _____ (large, hooved mammal) is born, it doesn't have any scent.
30. The area where an animal plays, eats, rests and raises its young is called its _____.
31. _____ _____ is the use of scientific knowledge and techniques to conserve wildlife and habitat.
33. A bird of prey whose name includes an old English word for white is a _____ _____.
39. A _____ _____ is a small mammal that gathers nuts and builds its nest in trees.

Adapted from: Discover Wildlife in Your World



Adapted from: Discover Wildlife in Your World

Worksheet 2

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Activity 37
Wildlife Conservation
The Value of Wildlife

Subject Area: Science, Social Studies

Objectives:
1. The students will be able to realize how the value of wildlife differs for different people.
2. The students will be able to use periodical resources to find current activities in our world that deal with people's values on wildlife.

Suggested Grade Level: 5-6

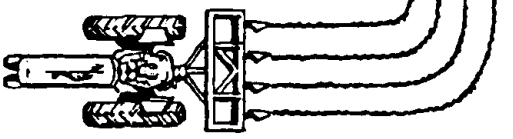
Background: Each person values wildlife differently. To a rabbit hunter, a cottontail may be the beginning of a delicious meal: to the owner of a newly-planted evergreen windbreak, the rabbit can be a pest that damages trees; and to others, a wild rabbit is just fun and exciting to watch. We can look at the values of wildlife in six ways: 1. Commercial Value, 2. Game Value, 3. Genetic Value, 4. Aesthetic (appreciation) Value, 5. Ecological Value, and 6. Scientific Value.

1. Commercial Value - Food on the Table, Money in the bank.

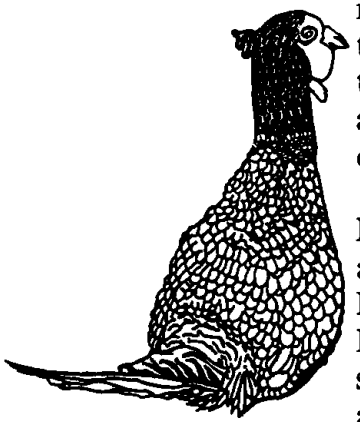
   A good example of wildlife's commercial value is ocean fish harvests, which provide an excellent food source, high in protein. Many people make their living catching, processing, and selling these fish and their products. Aquaculture-growing fish for food in specifically prepared ponds-is another source of food and income. Leasing hunting rights provides many millions of dollars of income each year for others.

   Demand for furs puts a commercial price on wildlife pelts. Years ago, beavers were threatened because of unregulated market trapping for beaver hats which were fashionable in Europe in the early 1700's. With strict regulations controlling the trapping seasons and good management, these animals are now doing fine. Trappers realize they must maintain and conserve the resource so they can continue to trap in the future.

   Wildlife can also have negative commercial value. Coyotes can cause losses for farmers and ranchers by killing sheep, turkeys, chickens, calves, pigs, etc. Flocks of birds can be pests in cities and on farms because of their noise and messy droppings. An example of wildlife damage familiar to many of us is that caused by rabbits and raccoons to garden produce.



2. Game Value - The Call of the Wild.



To those who hunt and fish, wildlife is very valuable as game. Harvesting an animal in the wild can be a thrill and a challenge. The hunter, trapper, or fisherman comes to understand the age-old struggle of humans to obtain food. These outdoor activities provide a chance to experience and enjoy the natural surroundings and to better appreciate modern conveniences.

People who hunt and fish generate a tremendous amount of business. Besides buying hunting and fishing licenses, they also purchase guns, rods and reels, camping equipment, special clothing, boats, and other gear. Making and selling these items provide jobs for a great number of people. Motels, hotels, restaurants, and service stations also benefit. A recent survey found that $42 billion were spent in the United States by hunters and fishermen in one year.

3. Genetic Value - "Bank" for the Future.

All of the domestic species of plants and animals we now depend on and enjoy were once wild. Cattle, sheep, corn, sorghum, dogs, and cats were domesticated from wild stocks, We depend on our wild species for future animals or plants we may need. If a disease or disaster affects one of our domesticated species, we can look only to wild species for help or replacement. Each species is a unique bundle of inherited traits that can't be found in any other species. Sometime in the future we may need what some wild plant or animal has to offer, even if the wild plant or animal now seems insignificant. Every species is special and we can't get it back once it's gone.

4. Aesthetic Value - Beauty in the Beast.

Wildlife can be beautiful and fascinating. Natural places and wild creatures enrich peoples' lives and lift their spirits. Millions of people each year visit parks, reserves, and refuges to get close to the natural wonders they have to offer. The uplifting, relaxing, and even restful feeling people get from nature helps reduce stress. Reduced stress means fewer pain pills for headaches and maybe fewer doctor bills.

Aesthetic values are difficult to measure in terms of dollars, but each one of us can understand our personal feeling of this value. Aesthetic values are the good feelings we have knowing and seeing wildlife like the feelings you get watching a deer run or hearing an owl at night. It's wonderful and fascinating. It's a friendly feeling and one that can always be there as long as we have wild places for wild things.

5. Ecological Value - In Tune With Nature.

   Ecology is the study of living things and how they relate to each other and to their surroundings. Each species interacts with many others. All the animal species living together and the environment they live in are called and ecosystem. Wildlife has value as part of that system.

   For wildlife, we often know very little about the complete role a species has in an ecosystem. However, not knowing doesn't mean there isn't value. Most of us don't understand the value or purpose of each part of a watch or a computer, but all the different parts work together to make a whole functioning unit. As scientists and others continue to learn more about wildlife, we will be better able to understand the role or value different wildlife species have in an ecosystem.

6. Scientific Value - Wildlife Teaches Us About Ourselves.

   Many animals have been vitally important in scientific and medical discoveries. Research on human blood groups using rhesus monkeys led to major discoveries saving thousands of lives. With the rhesus monkey's help, doctors now understand the fatal results that can occur if certain blood groups are mixed. No one could have guessed this little monkey's value years ago.

   New discoveries are continually being made. The Jarraraca is a poisonous Brazilian snake, its bite can be fatal by attacking the human circulatory system. Scientists studied the effects of an extract of the venom on patients with high blood pressure. Using what they learned, a man made medication was developed that helps control some types of high blood pressure.

   Wildlife also acts as an indicator of the quality of our surroundings. For example, researchers recently found large numbers of tumors in fish from water polluted with cancer-causing substances. Scientists are now trying to find more about the cause in hopes that people can avoid the problem.

   Important wildlife-based discoveries are used every day by great numbers of people. No one knows what species may hold the key to important discoveries in the future. Are we willing to risk losing the potential of any species through extinction caused by man?

Materials:

1. Periodicals (newspapers, news magazines, science magazines, natural history magazines, etc.)
2. Construction paper
3. Yarn
4. Paper punch

Procedure:

1. Make a scrapbook about the various values of wildlife (commercial value, game value, genetic value, aesthetic value, ecological value, and scientific

value). You can make a large class scrapbook or each student can make an individual scrapbook.

2. Have available in the classroom a number of periodicals that are current within a couple of months. After discussing the six different values of wildlife, have students look through the periodicals to find articles that shows an example or describes one of these values.

3. Label each article with:
   a. the source (name of newspaper, magazines, etc.)
   b. the date
   c. the page number
   d. the author (if known)

4. Find as many articles as you can for each kind of wildlife value. At least have three clippings for each value.

5. Students may know of examples of wildlife values for which there is no clipping. They might be from personal experience, information from others, books, etc. Have students include these in the scrapbook by writing a brief description.

6. Discuss the articles students found. Let students express their feelings toward these values.

7. Keep adding to your scrapbook by encouraging students to watch daily newspapers and other current periodicals.

Additional Activities:

1. Have students choose one or two wildlife values that they are interested in or have had experience with. They then can write a short story about why the value(s) is/are important to them or to people in general. For example: if a student likes to hunt or fish, they might write about game value; if they like to observe wildlife, aesthetic values would be a good topic. All six values can be written about in this matter.

2. The class scrapbook can become a bulletin board.

Adapted From:

1. Wildlife Conservation,
   4-H Members Manual

Activity 38
Wildlife Conservation
The Hunter

Subject Area: Social Studies, Language Arts, Science,

Objectives:
1. The students will be able to describe their feelings about hunting.
2. The students will be able to compare their attitudes to those of others.
3. The students will be able to make personal judgments about the appropriateness of hunting.

Suggested Grade Level: 5-6

Background: People have hunted animals since earliest time. Products of the hunt have been used for a wide variety of purposes including for food, clothing, tools, bedding, medicines, and religious objects.

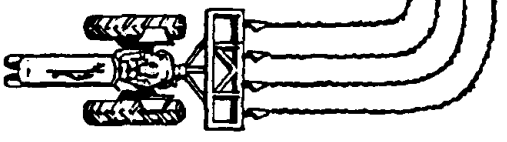
Centuries of time and modern technologies have tended to urbanize human populations, removing many from the necessity of having daily contact with natural systems.

By percent of population, fewer people hunt today. For many, the opportunity, interest, and necessity is not available. Many people have lost the knowledge and skills, as well as the need, to hunt. The slaughterhouse and butcher shop serve many instead.

There are still those who hunt. Some seek wild meats for nutrition. Some utilize horns, antlers, and hides for tools, clothing, and decoration. Today in the United States, hunters pay fees to hunt, and hunt under stringent and restrictive conditions, their harvest controlled by game management practices and concern for continuation of species and habitat.

Hunting has become recognized as a tool of game management. For example, it is used to control populations of large ungulates like deer, which tend to overpopulate and destroy their own habitats. A reduced population--whether by hunting, starvation, or other limiting factors-- typically recovers quickly where there is quality habitat for the species. Habitat once damaged, however, tends to recover slowly.

Wildlife managers refer to hunting as a means of "harvesting" a wildlife population, based on the characteristics of wildlife as a renewable resource.



Wildlife managers use regulated hunting seasons to maintain a population of animals in an area so that the population can reproduce successfully over time and live in a habitat that can be continuously renewed by natural processes.

Hunters pay license fees in order to hunt, and they must follow all regulations of the agency responsible for wildlife management in their state or province. The hunters' fees as well as a portion of taxes on certain hunting- related equipment go directly to continuing management of wildlife resources, purchase and restoration of wildlife habitat, and enforcement of wildlife-related laws.

Why do some people hunt? Most hunters in the United States and Canada today say they hunt because they like to get outside. They tend to find it difficult to express their feelings about the hunt itself. Most would call their hunting recreation, and yet most use the products of the hunt for food. Almost no one today in the United States or Canada uses all products of the hunt, as their ancestors did from necessity.

Some people are opposed to hunting for many reasons, some believing it to be unethical. Others, who choose not to hunt, or who do not believe it appropriate to kill for sport or recreation, accept hunting as a tool in managing certain kinds of wildlife. Within any community there will be a range of views on the subject.

The major purpose of this activity is for students to examine their own attitudes about hunting.

Materials:

1. Student Activity Sheets ("The Twins" Story)
2. Writing paper and pencils.

Procedure:

1. Provide each of the students with a copy of the activity sheets to read, or read it aloud to the students.

2. Have students discuss how they felt about the story.
   a. How does the boy feel about hunting? How does he feel about the animal he is hunting?
   b. What are your feelings about hunting? How do your feelings compare with the boy's feelings?
   c. Why is hunting allowed? Do you think hunting should be allowed? In your judgment, what, if any, are appropriate reasons for hunting?
   d. What responsibilities do you think people have if they choose to hunt? If they choose not to hunt?

3. Have students write an ending to the story, keeping in mind the ideas discussed in class.

Additional Activity:

1. Have students do a research project. Who sets the rules and enforces the legal regulations for hunting? What kinds of hunting, if any, are allowed in your area? Also find out when, why, by what methods with what equipment, at what age, and under what regulations? What about hunter safety and education courses.

Adapted From:

1. Project WILD

Note: "The Twins" is adapted, with permission, from a story which originally appeared in **Open Lands and Wildlife** (Union, New Jersey: Pollution Control Education Center, 1975), a multimedia instructional unit including both teacher and student materials. Thanks to Dr. Clifford Knapp for his cooperation and encouragement in providing the original material for use in Project WILD. Write the Pollution Control Education Center, Township of Union Public Schools, Union, New Jersey, for additional information about **Open Lands and Wildlife.**

The Twins

By Dr. Clifford Knapp
and Suzanne Iudicello

The twin fawns were born on a May day when the sun dappled the edge of the forest through the newly budding leaves, and apple blossom petals fell in the abandoned orchard like fragrant snow. They were not the only twins that year; food had been plentiful in the valley, and white-tailed deer were sleek and round-bellied.

Even as the doe licked her offspring clean, strength flowed into the young bodies. It hadn't hurt that she had been able, through the fall and winter, to slip into a nearby farm at night for corn, alfalfa, and clover to add to the leaves, twigs, juicy weeds, acorns, and mushrooms the forests and fields offered to the white-tails.

The valley was a generous place for the herd of 60 animals. Where the hillsides dipped down to meet the farm fields, the shady forest ended. This edge meant that food was varied and abundant. It hadn't always been that way.

In the early 1700's, when the valley was first settled, the white-tailed deer had been plentiful. By 1900, however, the deer population had been greatly reduced by the human appetite for venison. Too much hunting had reduced the size of the herds, and the cutting of the forests for conversion to farm fields had limited the white-tails' habitat. Later, laws that controlled hunting and protected the forests gave the herds the time and space to increase again. The young plants that grew in the open areas of the cut-over forest yielded an abundance of food, and by the 1930's there were more deer in the valley than when the settlers first came there.

The doe and her fawns didn't know much of history, but she knew where to find food, and her newborns knew that as they nuzzled their mother's udder, there was plenty of nourishment for them, too.

That soft, May afternoon saw another birthday celebrated in the valley. The boy ran out to greet his father who was climbing down off the tractor after a day of tilling for the spring planting. He looked up into the lined face of his father and barely contained his impatience while the farmer removed his hat and wiped the sweat from his forehead with a big, blue kerchief.

"Is it time?" the boy asked breathlessly.

The man smiled down at his son--a strong, wiry boy, made tough by summers of throwing hay bales and winters of chopping wood.

"Yes, Jamie," he grinned, "it's time." He put his arm across the boy's shoulders and they walked up onto the wide porch, where a table stood decked with early daisies and tiger lilies in a Mason jar, bright orange and yellow paper napkins, and a three-decker chocolate cake with 12 yellow candles. The boy's mother was already sitting at the table, pouring tall glasses of foamy, fresh milk.

"Do you want us to sing first?" she laughed, as Jamie scraped the chair legs across the porch floor in his haste to get to the table.

"Nope. Where's my present?"

"Now, Jamie," his father scolded good naturedly, "birthdays aren't just for presents. This is a special year for you, and it brings with it not just a gift but some responsibility. You're no longer a little boy. You're a young man. This is not a birthday for toys."

Jamie looked down at his hands on his lap. "I know, Dad; I'm sorry."

But when he looked up again at his father, the excitement and expectation shining in his eyes were not those of a serious young man, but of a boy about to burst with anticipation.

As his mother cut the cake, Jamie's father took from behind the door a long, narrow box, tied with a gold ribbon. "Okay, son, this is what you've been waiting for, and we won't keep you from it."

Jamie tore the ribbon from the box and lifted the cover. There, gleaming from the soft yellow cloth, lay the 30-30 rifle. It wasn't new, but the gloss on the stock showed a new coat of oil and betrayed hours of careful rubbing, and the barrel shone with new blueing. The scratches he remembered on the dull grey were gone, but the initials his grandfather had carved on the stock were still there.

He drew the rifle from the box, taking care to point it away from anyone as his grandfather and father had taught him. It was much heavier than the .22 he'd lugged through the woods to stalk squirrels.

"It's yours now, Jamie, just as we promised," his father said. "You're 12 now, and old enough to go deer hunting this fall."

Though Jamie thought the fall would never arrive, the summer passed quickly, filled with days of helping his father in the fields, fishing and swimming, and lots of practice with the 30-30.

In the hills above the farm valley, the twin fawns gained strength quickly. By June, they followed the doe along the well-worn trails. As summer ripened, they roamed with the herd over the length of the valley and high on the hillsides. They were just two of 50 fawns that had been born that spring, swelling the herd from 60 to more than 100.

They fed on leaves, twigs, fruits, and nuts of the trees and shrubs in the forest, and on the grasses and weeds along it edges. With nearly twice as many deer in the same valley, soon the best-tasting and most nutritious plants were gone, and the diet of the herd became less satisfying. By fall, the twin fawns were forced to eat the poorer quality foods, and by late in the season, the branches of their favorite trees had been cropped far beyond reach.

November blew in rainy and cold, and Jamie was restless after the crisp, bright days of October. The harvest was complete, the fields lay in a stubble under the grey sky, and the few brown apples remaining on the trees were torn down by the wind. He sat in the warm kitchen and looked out at the glistening black branches scratching at the sky.

"Can I go out, Mom?" he asked. She looked up from the lunch dishes at her son, his dungaree cuffs well above the tops of the worn boots, and the elbows frayed out of his plaid flannel shirt. The restlessness was about to burst his skin as his growing body had burst the seams of most of his clothes that summer.

"All right, but wear your father's poncho," she called as he was already halfway out the door, the 30-30 over his shoulder.

Jamie knew, from his summer forays and from past autumns when he'd been too young to hunt, that the deer often came down to the abandoned orchard to nip at the withered apples that grew on the overhanging trees. That part of the farm wasn't used now, and the orchard had long since overgrown, producing only tiny, bitter fruits, but the deer seemed to like them. He had watched, enthralled, many an evening, as the slender, tawny forms moved delicately and then froze like shadows in the dusk.

As he trotted away from the yellow light in the kitchen window, dusk gathered and the rain turned to sleet. The grey afternoon was threatening

to turn bleaker yet. He scrambled over the crumbling remains of a stone wall, and entered the orchard in a blast of wind that nearly took his breath away. "At least it's blowing toward me," he thought, settling in under a tree to wait.

Just before nightfall, his patience was wearing thin, his foot was tingling where he had been sitting on it, the rain was trickling under his collar, and the sleet was stinging his face. He was about to stomp his foot to bring it back to life so he could walk home, when the doe entered the orchard: Jamie caught his breath.

The words of the fish and wildlife license agent echoed in his ears as he raised the rifle to his shoulder. "We're going to open the season this year--bucks, does, fawns--because there are so many deer in that herd. They've over browsed the entire valley and a bunch of 'em are going to starve this winter anyway." The man had punched Jamie's slip of yellow paper for fishing and hunting--the first time he'd been the age to have a license for deer. "This your first hunting season, son?" he'd asked. "Good Luck!"

Jamie watched the doe down the barrel of the rifle. She was stretching up, her front feet off the ground, trying to reach a last, wrinkled apple clinging stubbornly to a high branch. The slender neck glistened from drops of rain caught in the soft fur. His heart was pounding and he wasn't sure if he was still breathing. He reached around with his thumb and gently pushed the safety off the rifle.

Just then the twin fawns stepped delicately into the orchard, melting from the darkened tree trunks like slightly smaller shadows of the doe. Jamie lifted his eyes from the barrel to the fawns. They too, were stretching to try to reach the last brown leaves and few apples high in the branches, but they were too short. They moved close to the doe, where her efforts at pulling on the branches had jostled a few apples to the ground.

Jamie refocused on the doe, sighted down the barrel, and let out a deep breath to steady his hand. A blast of wind ripped through the orchard, carrying sleet and snow before it, and ripping a tree branch in its fury. The branch tumbled down and the three deer bolted back into the thicket.

The boy reset the safety on the rifle, and gingerly got to his feet. He looked into the darkening sky and the tossing branches and thought. "I'm glad. Maybe those three will make it through the winter."

Winter hit that night, lashing the valley with wind and snow that drifted into 20-foot mountains, froze into hard crusts, and remained. The herd, trapped on the hillside, didn't move more than a quarter of a mile the whole winter. They competed for the dwindling food supply that remained poking above the snow, and many fawns and does died.

Jamie thought often about the trio, as he looked out over the white landscape.

The grip of the season finally loosened one moist, February day. Rain pelted the snow, turning it to slush and pitted mounds where the mud showed through. Spring returned to the valley, and with it the activity that kept life for a farm boy busy and full.

For the herd, the winter had taken its toll. Most of the fawns had died of starvation and cold, as did many older bucks and does, weakened by age. The herd was reduced from the summer high of more than 100, to fewer than 50. Those remaining ventured down out of the hills to the greening valley where their favored plants sprouted anew. Throughout the spring and summer, they found plenty of food to go around among their reduced numbers, particularly since no fawns had been born after the harsh winter.

Summer's hazy, golden days burned into fall, and as harvest time ended, Jamie's thoughts drifted again to the abandoned orchard and the 30-30. The rifle had lain in its yellow cloth all summer, neglected in the bustle of summer's activity. One evening he took it out of its wrappings, and cleaned and polished it, wondering if the twin fawns were among this autumn's yearlings.

The frosty straw stubble crunched under his feet as he made his way across the fields to the orchard. The passing of a year had seen more stones fall from the top of the wall, and Jamie noted that the tree that had been his resting place last season was uprooted and lying broken. He concealed himself among the twisted branches, and settled to wait.

The evening was still, the sky a pale salmon color where the sun had just slipped below the hills. Jamie hoped the slight varying breeze would not carry his scent. He slid a round into the chamber of the 30-30, wondering how many times his grandfather had sat like this, in this very orchard, with this very rifle. He checked to make sure the safety was on, and settled in.

Dusk fell with the twittering of a few last thrushes, and Jamie started at the sound of a snapping twig. A yearling doe stepped into the orchard, the brush rustling back to fill the space where she had emerged from the forest. Jamie exhaled quietly, trying to relax again, because this year was bucks only, the season restricted because the herd had so dwindled over the harsh winter. He watched the doe nosing among the brown weeds for fallen apples, wondering if she were the fawn of last autumn.

He watched, still, admiring the sleek brown sides and the graceful curve of the neck. The doe raised her head and listened, so close he could see her nostrils flickering to catch a scent. The deer glanced at the forest edge, tensed, then bent her head to browse again as a yearling buck emerged from the same trail, disguised by the thick brush.

Jamie lifted the rifle to his shoulder, nestling it close against the rough wool of his jacket. He looked down the barrel at the young white- tail, sure now that these were the twins of that blustery evening a year ago. "I can feel it, I know they're the same," he thought, reflecting on his hesitation of a year ago, and wondering if this time he'd be able to pull the trigger. "He made it through the winter--who am I to kill him now?" he asked himself.

The buck stepped away from his twin, and began pulling apples from the drooping branches. It would be a clean shot, Jamie knew, well away from the doe, certain to be a quick kill. He exhaled, steadied his arm, and concentrated on a patch of rusty brown hair on the animal's shoulder. "I can't look at his head," he thought. "I just have to keep thinking of him as meat for my family for the winter," and he thumbed off the safety. He allowed himself one last, stolen glance at the sculptured head, arching up to grasp an apple.

Jamie swallowed and . . .

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Activity 39
Wildlife Conservation
Oh Deer!

Subject Area: Science, Math, Social Studies

Objectives:
1. The students will be able to recognize that some fluctuations in wildlife populations are natural because of constant change.
2. The students will be able to describe a good habitat and why it is important.
3. The students will use gathered information to create a graph.

Suggested Grade Level: 5-6

Background: A variety of factors affect the ability of wildlife to successfully reproduce and to maintain their populations over time. Disease, predator/prey relationships, varying impacts of weather conditions from season to season (e.g., early freezing, heavy snows, flooding, drought), accidents, environmental pollution, and habitat destruction and degradation are among these factors.

Some naturally-caused as well as culturally- induced limiting factors serve to prevent wildlife populations from reproducing in numbers greater than their habitat can support. An excess of such limiting factors, however, leads to threatening, endangering, and eliminating whole species of animals.

The most fundamental of life's necessities for any animal are food, water, shelter, and space in a suitable arrangement. Without these essential components, animals cannot survive.

This activity is designed for students to learn that:
a. good habitat is the key to wildlife survival
b. a populations will continue to increase in size until some limiting factors are imposed
c. limiting factors contribute to fluctuations in wildlife populations
d. nature is never in "balance", but is constantly changing.

Wildlife populations are not static. They continuously fluctuate in response to a variety of stimulating and limiting factors. We tend to speak of limiting factors as applying to a single species, although one factor may affect many species. Natural limiting factors, or those modeled after factors in natural systems, tend to maintain populations of species at levels within predictable ranges. This kind of "balance in nature" is not static, but is more like a teeter-

totter than a balance. Some species fluctuate or cycle annually. Quail, for example, may start with a population of 100 pairs in early spring; grow to a population of 1200 birds by late spring; and decline slowly to a winter population of 100 pairs again. This cycle appears to be almost totally controlled by the habitat components of food, water, shelter, and space, which are also limiting factors. Habitat components are the most fundamental and thereby the most critical of limiting factors in most natural settings.

This activity is intended to be a simple but powerful way for students to grasp some basic concepts: that everything in natural systems is interrelated; that populations of organisms are continuously affected by elements of their environment; and that populations of animals do not stay at the same static number year after year in their environment, but rates are continually changing in a process of maintaining dynamic equilibria in natural systems. The major purpose of this activity is for students to understand the importance of suitable habitat as well as factors that may affect wildlife populations in constantly changing ecosystems.

Materials:

1. Large area such as a gym or a playground
2. Chalkboard
3. Pad and paper

Procedure:

1. Review the essential components of habitat with the students: food, water, shelter, and space in a suitable arrangement. This activity emphasizes three of these habitat components-food, water, and shelter-but the students should not forget the importance of the animals having sufficient space in which to live, and that all the components have to be in a suitable arrangement or the animals will die.

2. Ask your students to count off in four's. Have all the one's go to one area; all two's, three's, and four's go together to another area. Mark two parallel lines on the ground or floor ten to 20 yards apart. Have the one's line up behind one line; the rest of the students line up behind the other line.

3. The one's become "deer." All deer need good habitat in order to survive. Ask the students what the essential components of habitat are again: food, water, shelter, and space in a suitable arrangement. For the purposes of this activity, we will assume that the deer have enough space in which to live. We are emphasizing food, water, and shelter. The deer (the one's) need to find food, water, and shelter in order to survive. When a deer is looking for food, it should clamp its hands over its stomach. When it is looking for water, it puts its hands over its mouth. When it is looking for shelter, it holds its hands together over its head. A deer can choose to look

for any one of its needs during each round or segment of the activity: the deer cannot, however, change what it is looking for; e.g., when it sees what is available, during that round. It can change again what it is looking for in the next round, if it survives.

4. The two's, three's, and four's are food, water, and shelter (components of habitat). Each student gets to choose at the beginning of each round which component he or she will be during that round. The students depict which component they are in the same way the deer show what they are looking for; that is, hands on stomach for food, etc.

5. The game starts with all players lined up on their respective lines (deer on one side; habitat components on the other side) and with their backs to the students at the other line.

6. The facilitator or teacher begins the first round by asking all of the students to make their signs-each deer deciding what it is looking for, each habitat component deciding what it is. Give the students a few moments to get their hands in place-over stomachs, mouths, or over their heads. (As you look at the two lines of students, you will normally see a lot of variety- with some students water, some food, some shelter. As the game proceeds, sometimes the students confer with each other and all make the same sign. That's okay, although don't encourage it. For example, all the students in habitat might decide to be shelter. That could represent a drought year with no available food or water.)

7. When you can see that the students are ready, count: "one...two...three." At the count of three, each deer and each habitat component turn to face the opposite group, continuing to hold their signs clearly.

8. When deer see the habitat component they need, they are to run to it. Each deer must hold the sign of what it is looking for until getting to the habitat component person with the same sign. Each deer that reaches its necessary habitat component takes the "food," "water," or "shelter" back to the deer side of the line. This is to represent the deer's successfully meeting its needs, and successfully reproducing as a result. Any deer that fails to find its food, water, or shelter dies and becomes part of the habitat. That is, in the next round, the deer that died is a habitat component and so is available as food, water, or shelter to the deer who are still alive. NOTE: When more than one deer reaches a habitat component, the student who gets there first survives. Habitat components stay in place on their line until a deer needs them. If no deer needs a particular habitat component during a round, the habitat component just stays where it is in

the habitat. The habitat person can, however, change which component it is from round to round.

9. You as the facilitator or teacher keep track of how many deer there are at the beginning of the game, and at the end of each round you record the number of deer also. Continue the game for approximately 15 rounds. Keep the pace brisk, and the students will thoroughly enjoy it.

10. At the end of the 15 rounds, gather the students together to discuss the activity. Encourage them to talk about what they experienced and saw. For example, they saw a small herd of deer finding more than enough of its habitat needs. The population of deer expanded over two to three round of the game, until the habitat was depleted and there was not sufficient food, water, and shelter for all the members of the herd. At the point, deer starved or died of thirst or lack of shelter, and they returned as part of the habitat. Such things happen in nature also.

11. Using the chalkboard, post the data recorded during the game. The number of deer at the beginning of the game and at the end of each round represent the number of deer in a series of years. That is, the beginning of the game is year one; each round is an additional year.

12. Have the students take the information and construct a graph or you can do it as a class project. The students will see this visual reminder of what they experienced during the game: the deer population fluctuated over a period of years. This is a natural process, as long as the factors which limit the population do not become excessive, to the point where the animals cannot successfully reproduce. The wildlife populations will tend to peak, decline, and rebuild, long as there is good habitat and sufficient numbers of animals to successfully reproduce.

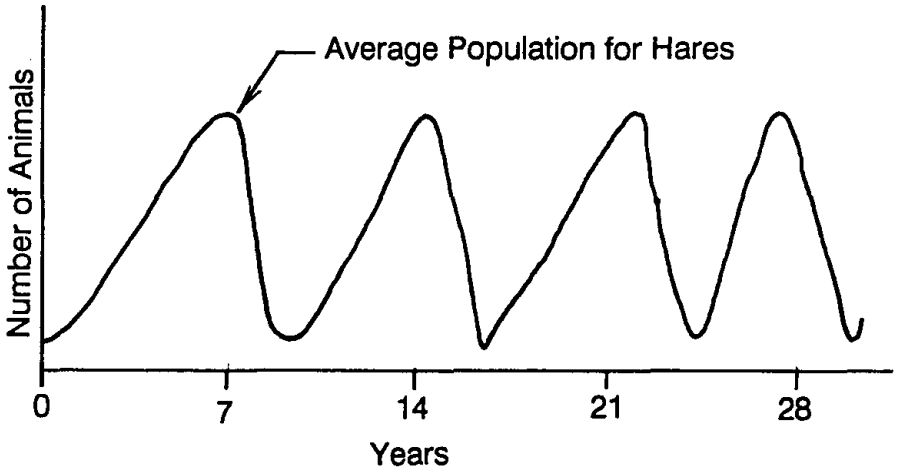
13. In discussion, ask the students to summarize some of the things they have learned from this activity. What do animals need to survive? What are some of the "limiting factors" that affect their survival? Are wildlife populations static, or do they tend to fluctuate, as part of an overall "balance of nature?" Is nature ever really in "balance," or are ecological systems involved in a process of constant change?

Additional Activity:

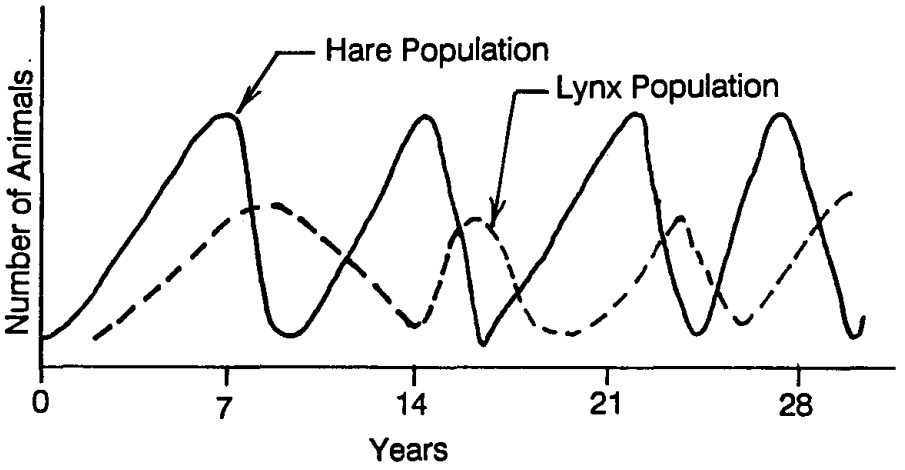
1. When you have finished tabulating the graph data and discussing it, ask the students if they have ever heard of the Hudson Bay trappers in American history. Tell them, briefly, who they were.

There is a hundred years, or more, of records of the activities of these trappers. These data refer to pelts shipped from America to Europe, particularly the pelts of snowshoe hares and lynx.

Researchers have found that snowshoe hare population seem to peak about every seven to nine years and then crash, repeating the process over each comparable time period. So, a snowshoe hare population graph would look like this:



It has also been discovered that lynx population do the same thing-except that they do it one year behind the hare populations. The combined graph would look like this:



Graph this right over the deer graph that you made, adding first the hares, and then the lynx.

Ask the students:

* Which animal is the predator? Which is prey?
* Are predators controlling the prey, or are prey controlling the predators? (We have been brought up to "know" that predators control the prey, and are now discovering that this is not so. The number of prey animals available tells us how many predators can live in the area.)
* Is this like the deer habitat game we just played? Who controls? (Sometimes the habitat when the deer population is not too large; sometimes the habitat when the deer population "gets on top of it" and destroys the vegetative food and cover.)

Adapted From:

1. Project WILD

Activity 40
Wildlife Conservation
Quick Frozen Critters

Subject Area: Science

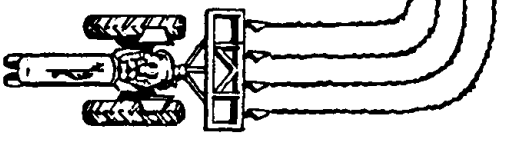
Objectives:
1. The students will be able to discuss predator prey relationships, including adaptations.
2. The students will be able to describe the importance of adaptations in predator/prey relations.
3. The students will be able to recognize that limiting factors affect wildlife populations (including predator/prey relationships).

Suggested Grade Level: 5-6

Background: **Predator:** An animal that kills and eats other animals for food.
Prey: An animal that is killed and eaten by other animals for food.
Limiting factors: There are many influences in the life history of any animal. When one of these (e.g., disease, climate, pollution, accidents, shortages of food) exceeds the limits of tolerance of that animal, it becomes a limiting factor. It then drastically affects the well-being of that animal. Predators are limiting factors for prey. Prey are limiting factors for predators.

Animals display a variety of behaviors in predator-prey relationships. These are adaptations to survive.

Some prey behaviors are: signaling to others, flight, posturing in a fighting position, scrambling for cover, and even "freezing" on the spot to escape detection or capture by predators. The kind of behavior exhibited partly depends on how close the predator is when detected by the prey. Each animal has a threshold for threat levels. If a predator is far enough away for the prey to feel some safety, the prey may signal to others that a predator is near. If the predator comes closer, the prey may try to run away. If the predator is too close to make running away feasible, the prey may attempt to scurry to a hiding place. If the predator is so close that none of these alternatives is available, the prey may freeze in place. The closer the predator comes to the prey animal, the more likely it is that the prey will "freeze" in place. This "freezing" occurs as a kind of physiological shock in the animal, (shelter or camouflage may also make them invisible to the predator when they freeze). Too often people who come upon animals quickly and see them immobile think that the animals are unafraid when, in reality, the animals are "frozen", or, as the adage



goes, "frozen stiff." The major purpose of this activities for the students to recognize the importance of adaptations to both predator and prey and to gain insight into limiting factors affecting wildlife populations.

Materials:

1. Three small pieces of cardboard per student
2. Gym vests or other labeling device to determine predators from prey
3. Four to five hula hoops
4. Whistle

Procedure:

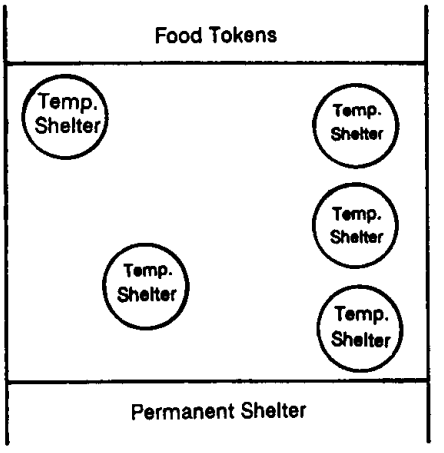
1. Have a discussion and make a classroom list of predators and a list of prey. Example:
   Prey: Cottontails, Ground Squirrels, Deer, Quail, etc.
   Predators: Coyotes, Hawks, Cougars, Foxes, etc.

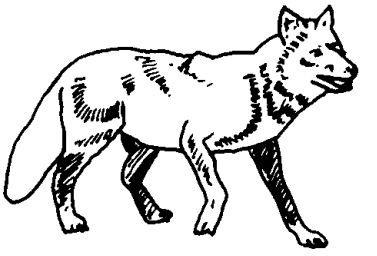
2. To play a version of "freeze tag", Select one pair (one predator and one prey make a pair, such as a deer and a cougar). Number students 1 through 5. All the ones are prey and the twos through the fives are predators.

3. Using a gymnasium or playing field, identify one end of the field as the food source and the other end as the shelter.

4. Randomly place the hula hoops in the open area between the shelter and the food. These represent additional shelter or cover for the prey.

5. The small pieces of cardboard will be food tokens. Place these in the food sources area. Allow three food tokens for each prey animal. For example:





6. Clearly label predators with a gym vest.

7. Use a whistle to start each round. When a round begins, prey start from their shelter. The task of the prey animals is to move from the primary shelter to the food source, collecting one food token each trip, and returning to the primary shelter. To survive, prey have to obtain three food tokens. Their travel is hazardous, however. They need to be alert to possible predators. If they spot a predator, they can use various appropriate prey behaviors-including warning other prey that a predator is near. Prey have two ways to prevent themselves from being caught by predators; they may "freeze" any time a predator is within five feet of them; or they may run to cover (with at least one foot within one of the hula hoops). Frozen prey may blink, but otherwise should be basically still without talking.

8. Predators start the game anywhere in the open area between ends of the field, and thus are randomly distributed between the prey's food and primary shelter. Predators attempt to capture prey to survive, tagging only moving (not "frozen") prey. (Optional: Prey can have bandannas in their pockets that the predators have to capture to represent the successful predation.) Predators must each capture two prey in order to survive. Captured prey are taken to the sidelines by the predator who captured them.

9. A time limit of five to seven minutes is suggested for each round of the game.

10. Play the game twice, allowing each student to be both prey and predator.

11. Discuss with the students the ways they escaped capture when they were prey. Which ways were easiest? Which were most effective? What means did they use as predators to capture prey? Which ways were best? What did predators do in response to a prey animal who "froze?" In what ways are adaptations important to both predator and prey? Ask the students to summarize what they have learned about predator/prey relationships. How do predator/prey relationships serve as natural limiting factors affecting wildlife?

Additional Activities:

1. Play the game for three or four rounds, recording the number of captures each playing period. Have students who are captured become a prey animal in the succeeding round. This quickly leads to the concept of

dynamic balance as prey and predator populations fluctuate in response to each other.

2. Students could select an animal and research its behavior patterns for avoiding detection and capture. Reports or demonstrations of the behavior could be presented to the class.

Adapted From:

1. Project WILD

Activity 41
Wildlife Conservation
Manage a Moose

Subject Area: Science, Math, Language Arts, Social Studies

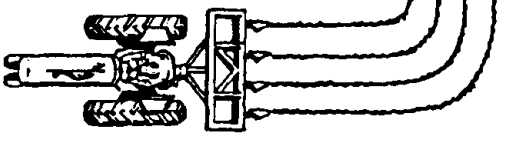
Objectives:
1. The students will be able to evaluate hypothetical wildlife management decisions.
2. The students will be able to identify at least four factors which can affect the size of a wildlife population.

Suggested Grade Level: 5-6

Background: Wildlife managers attempt to maintain healthy population of wild animals, while factors (avoidable and unavoidable) affect populations. Some of these factors are loss of habitat, weather conditions, pollution of food and water sources, development of other natural resources, poaching, and recreation pressures. Many people are unaware of how such pressures can affect wildlife.

In the United States, it is the legal responsibility of state wildlife agencies to manage the wildlife populations within their respective states. It is the legal responsibility of the U.S. Fish and Wildlife Service, under the U.S. Department of the Interior, to govern some policies and programs affecting migratory species of animals and threatened or endangered species, as well as illegal importation and exportation of animals and animal products, illegal interstate transportation of all species, with additional responsibilities related to the overall well- being of U.S. wildlife.

Wildlife management is based on the best scientific and technical knowledge available. Most wildlife managers have to deal with a lot of public criticism, this can be a factor affecting the success of a manager. For example, hunting is sometimes a controversial issue. In this activity, pro and con letters affect the result of the activity. In a sense, everyone shares responsibility for wildlife management. Although legally responsible agencies, their work requires the thoughtful and informed cooperation of citizens. There are frequently differences of opinion about the most appropriate policies and programs affecting wildlife. Individual citizens, private conservation groups, private industry, commodity groups and others all make contribution to the overall conservation and protection of wildlife and its habitat.



Materials:

1. Paper
2. Pencil
3. Dice, one die per student
4. Game Cards; There are 36 cards total. They are designed for students to recognize that a number of diverse factors can affect wildlife; the numerical weights should not be interpreted literally. (After using these cards once, students may want to experiment with making additional cards, or changing these cards.) Some cards include blank spaces and the students will need to specify what has occurred in those cases. The rate of reproduction on the Reproduction Cards is designed to vary with population density. As your population drops below 100, the potential rate of reproduction increases reaching a peak at just above 50 individuals. This effect mimics the potential for rapid population growth many herbivore populations can exhibit when population levels are well below carrying capacity. When your population drops below 10 individuals, reproduction is not allowed. This reflects the imbalanced sex ratios, the inability to find suitable mates, or the distribution of social and mating systems. As your population grows above 100, the cards decrease the reproduction rate, reflecting the increasing activity of limiting factors as the population exceeds carrying capacity. Ask students to specify what could be used to fill in the blanks in some of the cards.

Procedure:

1. Each student is asked to be the manager of a moose (or other animal) population. The carrying capacity of the habitat is 100 animals. The point of the activity is to end up with a viable population after nine rounds, simulating nine years. If at any time the student's population reaches less than 10 or more than 200 individual animals, that student no longer has a viable "herd" and watches the other students until the conclusion of the activity.

2. Each student has a beginning population of 100 animals. The cards are separated into three decks of a total of 36 cards: a condition deck (18 cards), a reproduction deck (9 cards). and a management deck (9 cards). Shuffle the cards within each deck. Explain that cards will be drawn in the following sequence: condition card, reproduction card, condition card, management card. This sequence of draw will be repeated, each repetition representing an annual cycle (the students may think of each draw as representing a different season, e.g., autumn, winter, spring, summer). As each card is drawn, it is read aloud to the entire class. each student then rolls his or her die and follows the instructions on the card to determine his or her herd population's new size. Some computations will result in fractions; numbers may be rounded to the nearest whole.

Wrap up the activity with a class discussion. Include topics such as:

* Identify and describe what appeared to be the impacts of the condition, reproduction, and management cards.
* Did populations "managed" under different strategies by different students show different trends? How do these compare? Would students "manage" differently if given a second chance?
* What aspects of this activity seemed realistic? Which did not?
* What are examples of ways that habitat can be improved? Short term? Long term?
* Is human management of wildlife populations necessary? Beneficial? Why or why not? For people? For the animal?
* What are four factors that can affect the size of a wildlife population.

Additional Activities:

1. Worksheets 1-4

Adapted From:

1. Project WILD

Weather Card

A blizzard has had a serious negative impact on the survival of the herd. Decrease your herd by the percentage equal to five times your roll.

Condition Card

Weather Card

A mild winter has had a dramatic positive impact on the survival of the herd. Increase your herd by the percentage equal to five times your roll.

Condition card.

Weather Card

_____ has had a serious negative impact on the survival of the herd. Decrease your herd by the percentage equal to five times your roll.

Condition Card

Weather Card

_____ has had a serious positive impact on the survival of the herd. Increase your herd by the percentage equal to five times your roll.

Condition Card

Habitat Destruction Card

A prairie fire has occured, destroying critical habitat. Decrease herd size by five times your roll.

Condition Card

Habitat Degradation Card

The lake, used for drinking water by the herd has been polluted, damaging critical habitat. Decrease the herd by the number equal to three times your roll.

Condition Card

Habitat Destruction Card

_____ has occured; destroying critical habitat. Decrease your herd size by five times your roll.

Condtion Card

Habitat Degradation Card

The lake, used for drinking water by the herd has been polluted, damaging critical habitat. Decrease the herd by the number equal to three times your roll.

Condition Card

Predator Card

Predation has occured, affecting the herd size. Decrease herd size by the percentage equal to your roll.

Condition Card

Habitat Degradation Card

_____ has occured, damaging critical habitat. Decrease herd by the number equal to three times your roll.

Condition Card

Habitat Degradation Card

_____ has occured, damaging critical habitat. Decrease herd by the number equal to three times your roll.

ContictionCard

Habitat Loss Card

A shopping center and parking lot has been built, resulting in a loss of critical habitat for the herd. Decrease herd by the number equal to five times your roll.

Condition Card

Habitat Loss Card

A shopping center and parking lot has been built, resulting in a loss of critical habitat for the herd. Decrease herd by the number equal to five times your roll.

Condition Card

Habitat Loss Card

A shopping center and parking lot has been built, resulting in a loss of critical habitat for the herd. Decrease herd by the number equal to five times your roll.

Condition Card

Habitat Loss Card

_____ has resulted in a loss of critical habitat for the herd. Decrease herd by the number equal to five times your roll.

Condition Card

Habitat Loss Card

_____ has resulted in a loss of critical habitat for the herd. Decrease herd by the number equal to five times your roll.

Condition Cared

Disease Card

Disease has struck the herd. Decrease herd by the percentage equal to your roll.

Condition Card

Poaching Card

Poaching, illegal killing of animals, has reduced the size of the herd. Decrease herd by the number equal to two times your roll.

Condition Card

Habitat Alteration Card

_____ has occured, altering critical habitat. Increase or decrease (students choose which before rolling the die) herd by the percentage equal to three times your roll.

Management Card

Habitat Alteration Card

_____ has occured, altering critical habitat. Increase or decrease (students choose which before rolling the die) herd by the percentage equal to three times your roll.

Management Card

Habitat Restoration Card

A wildlife refuge has been set up by a local conservation group, restoring critical habitat. Increase herd by the percentage equal to five times your roll.

Management Card

Research Card

_____ research has been successfully accomplished. Increase or decrease (students choose which before rolling the die) herd by two times your roll.

Management Card

Education Card

Your school's activities have led to increased understanding of wildlife and habitat. Increase or decrease (students choose which before rolling die) herd by two times your roll.

Management Card

Law Enforcement Card

Local law enforcement activities have protected the herd againset illegal actions like poaching. Increase your herd by the percentage equal to two times your roll.

Management Card

Habitat Acquisition Card

Habitat acquisition has increased the area of available and suitable habitat. Increase herd by five times your roll.

Management Card

Hunting Card

A request for a hunting season has been made. Do you wish to allow hunting in your area? If yes, decrease your herd by the percentage equal to five times your roll. If no, record no change in the size of your herd.

Management card.

Habitat Improvment Card

_____ has occured improving critical habitat. Increase herd by five times your roll.

Management Card

Excellent Year

This has been an excellent reproduction year. Increase your herd by (100/your population) times five times your roll, if your herd is over 50. If your herd is 10 to 50 , increase your herd by the number equal to five times your roll. If your herd is under ten, you may not reproduce.

Reproduction Card

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Reproduction Card

Average Year

This has been an average reproduction year. Increase your herd by (100/ your population) times three times your roll, if your current population is over 50. If your herd is 10 to 50, increase your herd by three times your roll. If your herd is under 10, you may not reproduce.

Reprodution Card

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Reprodution Card

Name _____

Directions: Read the story. Use standard notation to answer the questions below.

Wildlife Refuge

Many years ago, people realized that something had to be done to protect animals and birds that were becoming endangered. Many of these animals were in trouble because man had built roads and citites where they lived. Our government passed tax laws to raise money in order to buy land where these animals could live safely. These wildlife preserves became permanent homes where wild animals are protected, and where they can find food and shelter and bear their young.

The Fish and Wildlife Service of the United States Department of the Interior is in charge of two hundred and sixty four National Wildlife Refuges with a total area of nine million five hundred forty six thousand six hundred and forty six acres. Seventeen additional refuges exist in Alaska, Hawaii and Puerto Rico. One hundred and ninety nine of the refuges are set up mainly for birds that live in or near water. Forty one are for birds not normally hunted. Seventeen are for big game animals. And six are for birds other than water fowl.

These wildlife preserves have saved many animals that might have become extinct.

1. How many National Wildlife Refuges are there in the United States? _____
2. How many acres are being used for this purpose? _____
3. How many refuges exist in Alaska, Hawaii and Puerto Rico? _____
4. How many refuges are used for birds that live in or near water? _____
5. How many refuges are for birds that are not normally hunted? _____
6. How many refuges are for big game animals? _____

Adapted from: Conservation for Children

Name _____

What's Happening to our Wildlife?

The Destruction of wildlife is one way man has changed the environment.

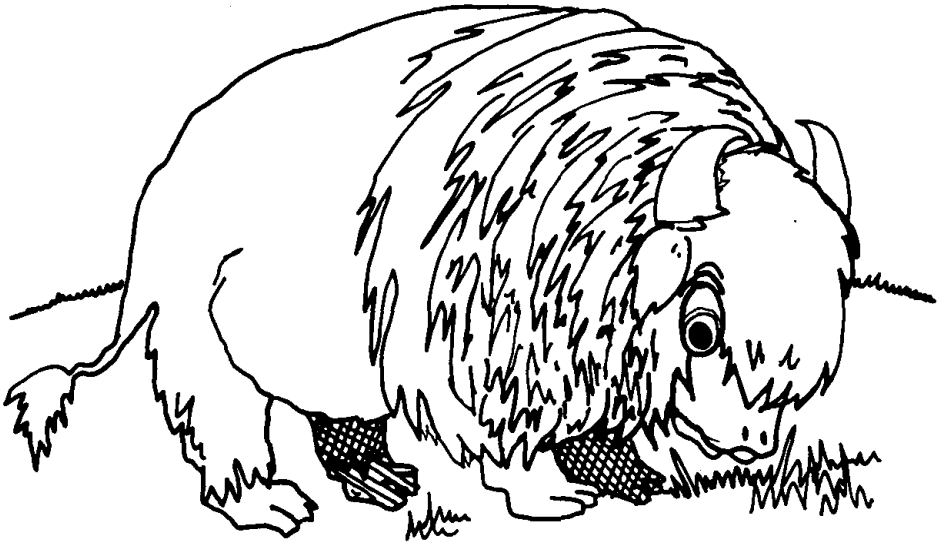
Many animals have been killed by people. Millions of predators, such as foxes, coyotes, wolves, mountain lions, hawks and owls have been killed to 'protect' ranch and farm animals. Today, as a result, many crops are threatened by rats, mice and other rodents. We have upset the balance of nature.

Over the past years, many other animals were killed for sport. The buffalo, also known as the American Bison, almost became extinct. In 1870 there were over fifty million buffalo in the United States but in 1889 only 551 could be found. Early train passengers used the buffalo for target practice by shooting them from the windows of the moving trains. Now the buffalo is protected by law and it is estimated that there will be over a half million by the year 2000.

Other animals are killed for fur and food. The passenger pigeon was killed for food until it became extinct. Many fur bearing animals are on the endangered animal list because of over trapping and hunting.

But, the biggest problem facing wildlife today is the loss of their habitats. Our growing population needs more land to build houses, factories and highways. We have drained swamps and filled in baylands to make room for more buildings and roads. What happens to the animals that lived there?

Even animals that have not lost their habitats and are not sought after for food, fur or sport are in danger. The increasing water and air pollution and the wide use of



William F. Cody was nicknamed "Buffalo Bill". Use the code to find out why.

Directions: Change each letter or numeral to the one that comes before it.

I F	L J M M F E	5 9 7 2	C V G G B M P	J O	P O F	T F B T P O
_ _	_ _ _ _ _ _	_ _ _ _	_ _ _ _ _ _ _	_ _	_ _ _	_ _ _ _ _ _

Do you think he would have been proud of this today?

Adapted from: Conservation for Children

Worksheet 2

Name _____

Directions: Read the story. Use the context clues to match the underlined words to their defintions at the bottom of the page.

Letting Wild Animals Go

Some people have tamed wild animals to be pets. Racoons, tortoises, snakes and many types of birds are some of the animals that are often kept as pets. Many well-meaning people who have these wild animals feel that they should let their pets go free to return to their natural habitats. This should not be done for several reasons:

1. Research shows that a captive has less than a 10% chance of surviving the demands of his natural habitat. The soft life of captive living makes it difficult for animals to adapt to their wild habitats.
2. Captive pets have or transmit diseases to the other wild animals.
3. The food supply of an area may not be enough to support another animal. Adding your pet to the habitat is another way of upsetting the balance of nature.

The best thing to do if you cannot keep your pet is to give it to someone who will care for it. Do not turn it loose!

Write the letter of the definition in front of the correct word.

_____ habitats	A - caged or contained in an unnatural setting
_____ research	B - needs, requirements
_____ captive	C - surroundings, home of an animal
_____ surviving	D - pass on to, infect
_____ demands	E - fit into different conditions or settings
_____ adapt	F - staying alive
_____ transmit	G - studies of past events or facts, investigations
_____ upsetting	H - disrupting, disturbing, changing

Adapted from: Conservation for Children

Name _____

Directions: Read the story. Below the story are some new words. Draw a line from the word to its meaning.

Endangered Animals

Many animals are close to extinction today. There are many resons why this is so. Some animals have **decreased** in number for hundreds of years due to changes in climate and **vegetation**. For example, the giant panda and the whooping crane are both **rare** probably for these reasons. Other animals such as the North American bison and the tiger are rare because of **senseless** and destructive hunting. Probably most endangered animals are threatened because of man moving into the places in which they live.

For Example, when the first settlers were moving across America's "Wild West", the herds of bison (or buffalo, as they are sometimes called) seemed **limitless**. There were probably sixty million bison roaming the plains in herds that often had several thousand animals. As the settlers spread across the prairies, the hunters went ahead. Sometimes they were **employed** to supply meat for workmen on the railroads, but often the **slaughter** was far greater than was needed. At that time it seemed that the bison would last forever – but by the beginning of this century there were only a few hundred left throughout America. By careful **conservation**, man has now managed to re-establish several large herds and in the National Parks of Canada and the U.S.A. these **magnificent** animals can once more be seen.

decreased	plant life; growing plants
vegetation	never ending
rare	protecting from loss or being used up
senseless	became less
limitless	splendid; grand; wonderful
employed	foolish; stupid
slaughter	unusual, seldom seen or found
conservation	give work and pay
magnificent	killing; butchering

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Activity 42
Wildlife Conservation
Wildlife on the Farm

Subject Area: Science, Social Studies, Math

Objectives:
1. The students will be able to define carrying capacity.
2. The students will be able to describe how changes in habitat can change the carrying capacity of an area.
3. The students will examine the benefits farmers have when they conserve habitat for the wildlife.

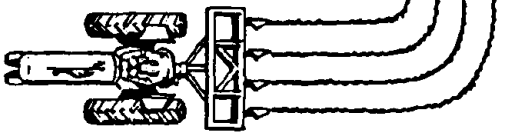
Suggested Grade Level: 5-6

Background: Wildlife depends on the land. The land provides food and shelter for animals, just as it does for people. We must realize that the expansion of agriculture is a major reason for the decline of wildlife.

In recent years the farmer has had one large problem -- low prices caused by over-production. When farmers grow more of a crop than people need the price of the crop goes down. In the 1950's the government started a program that paid farmers not to grow crops. This program was called the Soil Bank Program and farmers could join the "bank" for about ten years.

In the unneeded fields farmers planted heavy grasses and legumes. They were not allowed to mow the vegetation or graze their farm animals in those fields. These fields made excellent habitat for wildlife such as pheasants, quail and even deer. During these years wildlife numbers increased greatly. The Soil Bank Program ended in the late 1960's and farmers began to plow and farm the Soil Bank acres. Farms, however, were changing. Not since the start of the industrial revolution had so many farmers moved from the farm to the city. There were now fewer farmers but larger farms.

Farm equipment had grown larger and much more expensive. The price of a new tractor or combine could buy several new cars. With this new equipment, however, one American farmer now feeds 59 people, but farmers make up only four percent of the total American population. The world population explosion and crop failures in Europe and Russia created more demand for American farm products. This meant the farmers could farm more land. But again, because of their efficiency, the supply began to exceed demand for some crops. Irrigation, or watering, allowed farming of land that was once too dry



for farming. Rough areas and "odd" corners, old fence rows and shelterbelts, were cleared and planted. Many of these fence rows and shelterbelts were put in during the "Dust Bowl" years in the 1930's. Shelterbelts are trees planted to slow down the wind and prevent it from carrying away the soil.

The pace of this clearing is increasing. Some farmers have forgotten the conservation lessons their fathers learned in the "dirty thirties". The effect of this on wildlife has been disastrous. The edge and cover needed by rabbits, quail, doves, pheasants, song birds and even deer is being destroyed. Wildlife habitat is excellent on farms where there are many edges between different types of plant communities. On farms where only one kind of plant community is present, such as all corn or all wheat there is little or no edge and there will be little or no wildlife.

Years ago farming created the perfect habitat for numerous species of wildlife. This is because the traditional American farm provided much food and edge for these animals. Today's large machinery leaves little room for fence rows, odd corners, weedy gullies or woodland. After harvest, farm fields used to have left-over grain. This grain fed much wildlife over the winter. Today, many farmers plow in the fall. They do this in order to have the land ready to plant in the spring and to save time. Besides exposing the soil to water and wind erosion, fall plowing buries any left- over grain. Less wildlife can make it through the winter.

Another practice that is popular with farmers is placing cattle in harvested fields during the fall and winter. The cattle eat any left-over grain and the stalks. While this may be a valuable practice for the farmer, the livestock eat the grain that wildlife would use to survive the winter. Fences are rarely placed around cover areas such as waterways, ditches, and woodlots. Wildlife winter cover is trampled by the livestock.

There are often huge areas growing only corn, milo, soybeans or wheat. Such areas are called monocultures, where just one kind of plant is present. This condition is not good for wildlife or the fertility of the land. Even with increased production, farm prices are still low. Farmers are working to grow enough crops to stay in business. They have little money or time to spend on wildlife. Ninety-six percent of Nebraska's land is privately owned, mostly by farmers and ranchers. Seventy-five percent of U.S. land is privately owned. Most private land is used for farming or ranching.

The most important game managers are farmers and ranchers. Farmers and ranchers provide the four essentials of wildlife habitat - food, water, cover, and space. Game commissions and government natural resource agencies

give advice to land owners on how to provide these essentials of wildlife habitat. Some agencies provide free or inexpensive trees, shrubs and plant seeds to plant on farms or ranches. Government agencies also help landowners plant areas for wildlife through technical assistance or cost share. Despite these efforts, most private land is used to produce the greatest profit for the owner. Wildlife is often neglected. The farmer's main concern is to make a living. Wild animals do not pay many bills. In fact, they often cost the farmer money by eating crops. Wildlife has many values but few of these values provide any direct cash to the farmer. Fortunately, many farmers enjoy having wildlife on their farms and, when economically possible, will help it survive.

The problem farmers and wildlife face is this: Which is more valuable, wildlife habitat or more farm land? Most people would say that they are both important and necessary. Without farming there would not be enough to eat. If we want to make sure that wildlife exists on farms we must be willing to support programs that will pay the farmer for providing the habitat. We also may have to be willing to pay slightly higher food costs if farmers devote more land to wildlife.

In 1985, Federal legislation was passed that affects farmers and conservation practices they use. This legislation is called the Food Security Act of 1985. Many people refer to it as the Farm Bill. The Conservation Provisions in the Food Security Act of 1985 affects 85-90% of the farmers in Nebraska. It affects so many farmers in Nebraska because if they want to continue to participate in U.S. Department of Agriculture Programs, such as Federal Crop Insurance and Farmers Home Administration, they are required to comply with the conservation Provisions.

To comply with the Conservation Provisions farmers with highly erodible fields where annually tilled crops are planted, must develop and be actively applying an approved conservation plan by January 1 1990. The plan must be fully implemented by January 1, 1985. The plan might include adding terraces to the land, changing cropping systems or converting cropland to pasture, rangeland, woodland, recreation or wildlife habitat. If the farmer decided to convert cropland to pasture, rangeland, woodland, recreation or wildlife habitat, these lands might be eligible for the Conservation Reserve Program (part of the Food Security Act of 1985). The Conservation Reserve Program encourages farmers to stop growing crops on highly erodible land and plant it to grass or trees through 10 year contracts with the U.S. Department of Agriculture. So the government will pay the farmer each year for ten years to convert cropland to vegetative cover for the ten years. This program reduces soil erosion, reduces crop surplus, gives the farmer a guaranteed income for ten years, and adds important habitat for wildlife. The farmer can get help

from the local Soil Conservation Service, Cooperative Extension Service, and Natural Resource Districts. For more background information on these programs contact one of these offices in your area.

Resource words - Carrying capacity: the maximum number of species that can survive on a given area of land on a long term basis.
Cover: any plant, group of plants, or piles of bush that provides protection for wildlife. Wildlife edge: an area where two or more plant communities meet.

Materials:

1. Chalkboard or overhead projector
2. Pencil and paper for each student

Procedure:

1. Discuss wildlife on the farm, include the following topics in your discussion.
   - Edge: Ask students, when they sit in a car, would they rather sit in the middle or by the door? In a crowd would you rather be in the middle or near the edge? Most will answer by the edge or the door. Explain that animals like the "edge" too. Explain "edge" on the farm.
   - Importance of wildlife to farmers vs.growing
   - The Food Security Act of 1985 and how it affects Wildlife.

2. Reproduce the following sketch of a 240 acre farm on an overhead transparency or the chalkboard.

3. Describe the farm to the students: 240 acres with several nice areas of oak and hickory woodland, three fields (soybean, corn and pasture), fence rows containing a variety of shrubs, weeds and grasses, a pond and the usual buildings. Does this farm have "edge"?

4. Read the following situations to the students. Have them figure the answers on their own. Also be sure they write down the time of year with their answers:

   Our 240 acre farm had a population of twenty hen pheasants and five rooster pheasants in April. Spring soon arrived and the farm abounded with food and water. The lush grasses and other plants in the fence rows provided nesting cover for all the hens. Eighteen of the hens successfully raised broods of young pheasant chicks. The hens averaged eight chicks each. How many chicks were there in all? (144) What was the total number of pheasants on the farm then? (169)

During the summer four of the old roosters and twelve of the hens died from disease, accidents, mowing operations or summer storms. Thirty-three of the chicks died from farm mowing, storms, accidents, or by being eaten by other animals. How many pheasants were left at the end of the summer? (120) These remaining pheasants had an easy life through the fall. They grew fat on the grain left by the farmer's machinery.

Winter is the hardest time for wildlife. Weakened and diseased birds fall prey to predators. This is the valuable role that predators play - they remove the poor birds, making it easier for the better ones to survive and reproduce later on. Twenty-six pheasants were taken by predators. Then, in late January,70 others starved because food was hard to find through the thick, crusty snow. How many were left by April? (24)

This is the carrying capacity for pheasants on this farm. Carrying capacity of any area is related to the worst conditions over a period of time. No ice storms for several years might lead to an over-abundance of birds that the habitat might not support. Of these 24, ten were hens and fourteen were roosters. Very few of these are more than one year old. One rooster will mate with ten or more hens. Will there be more or fewer young raised on the farm this year than last? (Probably fewer because there are fewer hens.) Would hunting of only males in the fall hurt the population the next year? No. Explain that it is nearly impossible to hunt the male population to the point that hens go through the spring unmated.

What is the greatest limiting factor on the pheasant carrying capacity of this farm? (winter cover) What could this farmer do to increase the pheasant population? (increase winter cover)

Could you raise some young pheasants in a pen and then release them to increase the population? No! Natural reproduction is adequate. Winter cover must be increased if the population is to be increased. Any additional birds will only die during the winter.

For this farm, the carrying capacity is about one pheasant for every ten acres. How many quail can survive on this farm? (240 divided by 10 = 24 quail)

Assume the farmer removed some fence rows and other weedy areas which support many annual "weeds" and provide protective cover for the pheasant. Now the farm can only support one pheasant for every twenty acres. Ask the students what the carrying capacity for pheasant is now. (240 divided by 20 = 12 pheasants)

Suppose the farmer keeps the fence rows and does not harvest a few rows of soybeans or corn or plants several annual food plots (plots of soybeans, milo, and millet planted and left for wildlife). Now the farm is able to support one pheasant for every two acres. What is the carrying capacity? (240 divided by 2 = 120 pheasants)

5. Have students suggest places where food plots should be planted (corners and back areas of the farm, and next to the wooded areas so the quail and other animals don't have to cross open areas).

6. Have students complete Worksheet 1.

Adapted From:

1. Project WILD
2. Learning with Otis
3. USDA Fact Sheets

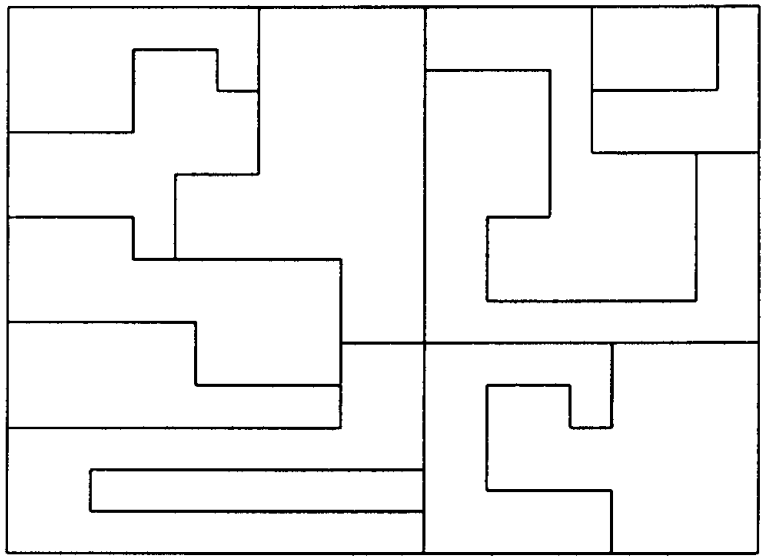
Name _____

The Difference Is...

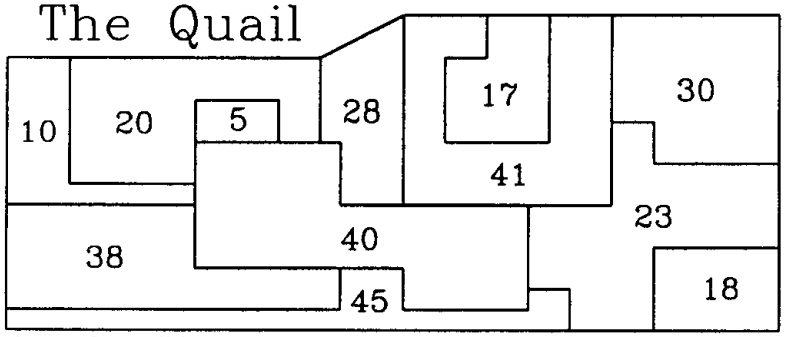
Directions: Find the carrying capacity for quail on this 360-acre farm by doing the following

1. Determine which shapes at the bottom of the page match the shapes drawn on the farm.
2. Add only the numbers of quail listed on the matching shapes to determine the total number of quail on the farm. Some shapes will have no numbers.
3. Determine the carrying capacity for quail on the farm.

The Farm



The Quail



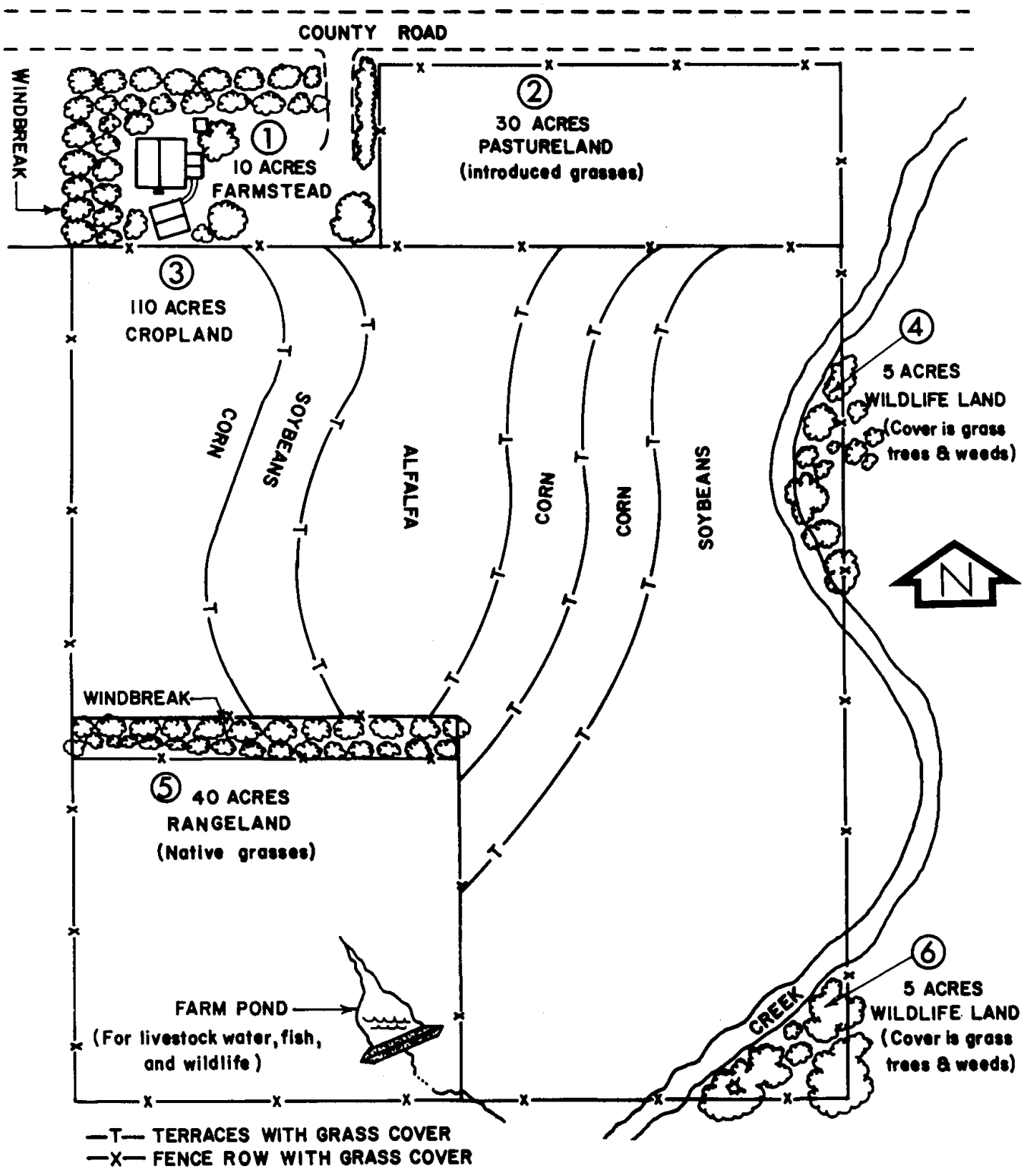
1. The total number of quail is _____.
2. The number of acres (carrying capacity) needed to support one quail on this farm is _____.

3. Excellent quail habitat in Nebraska will support one quail per two acres. (20 bird covey/40 acres) the quail habitat on this farm is:

( ) Excellent ( ) Good ( ) Fair ( ) Poor

240 ACRE FARM LAYOUT

(ACTIVITY 41)



Activity 43
Wildlife Conservation
Litter

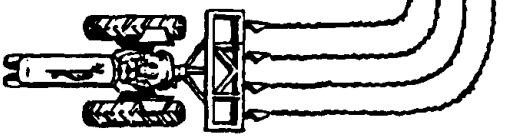
Subject Area: Social Studies, Language Arts, Science, Art, Math

Objectives:
1. The students will be able to identify and evaluate ways that litter and pollution can endanger wildlife.
2. The students will be able to propose ways that can eliminate these dangers that wildlife face.

Suggested Grade Level: 5-6

Materials:
1. Large sheets of paper for mounting collages
2. Glue
3. Litter

Procedure:
1. Divide the class into three or four teams.
2. Ask each team to bring a collection of litter to class in a paper bag. Suggest they look in parks, camping areas, or school grounds.
   NOTE: They should not take things out of garbage cans.
3. Have the teams make and display collages of these items.
4. Discuss the effects of litter. Optional: Ask a wildlife expert 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, least harmful has the lowest score.
6. Have each team figure a total score for their collage based on the numerical values of each piece of litter.
7. Propose and evaluate ways that people can eliminate litter pollution. Can manufacturers make cans with openings other than pop-tops? Could devise another method of packaging six- packs? 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



can the students do as individuals, as groups, or as family units, to eliminate or reduce their own litter?

Adapted From:

1. Project WILD

Activity 44
Wildlife Conservation
Wildwork

Subject Area: Social Studies, Science, Language Arts

Objectives:
1. The students will discover wildlife related careers.
2. The students will research a career related to wildlife or natural resources and present it to the class.

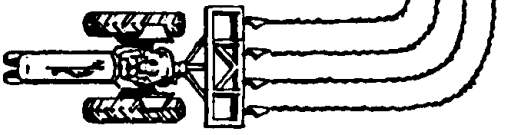
Suggested Grade Level: 5-6

Background: State and federal government agencies employ many specialists to help preserve and manage the wildlife resource. These employees do field work, conduct laboratory research, and oversee human interactions with wildlife. Universities and colleges, private and non-profit wildlife oriented agencies, zoos and museums, private industry, and others all employ people trained in the wildlife and natural resources field. Some of these careers include wildlife biologist, lab technician, naturalist, nature photographer, writer, animal ecologist, habitat specialist, conservation officer, park ranger or wildlife scientist. Some people photograph, paint, draw or write about wildlife for magazines, books, films, and television.

Materials:
1. Reference material
2. Writing paper and envelopes

Procedure:
1. Ask the students what career they are interested in pursuing when they grow up? What kind of jobs sound interesting? Have they ever considered wildlife or natural resources related careers? What kind of jobs do you think these are? Let students brainstorm different kinds of wildlife and natural resource careers. Be sure to encourage those mentioned in the background information.

2. Compile a list of the careers that were brought up in the discussion. Each student or a pair of students must pick one career that interests them. They will research their career and present the information they found to the class. They can look in the library for reference material that will give them information or they could call or write to state and government agencies to find out more information. If possible maybe they could interview a person in their career they are researching. Some questions to ask might include: Why did you choose this career? What do you do



in a typical day's work? How much do you work with wildlife? How much do you work with people?

Additional Activity:

1. Invite a wildlife professional in to your classroom to visit with the students.

Adapted From:

1. Project WILD

2. Wildlife Conservation
   4-H Member Manual 1253

Activity 45
Energy Conservation
Nuclear Energy

Subject Area: Language Arts, Science, Social Studies

Objectives:
1. The students will be able to gain a knowledge of how a nuclear power plant works.
2. The students will be able to recognize pro's and con's of nuclear energy.

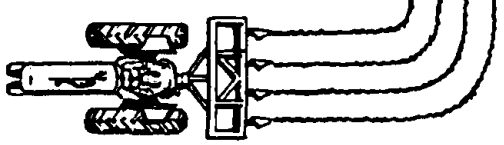
Background: Nuclear reactors, which have been operating safely in the United States for over 20 years, are fueled by uranium. Although the reactors use very little of this fuel compared with the amount of coal needed to produce similar amounts of electrical energy, uranium is a limited resource. Because of this, scientists are perfecting the breeder reactor, which actually produces additional nuclear fuel as it produces heat. When these reactors go into operation, we will be able to add substantially to our stockpile of nuclear fuel.

There are both benefits and risks associated with all energy use. One risk is the large amount of plutonium, a by-product of uranium, that all reactors produce. In addition to being radioactive, plutonium is the raw material for atomic bombs and thus must be kept isolated and protected from theft.

Of course, any device capable of this much potential power is bound to be controversial. Some people feel that use of the nuclear reactor involves just too many risks. Others insist that all energy sources involve risk from pollution- related health effects or environmental disruption. Nuclear-power risks, which have been studied in detail, have been calculated to be far smaller than many day to day risks our society now faces. Not using nuclear power could mean losing a valuable and necessary energy source. Nuclear energy is a very technical and complex subject and has been simplified in this information. It is important that your students know some of the pros and cons concerning nuclear power so that as more information becomes available through the years to them, they will be able to make wise decisions concerning their energy future.

Materials:
1. Worksheets 1-2

Procedure:
1. Using background information and worksheet 1, discuss how a nuclear power plant works.



2. Have students complete Worksheet 2, independently. Discuss.

3. Create two media campaigns. One should be designed to persuade people not to support it. Try to present the strongest arguments on both sides. For your campaign, you may want to create magazine ads, newspaper editorials, radio and TV spots, billboards and posters.

Additional Activities:

1. Worksheet 3 provides more information about pro's and con's of nuclear energy.

2. Worksheet 4 uses nuclear energy vocabulary

Adapted From:

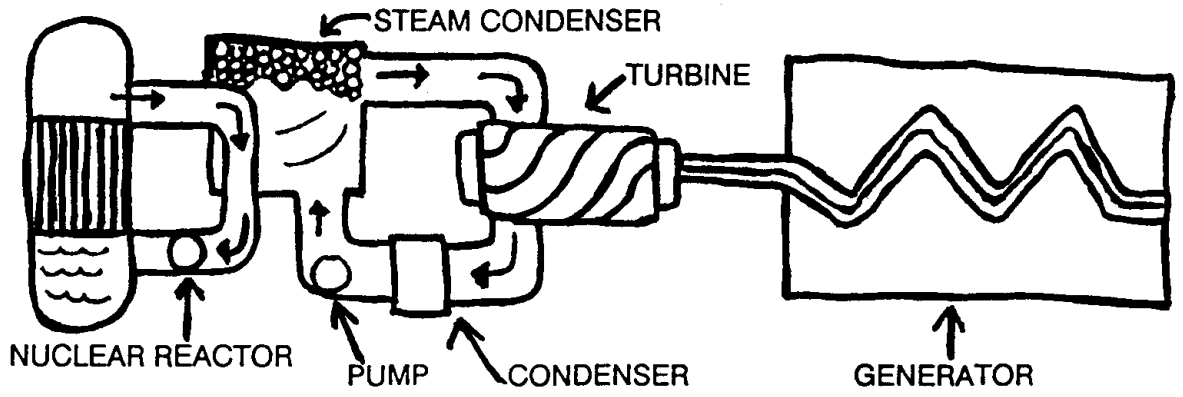
1. The Energy Challenge

2. Energy Learning Center

Name _____

Nuclear Energy

Nuclear energy is a source of power which does not depend on fossil fuels. Here's how a nuclear power plant works.



The nuclear fuel (uranium 235) gives off heat which creates steam. The steam turns turbines which generate electricity.

Here are some reasons why people think this is a good source of energy.

– Nuclear power plants work on a small amount of fuel. One pound of nuclear fuel (uranium 235) the size of a golf ball can create as much energy as 1,500 tons of coal. Fuel trasportation costs are minimum.

– Nuclear fuel is a clean source of energy. Because it does not burn, there is no smoke, soot or sulfur fumes to add to our air pollution problem.

– Nuclear fuel has only one use – to produce electricity. Oil, natural gas and coal are used to produce many other products such as plastics and fertilizers. We should save these fuels for purposes for which there are no substitutes.

There are more arguments over the use of nuclear power than any other energy source. Do you know why?

Directions: Use the story to fill in the blanks.

1. The fuel for nuclear power plants is _____.
2. The fuel heats water to make _____.
3. Steam turns _____ which generate electricity.
4. Nuclear power does not cause air _____.
5. Fossil fuels are needed to produce products such as _____ and _____.

Name _____

Nuclear Energy

The following is a list of benefits and problems associated with nuclear power plants. A key word or phrase in each item is printed in bold type. Read the list and put a (B) in the blank if it is a benefit, a (P) is it is a problem.

__ Less need for mining and **transport** of fuel.

__ No **pollutants** from burning fuel.

__ Less reliance on **imported fuels**.

__ Could be targets for **terrorists**.

__ Reactors produce **less waste** than fossil fuel plants do.

__ Overall **cost** of electricity will be less than with fossil fuels.

__ Higher **cost to build**.

__ Large amounts of **plutonium** could lead to spread of nuclear weapons.

__ Possibility of **radiation escaping**.

__ **Radioactive waste** must be handled and disposed of safely for thousands of years.

Now that you have identified the problem areas, look at the arguments below. Each one concerns a problem area and offers arguments for (PRO) and against (CON) the expansion of nuclear energy. Complete the arguments by inserting a KEY WORD (above) into the blanks for each.

PRO: The _____ is made into a type of glass or ceramic, put into special containers and stored in places like salt beds which have been undisturbed for millions of years.

CON: It takes thousands of years for the _____ to lose its radioactive properites. We cannot assure safe disposal for thousands of years and future societies may be hurt.

PRO: In more than 20 years of commercial nuclear power plant operation, no one has suffered any ill effects brought on by _____.

CON: There's always a chance that an accident or mechanical malfunction could present the danger of _____.

PRO: Regulations and safeguards can be strictly enforced to keep the _____ out of the hands of terrorists. This radioactive waste is usually sealed in an unbreakable capsule right after the fuel processing.

CON: Just 10 pounds of radioactive _____ is enough to make an atom bomb.

Adapted from: The Energy Challenge

Name _____

Directions: Use the words in the box to complete the story.
Read the story again to be sure it makes sense.

amount	safety	environment	expenses	pollutants
accidents	storage	uranium	sabotage	temperature

Nuclear Energy

There is more disagreement over the use of nuclear power than any other source of energy.

People who believe that nuclear energy is a good alternative source of power list the following reasons.

- Nuclear reactor power plants do not produce the air _____ associated with coal and other fossil fuel plants.
- Nuclear energy plants use only a small _____ of fuel. Breeder reactors 'breed' or create more energy than they use.
- The fuels necessary, like _____ are plentiful enough to last for hundreds of years.
- Nuclear energy is better for the _____ because the fuels necessary require less digging and mining.
- Nuclear power plants have higher _____ regulations than any other type of plant.

People who are against nuclear energy list these reasons.

- There is the danger of _____ which could allow radioactive materials to escape into the environment and endanger life.
- Radioactive wastes must be stored for hundreds of years before they are safe. Safe _____ and the effects on future generations are questionable.
- Hot water is a waste material which can raise the _____ of streams and oceans and could destroy wildlife.
- The danger of theft and _____ is frightening. These are the same materials used to make atomic bombs.
- _____ of building nuclear plants do not make it an economical power source.

Adapted from: Conservaion for Children

Worksheet 3

Name _____

Directions: These words that are associated with nuclear energy are hidden in the sentences below. Find the words and draw a cirlce around them.

WASTE RADIOACTIVE FUSION CORE REACTOR BREEDER FISSION ATOMIC STORAGE

1. Joe and Bill are actors in the school play.
2. Sally thought the cause of the damage was termites.
3. Have you heard the new radio act I've made up?
4. It had better be terrific or Ed will have to look for a new job.
5. Since there were three of us, I only needed fifty cents.
6. Give a banana to Michael, please.
7. When the coke went 'fiss', I only lost half of it.
8. Did Bob Reed erase the board?
9. Did you buy a daisy first or a geranium?

Write the words in the correct column. Divide them into syllables.

One syllable

_____

_____

Two syllables

_____

_____

Three syllables

_____

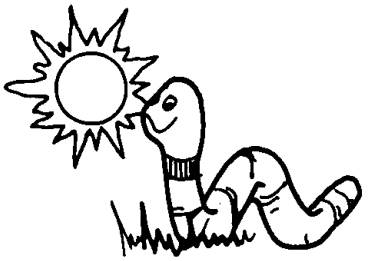
_____

_____

Five syllables

_____

Adapted from: Conservaion for Children



Activity 46
Energy Conservation
Solar Energy

Subject Area: Science, Social Studies

Objectives:
1. The students will gain a knowledge about the history of solar energy.
2. The students will recognize the basic technology of solar collection, of possible solar systems for heating and cooling buildings.
3. The students will apply simple concepts of solar energy by building a solar collector.

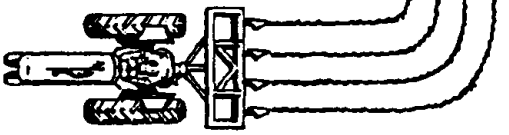
Suggested Grade Level: 5-6

Background: Solar energy is an inexhaustible source of energy that has been used for centuries. That means that we can never run out of it, like we could natural gas. One of the practical uses of solar energy is converting it to heat for spaceheating and domestic hot water heating. Solar energy works well for this because it is clean and renewable. In the future, it is hoped that the Energy Research and Development Administration will develop commercially acceptable ways to generate electricity directly from the sun.

The basic concepts of solar energy involve capturing the heat of the sun with special panels. These panels help hold the heat in. This keeps the area warmer without using electricity or gas heat. The panels are ideally located on the roof of a building facing south. At night or on a cloudy day heat is obtained from a storage system. When storage is empty heat is obtained from a backup conventional system. Everywhere in the U.S. would need this type of a back up because there are days where the sun is covered everywhere. The heat moves through the system with a fluid (either air or water). Sometimes a pump is used to send water back to the collectors to be reheated. You can compare costs in your area with conventional fuel vs. solar energy.

Materials:
1. Worksheets 1-3
2. Two small tin cans
3. Black paint
4. Two thermometers

Procedure:
1. Have students complete Worksheet 1. Discuss.



2. Using background information discuss and answer Worksheet 2.

3. Pass out Worksheet 3. Have student s work in pairs to complete.

4. Build a simple solar collector in you classroom. Paint the outside of one can black. Fill both cans with a measured (equal) amount of water and place them in direct sunlight. Place a thermometer in each can of water and record the temperature of each. Take readings every 15 minutes and record all observations. Determine which can collects solar heat faster. Discuss.

Adapted From:

1. The Energy Challenge

Name _____

The History of Solar Energy

The sun's energy has been used for heating and cooling for thousand of years. The early Greeks in the 5th century B.C. built entire citites facing south to take advantage of the sun's warming rays. A good example of early solar heating is in Mesa Verde, Colorado, where the Indians built their adobe homes in the cliffs to the mesa facing south. During the winter the sun would shine directly into the cliff dwelling and warm them naturally. The thick adobe walls stored the heat of the day. At night the stored heat would continue to keep the living space warm. During the summer when the sun was high, the overhanging cliffs shaded the structures to keep them cool. The Indians of Mesa Verde built their homes about 1200 A.D. Today, almost 800 years later, their natural heating and cooling system is still working.

In the early 1900's, fossil fuels and electricity were new kinds of energy used to provide heat for homes. When they were first used, they were very expensive, even more than they are today. Sunlight, on the other hand, was free. Solar water heating systems were introduced in California in 1891. The early models were simply shallow water tanks mounted on the roof of the house with plumbing leading to the kitchen and bathroom. In 1930, many rooftops in Los Angeles and other Southern California cities had solar collectors. But as electricity, natural gas and other fossil fuels became more readily available and dropped in price, the use of solar energy declined.

Directions: Circle 'true' or 'false' for each statement.

1. Solar energy is a new source of power. True False
2. The sun can be used to heat houses. True False
3. Fossil fuels were expensive when they were first used. True False
4. People stopped using solar power because it was too expensive. True False

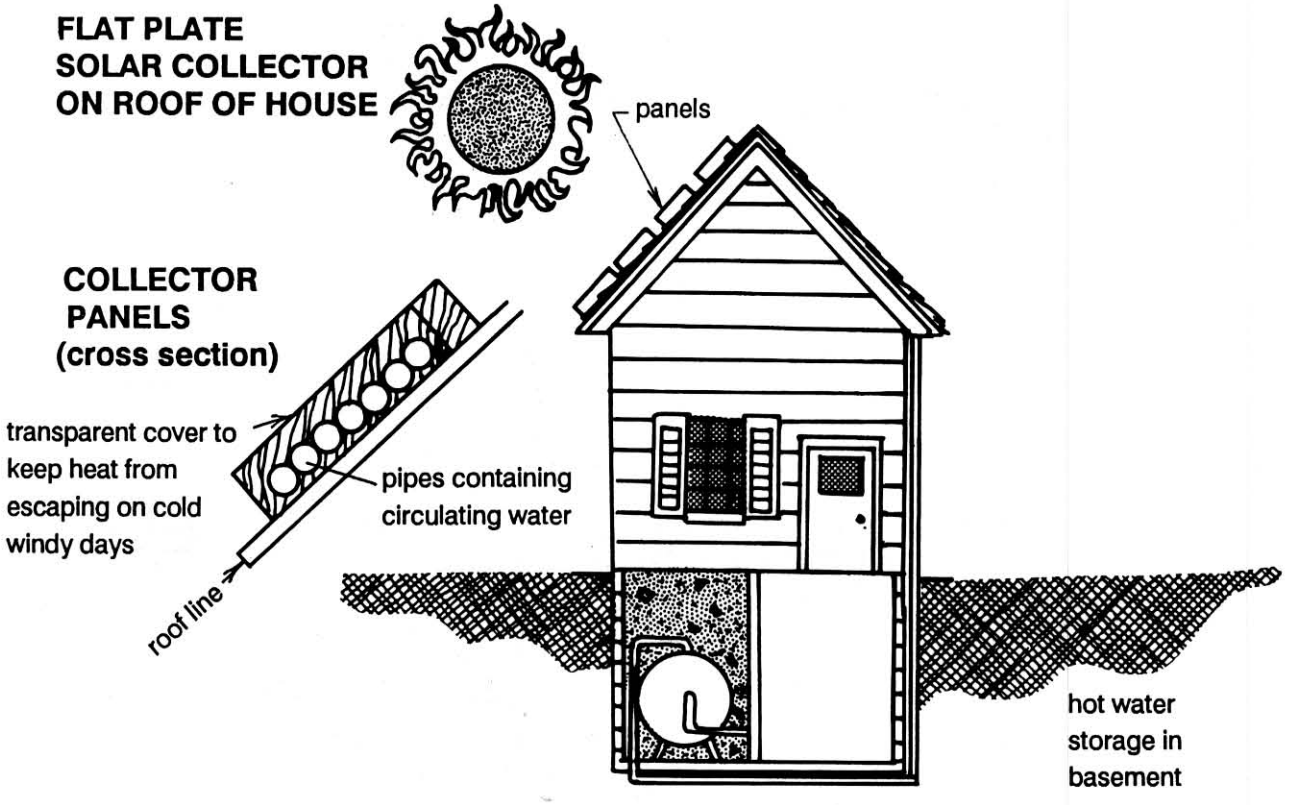
Adapted from: Conservation for Children

Worksheet 1

Name _____

Energy from the Sun

There are several ways to use solar (sun) energy. The simplest way is to design a building to take advantage of its natural environment, including the sun. Another way is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning and water heating, but not its electric power. A third way is to set up a huge collecting field to collect solar energy, turn it into heat in a power tower, and then to electricity that will be sent to individual dwellings. A one-square mile field of these collectors could supply electricity for about 20,000 houses.



1. What direction should the collectors face for the greatest amount of sun?_____
2. How is solar heat obtained at night or on a cloudy day? _____
   _____
3. What parts of the U.S. would be able to use solar heat without a conventional back-up furnace?_____
4. What kind of fluid can be used in a solar energy system? _____
5. How can someone decide whether or not to install a solar energy system in their home?_____
6. Could the heat from a solar collector field be used to generate electricity? _____
   _____

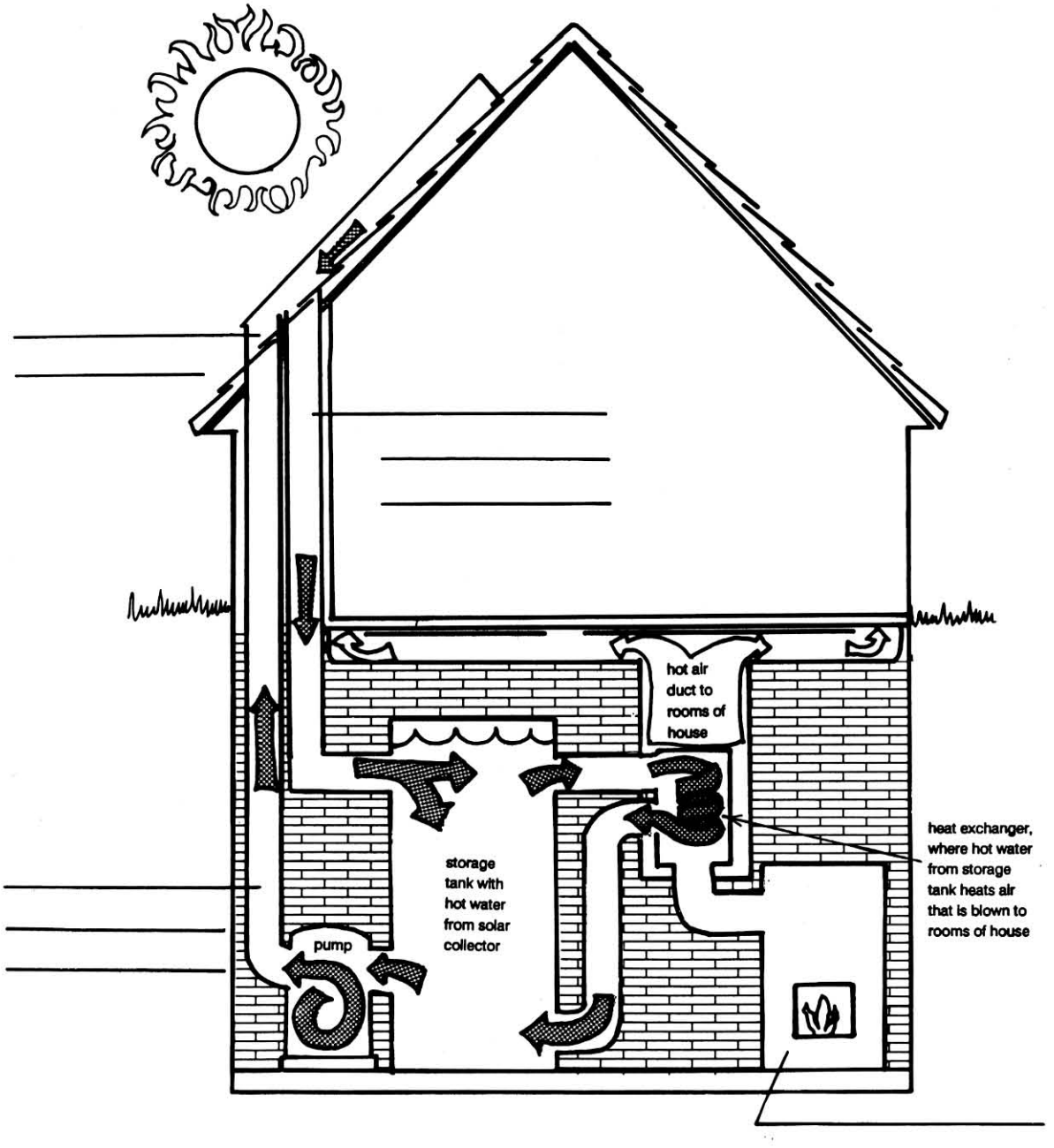
Adapted from: Conservation for Children

Name _____

Energy from the Sun

The diagram below shows how a solar heating system might heat a house. In this case you see a system that uses the energy of the sun to heat water that runs through collectors on the roof of the house. Because there can be many days when the sun doesn't shine, even a solar-heated house needs a conventional furnace. The conventional furnace runs when the storage tank runs short of hot water from the collector.

See if you can label the parts of the solar heating system below. Use these words: **solar collector panels, pipe to storage tank from collector, pipe to collector, conventional furnace**. Write the correct words on the lines.



Question for discussion:
Why would it be necessary to have a pump in this heating system?

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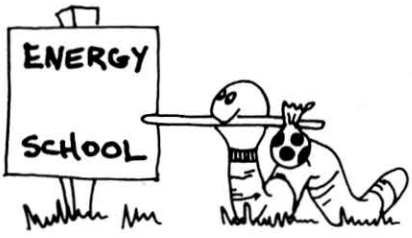
Activity 47
Energy Conservation

Energy Of The Future



Subject Area: Science

Objectives:
1. The students will discover some of the problems and benefits of several energy resources.
2. The students will discover ways they can personally conserve energy.

Suggested Grade Level: 5-6

Procedure:
1. Hand out Worksheets 1 and 2. Have students read and complete them.
2. Discuss the worksheets. Be sure to bring up the importance of conserving energy.
3. Have students complete Worksheets 3 and 4.
4. Discuss and brainstorm more ways of conserving energy.

Adapted From:
1. The Energy Challenge

Other New Energy Resources

Besides nuclear and solar energy, there are several other possibilities for the future. Read about some of these new energy sources on this page. Problems and solutions are associated with each of them. On the next page you will decide what some of these problems and solutions are.

WIND. Wind is actually a form of solar energy since it is caused by variations in the temperature of the air heated by the sun that causes air to move. Sailors used this energy for ages. For many years farms have used windmills to generate electricity. Maybe giant windmills will someday be able to provide electricity for entire towns. The major difficulites are that the wind doesn't blow all the time and that practical storage systems are still being developed.

GEOTHERMAL. The earth's center is a molten mass. In some areas this mass is close to the surface. Some evidence of this are volcanos, geysers and hot springs. This heat can be trapped and used to generate electicity to supply cities without polluting the atmosphere. The problem is that this energy can now be tapped only where it is near the surface. Scientists are searching for other areas where this geothermal energy can be reached, but they don't have all the anwers yet.

PYROLYSIS OF SOLID WASTE. It is possible to heat waste in an oxygen-free atmosphere and produce oil and gaseous products. This waste is what we're now having trouble removing from our environment; manure, garbage, paper, logging residue, some industrial waste, sewage and the like. The difficulty is that this material tends to be scattered in small amounts at various sites. The problem is one of gathering it together at a reasonable cost.

COAL GASIFICATION. By using high temperature and pressure, coal can be converted into a gas very much like natural gas. Building these conversion plants near coal fields can solve the problem of trasporting bulky fuel that gives of pollutants when it is burned. When coal gas is burned, it burns as cleanly as natural gas, causing virtually no air pollution. The usual pollution problems occur in the coal mining process, however, as they always have. The conversion process itself, however, uses large amounts of electrical enegry.

COAL LIQUEFACTION. Although the technology is not completely developed, coal can be converted to an oil-like liquid. It has the advantage over coal gas of being usable to make all the usual oil products, including a kind of gasoline to run our cars.

OIL SHALE. Oil shale is a rock containing a material that yields oil when it is crushed and heated. One ton of rock will produce about 25 gallons of oil. Most oil shale deposits are in the West. The rock must be mined, either by deep mining or surface mining. Extracting the oil takes large amounts of water – three barrels to every one barrel of oil processed. One of the big problems is the disposal of the spent rock after the oil extracted. Vegetation will not grow in the used shale without a moderate amount of rain – scarce in many parts of the West. Without vegetation, some animals may lose their homes and natural food supply. Rain water passing through this rock will possibly pick up pollutants and carry them to larger bodies of water if there is no vegetation. In addition, oil shale processing contributes to air pollution!

Name _____

Problems/Solutions

In this unit, you have learned about eight new energy sources. The use of any one of these resources may help to supply our energy requirements but may at the same time present us with new problems to consider. In the lefthand column of this page are some of these issues – some are problems, some are solutions. Mark each statement S (for solution) or P (for problem). Place a checkmark in every energy-resource column on the right to which a statement applies. The first one is done for you.

If this energy source is used, it . . .	SOLAR 	NUCLEAR 	WIND 	GEO-THERMAL 	COAL GASI-FICATION 	COAL LIQUI-FACTION	OIL SHALE 	PYROLYSIS 
S Would help solve the problem of solid waste disposal.	✓		✓	✓	✓	✓		✓
_____ Could pollute water.								
_____ Would conserve the dwindling reserves of fossil fuels.								
_____ Could damage wildlife or their habitat.								
_____ Would be difficult to store and transport.								
_____ Would not pollute the atmosphere.								
_____ Would disrupt the natural use of land surfaces.								
_____ Would not be able to supply energy all the time.								
_____ Would have to wait until the technology is developed.								
_____ Would use lots of water to process.								
_____ Will decrease the need for oil imports.								
_____ Will make large amounts of waste material.								
_____ Will make use of this countries most abundant fossil fuel.								

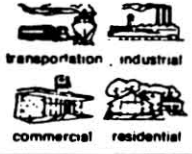
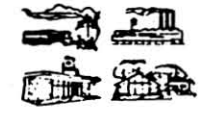
Adapted from: The Energy Challenge

Worksheet 2

Worksheet 3

It's Everyone's Job!

Read the idea for conserving energy in the column headed **Conservation Method**. Answer the questions in the spaces provided.

Conservation Method	What sector of society? (circle one or more)	What energy resources does this save? (write: natural gas, petroleum or coal)	Does it use less energy? (yes or no)	Does it use energy more efficiently? (yes or no)	How can we encourage this conservation measure? (brainstorm as many ideas as you can)
Flying passenger airplanes only when they are full.					
Shipping freight by train instead of truck.					
Replacing incandescent light bulbs with fluoroscent lights.					
Reducing heating and cooling where space is unoccupied.					
Recycling steel, paper, glass and aluminum.					

Adapted from: The Energy Challenge

Name _____

Name _____

What Can YOU Do To Save Energy?

Part One:

Brenda's mother and Wayne's father each work ten miles away from their homes. In a five-day week, each uses five gallons of gas driving to and from work. Wayne's father drives alone. Brenda's mother is in a car-pool in which she takes four other persons to work. If each of her passengers drove, each would also use five gallons of gas a week. Now that they car-pool, how much gasoline does Brenda's mother help save each week?_____ each year? _____
How could Wayne's father help save energy?_____ _____

The Bailey's are going away on vacation. They are concerned about burglars and want a light on in their house from 7:30 to 11 o'clock each evening. Can you suggest how they might do this without wasting energy?_____
_____

Selecting the right size electric light bulb can help save energy. On the package is listed the number of watts (the amount of power needed to make the light bulb work), the lumens (the brightness of the bulb) and the number of hours the bulb will last. With this information, how could you select the most efficient bulb?_____
_____

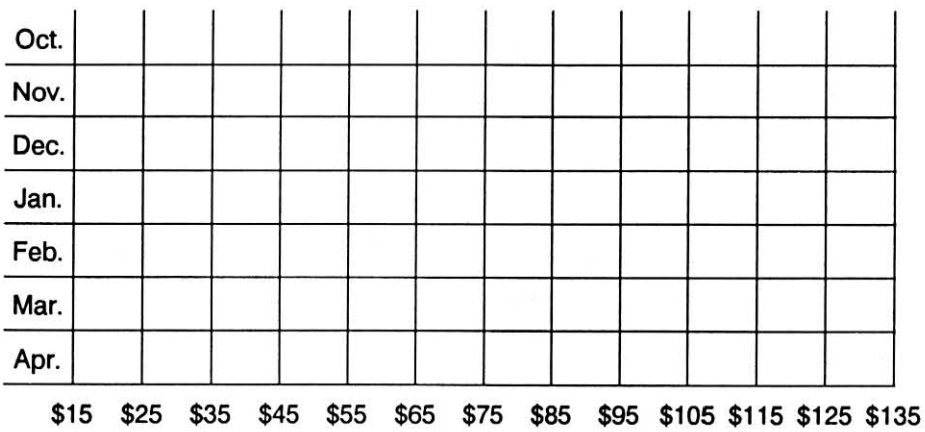
John and his sister are going to wash clothes. He wants to do his three shirts seperately. His sister wants to do them with her five blouses. Which way will conserve energy? _____Why?_____
_____

Jack has just come indoors after skating on the pond and feels cold. He wants to turn the thermostat up to 80° F. His mother tells him to leave it where she has set it a 68° and put on a sweater. Who is more energy concious?_____
Why?_____

Part Two:

Below are the Hazleton's heating bills for two different years. During the first year, they had no insulation in their 1800 sq. ft. home. At the end of the year they had their house fully insulated, so the cost of heating theri home went down. On the graph below, place a dot for the cost of cach heating month of the first year. Then draw a black line between the dots. Do the same thing in red for the following year. Compare the Hazleton's savings with insulation.
How much did they save in January? _____
How much for the entire heating season? _____

	First Year	Following Year
October	$24	$20
November	$61	$45
December	$98	$70
January	$135	$95
February	$116	$80
March	$98	$70
April	$73	$50



Do you think insulation would help to lower air-conditioning bills? Why or why not?_____
_____

Adapted from: The Energy Challenge

Worksheet 4

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Answer Keys

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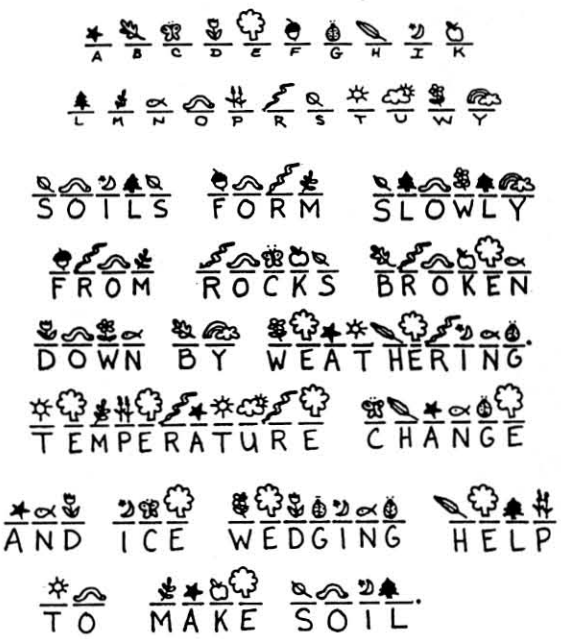
Name ACTIVITY 1 PAGE 6

Weathering Away

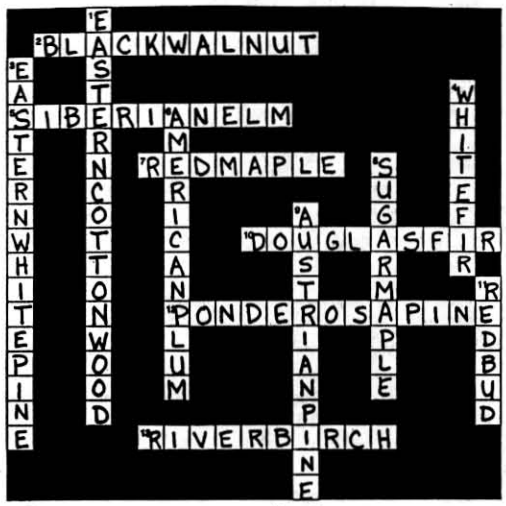
In the coded message below, find out what helps make soil. Write the letter of each picture under the same picture in the puzzle.



Worksheet 1

Name ACTIVITY 20 PAGE 71

Trees of Nebraska



Across Clues

2. A very high valued hardwood, a native found near Nebraska rivers.
5. Some people incorrectly call this tree Chinese Elm, what is its correct name.
7. The wood of this tree is brittle and decays readily.
10. Comprises 50% of the standing timber of western forests, not native to Nebraska.
12. Slow growing but important lumber producing western pine.
13. This tree fits its name, it is found along streams. (Hint: rivers and streams)

Down Clues

1. This is the state tree, it fits its name because its fruit contains a cottony material.
3. The fruit of this tree is about 5" long, narrow, stalked, with thin scales and unarmed.
4. A prized ornamental, not native to Nebraska.
6. The scintific name for this tree is Prunus Americana, what is its common name?
8. This tree is noted for the maple syrup made from its sap.
9. Similar in size and habit to the native ponderosa pine.
11. This tree has beautiful flowers that bloom before leaves appear in April.

Worksheet 1

Name ACTIVITY 23 PAGE 85

Recycling Newspapers

Old newspapers can be **recycled**. That means they can be used again instead of being thrown away or burned. You should save your old newspapers and take them to a recycling center or a paper mill. They will pay you money for bringing in old newspapers.

The paper mills have their own ways of making the old newspapers into new paper. They soak the newspapers with water and beat the pulp with paddles. Then the wet pulp is put through heated drying rollers. These rollers squeeze the water out of the pulp and dry it, making new paper and cardboard

When we use paper which has been recycled, we are saving trees. It takes about seventeen trees to make one ton (2,000 pounds) of paper.

Directions: Answer the questions.

1. What can you do with old newspapers besides throwing them away, making paper hats or burning them?

   YOU CAN RECYCLE THEM.

2. What does **recycle** mean?

   TO USE AGAIN

3. When the paper mills make paper from trees, they use wood chips from trees and cook them with water to make pulp. To make recycled paper, what do the paper mills mix with water to get pulp?

   OLD NEWSPAPERS

4. How many trees does it take to make one ton of paper?

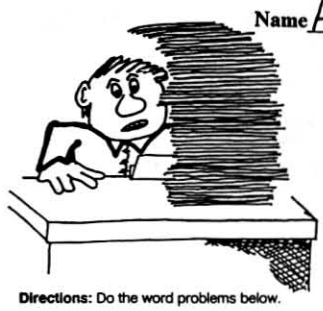
   17

5. What do you think is one of the most important reasons for recycling newspapers?

   SAVE TREES

Worksheet 1

Name ACTIVITY 23 PAGE 86



The National Wildlife Federation has started a paper recycling progam in their company offices. Each employee has a tray on their desk to hold used papers. The used papers go from the trays to boxes instead of into the wastebasket.

Their goal is to save four tons of used paper for recycling.

Directions: Do the word problems below.

1. The NWF goal is to save four tons of used paper. Each box of used paper weighs 50 pounds when it is full. How many boxes will they need to make four tons?

   8,000 ÷ 50 = 160 BOXES

2. Each 1000 pounds of paper that they collect will save 8.5 trees. If they reach their goal of four tons, how many trees will be saved?

   8.5 × 8 = 68 TREES

3. The four tons of used paper will be recycled and made into copier paper. Recycling one ton of waste paper uses 22,000 kilowatt hours of energy. Producing the same amount of paper from trees takes 67,000 kilowatt hours. How many kilowatt hours of energy will be saved by recycling four tons of waste paper?

   67,000
   - 22,000
   45,000 = 1 TON

   45,000 × 4 = 180,000

   180,000 KILOWATT HOURS

   (This is enough to air condition and heat two average houses in Washington, D.C. for an entire year.)

Worksheet 2

Name ACTIVITY 26 PAGE 94

Wanted: Water!

Calculate the answer of each of the following problems. Show your work.

Background Information

Babies weight = 3/4 water
Grown person's weight = 1/2 water
1 liter of water weighs 1 kilogram

1. Charlie is Sally's baby brother. He weighs 8 kilograms. What percentage of his weight is water? 75%
   How many kilograms is water?
   .75 x 8 = 6 KILOGRAMS

2. Sally's father said, "My body has 40 liters of water according to my weight." How much does he weigh?
   40 x 2 = 80 KILOGRAMS

3. a. The school nurse told 11-year-old Sally that she weighs 30 kilograms, and that 18 kilograms of that is water. How many kilograms are not water?
   30 - 18 = 12 KILOGRAMS

   b. Why isn't Sally's total number of kilograms in water, 18 kilograms?
   BECAUSE A CHILDS WEIGHT IS 3/4 WATER.

4. If Laura has 10 kilograms of water in her body, then . . .
   a. What is her total weight if she is a baby?
   10 x .75 = 7.5 KILOGRAMS

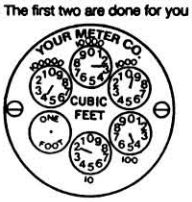
   b. What is her total weight if she is a full grown woman?
   10 x 5 = 50 KILOGRAMS

Worksheet 1

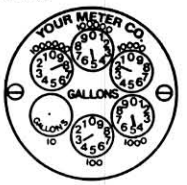
Name ACTIVITY 28 PAGE 101

Reading a Water Meter

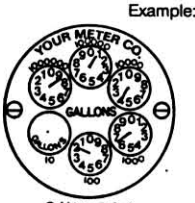
Some meters with dials record in cubic feet, some record in gallons. If the dial points directly to a number, record that number. If the dial points between two numbers, record the lower number. Read the following dial meters and record their readings below them. The first two are done for you to show how.



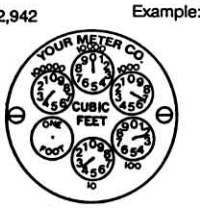
Example: 42,942



Example: 852,430

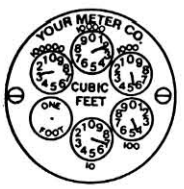


1. 8146200

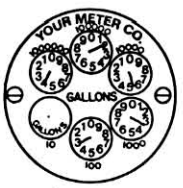


2. 407230

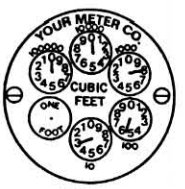
3. 58600



4. 325470



5. 4253300



6. 8530

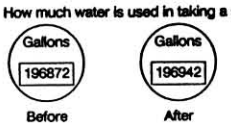
Worksheet 1

Name ACTIVITY 28 PAGE 102

Most water meters record gallons just as a car's odometer records mileage. However, some water meters show the usage in cubic feet. For these, you must multiply by 7.5 (the approximate number of gallons in one cubic foot) to find how many gallons are used.

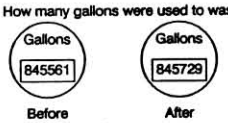
Directions: Use the meter readings below to find out how much water is being used. Be sure to label you answers as gallons or cubic feet.

1. How much water is used in taking a shower?



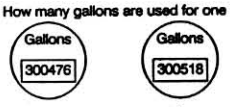
196842
-196872
70 gallons

2. How many gallons were used to wash the car?



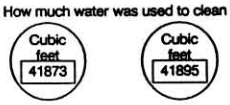
845729
-845561
168 GALLONS

3. How many gallons are used for one load of wash in the washing machine?



300518
-300476
42 GALLONS

4. How much water was used to clean the sidewalk with the hose?



41895
-41873
22 CUBIC FEET
22 x 7.5 = 165 GALLONS

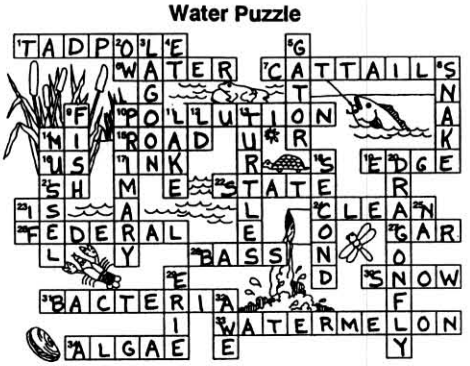
How many gallons of water is that? (Remember to multiply by 7.5)

Tips to save water:
1. Take shorter showers.
2. When washing the car, use a bucket for soapy water and use the hose to rinse only.
3. Be sure to wash full loads when using the washing machine.
4. Use a rake or broom to clean the sidewalk, not the hose.

Worksheet 2

Name ACTIVITY 29 PAGE 110

Water Puzzle



Across
1. Immature frog.
6. Most important liquid
7. Tall plants at water's edge
10. Contamination of nature.
14. Abbreviation for Michigan
15. Well traveled path.
16. Who is responsible for pollution.
17. Writing fluid.
19. Part of the pond where water meets land.
21. Slang for "be quiet".
22. Missouri is one.
23. Lives, exists.
24. Not dirty.
26. National government.
27. Long-nosed armored fish.
28. Large-mouth or small-mouth game fish.
30. Winter precipitation.
31. Micorscopic decomposers.
33. Fruit that is 97% water.
34. Single-celled water plants.

Down
2. Ouch!
3. A small pond or waste-water lake.
4. Extraterrestrial (abbr.)
5. Short for "alligator".
8. Reptile with no arms or legs.
9. Finned animal in water.
10. The first three grades.
11. Large body of fresh water.
12. Abbreviation for learning disability.
13. Reptiles with hard shells.
14. Clam-like invertebrate.
18. Runner-up, _____ place.
20. Large insect found near water.
23. Supposing that.
25. North America (abbr.)
29. One of the Great Lakes.
32. Feeling inspired by a waterfall.

Worksheet 2

Name ACTIVITY 31 PAGE 119

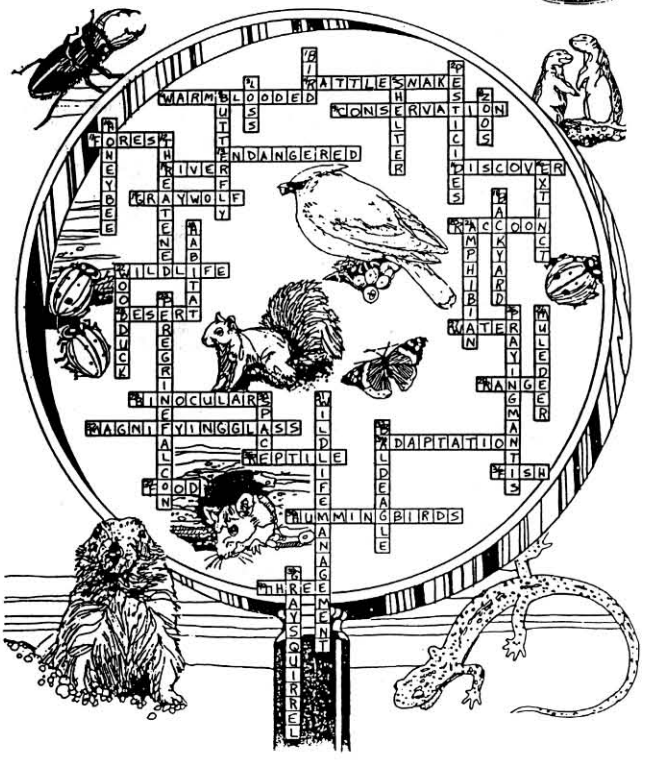
Irrigation

Irrigation has become one of the most important factores in making Nebraska a leading state known for its agricultural productivity. During the last two decades, tapping groundwater resources to help meet agricultural demand for water has increased at such a rapid pace that now more than 73 percent of the water used for irrigation is pumped from wells. Using Worksheet 2, answer the following questions.

1. Approximately how many irrigation wells were installed by 1936? 1,200
2. How many irrigation wells were registered by January 1, 1984? 70,087
3. How large of an increase in the number of irrigation wells is this? 68,887
4. In the year 1956 there was a sharp increase in the number of irrigation wells. Using the graph, find another year with a sharp increase. Write that year. 1976
   Why do you suppose this happened? INCREASES WERE CAUSED BY PERIODS OF DROUGHT.
5. In what year were there 2000 irrigation wells registered? 1968
6. What might be the reason for such a sharp dropoff of new irrigation well installation in recent years? MOST IDEAL AREAS HAVE BEEN UTILIZED BY WELLS OR NEW TECHNOLOGY
7. Between 1936 and 1984, which year had the lowest number of irrigation wells installed? Which had the highest?
   Lowest 1936 Highest 1976

Worksheet 1

ACTIVITY 36 PAGE 139



Worksheet 2

Name ACTIVITY 41 PAGE 172

Directions: Read the story. Use standard notation to answer the questions below.

Wildlife Refuge

Many years ago, people realized that something had to be done to protect animals and birds that were becoming endangered. Many of these animals were in trouble because man had built roads and cities where they lived. Our government passed tax laws to raise money in order to buy land where these animals could live safely. These wildlife preserves became permanent homes where wild animals are protected, and where they can find food and shelter and bear their young.

The Fish and Wildlife Service of the United States Department of the Interior is in charge of two hundred and sixty four National Wildlife Refuges with a total area of nine million five hundred forty six thousand six hundred and forty six acres. Seventeen additional refuges exist in Alaska, Hawaii and Puerto Rico. One hundred and ninety nine of the refuges are set up mainly for birds that live in or near water. Forty one are for birds not normally hunted. Seventeen are for big game animals. And six are for birds other than water fowl.

These wildlife preserves have saved many animals that might have become extinct.

1. How many National Wildlife Refuges are there in the United States? 264
2. How many acres are being used for this purpose? 9,546,646
3. How many refuges exist in Alaska, Hawaii and Puerto Rico? 17
4. How many refuges are used for birds that live in or near water? 199
5. How many refuges are for birds that are not normally hunted? 41
6. How many refuges are for big game animals? 17

Worksheet 1

Name ACTIVITY 41 PAGE 173

What's Happening to our Wildlife?

The Destruction of wildlife is one way man has changed the environment.

Many animals have been killed by people. Millions of predators, such as foxes, coyotes, wolves, mountain lions, hawks and owls have been killed to 'protect' ranch and farm animals. Today, as a result, many crops are threatened by rats, mice and other rodents. We have upset the balance of nature.

Over the past years, many other animals were killed for sport. The buffalo, also known as the American Bison, almost became extinct. In 1870 there were over fifty million buffalo in the United States but in 1889 only 551 could be found. Early train passengers used the buffalo for target practice by shooting them from the windows of the moving trains. Now the buffalo is protected by law and it is estimated that there will be over a half million by the year 2000.

Other animals are killed for fur and food. The passenger pigeon was killed for food until it became extinct. Many fur bearing animals are on the endangered animal list because of over trapping and hunting.

But, the biggest problem facing wildlife today is the loss of their habitats. Our growing population needs more land to build houses, factories and highways. We have drained swamps and filled in baylands to make room for more buildings and roads. What happens to the animals that lived there?

Even animals that have not lost their habitats and are not sought after for food, fur or sport are in danger. The increasing water and air pollution and the wide use of pesticides and poisons are other problems for wildlife.

We must learn to share the earth with all living things or our own survival may be in danger.

William F. Cody was nicknamed "Buffalo Bill". Use the code to find out why.

Directions: Change each letter or numeral to the one that comes before it.
Example: SJHIU = RIGHT

IF LJMMFE 5972 CVGGBMP HO POF TFBTPO
HE KILLED 4861 BUFFALO IN ONE SEASON

Do you think he would have been proud of this today?

Worksheet 2

Name ACTIVITY 41 PAGE 174

Directions: Read the story. Use the context clues to match the underlined words to their defintions at the bottom of the page.

Letting Wild Animals Go

Some people have tamed wild animals to be pets. Racoons, tortoises, snakes and many types of birds are some of the animals that are often kept as pets. Many well-meaning people who have these wild animals feel that they should let their pets go free to return to their natural habitats. This should not be done for several reasons:

1. Research shows that a captive has less than a 10% chance of surviving the demands of his natural habitat. The soft life of captive living makes it difficult for animals to adapt to their wild habitats.
2. Captive pets have or transmit diseases to the other wild animals.
3. The food supply of an area may not be enough to support another animal. Adding your pet to the habitat is another way of upsetting the balance of nature.

The best thing to do if you cannot keep your pet is to give it to someone who will care for it. Do not turn it loose!

Write the letter of the definition in front of the correct word.

C	habitats	A - caged or contained in an unnatural setting
G	research	B - needs, requirements
A	captive	C - surroundings, home of an animal
F	surviving	D - pass on to, infect
B	demands	E - fit into different conditions or settings
E	adapt	F - staying alive
D	transmit	G - studies of past events or facts, investigations
H	upsetting	H - disrupting, disturbing, changing

Worksheet 3

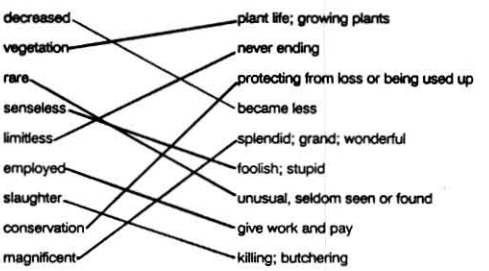
Name ACTIVITY 41 PAGE 175

Directions: Read the story. Below the story are some new words. Draw a line from the word to its meaning.

Endangered Animals

Many animals are close to extinction today. There are many resons why this is so. Some animals have **decreased** in number for hundreds of years due to changes in climate and **vegetation**. For example, the giant panda and the whooping crane are both **rare** probably for these reasons. Other animals such as the North American bison and the tiger are rare because of **senseless** and destructive hunting. Probably most endangered animals are threatened because of man moving into the places in which they live.

For Example, when the first settlers were moving across America's "Wild West", the herds of bison (or buffalo, as they are sometimes called) seemed **limitless**. There were probably sixty million bison roaming the plains in herds that often had several thousand animals. As the settlers spread across the prairies, the hunters went ahead. Sometimes they were **employed** to supply meat for workmen on the railroads, but often the **slaughter** was far greater than was needed. At that time it seemed that the bison would last forever – but by the beginning of this century there were only a few hundred left throughout America. By careful **conservation**, man has now managed to re-establish **several large herds** and in the National Parks of Canada and the U.S.A. these **magnificent** animals can once more be seen.



Worksheet 4

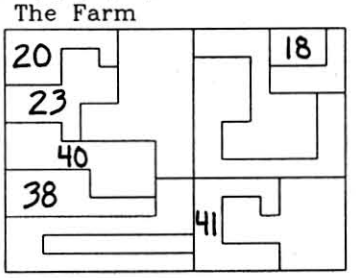
Name ACTIVITY 42 PAGE 183

The Difference Is...

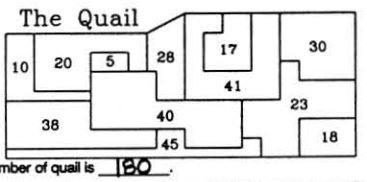
Directions: Find the carrying capacity for quail on this 360-acre farm by doing the following

1. Determine which shapes at the bottom of the page match the shapes drawn on the farm.
2. Add only the numbers of quail listed on the matching shapes to determine the total number of quail on the farm. Some shapes will have no numbers.
3. Determine the carrying capacity for quail on the farm.

The Farm



The Quail



1. The total number of quail is 180.
2. The number of acres (carrying capacity) needed to support one quail on this farm is 2. $360 \div x = 180 \quad x = 2$
3. Excellent quail habitat in Nebraska will support one quail per two acres. (20 bird covey/40 acres) the quail habitat on this farm is:

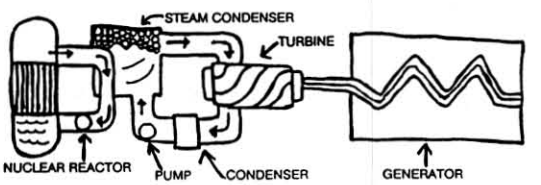
(X) Excellent ( ) Good ( ) Fair ( ) Poor

Worksheet 1

Name ACTIVITY 45 PAGE 191

Nuclear Energy

Nuclear energy is a source of power which does not depend on fossil fuels. Here's how a nuclear power plant works.



The nuclear fuel (uranium 235) gives off heat which creates steam. The steam turns turbines which generate electricity.

Here are some reasons why people think this is a good source of energy.

– Nuclear power plants work on a small amount of fuel. One pound of nuclear fuel (uranium 235) the size of a golf ball can create as much energy as 1,500 tons of coal. Fuel trasportation costs are minimum.

– Nuclear fuel is a clean source of energy. Because it does not burn, there is no smoke, soot or sulfur fumes to add to our air pollution problem.

– Nuclear fuel has only one use – to produce electricity. Oil, natural gas and coal are used to produce many other products such as plastics and fertilizers. We should save these fuels for purposes for which there are no substitutes.

There are more arguments over the use of nuclear power than any other energy source. Do you know why?

Directions: Use the story to fill in the blanks.

1. The fuel for nuclear power plants is URANIUM 235.
2. The fuel heats water to make STEAM.
3. Steam turns TURBINES which generate electricity.
4. Nuclear power does not cause air POLLUTION.
5. Fossil fuels are needed to produce products such as PLASTICS and FERTILIZERS.

Worksheet 1

Name ACTIVITY 45 PAGE 192

Nuclear Energy

The following is a list of benefits and problems associated with nuclear power plants. A key word or phrase in each item is printed in bold type. Read the list and put a (B) in the blank if it is a benefit, a (P) is it is a problem.

B Less need for mining and **transport** of fuel.

B No **pollutants** from burning fuel.

B Less reliance on **imported fuels**.

P Could be targets for **terrorists**.

B Reactors produce **less waste** than fossil fuel plants do.

B Overall **cost** of electricity will be less than with fossil fuels.

P Higher **cost to build**.

P Large amounts of **plutonium** could lead to spread of nuclear weapons.

P Possibility of **radiation escaping**.

P **Radioactive waste** must be handled and disposed of safely for thousands of years.

Now that you have identified the problem areas, look at the arguments below. Each one concerns a problem area and offers arguments for (PRO) and against (CON) the expansion of nuclear energy. Complete the arguments by inserting a KEY WORD (above) into the blanks for each.

PRO: The RADIOACTIVE WASTE is made into a type of glass or ceramic, put into special containers and stored in places like salt beds which have been undisturbed for millions of years.

CON: It takes thousands of years for the RADIOACTIVE WASTE to lose its radioactive properites. We cannot assure safe disposal for thousands of years and future societies may be hurt.

PRO: In more than 20 years of commercial nuclear power plant operation, no one has suffered any ill effects brought on by RADIATION ESCAPING.

CON: There's always a chance that an accident or mechanical malfunction could present the danger of RADIATION ESCAPING.

PRO: Regulations and safeguards can be strictly enforced to keep the PLUTONIUM out of the hands of terrorists. This radioactive waste is usually sealed in an unbreakable capsule right after the fuel processing.

CON: Just 10 pounds of radioactive PLUTONIUM is enough to make an atom bomb.

Worksheet 2

Name ACTIVITY 45 PAGE 193

Directions: Use the words in the box to complete the story. Read the story again to be sure it makes sense.

amount	safety	environment	expenses	pollutants
accidents	storage	uranium	sabotage	temperature

Nuclear Energy

There is more disagreement over the use of nuclear power than any other source of energy.

People who believe that nuclear energy is a good alternative source of power list the following reasons.

- Nuclear reactor power plants do not produce the air POLLUTANTS associated with coal and other fossil fuel plants.
- Nuclear energy plants use only a small AMOUNT of fuel. Breeder reactors 'breed' or create more energy than they use.
- The fuels necessary, like URANIUM are plentiful enough to last for hundreds of years.
- Nuclear energy is better for the ENVIRONMENT because the fuels necessary require less digging and mining.
- Nuclear power plants have higher SAFETY regulations than any other type of plant.

People who are against nuclear energy list these reasons.

- There is the danger of ACCIDENTS which could allow radioactive materials to escape into the environment and endanger life.
- Radioactive wastes must be stored for hundreds of years before they are safe. Safe STORAGE and the effects on future generations are questionable.
- Hot water is a waste material which can raise the TEMPERATURE of streams and oceans and could destroy wildlife.
- The danger of theft and SABOTAGE is frightening. These are the same materials used to make atomic bombs.
- EXPENSES of building nuclear plants do not make it an economical power source.

Worksheet 3

Name ACTIVITY 45 PAGE 194

Directions: These words that are associated with nuclear energy are hidden in the sentences below. Find the words and draw a circle around them.

WASTE RADIOACTIVE FUSION CORE REACTOR BREEDER FISSION ATOMIC STORAGE

1. Joe and Bill are actors in the school play.
2. Sally thought the cause of the damage was termites.
3. Have you heard the new radio act I've made up?
4. It had better be terrific or Ed will have to look for a new job.
5. Since there were three of us, I only needed fifty cents.
6. Give a banana to Michael, please.
7. When the coke went 'fiss', I only lost half of it.
8. Did Bob Reed erase the board?
9. Did you buy a daisy fast or a geranium?

Write the words in the correct column. Divide them into syllables.

One syllable	Two syllables
WASTE	STORAGE
CORE	FISSION
Three syllables	FUSSION
REACTOR	BREEDER
ATOMIC	Five syllables
	RADIOACTIVE

Worksheet 4

Name ACTIVITY 46 PAGE 197

The History of Solar Energy

The sun's energy has been used for heating and cooling for thousand of years. The early Greeks in the 5th century B.C. built entire citites facing south to take advantage of the sun's warming rays. A good example of early solar heating is in Mesa Verde, Colorado, where the Indians built their adobe homes in the cliffs to the mesa facing south. During the winter the sun would shine directly into the cliff dwelling and warm them naturally. The thick adobe walls stored the heat of the day. At night the stored heat would continue to keep the living space warm. During the summer when the sun was high, the overhanging cliffs shaded the structures to keep them cool. The Indians of Mesa Verde built their homes about 1200 A.D. Today, almost 800 years later, their natural heating and cooling system is still working.

In the early 1900's, fossil fuels and electricity were new kinds of energy used to provide heat for homes. When they were first used, they were very expensive, even more than they are today. Sunlight, on the other hand, was free. Solar water heating systems were introduced in California in 1891. The early models were simply shallow water tanks mounted on the roof of the house with plumbing leading to the kitchen and bathroom. In 1930, many rooftops in Los Angeles and other Southern California cities had solar collectors. But as electricity, natural gas and other fossil fuels became more readily available and dropped in price, the use of solar energy declined.

Directions: Circle 'true' or 'false' for each statement.

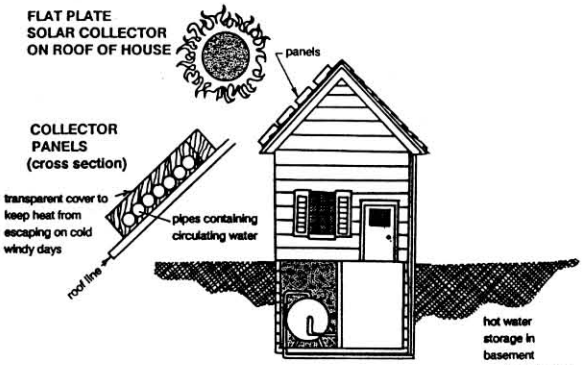
1. Solar energy is a new source of power. True (False)
2. The sun can be used to heat houses. (True) False
3. Fossil fuels were expensive when they were first used. (True) False
4. People stopped using solar power because it was too expensive. True (False)

Worksheet 1

Name ACTIVITY 46 PAGE 198

Energy from the Sun

There are several ways to use solar (sun) energy. The simplest way is to design a building to take advantage of its natural environment, including the sun. Another way is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning and water heating, but not its electric power. A third way is to set up a huge collecting field to collect solar energy, turn it into heat in a power tower, and then to electricity that will be sent to individual dwellings. A one-square mile field of these collectors could supply electricity for about 20,000 houses.



1. What direction should the collectors face for the greatest amount of sun? SOUTH
2. How is solar heat obtained at night or on a cloudy day? FROM STORAGE SYSTEM UNTIL EMPTY; THEN FROM A CONVENTIONAL BACK-UP FURNACE
3. What parts of the U.S. would be able to use solar heat without a conventional back-up furnace? NONE
4. What kind of fluid can be used in a solar energy system? AIR OR WATER
5. How can someone decide whether or not to install a solar energy system in their home? COMPARE COST OF SYSTEM WITH SAVINGS OF CONVENTIONAL FUEL.
6. Could the heat from a solar collector field be used to generate electricity? YES

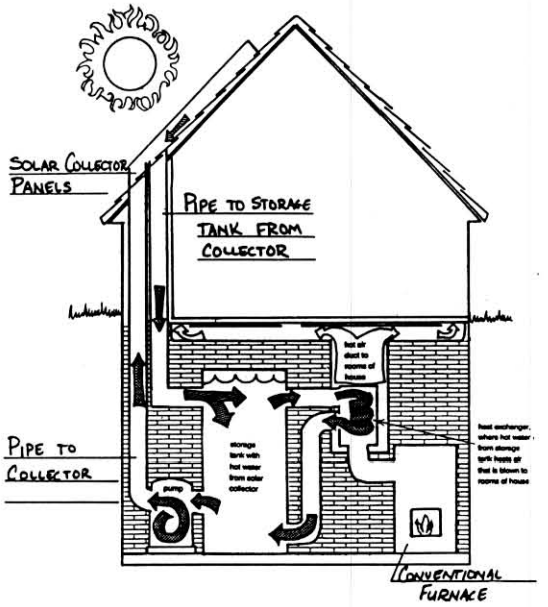
Worksheet 2

Name ACTIVITY 46 PAGE 199

Energy from the Sun

The diagram below shows how a solar heating system might heat a house. In this case you see a system that uses the energy of the sun to heat water that runs through collectors on the roof of the house. Because there can be many days when the sun doesn't shine, even a solar-heated house needs a conventional furnace. The conventional furnace runs when the storage tank runs short of hot water from the collector.

See if you can label the parts of the solar heating system below. Use these words: **solar collector panels, pipe to storage tank from collector, pipe to collector, conventional furnace.** Write the correct words on the lines.



Question for discussion:
Why would it be necessary to have a pump in this heating system?

Worksheet 3

Name ACTIVITY 47 PAGE 203

Problems/Solutions

In this unit, you have learned about eight new energy sources. The use of any one of these resources may help to supply our energy requirements but may at the same time present us with new problems to consider. In the lefthand column of this page are some of these issues – some are problems, some are solutions. Mark each statement S (for solution) or P (for problem). Place a checkmark in every energy-resource column on the right to which a statement applies. The first one is done for you.

	If this energy source is used, it . . .	SOLAR	NUCLEAR	WIND	GEO-THERMAL	COAL GASI-FICATION	COAL LIQUI-FACTION	OIL SHALE	PYROLYSIS
S	Would help solve the problem of solid waste disposal.	✓		✓	✓	✓	✓		✓
P	Could pollute water.		✓		✓			✓	
S	Would conserve the dwindling reserves of fossil fuels.	✓	✓	✓	✓				✓
P	Could damage wildlife or their habitat.				✓	✓	✓	✓	
P	Would be difficult to store and transport.	✓	✓	✓					
S	Would not pollute the atmosphere.	✓		✓					✓
P	Would disrupt the natural use of land surfaces.		✓		✓	✓	✓	✓	
P	Would not be able to supply energy all the time.	✓		✓					
P	Would have to wait until the technology is developed.	✓		✓	✓	✓	✓		
P	Would use lots of water to process.		✓					✓	
S	Will decrease the need for oil imports.	✓	✓	✓	✓	✓	✓	✓	✓
P	Will make large amounts of waste material.							✓	
S	Will make use of this countries most abundant fossil fuel.					✓	✓		

Worksheet 2

Name ACTIVITY 47 PAGE 204

It's Everyone's Job! Read the idea for conserving energy in the column headed Conservation Method. Answer the questions in the spaces provided.

Conservation Method	What sector of society? (circle one or more)	What energy resources does this save? (write: natural gas, petroleum or coal)	Does it use less energy? (yes or no)	Does it use energy more efficiently? (yes or no)	How can we encourage this conservation measure? (brainstorm as many ideas as you can)
Flying passenger airplanes only when they are full.		PETROLEUM	YES	YES	
Shipping freight by train instead of truck.		PETROLEUM	YES	YES	
Replacing incandescent light bulbs with fluorescent lights.		COAL PETROLEUM NATURAL GAS	YES	YES	
Reducing heating and cooling where space is unoccupied.		COAL PETROLEUM NATURAL GAS	YES	YES	
Recycling steel, paper, glass and aluminum.		COAL PETROLEUM NATURAL GAS	YES	YES	

Worksheet 3

Name ACTIVITY 47 PAGE 205

What Can YOU Do To Save Energy?

Part One:

Brenda's mother and Wayne's father each work ten miles away from their homes. In a five-day week, each uses five gallons of gas driving to and from work. Wayne's father drives alone. Brenda's mother is in a car-pool in which she takes four other persons to work. If each of her passengers drove, each would also use five gallons of gas a week. Now that they car-pool, how much gasoline does Brenda's mother help save each week? 20 GALLONS each year? 1040 GALLONS
How could Wayne's father help save energy? FORM A CARPOOL.

The Bailey's are going away on vacation. They are concerned about burglars and want a light on in their house from 7:30 to 11 o'clock each evening. Can you suggest how they might do this without wasting energy? INSTALL AN INEXPENSIVE TIMER THAT TURNS LIGHTS ON AND OFF AT PRESET TIMES.

Selecting the right size electric light bulb can help save energy. On the package is listed the number of watts (the amount of power needed to make the light bulb work), the lumens (the brightness of the bulb) and the number of hours the bulb will last. With this information, how could you select the most efficient bulb? FIND THE BULB THAT PROVIDES THE MOST LIGHT WITH THE LEAST WATTAGE.

John and his sister are going to wash clothes. He wants to do his three shirts seperately. His sister wants to do them with her five blouses. Which way will conserve energy? WASHING THEM TOGETHER Why? MORE EFFICIENT USE OF WATER, SOAP AND ELECTRICITY.

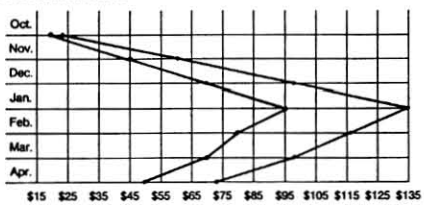
Jack has just come indoors after skating on the pond and feels cold. He wants to turn the thermostat up to 80° F. His mother tells him to leave it where she has set it a 68° and put on a sweater. Who is more energy concious? JACK'S MOTHER
Why? TURNING UP THE THERMOSTAT WASTES ENERGY AND A SWEATER WILL KEEP JACK JUST AS WARM.

Part Two:

Below are the Hazleton's heating bills for two different years. During the first year, they had no insulation in their 1800 sq. ft. home. At the end of the year they had their house fully insulated, so the cost of heating their home went down. On the graph below, place a dot for the cost of each heating month of the first year. Then draw a black line between the dots. Do the same thing in red for the following year. Compare the Hazleton's savings with insulation.

How much did they save in January? $40.00
How much for the entire heating season? $175.00

	First Year	Following Year
October	$24	$20
November	$61	$45
December	$98	$70
January	$135	$95
February	$116	$80
March	$98	$70
April	$73	$50



Do you think insulation would help to lower air-conditioning bills? Why or why not? YES, THE INSULATION WILL KEEP THE HOT AIR OUT AND COLD AIR IN.

Worksheet 4

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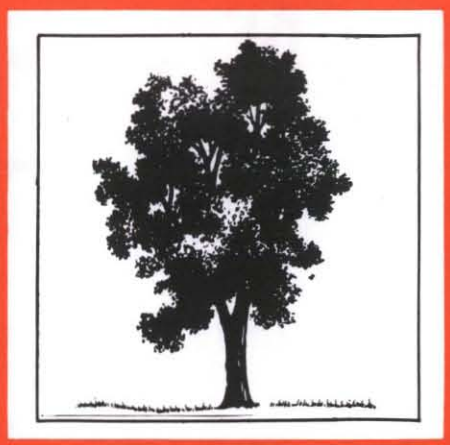
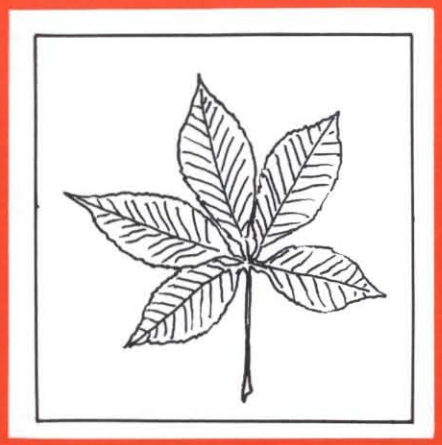
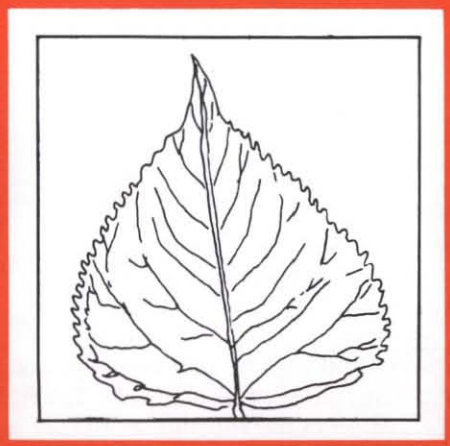
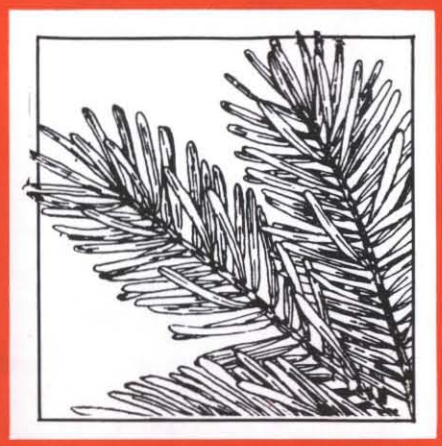
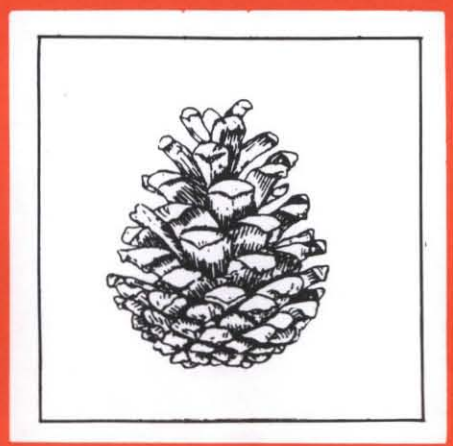
Nebraska Cooperative Extension Service EC 83-1750

43 TREES OF NEBRASKA


Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Leo E. Lucas, Director of Cooperative Extension Service, University of Nebraska, Institute of Agriculture and Natural Resources.

TREE IDENTIFICATION MANUAL

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How a Tree Grows	26
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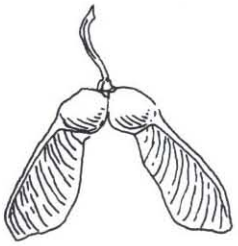
ACKNOWLEDGEMENT

EC 17-01-78, Tree and Shrub Identification by Karl Loerch and EC 71-1703, Tree Identification Manual by Ellsworth H. Benson were used for this manual. Special thanks to Joe Range, Extension Forester, and John Orr, Extension Specialist, 4-H and Youth Development, for their assistant and support. A special thank you is extended to Frances Gould for her exceptional illustrations and to Terry Meisenbach for his valuable editorial assistance.

TREE IDENTIFICATION MANUAL FOR SELECTED SPECIES

by
Mitchell D. Ferrill, Extension Forester

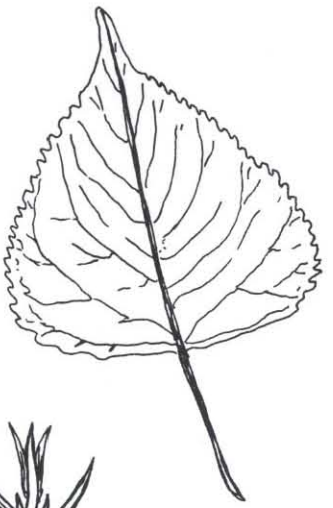


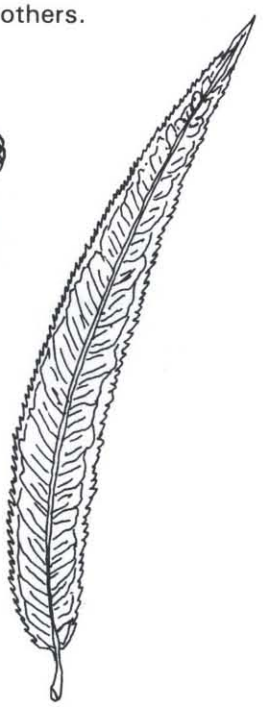
INTRODUCTION

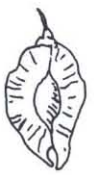
This manual is designed for people who are interested in learning about trees. It is important that a person be able to identify individual trees before exploring the study areas of tree and forest ecology and having a deeper understanding of the outdoor environment. The manual is a guide for forty-three species of trees growing in Nebraska, but does not include all trees that may occur in the state. Individuals using this manual will be able to identify trees and tree parts.

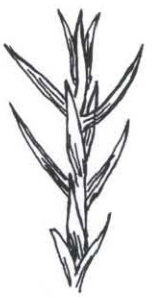
Included for each selected species is the common name, scientific name (the only sure way to be sure that everyone is working with the same species), a general description, leaf description, twig description, bud description, fruit description and wood description.

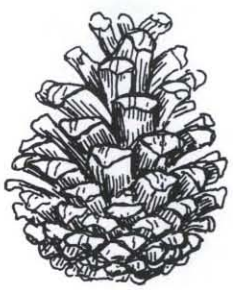
Trees and tree parts vary greatly in size, shape, form, color, etc. The proper identification of trees calls for not only knowing one leaf or one fruit from another, but also knowing something about the trees themselves. It must be kept in mind that all trees are different in some aspects and very much alike in others.

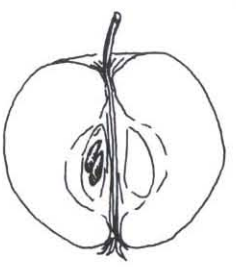












HARDWOOD AND CONIFERS

Whenever identifying trees the usual first decision should be to determine if the tree is a hardwood or conifer. Other terms used are:

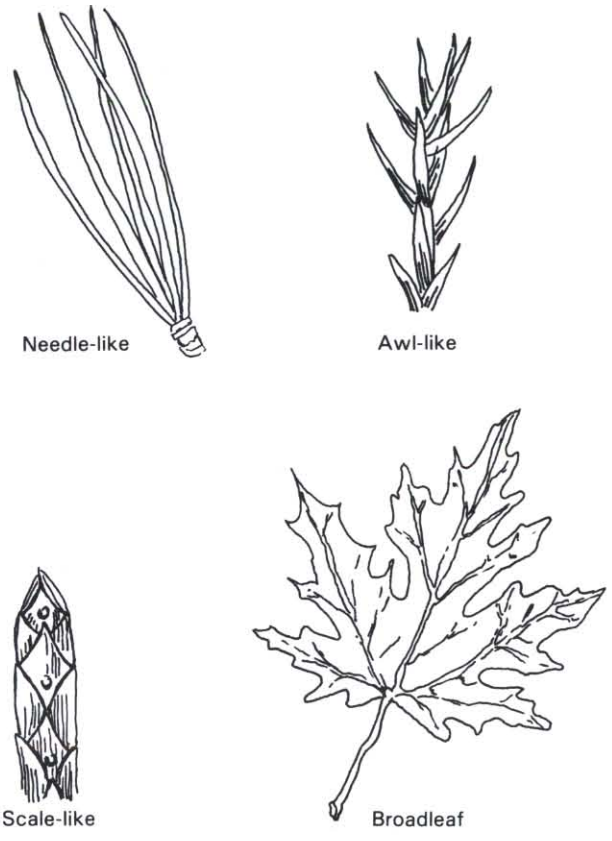
hardwoods	**conifers**
deciduous	evergreens
broadleaved	softwoods
	narrowleaved

Obviously the above names may not always seem to apply to a particular tree. Whenever leaves are on the trees, conifers will normally have needles or scale-like leaves, while hardwoods will have broader leaves. There are exceptions since there are deciduous conifers and evergreen hardwoods.

LEAVES (see diagram)

Conifers: Coniferous leaves are usually needles, but may be awl-shaped or scale-like. The needles may be borne in groups or bundles called fasciles or attached singly. A determination of the type of foliage and the arrangement of the foliage is important in the identification of a particular tree.

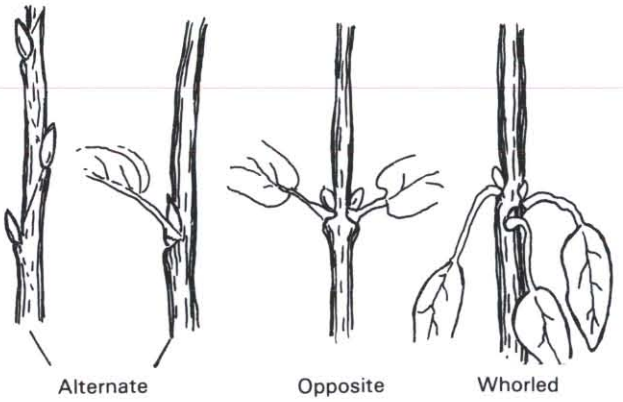
KINDS OF LEAVES



Hardwoods: Leaf arrangement and form are more variable in hardwoods. As a result, more understanding and terminology are necessary to properly identify hardwoods. Some helpful terms to know are:

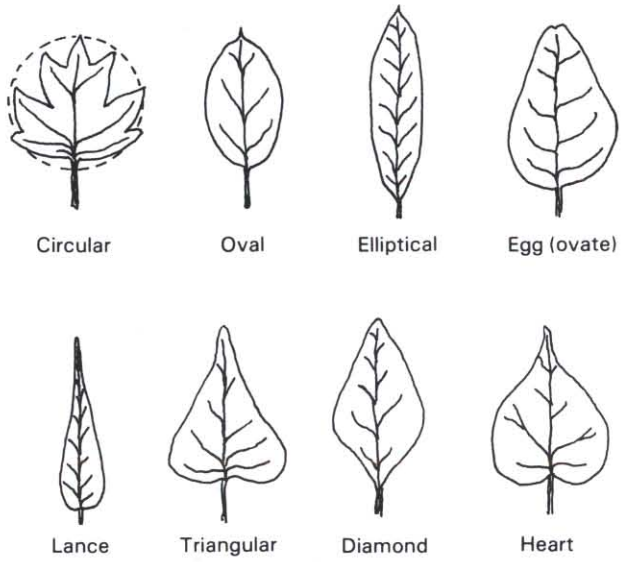
- alternate - a single leaf is attached at each node.
- opposite - paired at the same height, one on each side of the twig.
- whorled - when more than two leaves are found at a node.

LEAF ARRANGEMENT



Leaf shapes. The shape of a leaf or leaflet is usually characteristic of a species. There are numerous accepted terms to describe hardwood leaf shapes. Some of the basic ones are shown in the enclosed figures. For more detailed descriptions some of the books listed in the references should be consulted.

LEAF SHAPES



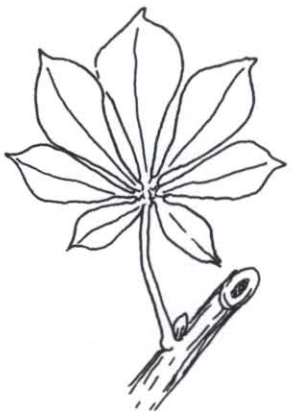
Leaf composition

The basic forms of leaf composition for hardwoods are: (see diagram)

- simple leaf - one with a single leaf blade.
- compound leaf - three or more blades attached to a common stalk.
  a. pinnately compound - leaflets are attached laterally along the stem or rachis.
     1) once pinnately compound - only divided once.
     2) twice pinnately or bipinnately compound - divided twice with leaflets on lateral stems.
  b. palmately compound - several leaflets radiate from the end of the rachis.

TYPES OF LEAVES

Simple



Palmately compound

Pinnately compound

Twice Pinnately compound

Leaf margins. Leaf margins are quite variable and many terms are used to describe them. Three of the more common types are:

1. entire - smooth, without lobes or teeth
2. serrate - with sharp teeth
3. lobed - divided into lobes separated by rounded sinuses (holes)

LEAF MARGINS

Smooth Wavy Serrate Doubly Serrate Lobed

Leaf apicies and bases. The tip and the base of the leaf may be very distinctive, but there are many different terms used to describe them. It is suggested that more detailed references be consulted.

Leaf surfaces. Leaf surfaces may also be quite variable and many terms are used to describe them. Two of the basic and more common terms are:

1. glabrous - smooth
2. pubescent -with hairs

TWIG ARRANGEMENT (see diagrams)

The twig arrangement is often characteristic of a species for either a conifer or hardwood.

Conifers. The arrangement of the twigs themselves are not very distinct, but the manner of leaf attachment may be (see diagram). Two of the more distinctive are:

1. fir - hole or crater-like leaf scars
2. spruce - pegs or "stumps" for leaf scars

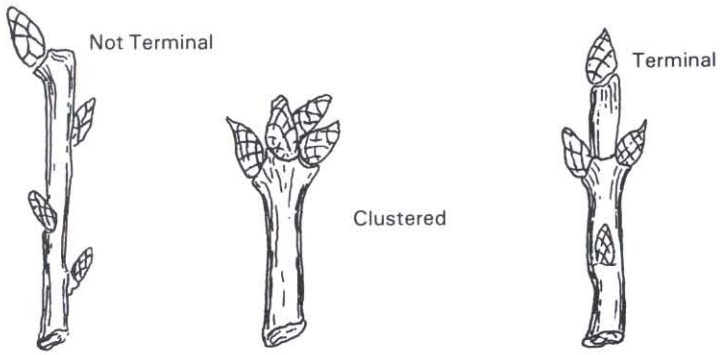
Hardwoods. The twig arrangement of hardwoods is very helpful in separating species groups. The basic arrangements are alternate, opposite, and whorled.

CONIFEROUS TWIGS

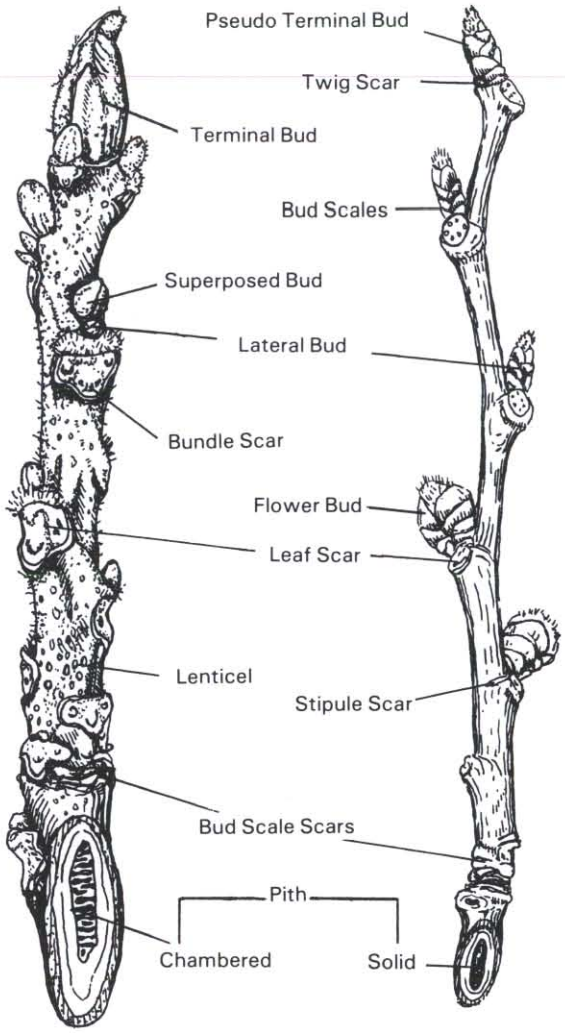
BUD ARRANGEMENT

Although buds are helpful in identification, the descriptive factors are so variable that simple terminology and descriptions are not always available. More detailed references should be consulted for identifying bud characteristics.

BUD ARRANGEMENT



TWIG DETAILS



FRUITS

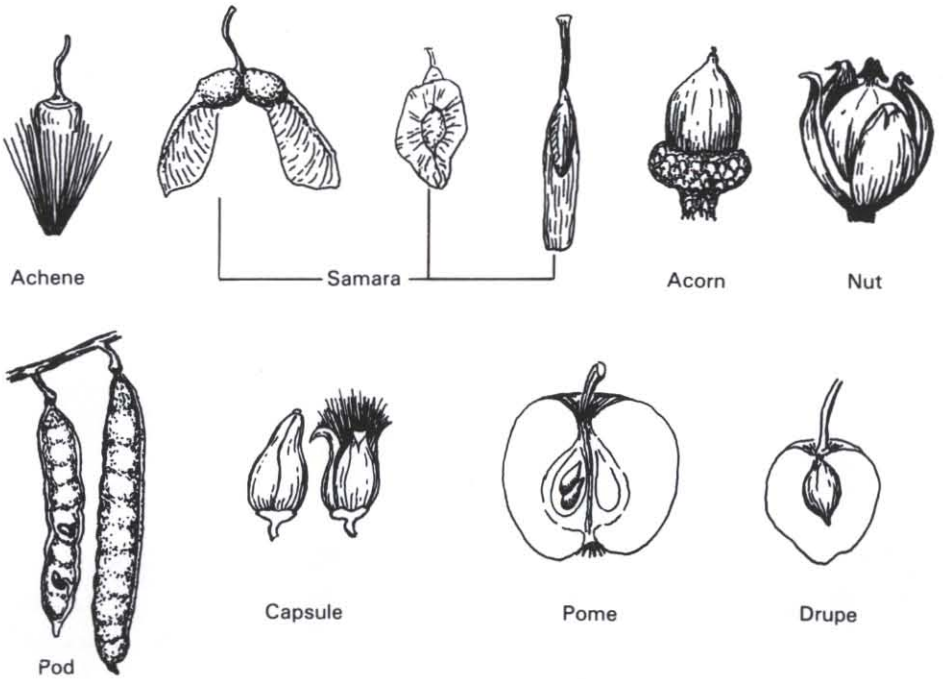
Whenever present, fruit or seed may be very helpful in verifying the species in question. Unfortunately it may be difficult to obtain the fruit.

Conifers. The majority of the conifers in the United States produce cones, as a result all coniferous species included in this manual produce a cone.

Hardwoods. Hardwood fruits or seeds are much more variable. Some of the types are (see diagram):

1. drupe - cherry (an example)
2. berry - persimmon (an example)
3. pome - apple (an example)
4. legume - bean (an example)
5. capsule - horsechesnut (an example)
6. achene - sycamore seeds (an example)
7. samara - maple (an example)
8. nut - hickory nut and acorns (examples)

TREE FRUITS



WOOD

The terminology and factors needed to correctly identify wood are relatively complicated and only a basic introduction will be included in this manual. Some of the structural features of wood that can be recognized and used for identification purposes are:

Planes of wood (see diagram)

a. transverse or cross-section is produced by cutting across the stem perpendicularly

b. radial surface is created by cutting longitudinally from the pith to the bark

c. tangential surface is created by cutting tangential to the bark

Growth rings

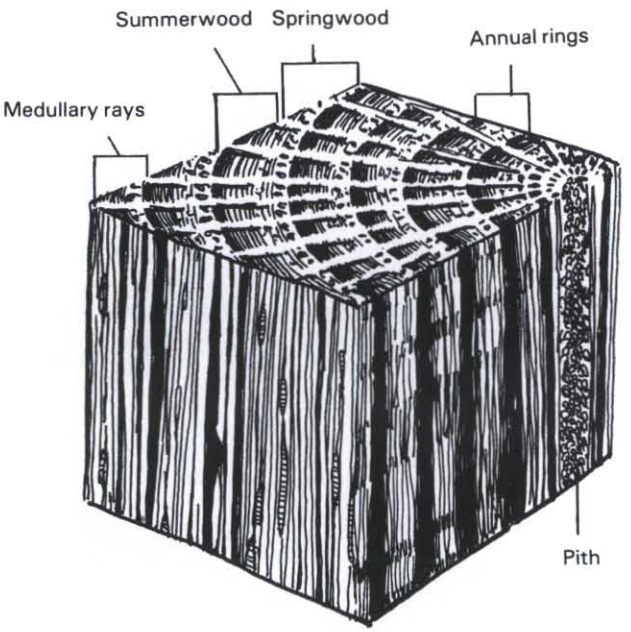
a Conifers

1) spring wood - normally have large thin-walled cells

2) summerwood - smaller, thicker-walled cells

3) abrupt transition - sharp distinction between spring and summerwood

PLANES OF WOOD



4) gradual transition - gradual change from spring to summerwood

b. Hardwoods

1) earlywood - formed early in the growing season, large cells

2) latewood - formed later in the growing season, smaller cells

3) ring porous - obvious distinction between early and latewood

4) semiring porous - identifiable change, but less obvious

5) diffuse porous - difficult to impossible to distinguish the change with the naked eye

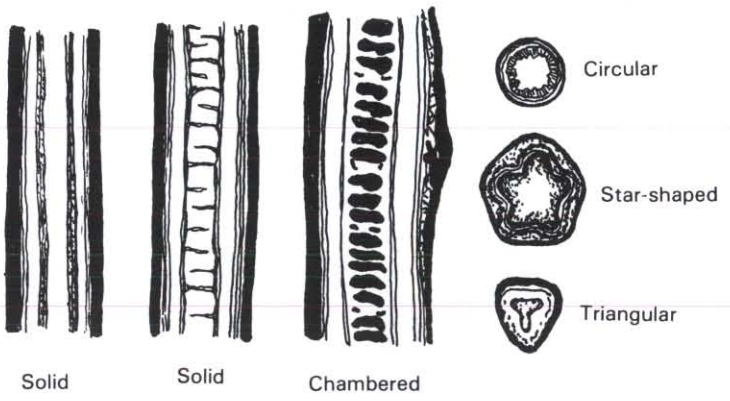
Sapwood-Heartwood (see diagram)

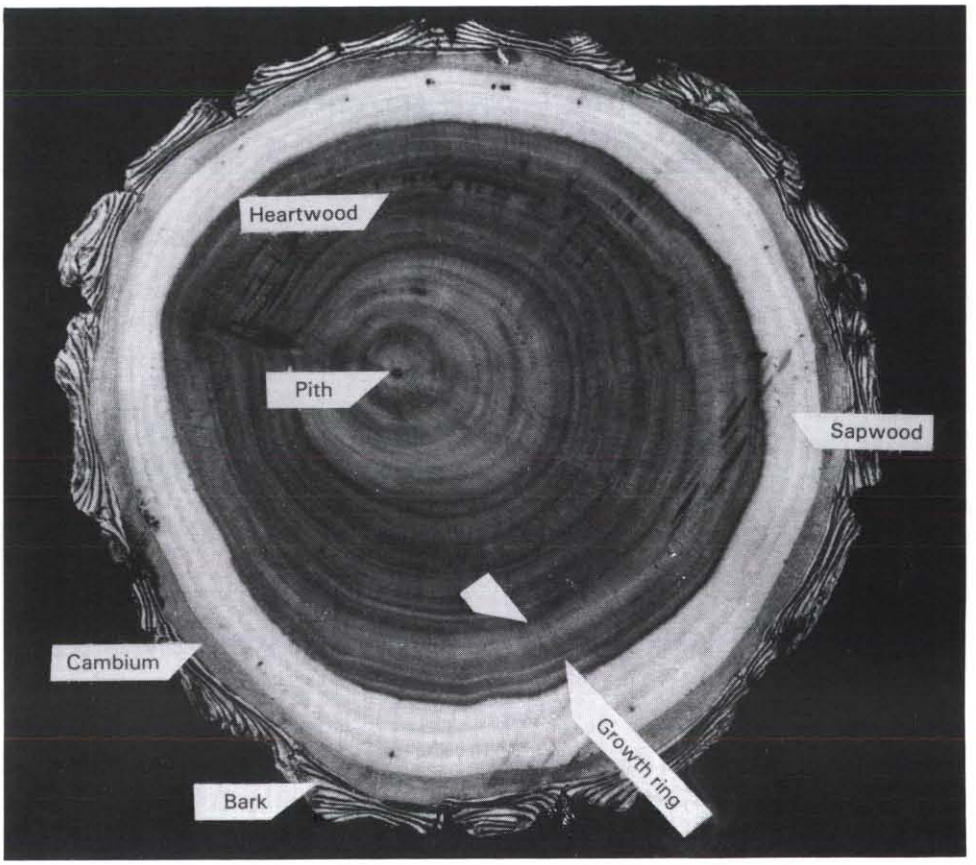
While observing the total cross-section of a tree trunk or limb you will frequently notice a change in color. The light colored wood toward the outside is called sapwood and the darker innerwood is called heartwood.

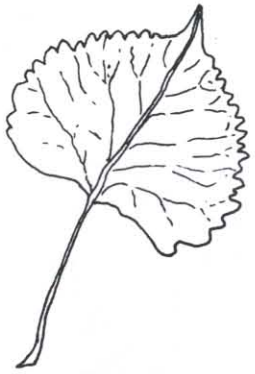
Wood Rays

Although wood rays, when present, are visible on the transverse and tangential surface, the beginner will find that those visible to the naked eye on the transverse surface are probably most helpful. Rays will appear on the transverse surface as lines radiating out from the pith.

PITH TYPES AND SHAPES

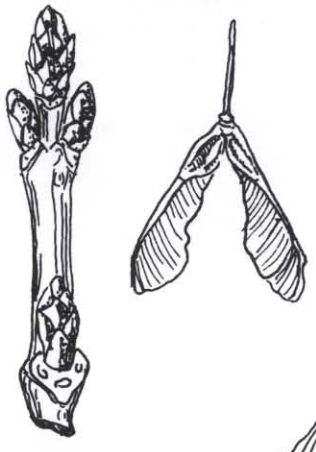


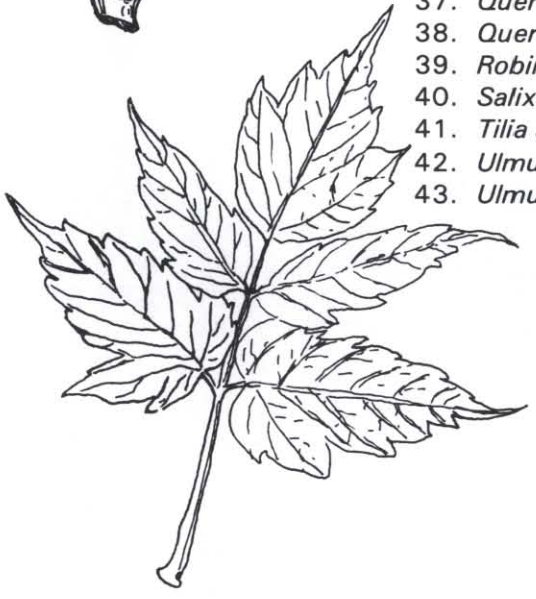


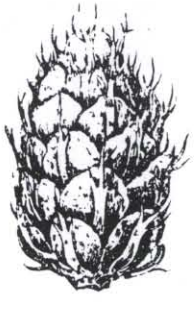


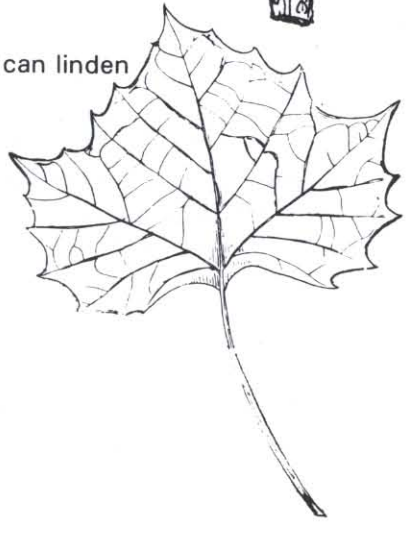
ILLUSTRATED SPECIES

1. *Abies concolor* - white or concolor fir
2. *Juniperus scopulorum* - Rocky Mountain juniper
3. *Juniperus virginiana* - eastern redcedar
4. *Picea pungens* - blue spruce
5. *Pinus nigra* - Austrian pine
6. *Pinus ponderosa* - ponderosa pine
7. *Pinus strobus* - eastern white pine
8. *Pinus sylvestris* - Scotch or Scots pine
9. *Pseudotsuga menziesii* - Douglas-fir
10. *Acer negundo* - boxelder
11. *Acer rubrum* - red maple
12. *Acer saccharinum* - silver maple
13. *Acer saccharum* - sugar maple
14. *Aesculus glabra* - Ohio buckeye
15. *Aesculus hippocastanum* - horsechestnut
16. *Ailanthus altissima* - ailanthus or Tree-of-Heaven
17. *Betula nigra* - river birch
18. *Carya ovata* - shagbark hickory
19. *Catalpa speciosa* - northern catalpa
20. *Celtis occidentalis* - hackberry
21. *Cercis canadensis* - redbud
22. *Cornus florida* - flowering dogwood
23. *Elaeagnus angustifolia* - Russian olive
24. *Fraxinus pennsylvanica* - green ash
25. *Gleditsia triacanthos* - honeylocust
26. *Gymnocladus dioicus* - Kentucky coffeetree
27. *Juglans nigra* - black walnut
28. *Maclura pomifera* - osage orange, hedge apple, bois d'arc, bodark
29. *Malus pumila* - apple
30. *Morus rubra* - red mulberry
31. *Platanus occidentalis* - American sycamore or buttonball tree
32. *Populus alba* - white poplar
33. *Populus deltoides* - eastern cottonwood
34. *Prunus americana* - American plum
35. *Prunus serotina* - black cherry
36. *Quercus macrocarpa* - bur oak or mossycup oak
37. *Quercus palustris* - pin oak
38. *Quercus rubra* - northern red oak
39. *Robinia pseudoacacia* - black locust
40. *Salix nigra* - black willow
41. *Tilia americana* - American basswood or American linden
42. *Ulmus americana* - American elm
43. *Ulmus pumila* - Siberian elm

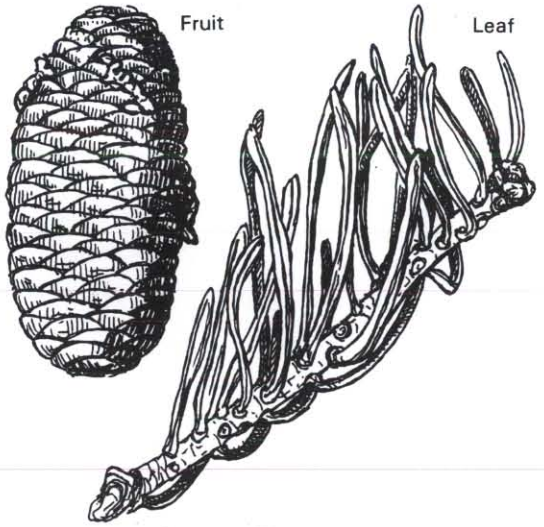




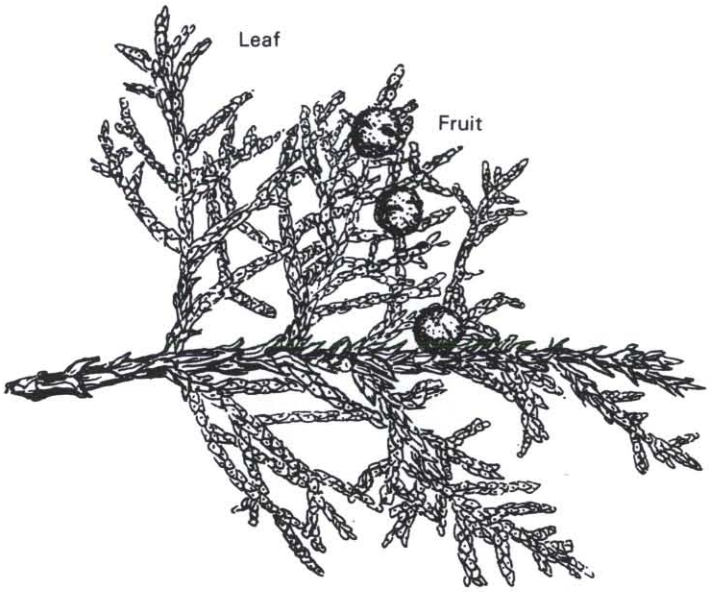




White or Concolor Fir *(Abies concolor)*
General - White fir is not native to Nebraska but has been used as an ornamental throughout the United States. A prized ornamental.
Leaves - 2'' to 3'' long, borne singly, silvery-green, normally extending at nearly right angles from all sides of the twig.
Twigs - moderately stout, yellowish to brownish-green.
Buds - 1/4'' long, tends to be sticky, yellowish brown.
Fruit - 3'' to 5'' long, oblong, green to purple.
Wood - whitish to yellowish brown, summerwood often darker, without characteristic odor, normally evengrained, growth rings distinct.



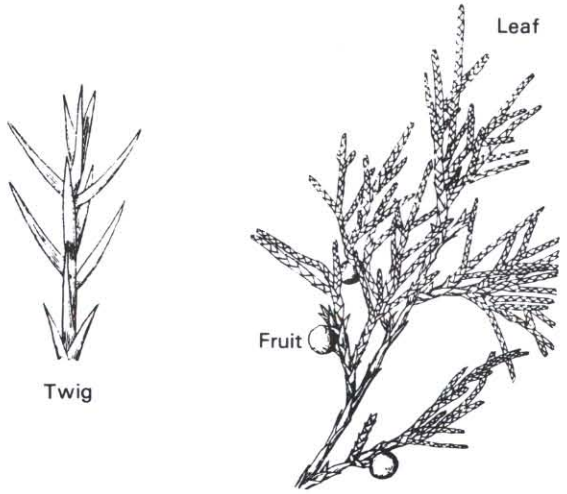
White or Concolor Fir - Abies concolor



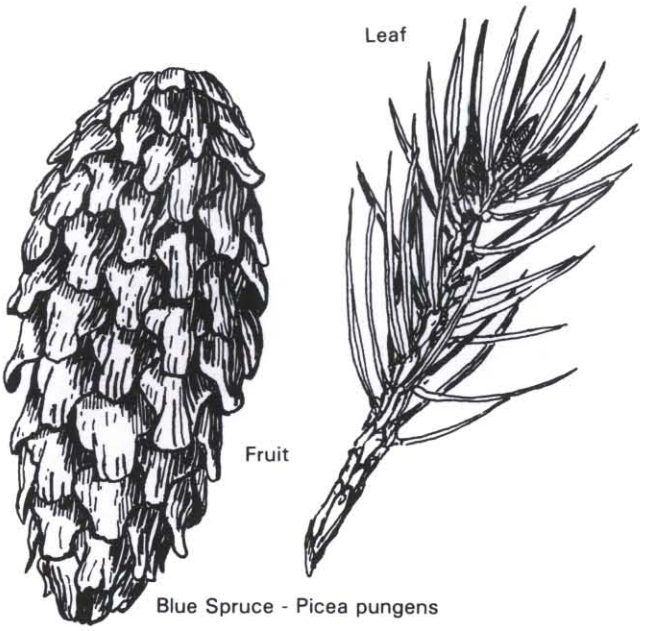
Rocky Mountain Juniper - Juniperus scopulorum

Rocky Mountain Juniper *(Juniperus scopulorum)*
General - Occurs naturally west of the Great Plains and into the Rocky Mountains. May be native to western Nebraska.
Leaves - Usually opposite on the twig, pressed close to the twig, variable in color, awl-shaped or scale-like, retains bluish-green color in winter.
Twigs - sleader, about 1/32'' in diameter, older twigs reddish-brown and nearly smooth, peeling off.
Buds - very small, indistinct, not useful for identification purposes.
Fruit - takes two years to mature, nearly round, 1/4 to 1/3 inch in diameter, bright blue, often covered with a white coating, usually contains 2 seeds.
Wood - similar to redcedar, soft, lightweight, light red with narrow whitish sapwood.

Eastern Redcedar *(Juniperus virginiana)*
General - A medium to large, upright-growing evergreen native to Nebraska, hardy and long-lived. Alternate host for cedar/apple rust.
Leaves - Either awl-shaped or scale-like, both kinds often borne on the same tree, bluish-green turning a russet color in the winter.
Twigs - slender, greenish or reddish-brown in color.
Buds - very small, indistinct, not useful for identification purposes.
Fruit - bluish or purplish, berry-like round cone about 1/4 inch in diameter, contains 2 or 3 hard seeds, ripens in one season.
Wood - sapwood nearly white, heartwood purplish or rose-red to reddish brown, characteristics odor, growth rings distinct.



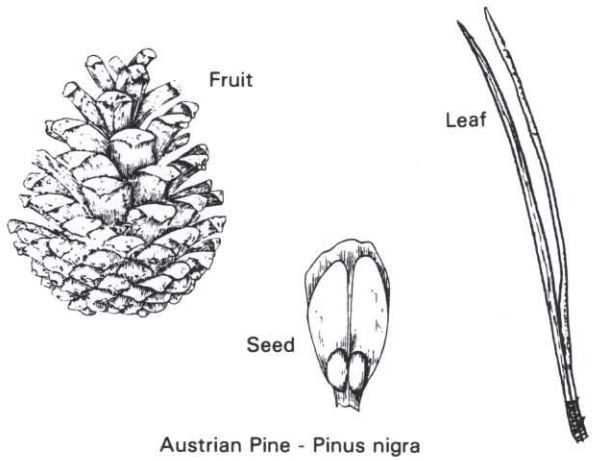
Eastern Redcedar - Juniperus virginiana



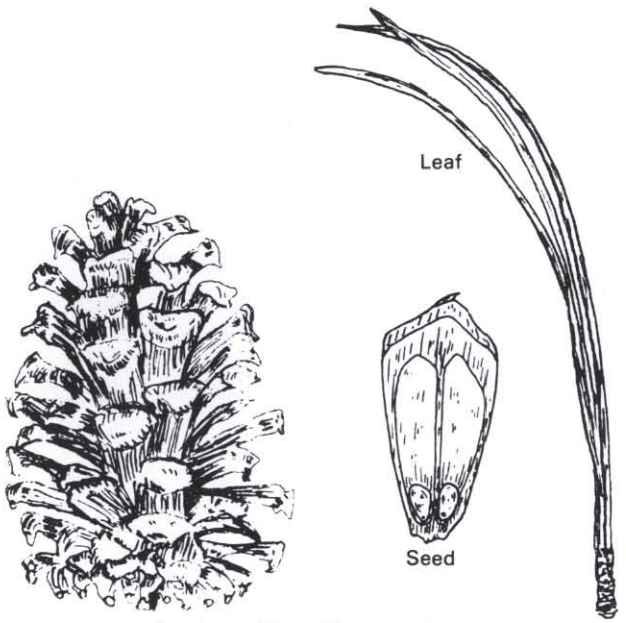
Blue Spruce - Picea pungens

Blue Spruce *(Picea pungens)*
General - in its native range, which does not include Nebraska, the blue spruce will more often be green rather than the selected ornamental blue. Wild trees may bear little resemblance to those selected as ornamentals.
Leaves - borne singly, about 1 inch long, sharp, extending at right angles to the twig, when chewed has a pungent taste.
Twigs - free of hair, leaves borne on a short stalk which remains part of the twig.
Buds - bud scales tend to bend or turn out.
Fruit - about 3'' long, scales thin and somewhat papery.
Wood - heartwood not distinct, nearly white to light brown, lustrous, no characteristic odor, growth rings distinct.

Austrian Pine *(Pinus nigra)*
General - not native to Nebraska, a native of Europe, but grows well in Nebraska. Similar in size and habit to the native ponderosa pine.
Leaves - borne in groups of 2, 3'' to 6'' long, slender, stiff, sharp-pointed, bluish-green.
Twigs - orange-brown, lustrous.
Buds - silvery.
Fruit - about 2 1/2'' long, unarmed.
Wood - sapwood nearly white, heartwood reddish brown, somewhat oily and resinous, no characteristic odor, growth rings distinct.



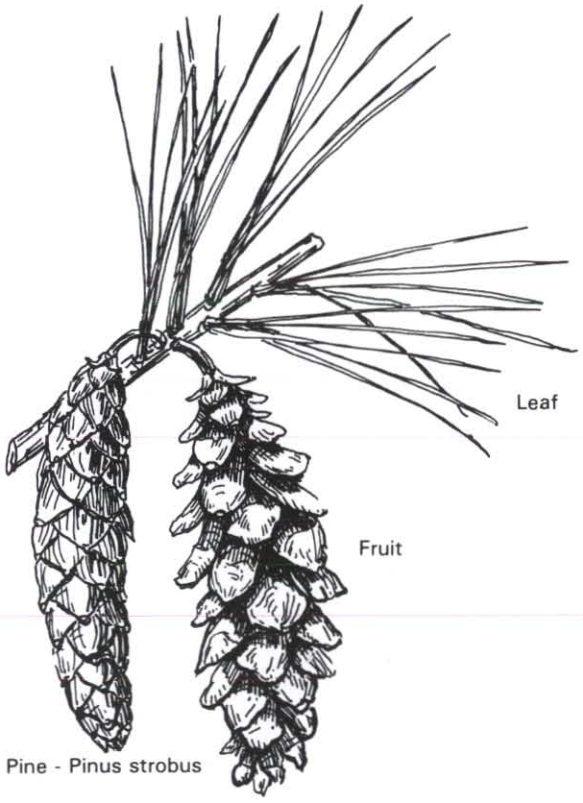
Austrian Pine - Pinus nigra



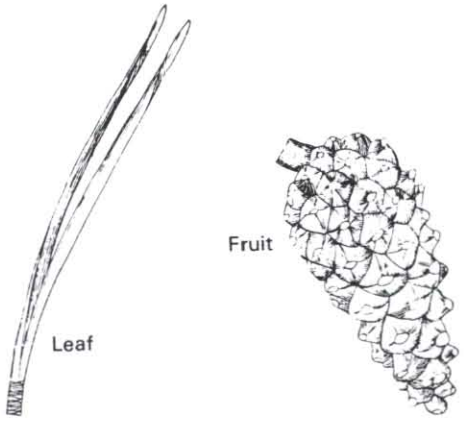
Ponderosa Pine - Pinus ponderosa

Ponderosa Pine *(Pinus ponderosa)*
General - an important lumber-producing western pine. Native to northern and western Nebraska. Normal growth rate in Nebraska is relatively slow.
Leaves - borne in groups of 2 and 3, 3'' to 10'' long, yellowish-green, usually less sharp-pointed than those of Austrian pine, usually somewhat twisted.
Twigs - stout, smells like turpentine when crushed.
Buds - usually covered with resin droplets, light-chestnut brown.
Fruit - 3'' to 6'' long, each cone scale is armed with a short, sharp spine, mature in August of second season and shed most seeds in September.
Wood - sapwood white to yellowish, heartwood yellowish to light brown, distinct but not characteristic resinous odor, growth rings distinct.

Eastern White Pine *(Pinus strobus)*
General - not native to Nebraska, but may be planted as an ornamental.
Leaves - borne in groups of 5, 3'' to 5'' long, dark blue-green, straight, slender, flexible.
Twigs - orange-brown, smooth or with only a few hairs.
Buds - covered with thin reddish or orange-brown scales.
Fruit - about 5'' long, narrow, stalked, with thin scales, unarmed.
Wood - sapwood nearly white, heartwood darker, noncharacteristic odor, growth rings distinct.



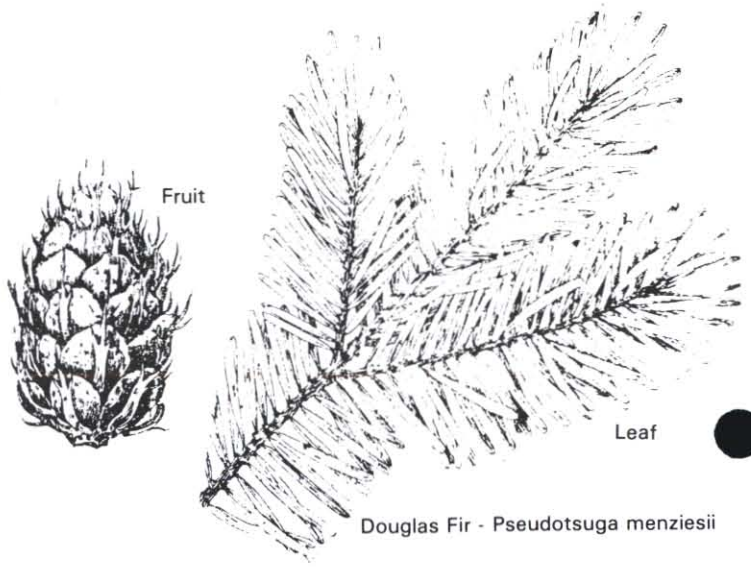
Eastern White Pine - Pinus strobus



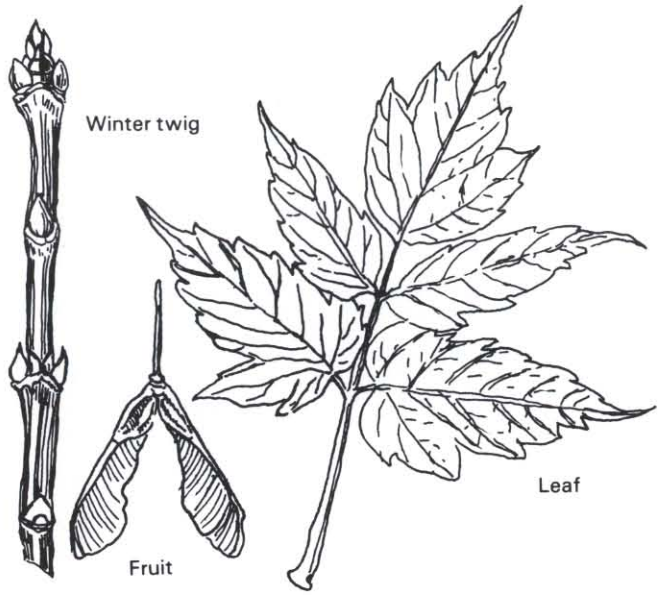
Scotch Pine - Pinus sylvestris

Scotch or Scots Pine *(Pinus sylvestris)*
General - not native to Nebraska. A preferred species for Christmas tree production.
Leaves - borne in groups of 2, about 2'' long, bluish-green, often twisted.
Twigs - medium-thick, dull grayish-yellow, roughed by scales at base of leaf clusters, upper branches.
Buds - no distinct features which are helpful in identification.
Fruit - a woody cone, 1 1/2-2'' long, scales with raised pyramid-shaped tips.
Wood - an exotic which is used very little in the wood products industry, little data available in introductory textbooks.

Douglas-fir *(Pseudotsuga menziesii)*
General - Douglas-fir is an important western commercial lumber tree and comprises about 50 percent of the standing timber of western forests. It is not native to Nebraska.
Leaves - borne singly, flat, blunt, about 1'' long, yellow-green.
Twigs - slender, flexible, smooth when leaves are detached.
Buds - the cigar-shaped, sharp-pointed winter buds are about 1/2'' long.
Fruit - about 3'' long, pendent, each scale has attached to it a 3-pointed woody bract.
Wood - sapwood whitish to yellowish, heartwood, yellowish to reddish, with characteristic resinous odor, growth rings very distinct.



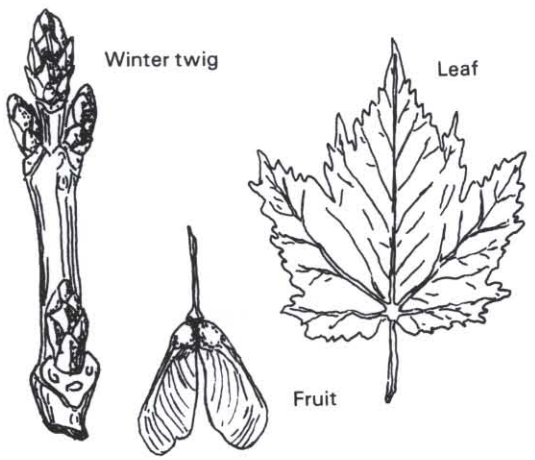
Douglas Fir - Pseudotsuga menziesii



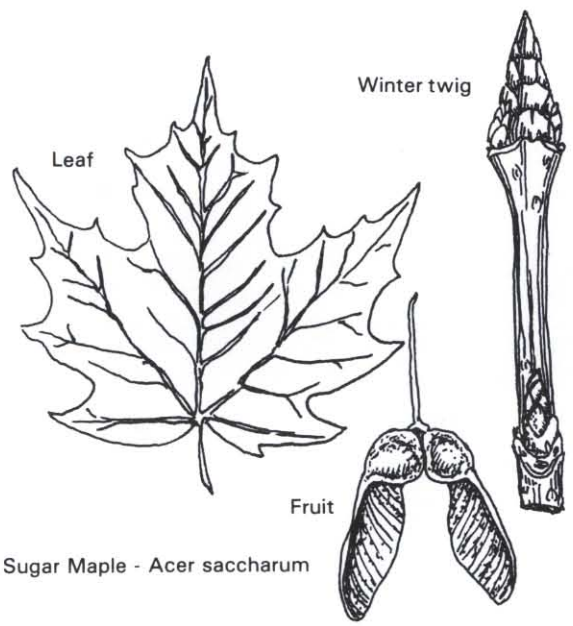
Boxelder - Acer negundo

Boxelder *(Acer negundo)*
General - although this tree has been planted extensively through the middle west because of its hardiness, it is not particularly decorative and is short lived and of poor form.
Leaves - opposite, compound with 3 to 7 leaflets, leaflets quite variable.
Twigs - stout, purplish to greenish, frequently covered with a bluish white coating.
Buds - terminal bud present, somewhat whitish woolly.
Fruit - V-shaped, double-winged samara, ripens in fall.
Wood - sapwood white, heartwood light brown, often colored by mineral stains, without characteristic odor, growth rings not very distinct.

Red Maple *(Acer rubrum)*
General - wood is brittle and decays readily. Not native to Nebraska.
Leaves - simple, about 4'' in diameter, typically 3-lobed, but may be 5-lobed.
Twigs - opposite, reddish, without a disagreeable odor when crushed.
Buds - terminal bud present, lateral buds opposite around terminal.
Fruit - may be either V- or U-shaped, matures in late spring, about 3/4'' long.
Wood - sapwood white, heartwood light brown, without characteristic odor, growth rings not very distinct.



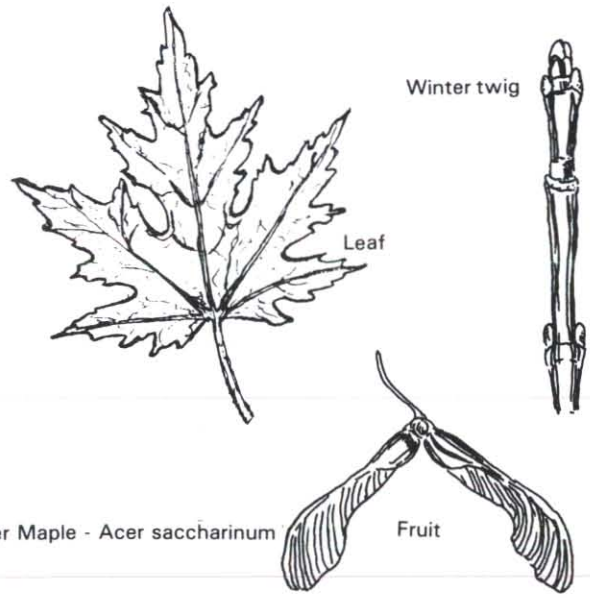
Red Maple - Acer rubrum



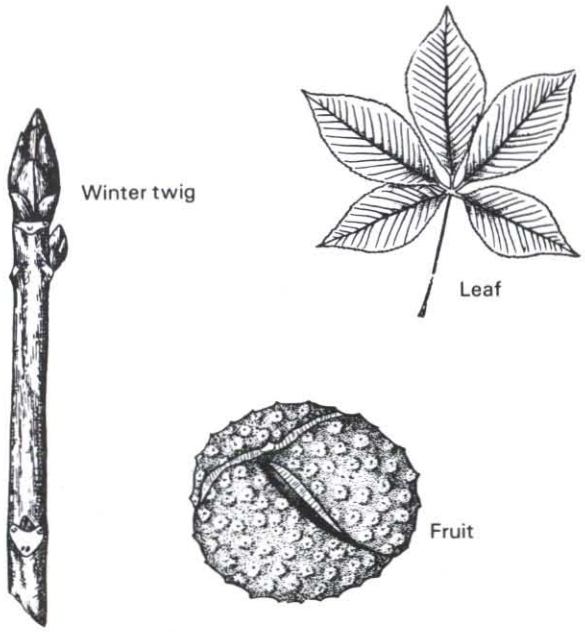
Sugar Maple - Acer saccharum

Sugar Maple *(Acer saccarum)*
General - although not native to Nebraska, this species is probably the most common and important of the maples. Noted for the maple syrup made from the sap.
Leaves - simple, about 4'' in diameter, 5-lobed.
Twigs - moderately slender, shiny, brown, opposite.
Buds - terminal bud present, pointed, many scales.
Fruit - U-shaped, double-winged samara, borne in fall.
Wood - sapwood whitish with a reddish tinge, heartwood light brown, without characteristics odor, growth rings fairly distinct.

Silver Maple *(Acer saccharinum)*
General - native to eastern Nebraska. A large and beautiful tree. Grows rapidly, but is prone to be brittle and breaks easily in storms.
Leaves - simple, about 5'' in diameter, deeply 5-lobed, sides of terminal lobe V-shaped, serrate on margin, green on upper surface, silvery below.
Twigs - opposite, orange-brown to red, disagreeable odor when bruised.
Buds - terminal bud present, blunt.
Fruit - widely divergent wings, about 1 1/2'' long, borne in late spring.
Wood - sapwood white, heartwood light brown, without characteristic odor growth rings not very distinct.



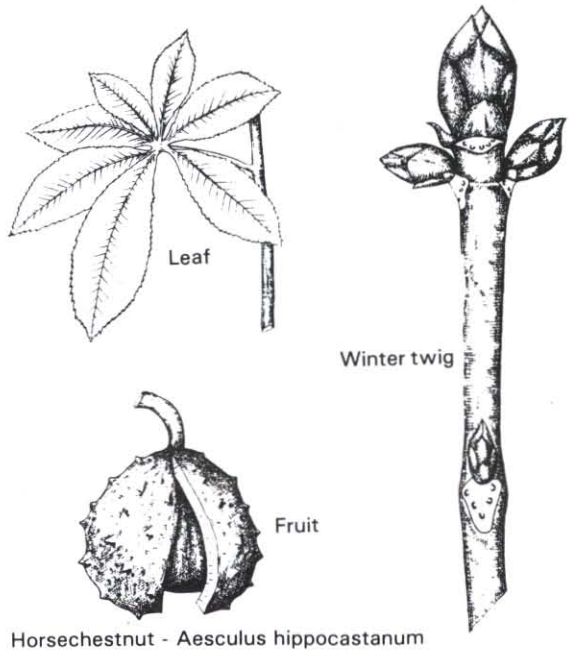
Silver Maple - Acer saccharinum



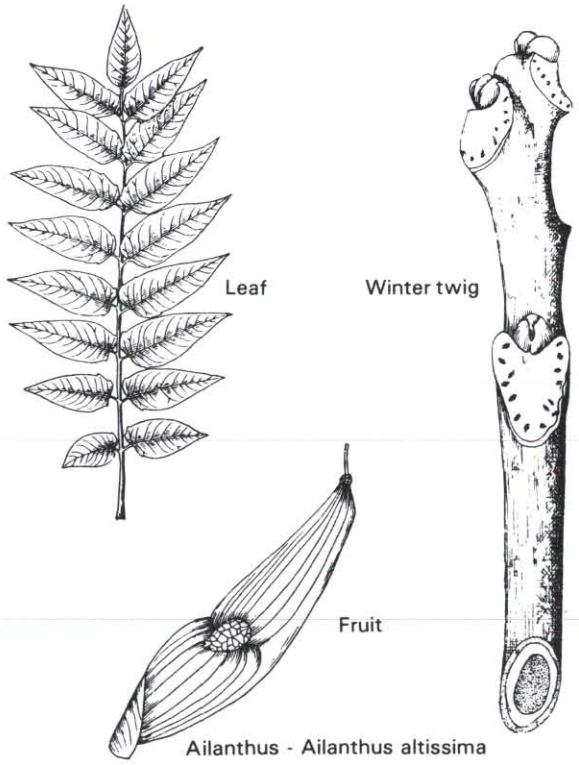
Ohio Buckeye - Aesculus glabra

Ohio Buckeye *(Aesculus glabra)*
General - a medium-sized tree native to extreme southeastern Nebraska. Nowhere is it abundant.
Leaves - palmately compound, 5 leaflets, 3'' to 6'' long, smooth.
Twigs - opposite, stout, smooth, orange to brown.
Buds - terminal buds large, brown, not waxy.
Fruit - a thick leather, prickly, brownish, globular pod, about 1'' in diameter, containing a large, smooth, shiny, brown ''nut.''
Wood - sapwood white to dull white, heartwood creamy to yellowish, growth rings normally not visible.

Horsechestnut *(Aesculus hippocastanum)*
General - not native to Nebraska. Planted as an ornamental.
Leaves - palmately compound, usually 7 leaflets 5'' to 7'' long.
Twigs - opposite, stout, smooth, reddish-brown.
Buds - terminal buds over 1'' long, brownish, covered with waxy gum.
Fruit - a thick, leathery, prickly, yellowish-brown, roundish pod, 1'' to 2'' in diameter, containing 1 to 3 smooth, shining, brown nuts.
Wood - similar to Ohio buckeye.



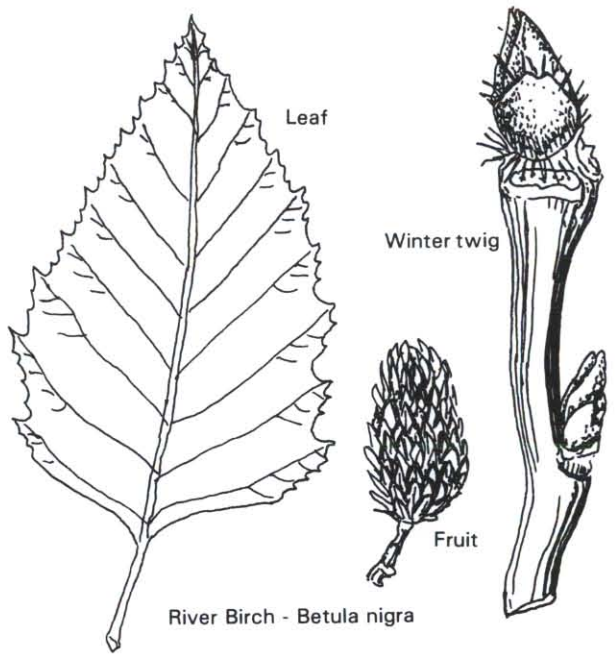
Horsechestnut - Aesculus hippocastanum



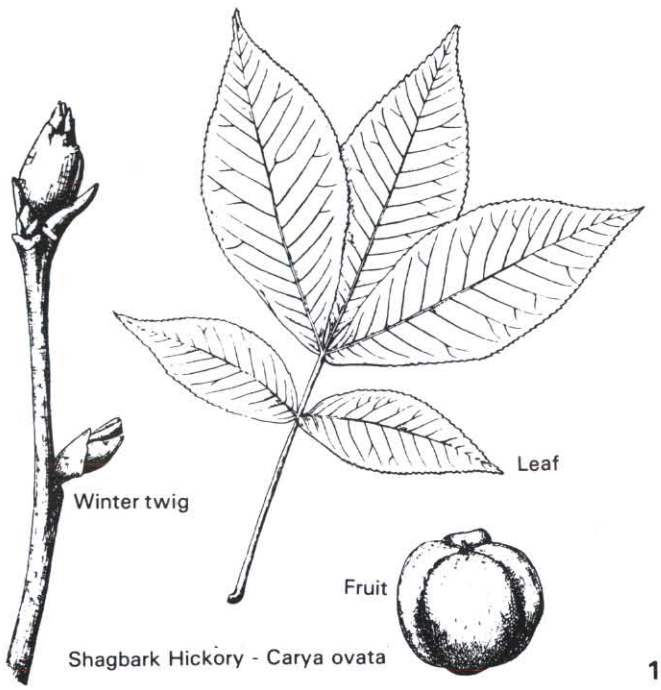
Ailanthus - Ailanthus altissima

Ailanthus or Tree-of-Heaven *(Ailanthus altissima)*
General - not native to Nebraska. Starts readily from seed that is scattered by wind, and from root sprouts. Thrives under almost any type of condition. Resistant to smoke and gases, difficult to get rid of.
Leaves - once pinnately compound, 1' to 3' long with 11 to 41 leaflets, always an odd number of leaflets, ill smelling when crushed.
Twigs - alternate, coarse, more or less velvety or downy, brown pith.
Buds - terminal bud lacking, hemispherical, normally pubescent, relatively small.
Fruit - oblong, spirally twisted wing in center of which is a single, dry seed. Normally occurs in great abundance.
Wood - little information is published. Light colored, brittle.

River Birch *(Betula nigra)*
General - native to extreme eastern Nebraska. Somewhat rare in the north. More common in the southern part of the range where it is the only birch at low elevations. Normally found along streams. Bark salmon-pink, papery.
Leaves - simple, doubly serrate, rhombic, wedge-shaped base.
Twigs - alternate, slender, reddish-brown, usually pubescent.
Buds - terminal bud lacking, laterals acute.
Fruit - a cylindrical, erect, pubescent strobile with deciduous scales.
Wood - sapwood whitish to yellowish, heartwood brown, without characteristic odor, growth rings frequently not very distinct (diffuse porous).



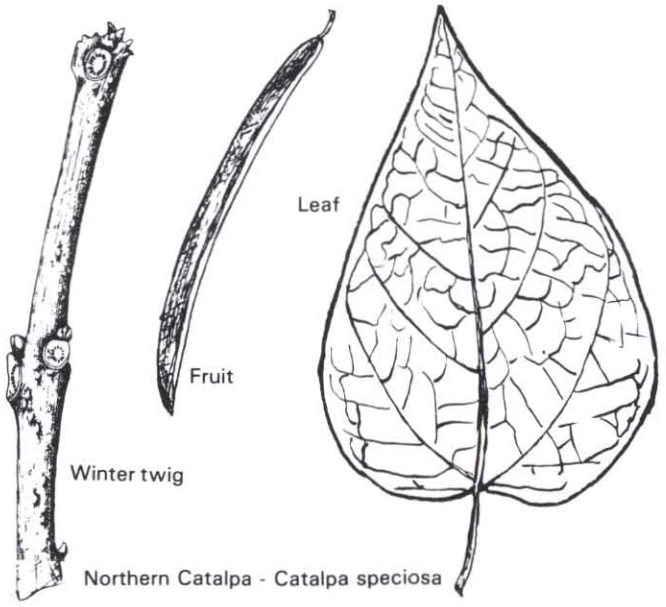
River Birch - Betula nigra



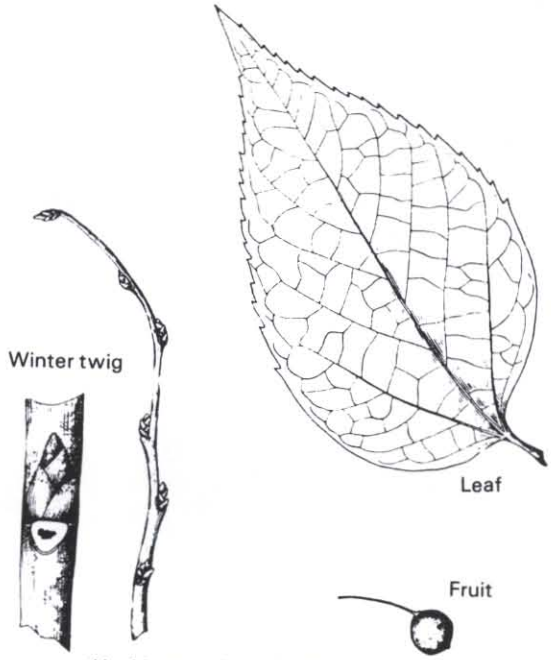
Shagbark Hickory - Carya ovata

Shagbark Hickory *(Carya ovata)*
General - occurs in southeastern Nebraska. Medium-sized tree, slender, tall and straight, with narrow, rounded, open crown of stout branches and twigs. Bark smooth to seamy when young, shagging, flat plates when old.
Leaves - once pinnately compound, 6'' to 12'' long, usually 5 leaflets.
Twigs - alternate, stout, smooth and shining to somewhat downy.
Buds - terminal bud present, large, rather blunt-pointed.
Fruit - a nut encased in a 1/4'' to 1/2'' thick husk, total diameter of 1' to 2 1/2'' in diameter, husk splits readily to release globose nut.
Wood - sapwood whitish to light brown, heartwood pale brown to brown, without characteristic odor, growth rings distinct (ring porous or semi-ring porous).

Northern Catalpa *(Catalpa speciosa)*
General - has escaped cultivation and is naturalized in Nebraska. It was planted to be cut down for fence posts.
Leaves - simple, heart-shaped, 4'' to 10'' long and 3'' to 8'' wide, entire.
Twigs - opposite or whorled, stout, greenish to purplish, circular leaf scars.
Buds - terminal bud lacking, buds smaller than leaf scars.
Fruit - a long, slender pod 6'' to 15'' long and 1/2'' in diameter.
Wood - sapwood pale gray, heartwood grayish brown, faint aromatic but not characteristic odor, growth rings distinct (ring porous), durable soft.



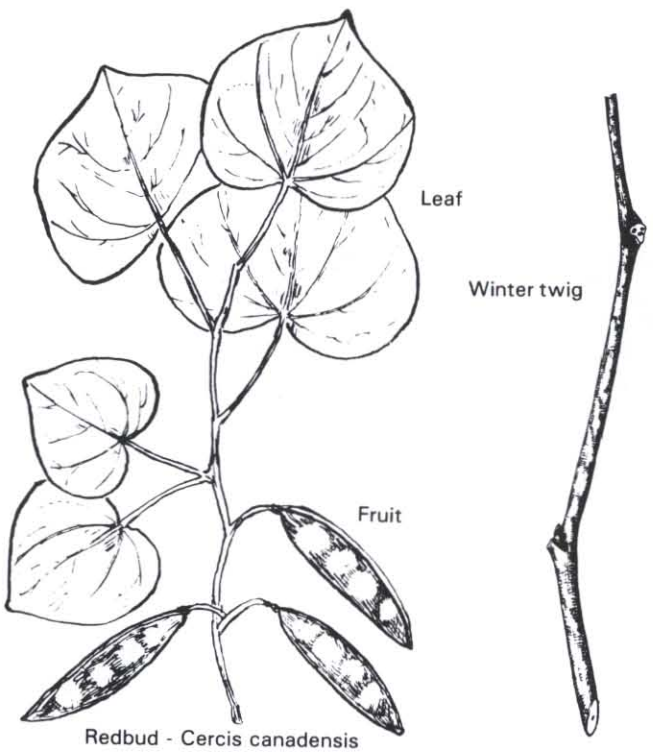
Northern Catalpa - Catalpa speciosa



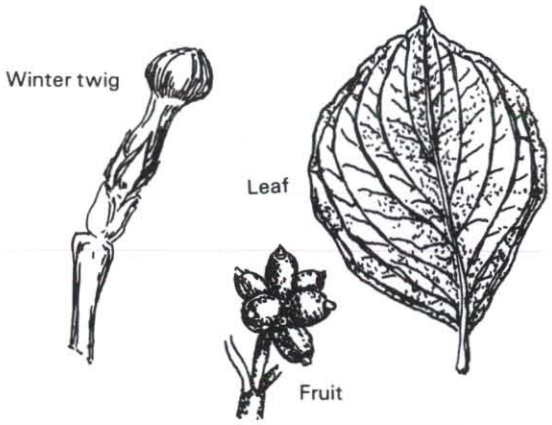
Hackberry - Celtis occidentalis

Hackberry *(Celtis occidentalis)*
General - a medium to large tree, having a rounded, rather wide spreading crown, native to Nebraska, bark on trunk and larger limbs gray and warty.
Leaves - simple, 2'' to 4'' long, serrate, frequently with a long tapering tip, ''nipple galls'' often occur on underside of leaves.
Twigs - alternate, slender, brownish.
Buds - terminal bud lacking, laterals appressed to twig.
Fruit - 1/4'' in diameter, round, purplish, one per stem, flesh edible.
Wood - sapwood pale yellow to greenish yellow, heartwood yellowish to light brown, without characteristic odor, growth rings distinct (ring porous), rays visible to naked eye.

Redbud or Judas Tree *(Cercis canadensis)*
General - an attractive small, low tree, often with several stout, branches forming a rounded crown. Blooms before the leaves appear in April. Beautiful flowers.
Leaves - simple, heart-shaped, 2'' to 4'' long, entire.
Twigs - alternate, usually zigzag, bark on twigs shiny brown.
Buds - terminal bud lacking, small, blunt, glabrous, purplish.
Fruit - short-stalked, flat, brownish pods 2'' to 4'' long, 1/2'' wide, pointed on both ends, contains 8 to 12 brown, hard seeds.
Wood - little data published, hard, brownish.



Redbud - Cercis canadensis

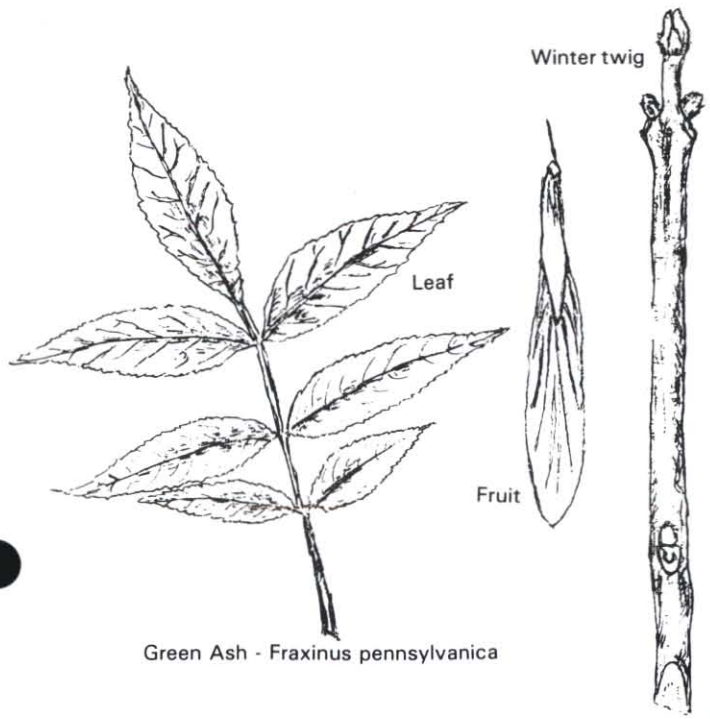


Flowering Dogwood - Cornus florida

Flowering Dogwood *(Cornus florida)*
General - widely planted as an ornamental because of beautiful flowers. Only dogwood important for its wood.
Leaves - simple, entire, about 3 1/2'' long, secondary leaf veins parallel margin.
Twigs - opposite, slender, purplish, more or less covered with a whitish bloom.
Buds - terminal bud present, scales meet in a straight line without overlapping, flower buds look like miniature urns.
Fruit - a bright red drupe, about 1/3'' long, borne in compact clusters.
Wood - sapwood light pinkish brown, heartwood dark brown, without characteristic odor, hard, heavy, growth rings distinct but not sharply delineated (diffuse porus), rays visible to naked eye.

Russian-olive *(Elaeagnus angustifolia)*
General - not native to Nebraska but has been planted extensively.
Leaves - simple, silvery, oblong, 1 1/2'' to 3'' long.
Twigs - alternate, silvery, sometimes with thorns.
Buds - no outstanding characteristics to aid identification.
Fruit - silvery yellow drupe about 1/4'' in diameter.
Wood - little data available, yellow to brown.

Russian Olive - Elaeagnus angustifolia



Green Ash - Fraxinus pennsylvanica

Green Ash *(Fraxinus pennsylvanica)*
General - a medium-sized tree with a compact, broad and rounded crown.
Leaves - once pinnately compound, 8'' to 12'' long, 5 to 7 leaflets, 1' broad, smooth on both sides, serrate.
Twigs - opposite, medium-slender, gray to brownish.
Buds - rusty brown, smaller and narrower than those of white ash.
Fruit - paddle-shaped in dense clusters, often clinging to twigs into or throughout the winter, 1 1/2'' long, 1/4'' wide, abruptly narrowed wing along the slender seed cavity.
Wood - sapwood white, heartwood light brown, growth rings distinct (ring porus), without characteristic odor, rays not distinct.

Honeylocust *(Gleditsia triacanthos)*

General - a medium-sized tree with somewhat drooping lateral branches forming a broad flat-topped head.

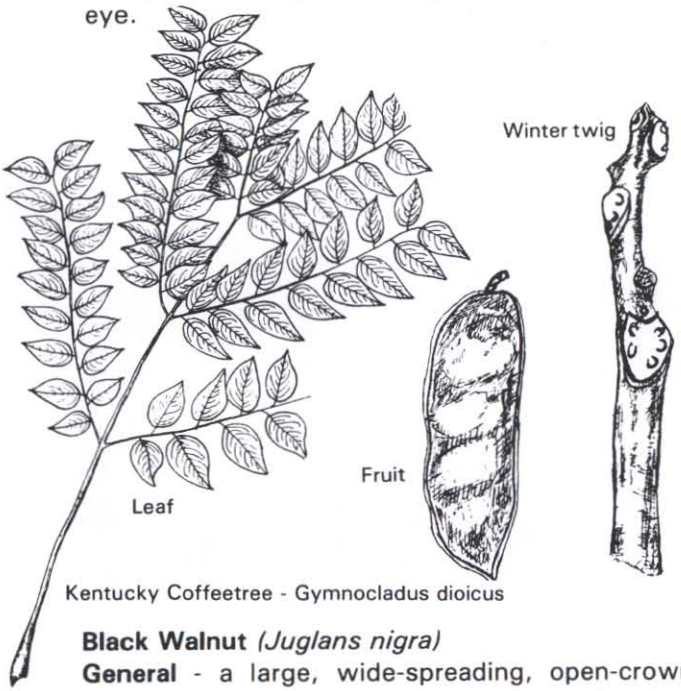
Leaves - both once and twice pinnately compound, once pinnately compound leaves with 15 to 30 nearly sessile leaflets, bipinnate leaves with 4 to 7 pairs of lateral twigs, 6'' to 8'' long, leaflets 1 1/2'' long by 3/4'' wide.

Twigs - alternate, stout, smooth, glossy, zigzag, often having stiff, branched thorns from 3'' to 6'' long, there is a thornless variety.

Buds - terminal bud lacking, superposed, partly sunken in bark.

Fruit - a flat pod, reddish-brown, twisted, 8'' to 12'' long.

Wood - sapwood yellowish, heartwood reddish brown, without characteristic odor, growth rings conspicuous (ring porus), rays conspicuous to naked eye.



Kentucky Coffeetree - Gymnocladus dioicus

Black Walnut *(Juglans nigra)*

General - a large, wide-spreading, open-crowned tree with heavy branches and coarse twigs. It prefers rich bottom soil and under favorable conditions attains large size. It is native along the Missouri River and halfway across the state along the Republican and Niobrara Rivers, and has been planted to some extent throughout the state. A very high-valued hardwood.

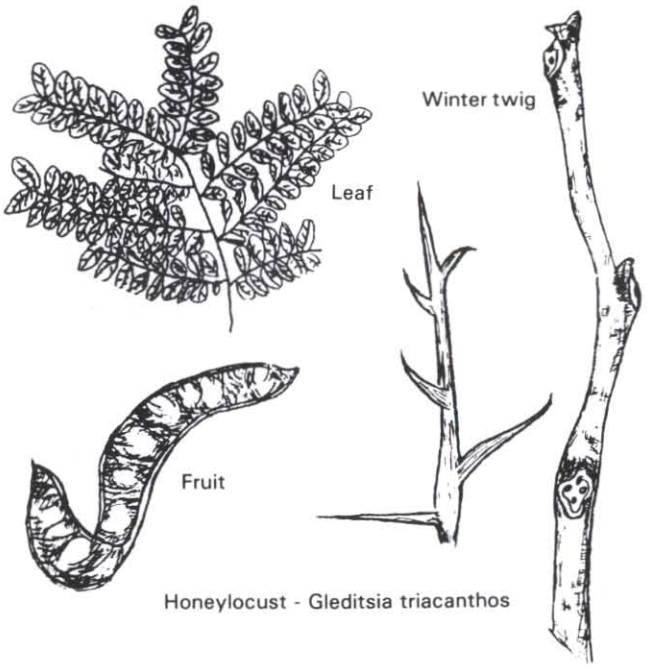
Leaves - compound, 1' to 2' long, with 15 to 23 leaflets, terminal leaflet often missing.

Twigs - alternate, stout, brown, with chocolate-colored chambered pith.

Buds - terminal bud present, short and blunt, larger than laterals.

Fruit - globular nut, 1 3/4'' in diameter, covered by a smooth, yellowish-green husk which becomes black.

Wood - sapwood white to light brown, heartwood chestnut-brown, without characteristic odor, growth rings distinct (semi-ring porus), rays indistinct.



Honeylocust - Gleditsia triacanthos

Kentucky Coffeetree *(Gymnocladus dioicus)*

General - a medium-sized tree with comparatively few large coarse branches.

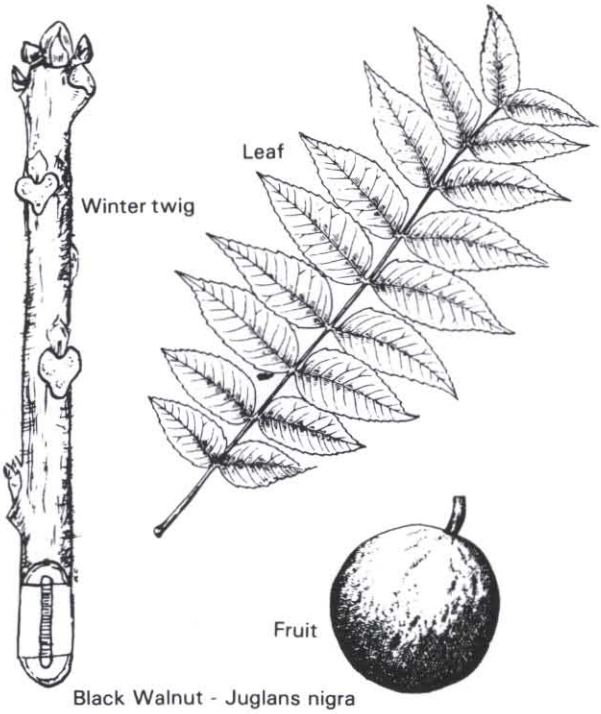
Leaves - twice pinnately compound, very large, 1' to 2' long, 20 to 40 leaflets 1 1/2'' long.

Twigs - very stout, blunt, brown and generally white-crusted. Pith is wide and salmon pink.

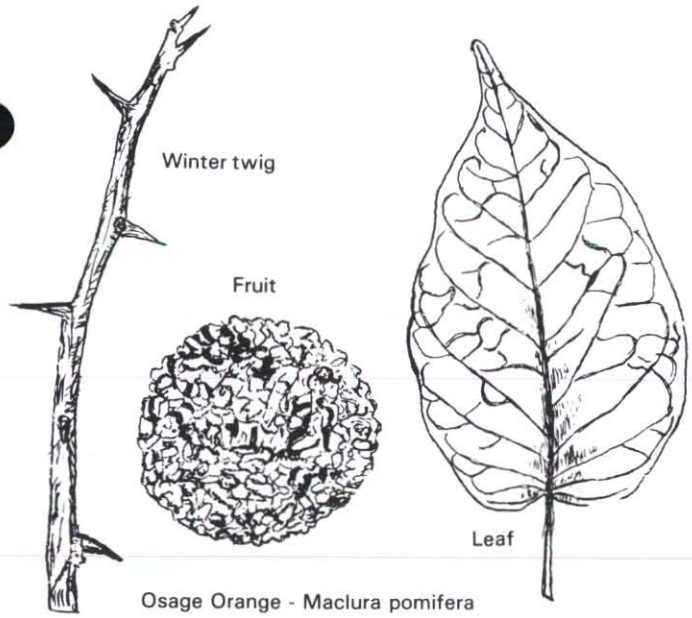
Buds - terminal bud lacking, two or three together, superposed, deeply sunken in the bark.

Fruit - a reddish-brown, leathery, flat, abruptly pointed pod usually 4'' to 6'' long by 1 3/4'' wide, remaining closed until winter, contains 1 to 8 olive-brown, flat, flint-hard seeds imbedded in a sweetish pulp.

Wood - sapwood yellowish, heartwood reddish, without characteristic odor, growth rings conspicuous (ring porus), rays not very conspicuous to naked eye.



Black Walnut - Juglans nigra



Osage Orange - Maclura pomifera

Osage-orange, Hedge Apple, Bois D'arc *(Maclura pomifera)*

General - originally this tree was confined to the rich bottom lands of Arkansas, Oklahoma, and Texas but was extensively planted as a hedge by early Nebraska settlers. In Nebraska the usual height is less than 30 feet.

Leaves - simple, entire, 3'' to 5'' long, with a narrow, pointed apex, dark green and shiny above, milky juice.

Twigs - alternate, bright green, hairy, becoming yellowish and armed with stout, sharp-pointed thorns. Bark on roots is bright orange-red.

Buds - terminal bud lacking, small, globular.

Fruit - a pale green orange-like structure 2'' to 4'' in diameter. Seeds brown.

Wood - characteristic bright orange color, yields a yellow dye, used to make bows, thus the name bois d'arc.

Apple *(Malus pumila)*

General - not native to Nebraska. Apples are of European or Asiatic origin. Most eating apples are cultivars or varieties that must be grafted.

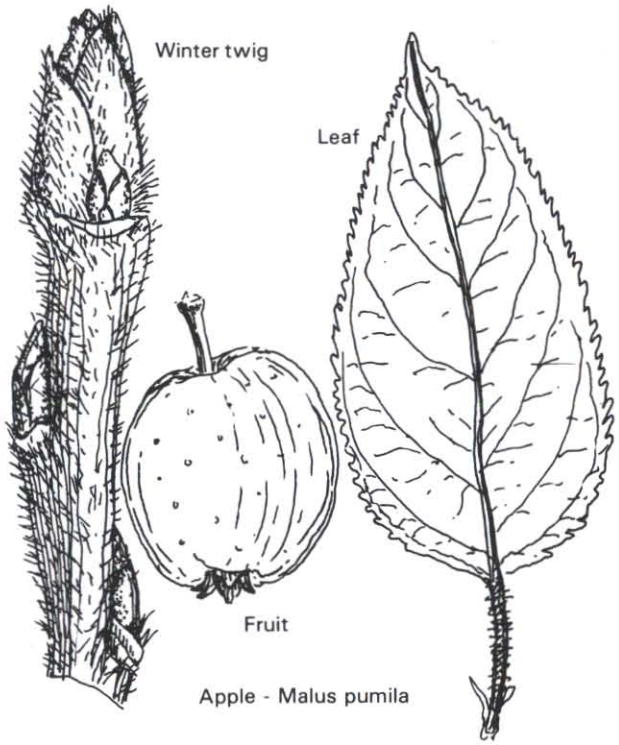
Leaves - simple, serrate, elliptical to ovate, white pubescent below.

Twigs - alternate, somewhat woolly, characteristic sweet taste.

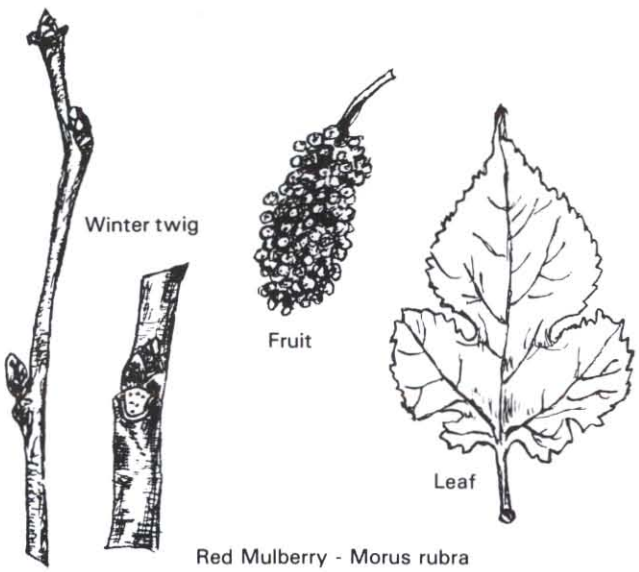
Buds - terminal bud present, woolly (particularly at tip), blunt, laterals smaller than terminal bud.

Fruit - pome or apple.

Wood - hard, good firewood.



Apple - Malus pumila



Red Mulberry - Morus rubra

Red Mulberry *(Morus rubra)*

General - a small tree which develops a broad, rounded head with numerous small branches.

Leaves - simple, variable in shape, may be entire but often 3 to 5 lobes, 2'' to 5'' long, hairy beneath.

Twigs - alternate, slender, somewhat zigzag, reddish to greenish-brown, showing milky sap when cut.

Buds - terminal bud lacking, mostly covered by two-ridged scales.

Fruit - dark purple or nearly black, 1/2'' to 3/4'' long, ripening in June or July.

Wood - sapwood yellowish, heartwood yellow-brown, without characteristic odor, growth rings distinct (ring porus), rays plainly visible to naked eye.

American Sycamore or Buttonball-tree *(Platanus occidentalis)*

General - a tall, spreading tree usually found along streams, native along the Missouri River as far north as Omaha. Has been planted in all sections of the state.

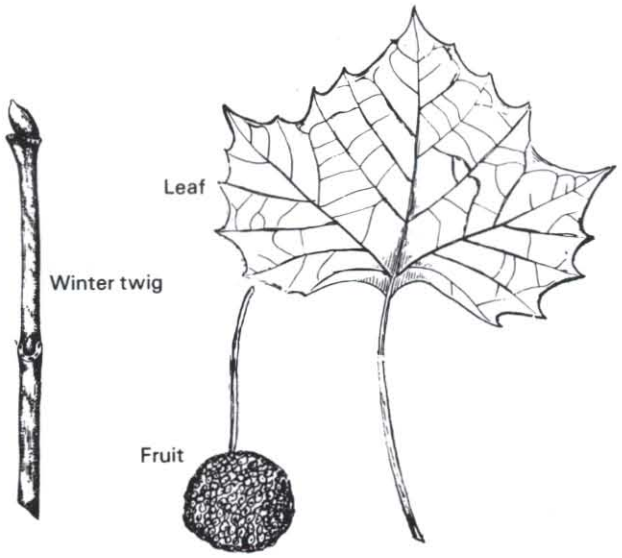
Leaves - simple, 3'' to 8'' broad, more or less deeply 3 to 5 lobed, bright green.

Twigs - alternate, pale green and hairy when young, smooth and gray when older.

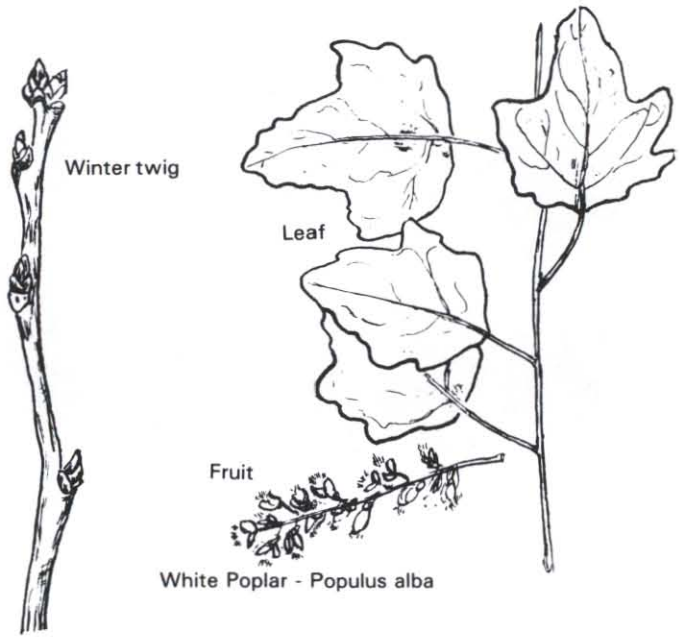
Buds - terminal bud lacking, conical, covered by a single cap-like scale and hidden under hollow base of petiole.

Fruit - round, yellowish-brown ball about 1'' in diameter that hangs from slender stem. Often persists throughout winter and into following summer.

Wood - sapwood light yellowish, heartwood light to dark brown, without characteristic odor, growth rings distinct, rays conspicuous to naked eye.



American Sycamore - Platanus occidentalis



White Poplar - Populus alba

White Poplar *(Populus alba)*

General - introduced from Europe. This is a member of the willow family and is often wrongly called silver maple. It is a large tree, grows rapidly in favorable locations, and also thrives under less favorable conditions. Many root suckers occur about the trees.

Leaves - often resemble a maple leaf in shape, dark green above, white and woolly below, rhombic with very coarse teeth or lobes.

Twigs - alternate, covered with white woolliness.

Buds - terminal bud present, more or less woolly.

Fruit - a small capsule borne in necklacelike strings, seeds very small, capsules contain a large amount of cottony material in addition to seeds.

Wood - little information published, similar to other poplars.

Eastern Cottonwood *(Populus deltoides)*

General - state tree of Nebraska. Very easily propagated by planting a piece of a young branch in moist earth. The Plains Indians used the root wood for starting fires by friction, but as a firewood it burns quickly.

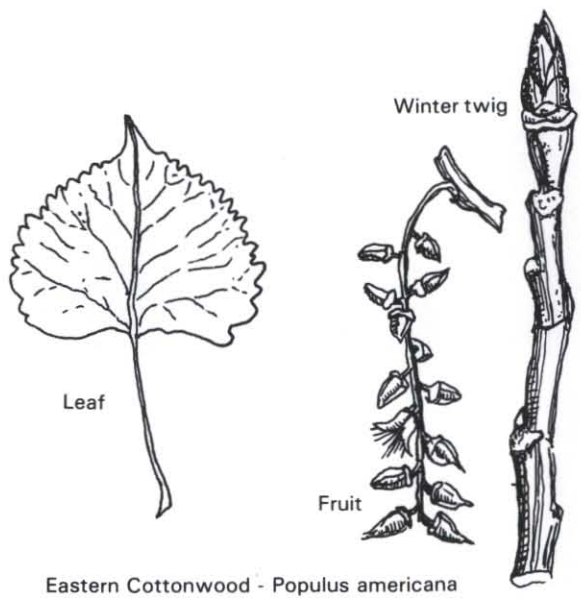
Leaves - simple, rounded teeth, triangular in outline, 2'' to 4'' long, leaf stem long and flattened.

Twigs - alternate, yellowish-brown, stout, pith 5-angled.

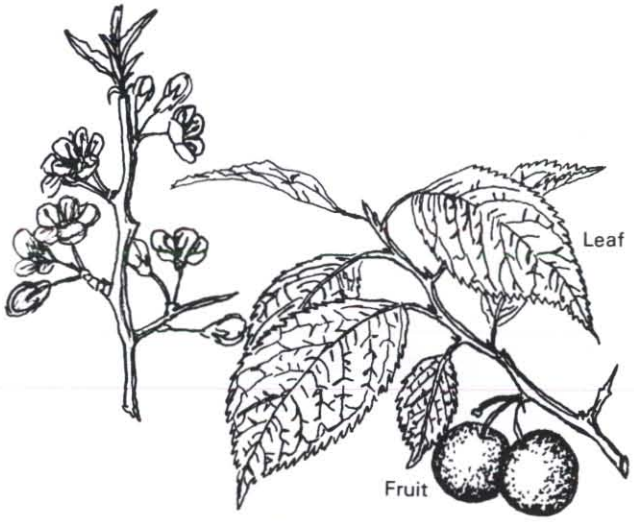
Buds - terminal bud present, brownish, sticky, ovoid.

Fruit - a small, ovoid capsule about 1/3'' long, borne like a string of beads, capsule contains many seeds and cottony material, seeds small.

Wood - sapwood whitish, heartwood grayish, often not a clearly defined change from sapwood to heartwood, growth rings distinct but inconspicuous, (diffuse porus), rays not visible without magnification.



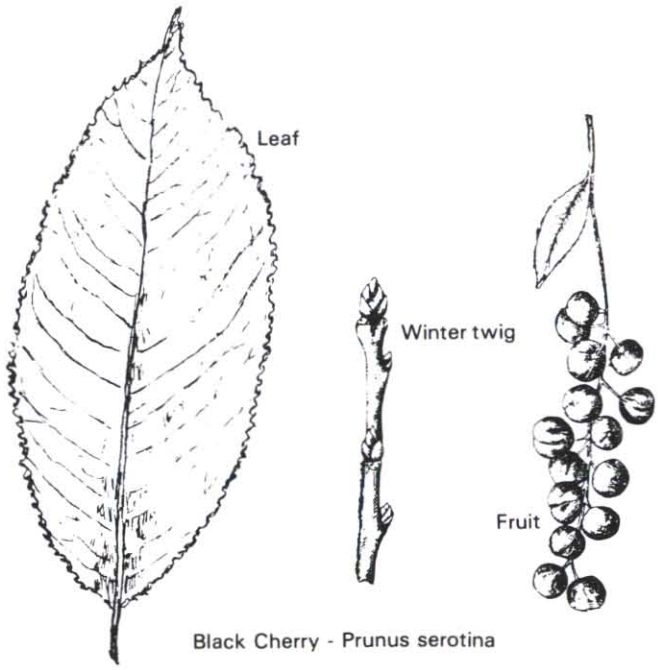
Eastern Cottonwood - Populus americana



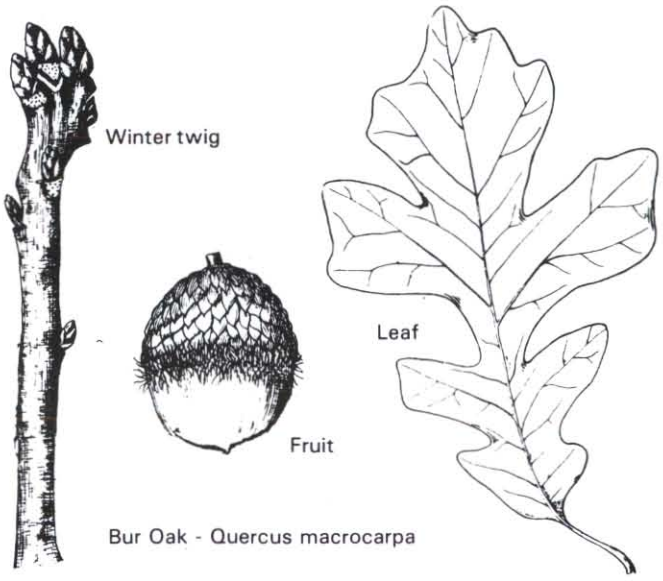
American Plum - Prunus americana

American or Wild Plum *(Prunus americana)*
General - widely planted in Nebraska and has escaped into pastures, fields and roadsides. Useful to wildlife.
Leaves - simple, serrate, 3'' to 4'' long, 1 1/2'' wide, oval.
Twigs - alternate, slender, greenish when young becoming darker with age.
Buds - terminal bud present, acute, 1/8'' to 1/4'' long.
Fruit - subglobose, less than 1'' in diameter, bright red when fully ripe, ripens usually from the middle of August to as late as October, edible.
Wood - heavy, hard, dark brown with light colored sapwood.

Black Cherry *(Prunus serotina)*
General - a medium-sized tree attaining a height of 50 feet or more and a diameter of 1 to 2 feet. Native to southeastern Nebraska. Grows along fence rows, in open places and on the edge of timbered areas.
Leaves - simple, about 3'' long and half as broad, dark green and shiny above, paler beneath, finely toothed with incurved teeth, petiole with a conspicuous gland on each side.
Twigs - alternate, slender, usually bitter to taste, red to brown.
Buds - terminal bud present, laterals same size as terminal, scales imbricate.
Fruit - a dark red nearly black drupe about 1/3'' in diameter.
Wood - sapwood light brown, heartwood light to dark reddish-brown, without characteristic odor, growth rings fairly distinct (semi-ring porus), rays plainly visible to the naked eye.



Black Cherry - Prunus serotina



Bur Oak - Quercus macrocarpa

Bur Oak or Mossycup Oak *(Quercus macrocarpa)*
General - an important tree species in Nebraska. It is long lived. Valuable as an ornamental and for lumber. A white oak.
Leaves - simple, 5 to 7 rounded lobes, 6'' to 10'' long and 3'' to 5'' wide.
Twigs - alternate, stout, yellowish-brown, becoming ashen or brownish, often with corky ridges.
Buds - terminal bud present, cluster or buds toward the end of the twig, blunt.
Fruit - an acorn, about 1'' long, fringed cup covers 1/2 or more of the acorn, matures in fall of first year.
Wood - sapwood whitish to light brown, heartwood light to dark brown, without characteristic odor, growth rings very distinct (ring porus), rays visible to naked eye, pores normally occluded by tyloses.

Pin Oak *(Quercus palustris)*

General - called pin oak because the trunk is more or less studded with tough lower limbs which do not prune readily. Widely planted as an ornamental. A member of the black oak group.

Leaves - simple, 5- sometimes 7- or 9-lobed, 3'' to 5'' long, 2'' to 5'' wide. Sinuses extending 2/3 or more to the midrib, lobes bristle-tipped.

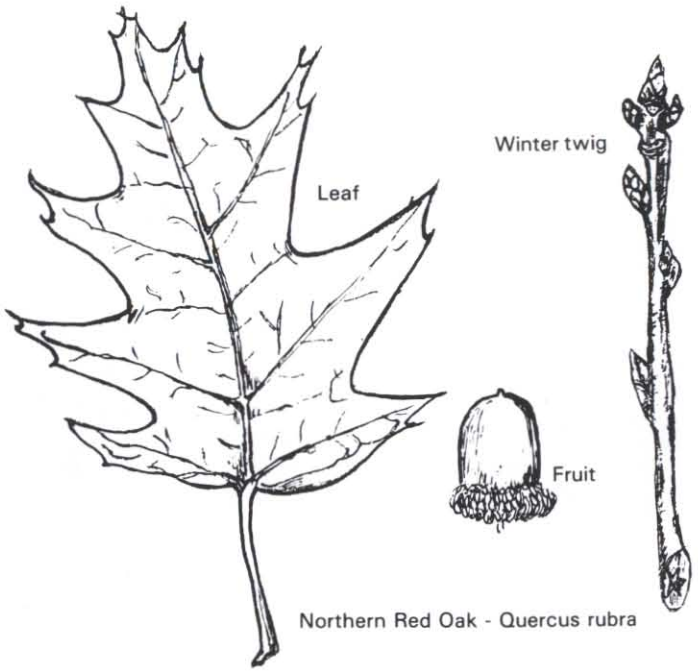
Twigs - alternate, slender, reddish-brown.

Buds - terminal bud present, 1/8'' long, ovoid, with reddish-brown scales, lateral buds similar but smaller.

Fruit - acorn, 1/2'' long, nearly hemispherical, enclosed only at the base by a thin, saucerlike cup.

Wood - sapwood whitish to pale reddish-brown, heartwood pinkish to light reddish-brown, without characteristic odor, growth rings very distinct (ring porus), rays conspicuous to naked eye, pores not filled with tyloses.

Pin Oak - Quercus palustris



Northern Red Oak - Quercus rubra

Northern Red Oak *(Quercus rubra)*

General - a large tree of the black oak group whose acorns mature in autumn of the second season. Makes an attractive ornamental tree.

Leaves - simple, 5'' to 9'' long, 4'' to 9'' wide, with coarse-toothed, bristle-tipped lobes, dark green and smooth above, paler beneath.

Twigs - alternate, medium-stout, reddish to greenish-brown.

Buds - terminal bud present, smooth, light chestnut-brown, 1/8'' to 1/4'' long, lateral buds smaller.

Fruit - acorn oblong or nearly round, about 1'' long, reddish-brown, cup shallow, saucer-shaped, usually covering only the base of the acorn.

Wood - sapwood whitish to pale reddish-brown, heartwood pinkish to light reddish-brown, without characteristic odor, growth rings very distinct (ring porus), rays conspicuous to naked eye, pores not filled with tyloses.

Black Locust *(Robinia pseudoacacia)*

General - generally a medium-sized tree belonging to the pea family. A rapid-growing tree. Spreads by means of root suckers. Often severely damaged by locust borer.

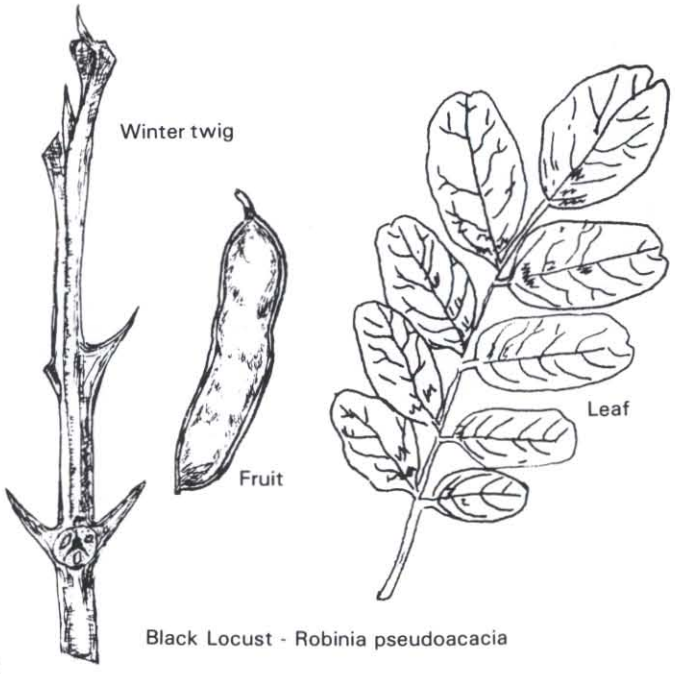
Leaves - once pinnately compound, 6'' to 12'' long, 7 to 19 leaflets.

Twigs - alternate, slender, brittle, often zigzag, generally have short, stiff spines, 1/4'' to 1/2'' long, in pairs at base of leaves.

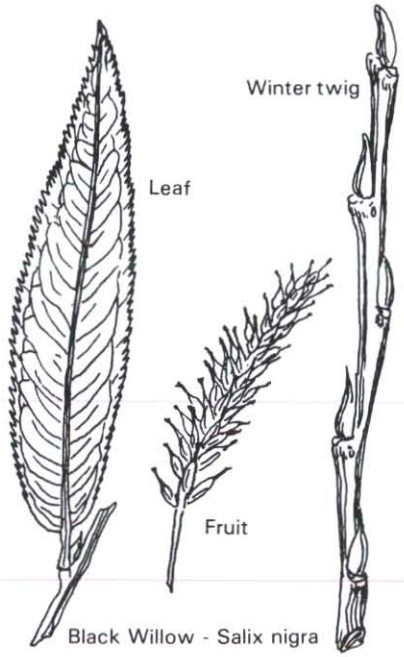
Buds - terminal bud lacking, superposed, hidden under fringe cracks of bark of leaf scar.

Fruit - a dark brown, flat pod, 3'' to 5'' long.

Wood - sapwood yellowish, heartwood yellowish to golden-brown, without characteristic odor, growth rings distinct (ring porus), rays generally visible to the naked eye.



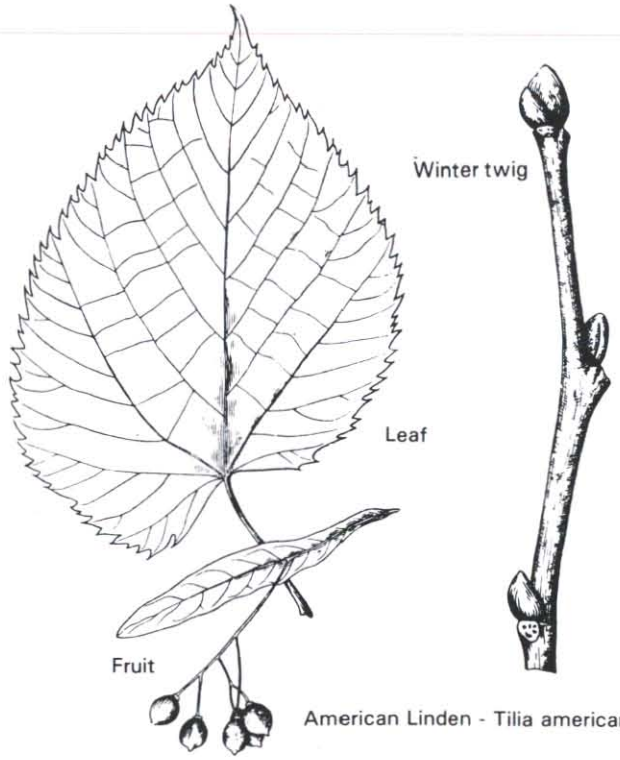
Black Locust - Robinia pseudoacacia



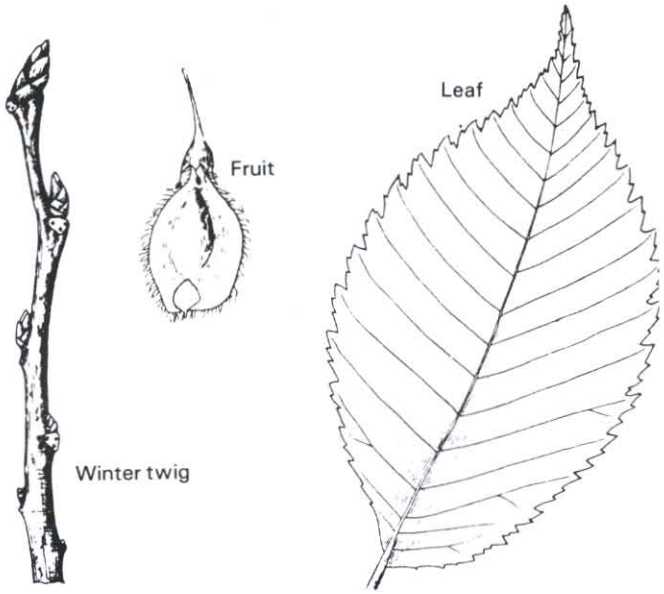
Black Willow - Salix nigra

Black Willow *(Salix nigra)*
General - native to Nebraska. Usually found on moist soils along the banks of streams. Grows rapidly and matures in 50 to 70 years.
Leaves - simple, serrate, 3'' to 6'' long, 3/8'' to 3/4'' wide, lanceolate.
Twigs - alternate, slender to stout, often brittle.
Buds - terminal bud absent, lateral buds appressed, covered by a single cap-like scale.
Fruit - a capsule about 1/4'' long, short-stalked, seeds very small.
Wood - sapwood whitish, heartwood light brown to reddish-brown, without characteristic odor, growth rings inconspicuous (diffuse porus), rays barely visible with a hand lens.

American Basswood or American Linden *(Tilia americana)*
General - a large tree with rounded, spreading crown. A native in rich, moist woodlands and along river bottoms in the extreme eastern part of the state.
Leaves - simple, heart-shaped, 2'' to 4'' long and almost as wide.
Twigs - alternate, usually zigzag, smooth, reddish to gray.
Buds - terminal bud lacking, dark red or greenish, about 1/4'' long, lateral buds inequilateral, mucilaginous, usually with two visible scale.
Fruit - subglobose, nutlike, 1/3'' to 1/2'' in diameter, clustered, bract persistent.
Wood - sapwood whitish to pale brown, heartwood pale brown, with a faint characteristic odor, growth rings fairly distinct (diffuse porus), rays not visible without a hand lens.



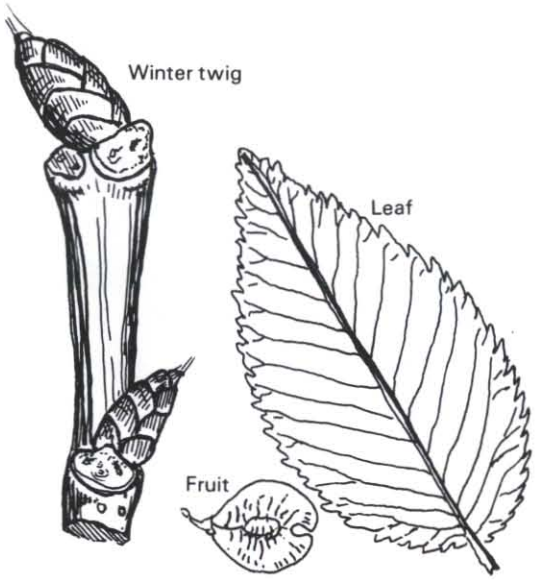
American Linden - Tilia americana



American Elm - Ulmus americana

American Elm or White Elm *(Ulmus americana)*
General - a large, graceful tree distributed throughout the state. Greatly admired as a lawn and street tree. Subject to Dutch Elm disease.
Leaves - simple, 3'' to 5'' long and half as broad, dark green above, pale and smooth or somewhat hairy below, unequal base.
Twigs - alternate, slender, generally smooth, light reddish-brown.
Buds - terminal bud lacking, lateral buds about 1/4'' long, ovoid, not sharp-pointed, characteristic one-sided position above leaf scar.
Fruit - samara, a flat membranous wing about the seed, wing hairy-fringed and notched at tip. Ripens in spring.
Wood - sapwood grayish to light brown, heartwood light brown to brown, without characteristic odor, growth rings distinct (ring porus), rays not distinct to naked eye, cross-section of bark shows corky white layers.

Siberian Elm *(Ulmus pumila)*
General - not native to Nebraska. Much planted throughout Nebraska in shelterbelts. Commonly, but incorrectly, called Chinese elm.
Leaves - simple, usually nearly equal at base, serrate, 1'' to 3'' long.
Twigs- terminal bud lacking, alternate, gray, slender.
Buds - spherical, bud scale tipped with long hairs.
Fruit - samara, small, about 1/2'' long.
Wood - little data published but similar to other elms.



Siberian Elm - Ulmus pumila

DICHOTOMOUS

IDENTIFICATION KEY

1. Leaves, needles or scale-like; evergreen 2
1. Leaves, broad; deciduous 10
2. Leaves, small and scale-like, awl-shaped 3
2. Leaves, long and narrow; needles 4
3. Fruit ripening at the end of the first season----------*Juniperus virginiana*
3. Fruit ripening at the end of the second season----------*Juniperus scopulorum*
4. Leaves, united at base to form bundles 5
4. Leaves, not in bundles, occur singly 8
5. Leaves, bundles of 5----------*Pinus strobus*
5. Leaves in bundles of 2 or 2 and 3 6
6. Leaves, bundles of 2 and 3----------*Pinus ponderosa*
6. Leaves, bundles of 2 7
7. Leaves, 3'' to 6'' long----------*Pinus nigra*
7. Leaves, 2'' long ----------*Pinus sylvestris*
8. Leaves, 4-sided in cross-section, sharp pointed----------*Picea pungens*
8. Leaves, flat in cross-section 9
9. Leaves, 1'' long, petioled; buds, sharp-pointed----------*Pseudotsuga menziesii*
9. Leaves, 2 1/2'' long, sessile; buds, subglobose----------*Abies concolor*
10. Leaves, opposite or in 3's 11
10. Leaves, alternate 19
11. Leaves, simple 12
11. Leaves, compound 16
12. Leaves, lobed palmately 13
12. Leaves, not lobed 15
13. Margins of lobes not toothed, 5-lobed----------*Acer saccharum*
13. Margins definitely toothed 14
14. Leaves, 5-lobed; bruised twigs have a rank odor----------*Acer saccharinum*
14. Leaves, normally 3-lobed; bruised twigs not offensive----------*Acer rubrum*
15. Side veins parallel leaf margin----------*Cornus florida*
15. Leaves, heart-shaped, whorls of 3 ----------*Catalpa speciosa*
16. Leaves, palmately compound 17
16. Leaves, pinnately compound 18

17. Leaflets, 5; foliage with disagreeable odor---------- *Aesculus glabra*
17. Leaflets, 7; buds, dark and sticky---------- *Aesculus hippocastanum*
18. Leaflets, 3 to 7, variable in shape; fruit, a double samara---------- *Acer negundo*
18. Leaflets, 7 or 9, similar in shape; fruit, a single samara---------- *Fraxinus pennsylvanica*
19. Leaves, simple 20
19. Leaves, compound 39
20. Leaves, lobed 21
20. Leaves, unlobed 26
21. Leaves, undersurface covered with silvery wool---------- *Populus alba*
21. Leaves, undersurface not covered with silvery wool 22
22. Lobes, each bears a bristle-tip 23
22. Lobes, not bristle-tipped 24
23. Leaf sinuses, deep, nearly to the midrib; acorn, short and wide; cup, flat, saucerlike---------- *Quercus palustris*
23. Leaf sinuses, extending only about halfway to the midrib; acorn, ellipsoidal, partly enclosed by a deep cup---------- *Quercus rubra*
24. Leaf outline, broadest above middle; center pair of sinuses going nearly to midrib---------- *Quercus macrocarpa*
24. Leaf outline, will fit in a circle 25
25. Base of leaf stem, hollow, enclosing the bud---------- *Platanus occidentalis*
25. Base of leaf stem, solid; sap, milky---------- *Morus rubra*
26. Leaf stem, flattened---------- *Populus deltoides*
26. Leaf stem, circular 27
27. Leaf margin, entire 28
27. Leaf margin, serrate 30
28. Twigs, without thorns; leaves, heart-shaped---------- *Cercis canadensis*
28. Twigs, with thorns 29
29. Sap, milky; leaves, shiny---------- *Maclura pomifera*
29. Sap, clear; leaves, long and narrow---------- *Elaeagnus angustifolia*
30. Sap, milky---------- *Morus rubra*
30. Sap, clear 31
31. Leaves, 4'' in diameter---------- *Tilia americana*
31. Leaves, less than 4'' in diameter 32
32. Margins, single teeth---------- *Celtis occidentalis*
32. Margins, double teeth 33
33. Teeth, conspicuous, medium-sized to large 34
33. Teeth, small 35
34. Leaves, 3'' to 5'' long; base, unequal---------- *Ulmus americana*
34. Leaves, 1'' to 3'' long; base, nearly equal---------- *Ulmus pumila*
35. Taste of twig, bitter 36
35. Taste of twig, not bitter 38
36. Bud scale, single cap-like---------- *Salix nigra*
36. Bud scales, 2 or more 37
37. Petiole, glandular; fruit, nearly black, 1/3'' in diameter---------- *Prunus serotina*
37. Petiole, not glandular; fruit, red, 3/4'' to 1'' in diameter---------- *Prunus americana*
38. Twig taste, sweetish---------- *Malus pumila*
38. Bark, salmon-pink, papery---------- *Betula nigra*
39. Leaves, twice pinnately compound 40
39. Leaves, once pinnately compound 41
40. Leaves, less than 1' in length---------- *Gleditsia triacanthos*
40. Leaves, larger than 1', may be nearly 3'---------- *Gymnocladus dioicus*
41. Twigs, armed with spines or thorns (some varieties are thornless) 42
41. Twigs, unarmed 43
42. Twigs, with long, branched thorns (except in thornless variety); fruit, a bean about 12'' long---------- *Gleditsia triacanthos*
42. Twigs, with paired spines; fruit, a bean about 3'' long---------- *Robinia pseudoacacia*
43. Crushed leaves, with disagreeable odor; pith, large, brownish---------- *Ailanthus altissima*
43. Crushed leaves, not a disagreeable odor 44
44. Pith, chambered, light yellowish-gray---------- *Juglans nigra*
44. Pith, homogeneous---------- *Carya ovata*

HOW A TREE GROWS

CROWN

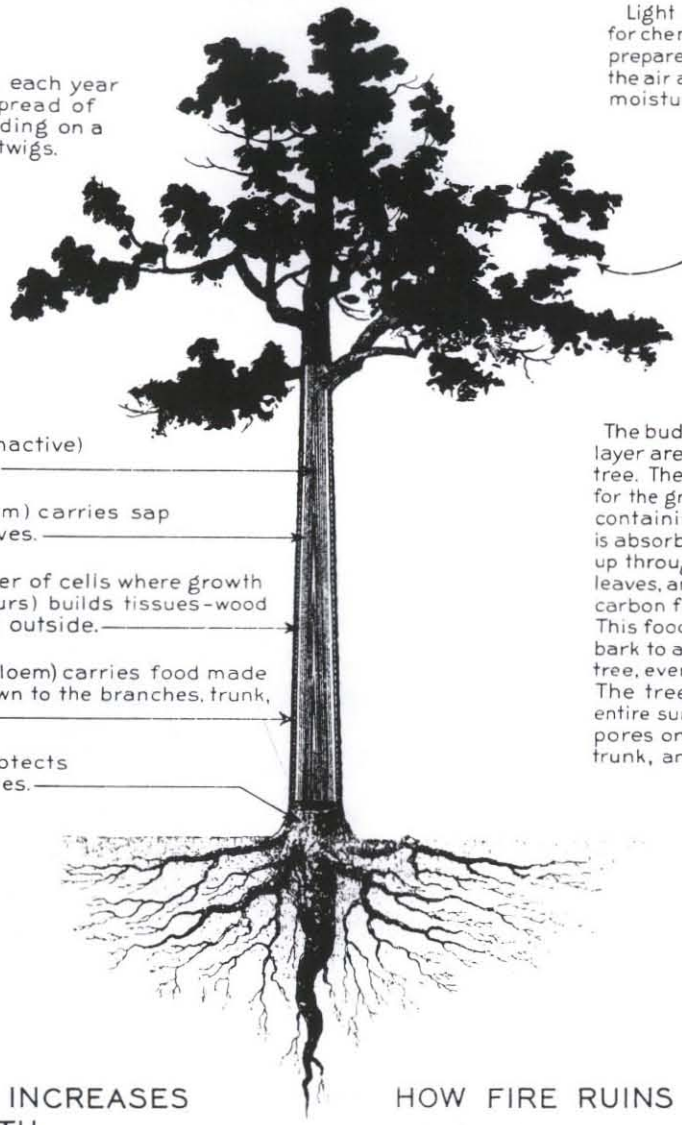
TRUNK

ROOTS

Trees increase each year in height and spread of branches by adding on a new growth of twigs.

Light and heat are necessary for chemical changes. The leaves prepare the food obtained from the air and the soil and give off moisture by transpiration.

The air supplies carbon, the principal food of the tree, which is taken in on the under surface of the leaves.



Heartwood (inactive) gives strength.

Sapwood (xylem) carries sap from root to leaves.

Cambium (layer of cells where growth in diameter occurs) builds tissues - wood inside and bark outside.

Inner bark (phloem) carries food made in the leaves down to the branches, trunk, and roots.

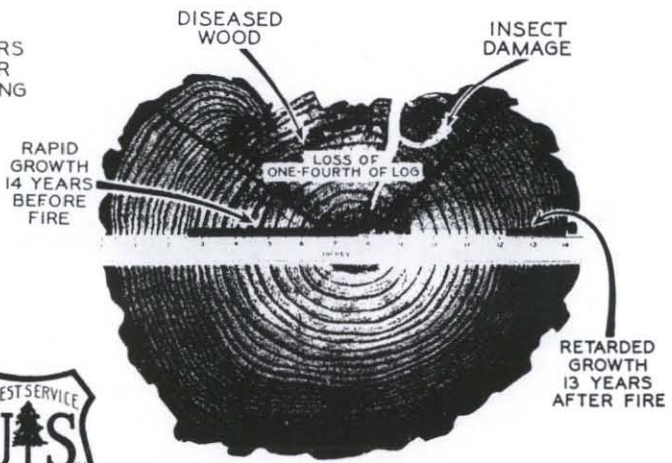
Outer bark protects tree from injuries.

The buds, root tips, and cambium layer are the growing parts of the tree. The leaves manufacture food for the growing processes. Water, containing minerals in solution, is absorbed by the roots, carried up through the sapwood to the leaves, and is there combined with carbon from the air to make food. This food is carried by the inner bark to all growing parts of the tree, even down to the root tips. The tree takes in oxygen over its entire surface through breathing pores on leaves, twigs, branches, trunk, and roots.

HOW THINNING INCREASES GROWTH

HOW FIRE RUINS TIMBER

DISEASE AND INSECTS ENTER THROUGH FIRE SCARS



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