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ABSTRACT

The materials in this educational packet consist of an overview, three lesson plans, student data sheets, and a poster. The overview describes the flow of a river from its source to its mouth. A glossary and list of reference materials are included. The lesson plans provide a statement of purpose, list of learning outcomes, and instructional strategies. The first two lessons (involving a treasure hunt in which students match objects in the environment to a list of characteristics, and survey a river/stream and evaluate it from the point of view of a plant or animal) include a quiz and student data sheet. The third lesson is a water resources game in which students learn about the management problems of rivers and streams regarding water use. Ready-to-duplicate game items (including the game board) are provided. The two-sided poster has (on side 1) three pictures showing a river from its source to its mouth and (on side 2) background information for the water resources game in the third lesson. An additional student sheet is also included with a maze to complete on one side and instructions for making a note on a piece of driftwood on the other side. (JN)

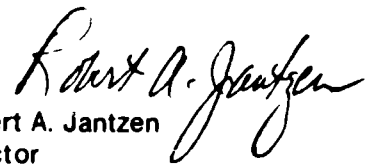
Rivers and Streams

Habitat Pac

A Message To Educators

The Fish and Wildlife Service manages millions of acres of land, conducts wildlife research, raises fish for restocking depleted waters, and performs hundreds of other tasks designed to benefit fish and wildlife resources. However, as important as these activities are, we realize that in the long run an informed, motivated, and involved public can do more to benefit wildlife than all of our management activities.

This education package represents an important step in our efforts to provide teachers and other educators with factual, unbiased information about wildlife, habitat needs, and resource management issues. We hope that you find these materials useful and enjoyable and that you will encourage your students to learn more about America's wildlife heritage.



Robert A. Jantzen
Director
U.S. Fish and Wildlife Service

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Major Rivers in the United States

Key:

1. Yukon
2. Columbia
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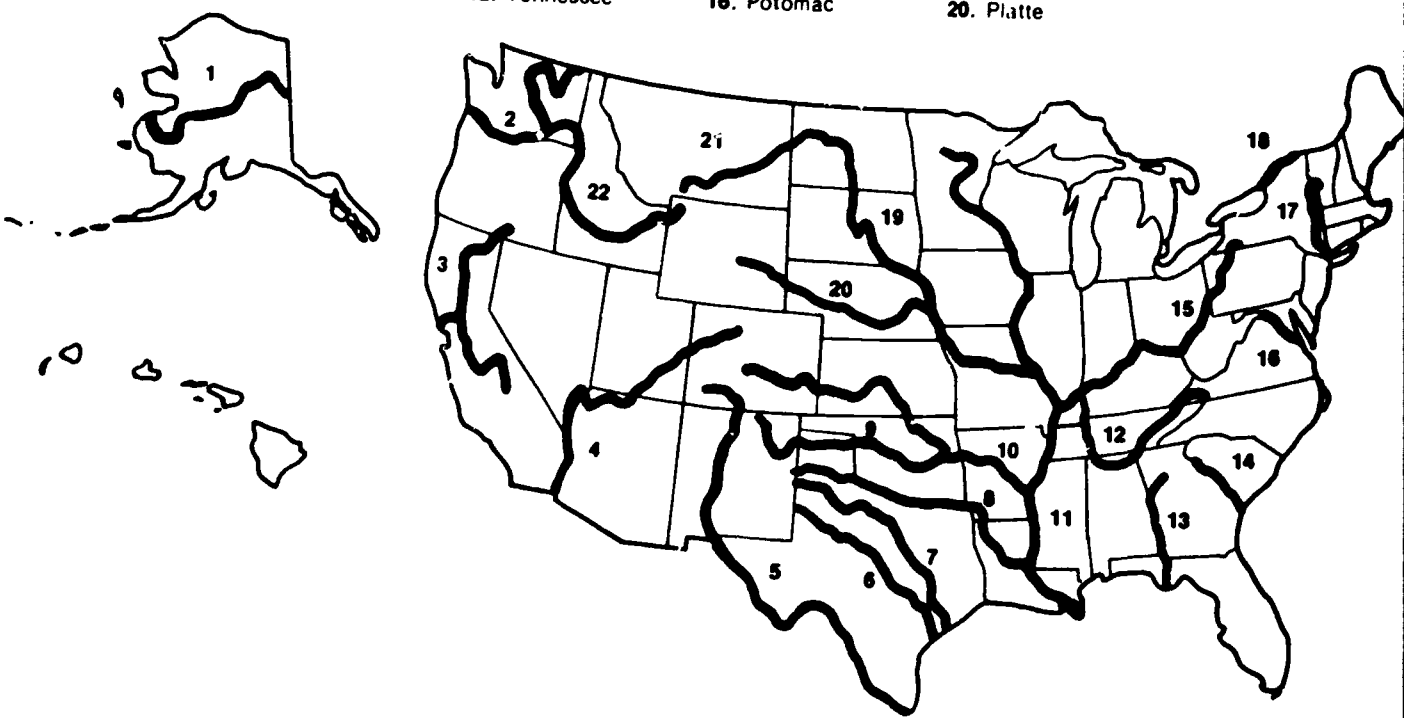
6. Colorado
7. Brazos
8. Red
9. Canadian
10. Arkansas
11. Mississippi
12. Tennessee
13. Chattahoochee
14. Savannah
15. Ohio
16. Potomac
17. Hudson
18. Saint Lawrence
19. Missouri
20. Platte
21. Yellowstone
22. Snake



Rivers and Streams

Habitat Overview

Historical Perspective

The streams and rivers of America presented wonderful opportunities for early explorers They embarked on rivers to claim "mountains of gold" and to realize riches from the fur trade

Imagine adventuring up the great Missouri River Basin on an expedition with Lewis and Clark This is how Meriwether Lewis described the river in 1804

"This immense river, so far as we have yet ascended, waters one of the fairest portions of the globe, nor do I believe there is in the universe a similar extent of country equally fertile, well watered, and intersected by such a number of navigable streams Game is very abundant, and seems to increase as we progress—our prospect of starving is therefore consequently small "

In early America, rivers were sources of food, water and transportation Settlers soon followed the explorers, building their towns near the rivers Before the advent of trains, when roads were muddy ruts, rivers provided the major lifelines of transportation for trade Abundant fish, game, and crops from the fertile bottomlands fed a growing population Streams sprouted water wheels to power grain and lumber mills

As America grew, its people and rivers had profound interactions Much has happened to rivers and to the ecosystems they support How have people, in their dependence on rivers, changed them? Is there today the abundance of fish and game found in earlier times? The fertile land? Let us examine the life of a river

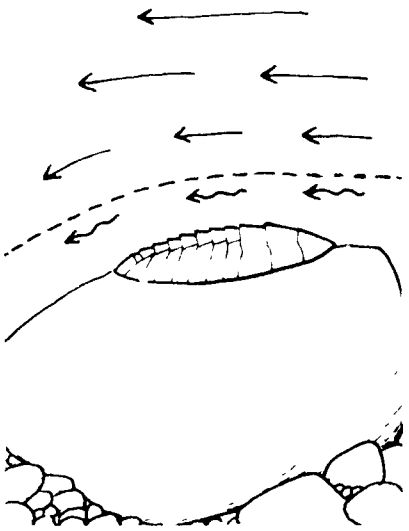
Ecology

The flowing water of streams and rivers seems almost alive Forever moving, changing, working—these waters shape the land through which they flow Though the water itself is not alive, it supports a wealth of plant and animal life In the river, on it, or beside it thrive many organisms that are uniquely adapted to their environment

Rivers and streams are composites of many different **microhabitats—riffles**, pools, broad meandering channels—each providing a different physical environment and having as a result various plants and animals The difference between rivers and streams is mainly one of size Rivers are broader and generally longer than streams

Even the broadest rivers begin as small streams At their headwaters you may find only melting snow or glacial ice, or a small

lake or spring The water moves downhill, starting a journey that ends ultimately at the sea Here is one river s journey



Waterpenny larva in boundary layer

The Source

Amid moss-covered rocks in a quiet hollow, a crystal spring wells into a small pool The water, gushing from deep beneath the rocks, is cool and clear but, as yet, supports few organisms Underground water contains little **dissolved oxygen** to sustain life As the water flows, riffling over rocks and branches, it mixes with air

In mountain areas, the water tumbles rapidly, cutting a narrow channel and scouring out pools on its way to lower terrain The organisms living in this stretch of the stream have adapted to a cool water habitat containing plenty of oxygen

The speed of the water greatly affects stream life Plants, mostly algae and mosses, grow tightly attached to rocks to avoid being swept away Rooted plants, like cattails grow in quieter waters

Animals adjust to the current in several ways Flattened shapes allow them to slip under rocks or move in the boundary layer between the surface of the rocks and the water In this layer, about as thick as a quarter, the water speed is greatly reduced The waterpenny, a round, very flat, copper-colored beetle larva, clings tightly to rocks Here also lives the larva of the dreaded black fly, whose burning bite is the scourge of spring hikers and fishermen However, the black fly is an important food source to many fish

Pick up a rock, and you may find clinging to its underside the immature forms, or **nymphs,** of mayflies and stoneflies These pudgy creatures will become delicate, winged adults that hover over the water Caddisfly larvae, small caterpillarlike creatures, construct elaborate tubular cases, or houses In fast water, they make these of heavy sand and gravel for anchorage in the current In quieter water, they build their cases of lighter sticks and leaves

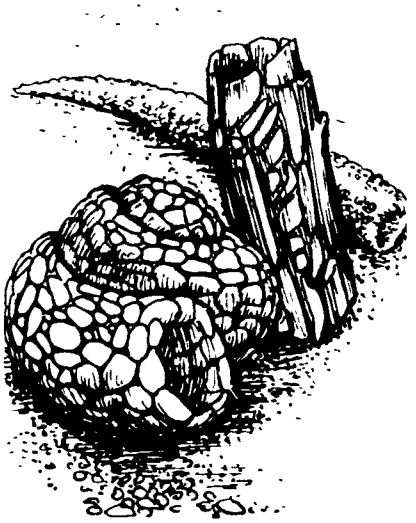
The fish in streams are not as easy to find as insects Trout, well-streamlined for swimming in the current, rest in quiet pools and behind rocks Darters and sculpins brace themselves among the rocks near the bottom

Many stream animals depend for their food on input from the surrounding **watershed.** Leaf litter and other organic debris drifting in the current are caught by insect larvae and worms, which are in turn eaten by fish and frogs

Slower Waters

As the stream continues to flow, it grows larger—augmented by other streams and by **runoff.** The moving water carries soil washed into the stream As the water current slows along the inside of a bend or in a pool, soil settles out of the water Soft **sediments** build, and rooted plants take hold

The slower water warms and holds less oxygen Trout and darters are replaced by fish more tolerant of warm water, such as bass and sunfish Snails climb on rocks, scraping algae for food Turtles bask on fallen logs A spotted sandpiper flies along the shore On the banks you can see crayfish chimneys and tracks of raccoons and otters that came to the river to feed on crayfish and frogs



Caddisfly larva cases

Stream to River

Still further downstream, the water channel becomes wide and follows broad meanders Now it is called a river The water here is often more **turbid** and its oxygen content is lower Bass live where the water is not too muddy, catfish and carp can survive muddier waters Herons and other wading birds stalk fish and frogs along the shore

Finally the river ends its long journey as it flows into an estuary and mixes with the sea

Uses, Problems, and Management

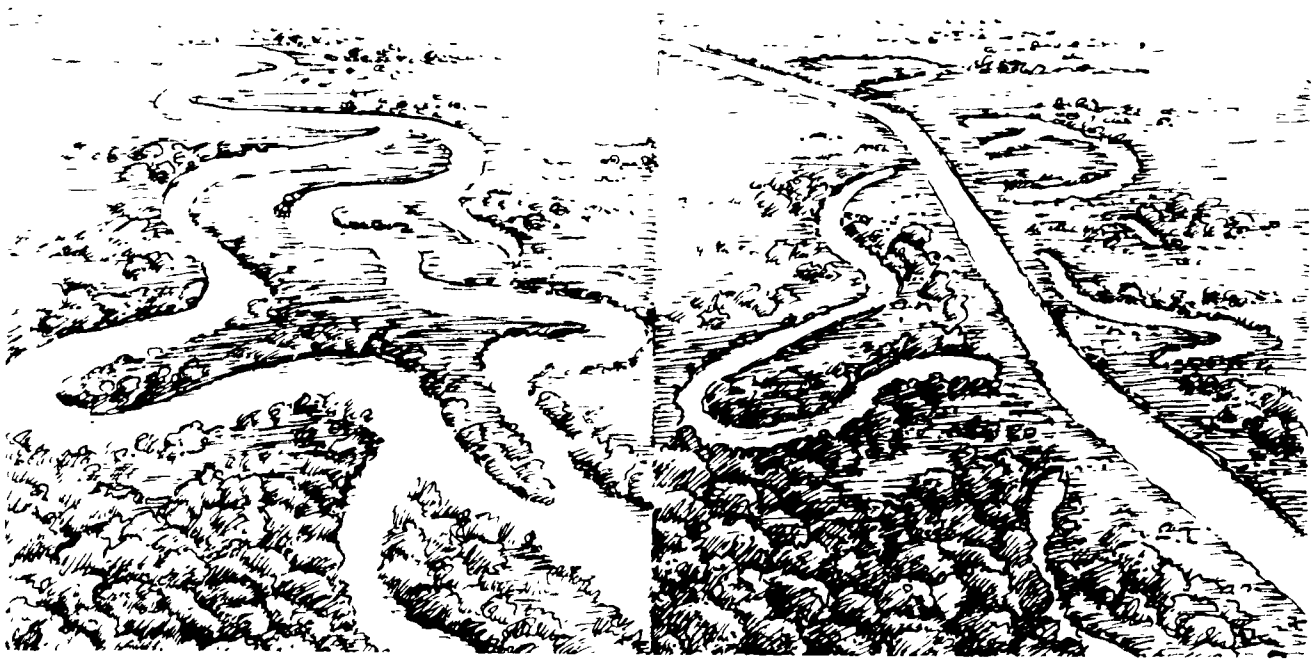
Rivers and streams supply many human needs recreation, transportation, waste disposal, water supply, food, and power generation Sometimes these uses conflict For example, too much waste makes river water unsuitable for drinking and ties up oxygen needed by fish

People change rivers in attempts to control them or to make them more suitable for particular uses Since uses conflict, however, tailoring a river to one purpose can destroy it for another

- **Channelization**

One of the most drastic ways in which people change rivers is by **channelization:** digging out the riverbed and clearing obstruc-

Crayfish chimneys and otter tracks



Before channelization

After channelization

tions straightening, and deepening it Rivers are channelized to improve flood control, make them better transportation routes, or facilitate draining of the adjacent wetland areas

The price paid for this "improvement" can be high Channels need very regular maintenance to keep them from filling in with silt and to counter the tendency of the river to return to its natural, meandering course With the vegetation removed and the natural cover destroyed, the river is degraded or ruined as a habitat for fish and wildlife This straightened course may increase flooding during times of heavy rains Much of the river's normal capacity for self-cleaning is lost Normally, organic wastes in the water are broken down as the water flows through the river and wetlands along the shore When the river is straightened and the wetlands are destroyed, this process is curtailed

- **Dams and Reservoirs**

Dams are constructed on rivers for flood control and to generate electrical power Gradual release of water stored in dam reservoirs assures a continuous water flow in dry seasons When this supply is insufficient, hot controversy arises over who has rights to the water While people make treaties and laws to ensure their drinking water and irrigation supplies, the ecology of the river is too often ignored Fish and other wildlife populations are destroyed when water levels below the dam are drawn too low Parts of the river dry up or become too hot under the summer sun, water animals die

Reservoir lakes provide recreation (boating and fishing), but destroy the fishing and canoeing of a free-flowing river Fish migrating in the rivers have trouble getting past dam sites, even when special **fish ladders** are provided in some areas Important salmon and sturgeon fisheries have been depleted, though some of this impact has been mitigated by fish-stocking programs Scenic habitats, such as the majestic Glen Canyon in Utah, have been inundated by large reservoirs Thus, any decision concerning how rivers will be utilized may have both positive and negative impacts on the river, its vegetation, wildlife, and ultimately its people

- **Pollution**

People have always used rivers as convenient places to dump their waste for the current to carry somewhere else The river's self-cleaning capacity has limits, and excessive waste dumping degrades the water quality

Even contaminants that are not dumped directly into the river find their way into its waters Gases released into the air by burning fossil fuels produce **acid rain. Mine tailings** acidify water that percolates through them Acid rain and mine runoff have lowered the **pH** of many streams so that very little can live in them

The people who use rivers and streams for recreation usually prefer that they be left in their natural state Canoeing, fishing, swimming, hiking, and birdwatching are some favorite pastimes River management techniques, such as fish stocking and planting or fencing to protect the banks, can enhance the river for these uses

The pressures of use on rivers and streams will continue to grow with increases in human population Careful planning and compromise measures are necessary if rivers and streams are to be preserved and utilized to satisfy many human as well as fish and wildlife needs

Glossary

acid rain—Natural precipitation that has become acidic because of sulfur dioxide and nitrogen oxides discharged into the air when fossil fuels are burned
channelization—Changing the shape and course of a streambed to permit more direct waterflow
dissolved oxygen—The oxygen dissolved in water Adequate dissolved oxygen is necessary for the life of aquatic organisms
fish ladder—A structure built next to a dam, allowing fish to pass by the dam
microhabitat—A small habitat within a larger one, e g , rapids and pools are microhabitats within the same river habitat, yet each one imposes different conditions on animals living there
mine tailings—Lower grade or waste material derived when raw materials from mines are screened or processed
nymph—The immature form of certain insects such as stoneflies and dragonflies
pH—A measure of acidity or alkalinity on a scale on which 0 is most acid, 7 is neutral, and 14 is most alkaline
riffle—Broken and turbulent waterflow, usually fast
runoff—Rainfall or snowmelt which flows across the ground surface rather than soaking in
sediment—Fine particles of matter which are carried in flowing water and settle out when the water is still
turbid—A cloudy condition in water due to the suspension of small particles
watershed—The area of land which drains into a particular body of water

Resources

General References

The Life of Rivers and Streams, R L Usinger. McGraw-Hill, New York, 1967 (Good pictures)

New Field Book of Freshwater Life, Elsie B Klots G P Putnam's Sons, New York, 1966 (Field Guide)

"Rivers Wild and Pure: A Priceless Legacy," Robert E Doyle. *National Geographic,* National Geographic Society, Washington, DC, July, 1977, pages 2-59

The Stream Conservation Book, J. Michael Migel. Crown Publishers, Inc , New York, 1974

"Unseen Life of a Mountain Stream," William H. Amos. *National Geographic,* National Geographic Society, Washington, DC, April, 1977, pp. 562-580

Wild River, Laurence Pringle J B Lippincott Co , Philadelphia, 1972 (Good pictures)

For Young Readers

Exploring a Brook: Life in the Running Water, Winifred and Cecil Lubell. Parents Magazine Press, New York, 1975

Field Book of Ponds and Streams, Anne H. Morgan G P Putnam's Sons, New York, 1930

Life in and Around Freshwater Wetlands, Michael J Ursin T Y Crowell, New York, 1975.

Pond Life, George K Reid Golden Press, New York, 1967 (Field Guide)

Rivers, C William Harrison. Julian Messner, New York, 1967

The Stream, Robert Murphy Farrar, Straus and Giroux, New York, 1971

This is a River, Laurence Pringle Macmillan Co , New York, 1972

Films and Filmstrips

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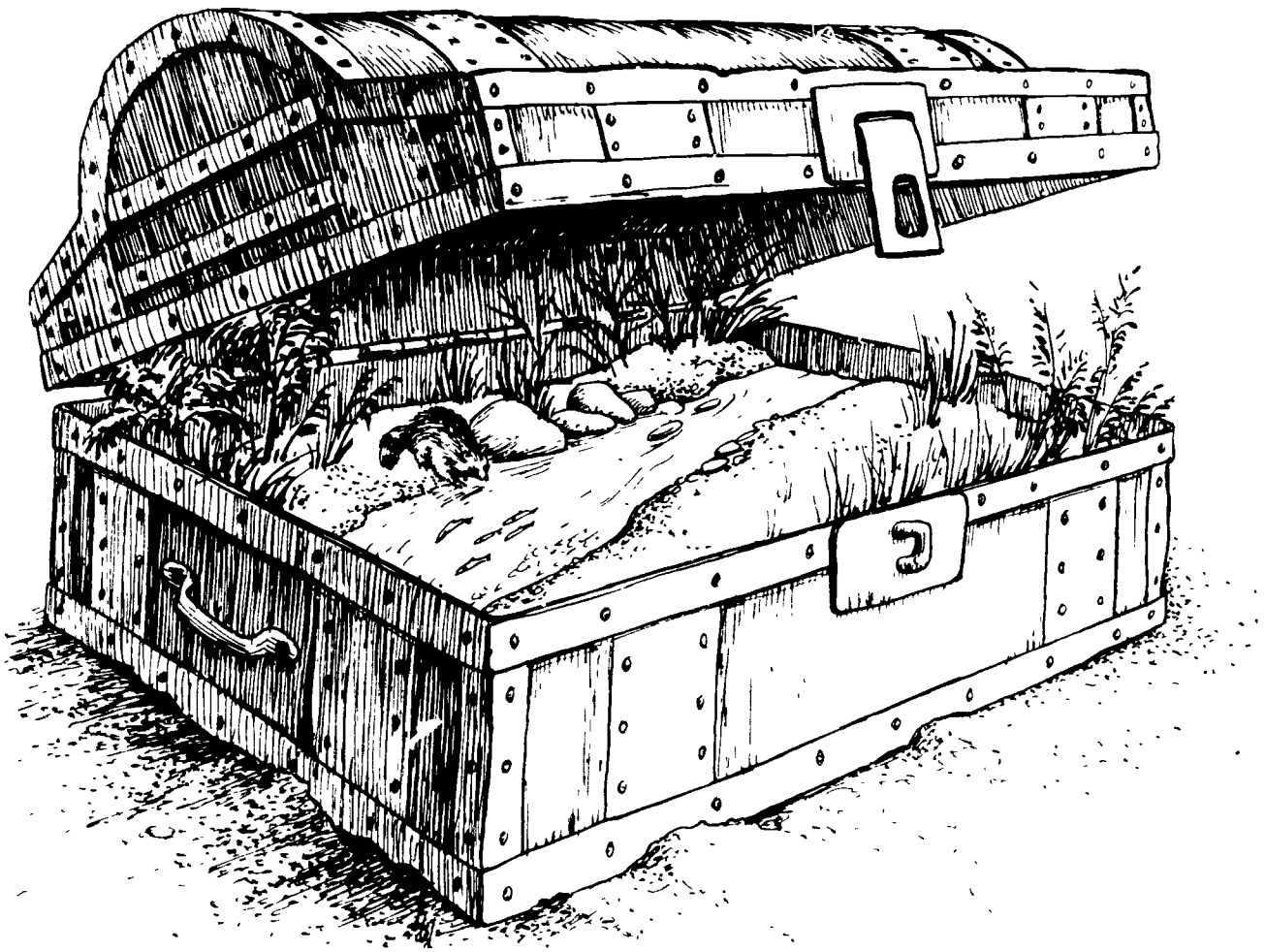
Stream, International Film Bureau, Chicago, 1963

Wild River, Encyclopedia Brittanica Education Corp , Chicago, 1967

Rivers and Streams

Lesson Plan 1

Stream Treasures



Purpose

This activity is a treasure hunt at a stream or river that will help students observe their natural surroundings. The treasures are objects which match the characteristics provided.

Learning Outcomes

After completing this activity, the students will be able to

A. Name objects possessing given characteristics, explain how the objects fit the criteria of the characteristics, and give examples of how river or stream organisms use or are affected by the objects

B. When presented with an object, use their senses to describe it

C. Choose from a list two values of a clean river or stream habitat

Organization

Who: Individuals or pairs
Where: Classroom, river site
When: Anytime
Time: 1 hour each, classroom and field trip site
Safety: The second part of this Activity takes place around open water

a. Bring one adult for every ten students

b. Students should not enter the water and must be careful of slippery rocks and look out for poison ivy

c. Organize students into buddy teams

Materials: For Each Student

- Data Sheet and pencil
- Clipboard (Masonite or stiff cardboard with a binder clip or paper clip)
- Old tennis shoes

Directions

1. In the classroom, write the following words (characteristics) on the chalkboard

beautiful	colorful
valuable	soft
useful	fragile
new (one week)	rough
old (one year)	moving
scarce	growing
smells good	changing
round	warm
sharp	strong
makes a sound	abundant

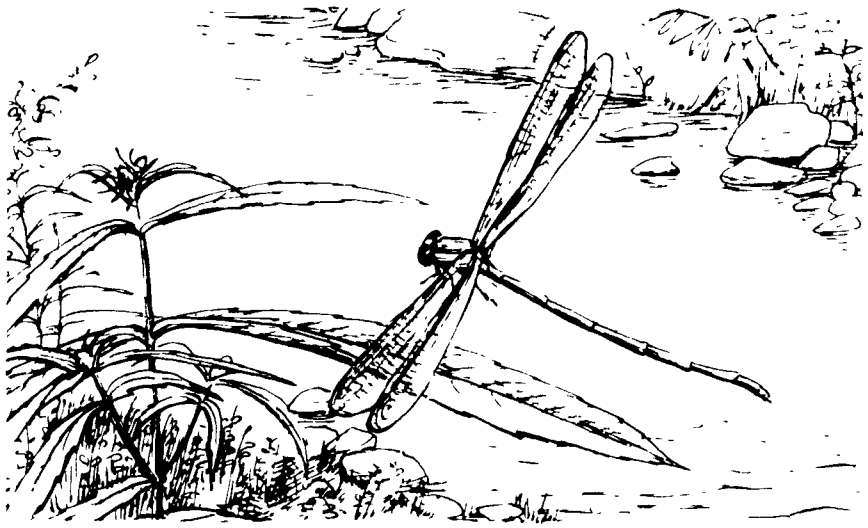
Also write the five senses (sight, hearing, taste, touch, smell) on the chalkboard

2. Point to characteristics list and ask the students which sense(s) they would use to tell if an object had this characteristic (roundness could be determined by sight or touch, etc) Ask students to find examples in the classroom, listing which sense(s) they used to find each object Ask them to locate an object that has one of the given characteristics, using only one or two senses

3. Ask students to find an object with two or more of the given characteristics, such as *new* and *fragile*, *sharp*, *scarce*, and *fragile*, *strong*, *useful*, and *abundant*, and so forth How many of the given characteristics can they find in one object Which senses must they use? This preliminary exercise prepares the students for the field trip and their own river or stream treasure hunt

4. At the river or stream tell the class they are going on a treasure hunt Divide the students into pairs and review water safety precautions

Provide each student with a Data Sheet and each team with a treasure hunt assignment (see table on next page) Introduce the treasure hunt For example, one team must find an object that is beautiful, another object that is soft and round, and one that is fragile, beautiful and scarce



Abundant and moving—damselfly

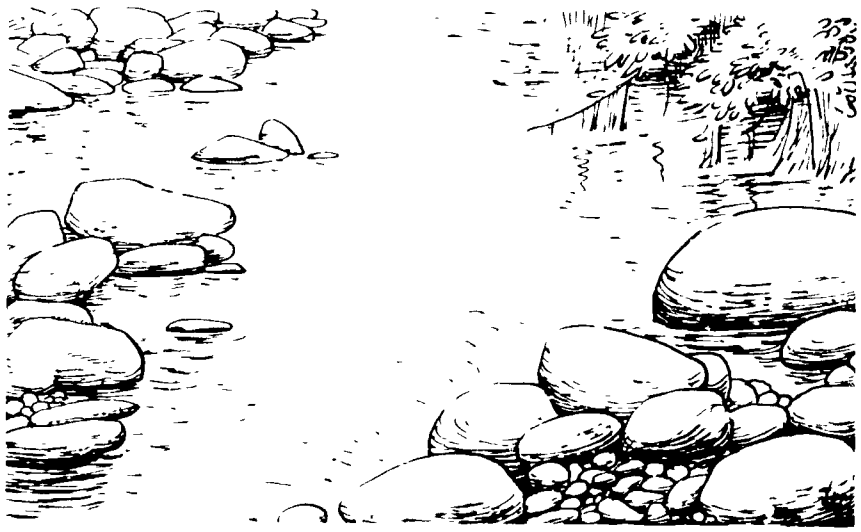
Changing—tadpole

5. Challenge the students to find objects with the indicated characteristics, and to tell why these fit the descriptions Let them tell how animals or plants use or are affected by the objects The students must complete their Data Sheets before the treasure hunt is finished, but they need not actually collect their finds

6. When each team has completed the treasure hunt, assemble the class and invite each team to share its finds Were any objects not found?

7. Encourage the students to discuss the relationship of their finds to people and to the river or stream habitat Discussion can focus on the questions below and those listed on page 1 of their Data Sheets

- Are any of their finds synthetic? If so, how did they get here?
- Are any of their finds "litter"? Will this litter break down? Could it have been recycled?
- Are their finds considered "valuable"? Why?
- What would happen to their finds if people changed the river or stream (e g , built a dam on it or polluted it)?
- Could the students find the same kinds of things elsewhere?



Old and round—stones

Characteristics for Treasure Hunt Assignments

Object	Characteristic	Object	Characteristic
Team A		Team G	
1	beautiful	1	useful
2	soft and round	2	new and sharp
3	fragile, beautiful, and scarce	3	strong, useful, and abundant
Team B		Team H	
1	scarce	1	round
2	abundant and moving	2	sharp and fragile
3	moving, making a sound, and scarce	3	colorful, round, and rough
Team C		Team I	
1	colorful	1	rough
2	useful and sharp	2	old and changing
3	new, colorful and valuable	3	abundant, rough, and useful
Team D		Team J	
1	valuable	1	new (one week)
2	fragile and new	2	old and round
3	moving, beautiful, and valuable	3	soft, smells good, and new
Team E		Team K	
1	smells good	1	sharp
2	rough and warm	2	changing and making a sound
3	old, beautiful, and abundant	3	beautiful, sharp, and new
Team F		Team L	
1	rough	1	changing
2	old and changing	2	warm and beautiful
3	abundant, rough, and useful	3	colorful, new, and changing

Quiz Answers

1. Rocks, wood Other answers may depend on specific sites visited For example, if the site was littered, the response might be "beer bottles "

2. Sample answers
Insects and fish hide under rocks, insects live in wood, etc

3. and **4.** Answers to these questions can be used to stimulate a discussion of the unique biological values of rivers and streams

5. a. Rivers can break down some wastes, but excessive waste dumping pollutes the water farther downstream

Rivers and Streams Lesson Plan 1 Quiz

Name:

1. Name a river or stream object that is old, strong, and abundant (plentiful)

_____

_____

2. How does an animal or plant living in a river or stream use the object named in Question 1?

_____

_____

3. Are any of the objects that were found by your class valuable to plants or animals? (Circle your answer.)

Yes **No**

If yes, which objects?

_____

_____

4. Do you think you could find these same objects in other areas? (Circle your answer.)

Yes **No**

5. Which of the following statements is *not* true of a clean, natural river or stream? (Circle your answer.)

a. People can use clean rivers to get rid of wastes because the river currents can carry the wastes away

b. Many fish and animals live in and near clean rivers

c. People can use clean river water for drinking

Name:

At the top of each section—A, B, and C--write the qualities your teacher will give you for your object. Then find objects that have these qualities.

Example: Find something that is sharp or something that is old and round.

For each object, draw a picture and answer these four questions in the space provided.

1. What sense(s) did you use to find the object?

2. Give one reason why your object fits the description?

3. How might a plant or animal use this object? (Eat it. Hide under it.) Or could the object affect a plant or animal? (Frighten it. Hurt it.)

4. Do people have any effect on this object?

A.

Quality

_____

Object

_____

Answers to Questions

1. _____

_____

Picture

2. _____

_____

3. _____

_____

4. _____

_____

Name:

B.

Qualities (2)

_____

_____

Object

_____

Picture

Answers to Questions

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

C.

Qualities (3)

_____

_____

_____

Object

_____

Picture

Answers to Questions

1. _____

_____

2. _____

_____

3. _____

_____

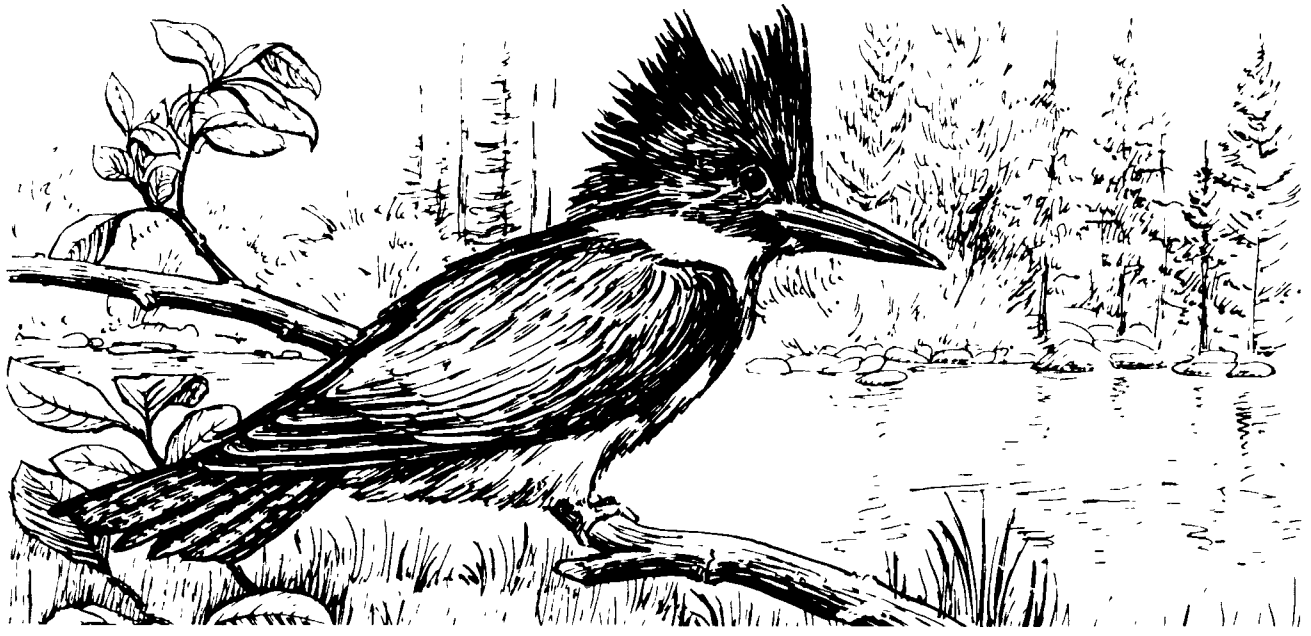
4. _____

_____

Rivers and Streams

Lesson Plan 2

Stream Animals



Kingfisher

Purpose

In this Activity students will survey the habitat of a river or stream and evaluate it from the point of view of a plant or animal They will learn about both the physical and biotic environments of the river or stream, and how plants and animals are adapted to live there

Learning Outcomes

After completing this activity, the students will be able to

A. Measure physical factors (temperature, pH, current speed) of a river or stream

B. Identify various structural and behavioral adaptations of river and stream organisms and the biological needs (food, protection) met by those adaptations

C. Demonstrate concern for wildlife of river and stream habitats in responding to an attitude scale.

Organization

Who: Part One—Individuals
Part Two—Groups of 3 to 5

Where: Part One—Library or classroom
Part Two—River (field trip)

When: Field Trip—spring, summer, or early fall (preferably on a warm day when there has not been recent, heavy rain)

Time: Part One—1 to 2 hours
Part Two—2 to 3 hours

Safety: Part Two takes place in and around open water

a. Bring one adult for every ten students

b. They should only enter the water for the sampling activities, and no further than knee-deep Old shoes should be worn in the water

c. Organize students into buddy teams

Materials: For the Class

- Field guide (see Resources)
- Insect repellent (if necessary)
- pH test kit (indicator solution and chart—buy from science supply houses or pet shops)

Materials: For Each Group

- 1 clear jar—approximately 12 cm (5 in) in diameter
- Thermometer
- 1 stick
- String 10 meters (33 ft) long or one measuring tape
- 1 watch with a second hand
- 1 light-bottomed, shallow container (white enamel or plastic pan, or milk carton split lengthwise)
- 1 seining net (see diagram)
- 1 hand lens

Materials: For Each Student

- Data Sheets and pencils
- Clipboard (Masonite or stiff cardboard with a paper clip or binder clip)
- Old tennis shoes or boots and jeans (for getting wet)

Directions

Part One (Background Research)

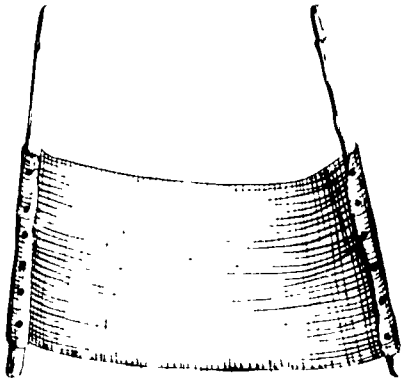
1. Each student will research the habitat requirements of one animal that lives in or frequently visits rivers or streams. After giving the students their "What Do I Need To Live?" Data Sheets (page 1), assign each student one animal to research (see suggested list below). You might first consult a local expert or guide book to find species most common in your area.

Suggested river animals (assign one per student)

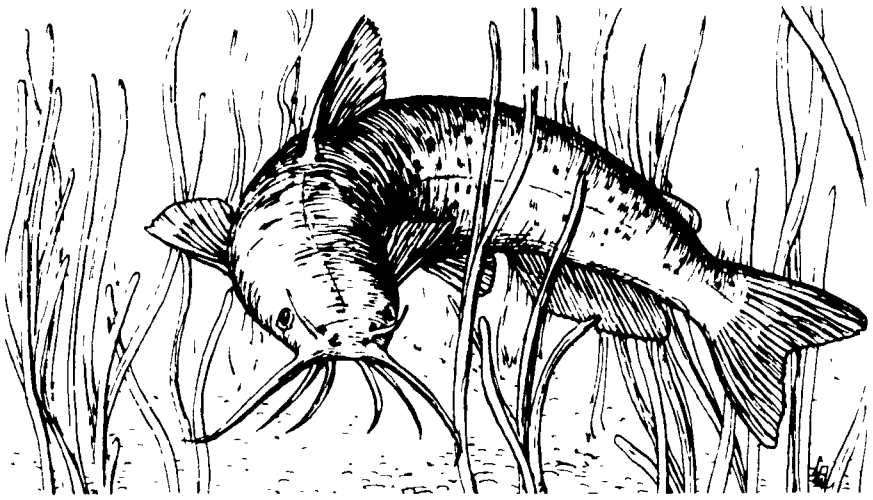
trout	raccoon
catfish	snail
darter	bass
frog	kingfisher
turtle	leech
muskrat	crayfish
beaver	carp
otter	mink

mayfly (nymph)*
black fly (larva)*
stonefly (nymph)*
caddisfly (larva)*
water penny (larva)*
water strider
tubifex (sludge) worm
sponge (freshwater)
clam, mussel (freshwater)

*Nymphs and larvae are most abundant during the spring of the year.



Simple seining net made from window screening



Catfish

2. Students should research their animals independently, using the questions on page 1 of the Data Sheet as a guide. They can do this at the library or with books you bring into the classroom. If they are stuck, you might help them locate information in more advanced books.

Part Two (Habitat Evaluation at the River or Stream)

1. At the field trip site, review all safety precautions.

2. Now the students will evaluate a river or stream as habitat for their animals.

3. Group the students and distribute the materials.

4. They will evaluate seven aspects of this habitat, as listed on the Data Sheet, page 2. The first two factors, oxygen and pH, are evaluated by the whole class, and the data recorded at each step. The other five factors are measured by each small group.

Methods Are As Follows

- **Oxygen**—visual evaluation of stream

a. Cool, clear water, especially if flow is turbulent—high oxygen content

b. Warmer water, slightly turbid, slow flow—medium oxygen content

c. Warm water, stagnant, turbid—low oxygen content

Ask students to evaluate these alternatives. Is the oxygen level the same in all parts of the stream? (A pool or eddy will have less oxygen than a riffle area.)

- **Acidity (pH)**—Follow directions for the test kit. Mix indicator solution with stream water sample and compare the color with the chart.
- **Temperature**—Place the thermometer a few centimeters below the water surface, wait two minutes, and record the temperature. Repeat in different parts of the stream.
- **Current speed**—Have each team measure a 10-meter (33-ft) section of the stream, marking the ends with rocks or sticks. Students then measure the length of time it takes the current to carry a stick between these points. One student drops the stick into the stream by the first rock and calls "Start." A second student calls "Stop" when the stick passes the second rock. A third student watches the time. What happens if the stick floats into a pool or eddy? (It stops or slows. Prompt the students to think about differences in the current.)

To calculate surface current speed.

10 m ÷ x seconds (student measurement) = current speed in m/sec

- **Odor**—Students should fill their jars with water and record how it smells. Clean, fresh water is odorless.

Students seining

- **Clarity**—Students should compare the water in their sample jars with the gray shaded areas on their Data Sheets Which shade does the water most closely resemble?
- **Plants and Animals**—Students should record all plants, animals, and animal signs they can find Look on the banks, pick up and inspect rocks (be sure to put them back) In a shallow area, two students should stretch the seining net across the current while one or two others walk toward the net from upstream, flipping rocks and driving animals toward the net The netted animals should be placed for inspection in the shallow container with some stream water Keep the container in a cool place Students should record their findings, looking particularly for their own animal (or its signs), its food, and its predators After the data have been recorded, return animals to the stream

When all the groups have collected the data, the students should evaluate the stream as a habitat for their own animal by comparing the stream data with the animal's requirements Did they find their animal (or its signs)? If not, why not? If they did find it, but their data show the stream is less than a "perfect" habitat, might the animal be more abundant in better conditions?

Followup

People can change the habitat of a stream or river Let the students consider how the following situations would affect their animals

1. A factory begins dumping waste in the river It is not poisonous waste, but its decay uses up a lot of oxygen in the water (Plants and animals that need this oxygen will become less numerous or disappear)

2. Water that has seeped through mining waste, turning it acid (Most organisms die if the pH stays below 5 5)

3. The river is dug out, cleared of rocks and logs, and straightened to carry flood water (Dirt from digging clogs fish gills, plants are destroyed, cover is destroyed)

List the values to people of fish and wildlife found in rivers or streams (economic, esthetic, recreation) What can citizens do to encourage populations of fish and wildlife in rivers and streams?

Quiz Answers

1. Dark color (c) would not help the animal survive Hooks on feet (a) and flattened shape (d) are structural adaptations, hiding behind rocks (b) is a behavioral adaptation Adaptations (a), (b), and (d) would all help animals survive in fast currents

2. There are several possible answers to this question such as those given below From the examples given in the lesson followup, students will most likely come up with two of the first three

a. Lower the oxygen content (by dumping wastes)

b. Turn water acid (acid rain or mine drainage)

c. Dig up the streambed (causes more dirt in the water, removes food plants and cover)

d. Poison the water (by dumping wastes)

e. Lower water level

f. Raise water level and stop current (building dams to make reservoir lakes)

3. False. Downstream the river will become polluted

4. Answers depend on each student's animal, but every answer should mention some structural and/or behavioral adaptations of the creature

5. See Number 6—there is no correct answer

6. This question asks for an opinion (vote) and therefore has no correct answer Students' votes can be used to generate a class discussion

Name:

1. Which of these adaptations would *not* help an animal live in fast river currents?
(Circle the correct answer)

a. Hooks on feet

b. Hiding behind rocks

c. Dark color

d. Flattened shape

2. Name two kinds of changes humans can cause in the river habitat that will affect the animals that live there

a. _____

b. _____

3. Is this statement true or false? (Circle your answer)

"It's all right to dump a lot of waste in a river because the current will carry it away

True **False**

4. How was your animal adapted to living or near the river?
List two ways

a. _____

b. _____

5. Many animals will die if the river or stream becomes very acid
How do you feel about this? (Circle one)

a. Very unconcerned

b. Unconcerned

c. Undecided

d. Concerned

e. Very concerned

6. A manufacturing company wants to build a factory by a river in your town The factory would dump wastes into the river The town council will vote on whether to allow the company to build the factory How would you vote on this issue? (Put an X in the box)

☐ 1. Let the company build the factory

☐ 2. Let the company build the factory if they will also build a community swimming pool since the river water will become too dirty for swimming

☐ 3. Let the company build the factory if they will build a water-cleaning plant to clean the water before they dump it into the river

☐ 4. Do not let the company build the factory

What Do I Need To Live?

Name of your animal

_____

Picture (draw or paste a copy)

Name:

What do I eat?

_____

_____

How do I get my food?

_____

_____

What eats me?

_____

_____

Where do I live? (In the mud? Under rocks?)

_____

_____

How do I cope with the stream current? (Can I live in fast-flowing water?)

_____

What water temperature do I need?

- ☐ cold
- ☐ cool
- ☐ warm

How much air (oxygen) do I need in the water?

- ☐ a lot
- ☐ medium
- ☐ little

What acid level (pH) can I tolerate?

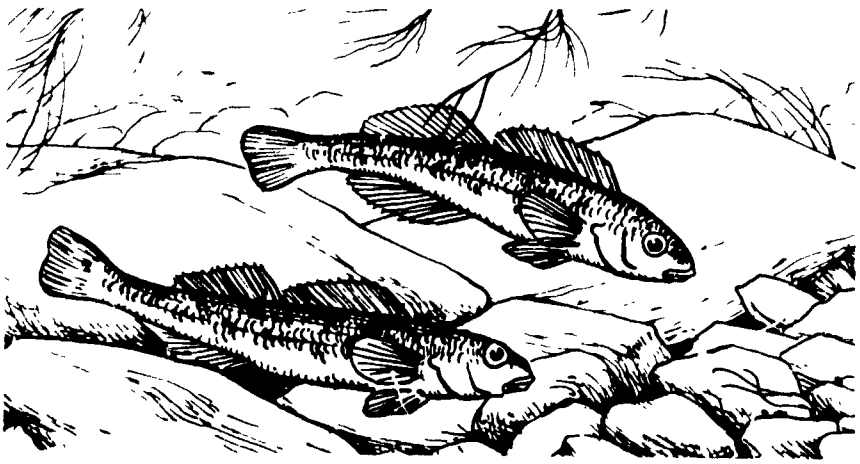
_____

Can I live in muddy water?

_____

Can I live in polluted water?

_____



Darters

Freshwater sponge

Name:

River or Stream Evaluation

Oxygen Level	Acidity (pH)	Temperature	Current Speed	Odor	Clarity

Plants, Animals, and Animal Signs (Draw, describe, or name—note in which part of the stream you found them)

Can you find things your animal eats?

Yes ☐ **No** ☐

If so, what are they?

_____

Can you find your animal or signs of your animal?

Yes ☐ **No** ☐

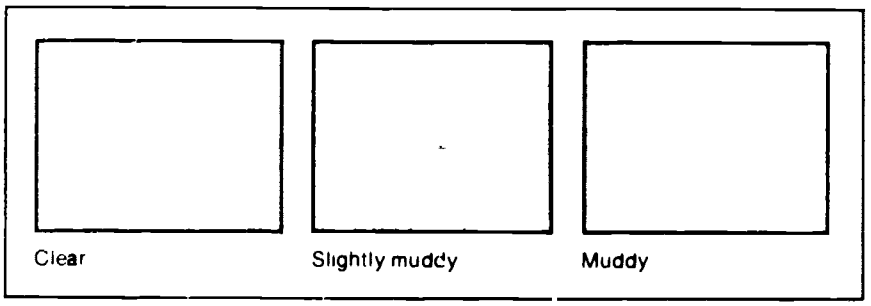
Why?

_____

Why not?

_____

Mayfly nymph



Water Clarity Chart

Rivers and Streams

Lesson Plan 3

Water Resources Game

Purpose

In this activity students will assemble and play a board game that teaches them about the management problems of rivers and streams with regard to water use

Learning Outcomes

After completing this activity, the students will be able to

A. List competing uses for limited water resources, such as farms, wildlife, and homes

B. State ways in which given water-using activities can be altered to conserve water

C. Indicate a belief that compromise and careful planning are necessary in managing and allocating water resources

Organization

Who: Groups of 4 students
Where: Classroom
When: Anytime
Time: 2 to 3 hours

Materials: For the Class

Duplicate enough sheets of game items to supply the class—to be cut out and colored Half of the board fits on an 8 1/2 x 11 inch page

Materials: For Each Group

- 1 game board (2 halves)
- 1 set of chance cards
- 1 set of "big dipper" markers
- 1 copy of the Water Resources Game Rules
- "Waterpennies" —use three colors of chips (or dried lima, red, and black beans, or three sizes of paper clips) to signify denominations of 1, 5, and 10 waterpennies
- 2 dice
- 4 markers (small objects to move around board)
- Scissors
- Crayons or markers (for coloring game)
- Clear tape (for joining game board)

Directions

1. Tell the students they are going to play a board game incorporating information printed on the board game poster They will use "waterpennies" to buy the businesses and the "big dippers" of water needed to run them Distribute game materials to the groups Students should cut the chance cards, deeds, and big dippers, then color the game board and join with tape

2. Explain and study the rules and let the game begin Although the game can be played entirely following these rules, for some classroom purposes you can add an extra surprise—a drought Prepare the students for this possibility by discussing potential water shortages before they begin the game

3. When the students have begun to acquire water and property, and the Reservoir has been lowered (try to wait until water is down to 75 big dippers or below), interrupt the game to announce the **Drought.** That is the signal when the Reservoir must **release 75 big dippers** of water into the "extra" pile This ensures that downstream towns will have enough drinking water and that there will be enough water in the river for plants and animals to survive If there is not enough water in the Reservoir, *players must bargain among themselves* until there are 75 big dippers to release (Players may bargain against the **possibility** of regaining lost water from future rains)

4. This will probably bring the game to a standstill since most students will not want to give up their water Ask around if any of the groups are solving the problem Stress that droughts occur in real life and these problems must be faced How do the students think the problems are solved in real life (e g , by allocation programs)? Impose allocations (players must return half of their water, including the business reserves, to the Reservoir) on any groups that are unable to reach their own settlements (This will probably be most of them) Now remove the 75 big dippers from the Reservoir and place them in the "extra" pile

5. Allow the game to continue for two to three rounds Then announce **Heavy Rains.** This is the signal when you **add 75 big dippers** to the Reservoir from the "extra" pile (Distribute according to the students' agreements above, or water can be bought back at Water Supply squares)

6. When the game is over (see rules), encourage the students to discuss water resources and uses What have they learned from the game? Did they have trouble obtaining water? What kinds of problems did a water shortage present? How well did the group cooperate in distributing water? Were they

angry? At Whom? Did they feel the distribution was fair?

7. Students might play the game a second time the following day as a competition between groups to see who can establish the **best town.** The class can vote on its own criteria for "best town" based on the first playing experience Encourage further discussion at the end of this game Was water distributed more fairly? Did any parts of the game make them angry? At whom? How did the second playing compare with the first?

Followup

Students can research the ways in which business properties such as the ones on the game board use water

Water Resources Game Rules

1. Each player takes at least one of these four jobs

- **Banker**—pays out and collects all money
- **Bill Collector**—reminds players to pay their water bills when they pass the Water Bill Due square
- **Deed Manager**—holds all deeds and passes them out to people who buy property
- **Reservoir Manager**—monitors the number of big dippers in the Reservoir Removes or adds big dippers when required by chance cards or board squares Notifies owners of the Canoe Rental, Fish Farm, and Power Plant if the Reservoir level drops below the 50 big dippers needed to run these businesses

2. Each player starts with 100 waterpennies and 15 big dippers Extra waterpennies are kept in the Bank Put 180 big dippers into the Reservoir Put the other big dippers into an "extra" pile

3. Roll a die Highest number starts Movement is in a counter-clockwise direction

4. Players should follow directions on the squares where they land

5. Property (Water Uses)

- **Buying:** Players landing on a property square may buy it if it is not already owned The buyer must have both the purchase price and enough water to fill the business reserve (all the businesses require water for their operation)

Players may later draw water from this reserve but cannot collect rent on the property while the reserves are not full

Players may not buy new property unless the water reserves on the properties they already own are full They must have enough extra water to fill the reserve on the new property they wish to buy

- **Collecting Rent:** Players landing on property owned by another player must pay the rent indicated on the deed (as long as the property's water reserve is full) Property owners must put the specified amount of water (used in operating the property) back into the Reservoir
- **Selling:** Property can be sold back to the Bank at half price if no other players want to buy it

6. Water Supply

- **Buying:** Players may buy water from the Reservoir (if it contains some) only when landing on a Water Supply square. They can buy up to the number of big dippers indicated, the price is one waterpenny per big dipper

Players may bargain to buy water from each other at any time.

- **Selling:** Players may sell water back to the Reservoir at half price if no other player wants to buy it.

7. Paying Penalties and Rents

- **Big dippers:** Players who must pay big dippers can pay from their available dippers or draw from their business reserves If they have no big dippers and cannot obtain any, they must pay a fine of 10 waterpennies to the Bank *and* lose a turn
- **Waterpennies:** Players who must pay waterpennies and have none available must sell water or businesses to raise the money

8. Winning—the game can end in one of two ways

- When all players but one are out of money, water, and property
- At a previously set time limit (e g , one hour)

Players then add up the value of their money, water (one big dipper is worth one waterpenny), and property The highest total wins

1. Everyone agrees not to water lawns.
Add 20 big dippers to the Reservoir from the "extra" pile

2. River flow below your dam was too low—fish died.
Pay Bank 5 waterpennies to restock

3. A chemical has polluted the river. The water cannot be used for drinking or cooking, or by hospitals.
Miss two turns

4. During a long dry spell, your town is declared a disaster area.
You may buy 10 big dippers from any other player for 5 waterpennies

5. The town upstream is using less water so your town can have enough.
Add 10 big dippers to the Reservoir from the "extra" pile

6. The golf course and park lawns have to be watered all summer.
Pay each player one waterpenny

7. High water floods your town in spring. Properties are ruined.
Return one deed to the Bank

8. There's a huge fire at the grain elevators needing lots of water from fire hydrants.
Pay two waterpennies into the Bank

9. An upstream town uses too much water.
Reservoir level drops by 40 big dippers Put into "extra" pile If Reservoir is below 40, each player puts in 10 big dippers

10. You wash your car by carrying water in pails instead of driving to the carwash.
Collect three big dippers from each player

11. Your town signs a water agreement with an upstream town.
Advance to next Water Supply

12. You dig a deeper well and get a good supply of water for your home and farm.
Advance to next Water Supply

13. Your class helps clean up the river after the recent flood.
Advance one, two, or three spaces, or go to the next Water Supply

14. The new dam is completed.
Each player collects 5 big dippers from the "extra" pile and pays Bank 10 waterpennies for farm land flooded by new Reservoir

15. Good rainfall.
Add 20 big dippers to Reservoir (From the "extra" pile)

16. The river pollution has now been cleaned up, but it was a very expensive operation.
Each player pays you one waterpenny

17. Irrigation helps all the orchards.
Advance to Cider Hill Orchard

18. You plan to open a boating concession on the Reservoir lake.
Advance to Canoe Rental to see how it is run
You can buy the property or must pay rent if it is owned

19. Rains have left the marsh full of water. Many people come to hunt, fish, and boat.
Advance to Wildlife Refuge

20. You are starting a new business in town.
You may buy any property left over

21. You have bought a special shower head that reduces the water flow when you take a shower. You save quite a lot of water each day.
Collect two big dippers from each player

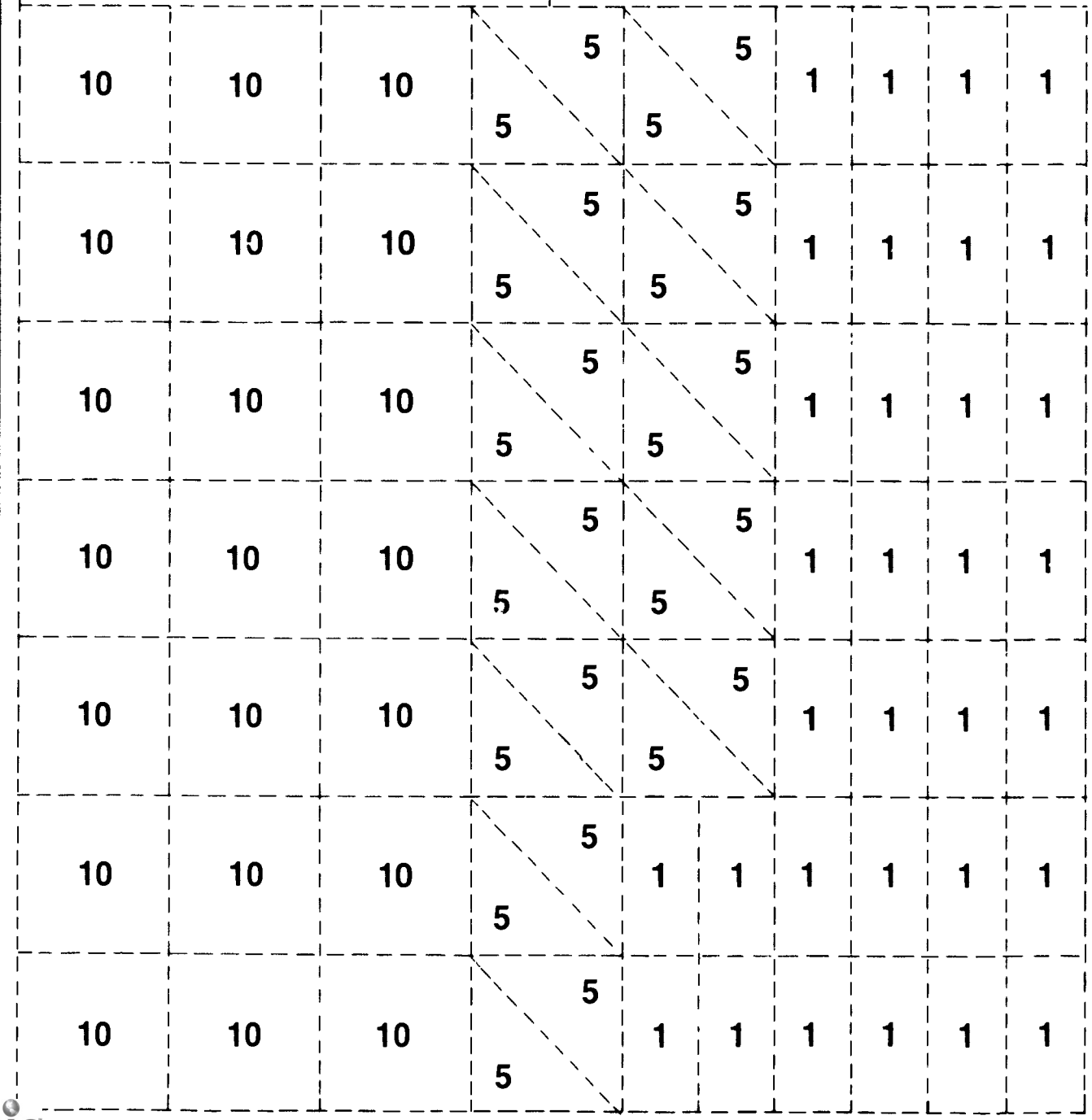
22. You turn off the faucet while you brush your teeth.
Take an extra turn

23. You have fixed the washer in your faucet so that it doesn't drip.
Collect one big dipper from each player

24. You have adjusted the float in your toilet so that it uses less water.
Collect two big dippers from each player

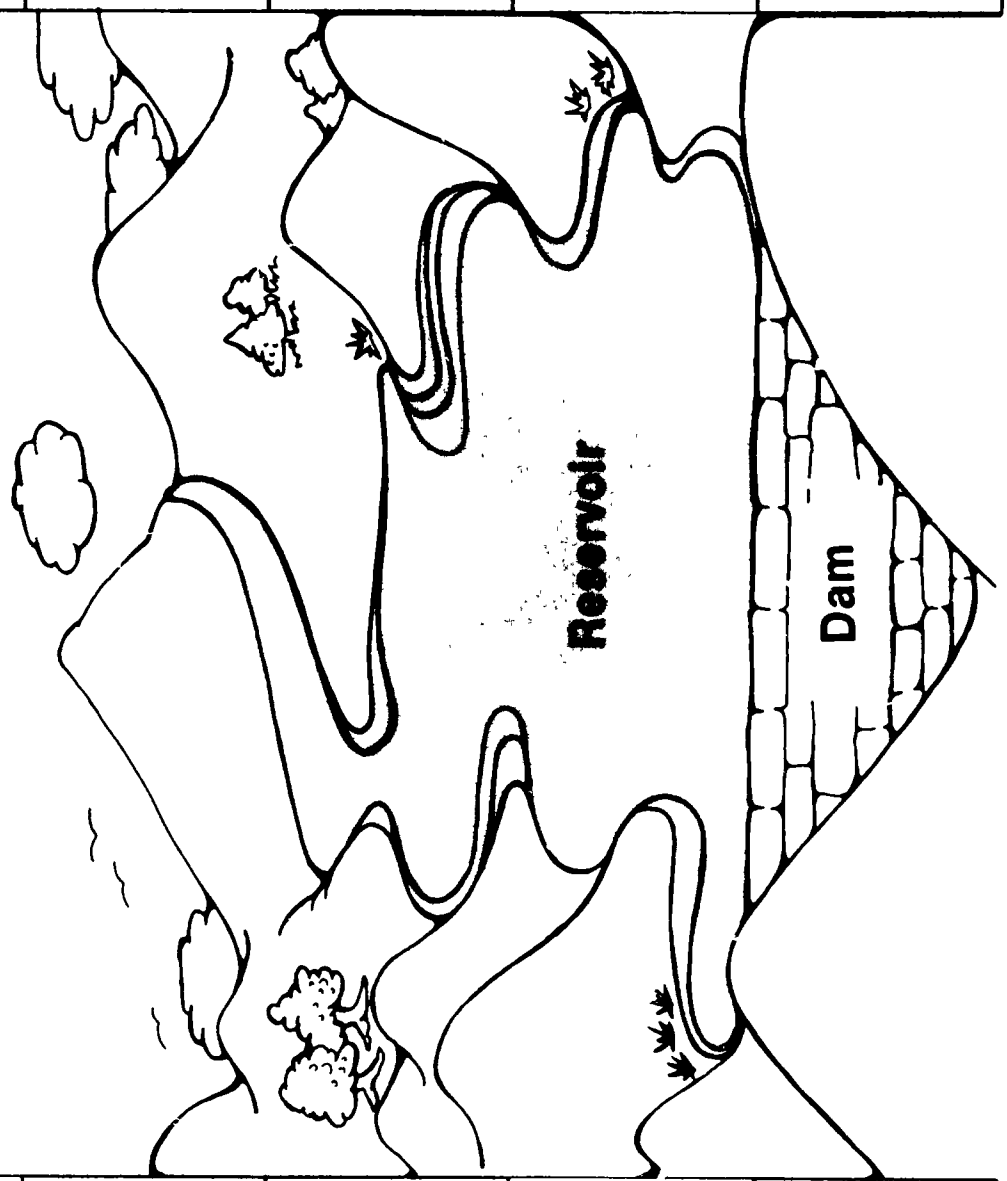
25. You wash only full loads of clothes so not to waste water.
Keep this card and miss paying the next Water Bill

26. You have painted a SAVE WATER poster and won the Junior Chamber of Commerce Water Poster Contest.
You win 5 waterpennies from the Bank



Poplar Paper Products **Price:** 15 waterpennies **Reserve:** 20 big dippers **Rent:** Each time another player lands on this property **User** pays 8 waterpennies to owner, **Owner** puts 3 big dippers into Reservoir.	**Has-Been Food Cannery** **Price:** 20 waterpennies **Reserve:** 15 big dippers **Rent:** Each time another player lands on this property **User** pays 10 waterpennies to owner, **Owner** puts 4 big dippers into Reservoir	**Rolling Stone Gravel Pit** **Price:** 20 waterpennies **Reserve:** 10 big dippers **Rent:** Each time another player lands on this property **User** pays 10 waterpennies to owner. **Owner** puts 3 big dippers into Reservoir.	**Dazzling Shine Car Wash** **Price:** 20 waterpennies **Reserve:** 15 big dippers **Rent:** Each time another player lands on this property **User** pays 10 waterpennies to owner, **Owner** puts 2 big dippers into Reservoir.
Keep Your Reserve Here. **20 big dippers** **If reserve falls below 20, you cannot collect rent.**	**Keep Your Reserve Here.** **15 big dippers** **If reserve falls below 15, you cannot collect rent.**	**Keep Your Reserve Here.** **10 big dippers** **If reserve is below 10, you cannot collect rent.**	**Keep Your Reserve Here.** **15 big dippers** **If reserve falls below 15, you cannot collect rent.**
Tippy's Canoe Rental **Price:** 10 waterpennies No reserve needed **Rent:** Each time another player lands on this property **User** pays 2 waterpennies to owner, **Owner** cannot collect any rent on this property if the Reservoir has less than 50 big dippers—lake is too low for canoeing	**Shiny Penny Copper Mine** **Price:** 30 waterpennies **Reserve:** 30 big dippers **Rent:** Each time another player lands on this property **User** pays 15 waterpennies to owner, **Owner** puts 3 big dippers into Reservoir	**Bar-B-Q Cattle Ranch** **Price:** 25 waterpennies **Reserve:** 25 big dippers **Rent:** Each time another player lands on this property **User** pays 12 waterpennies to owner, **Owner** puts 4 big dippers into Reservoir	**Paddy's Rice Farm** **Price:** 10 waterpennies **Reserve:** 15 big dippers **Rent:** Each time another player lands on this property **User** pays 5 waterpennies to owner, **Owner** puts 1 big dipper into Reservoir
	Keep Your Reserve Here. **30 big dippers** **If reserve falls below 30, you cannot collect rent.**	**Keep Your Reserve Here.** **25 big dippers** **If reserve falls below 25, you cannot collect rent.**	**Keep Your Reserve Here.** **15 big dippers** **If reserve falls below 15, you cannot collect rent.**

Water Resources Game



START
Collect 10 waterpennies each time you pass

Water Supply
Buy up to 25 big dippers from Reservoir.

Wildlife Refuge
Enjoy your visit!
Next turn throw dice or move 1.

Linly Towel Laundry
Price: 10 waterpennies
Reserve: 10 big dippers

Bar-B-Q Cattle Ranch
Price: 25 waterpennies
Reserve: 25 big dippers

Chance

Chance

Water Supply
Buy up to 15 big dippers from Reservoir.

Tippy's Canoe Rental
Price:10 waterpennies
Reserve: None

Chance

Rolling Stone Gravel Pit
Price: 20 waterpennies
Reserve: 10 big dippers

Warm Springs Fish Farm
Price: 10 waterpennies
Reserve: 5 big dippers

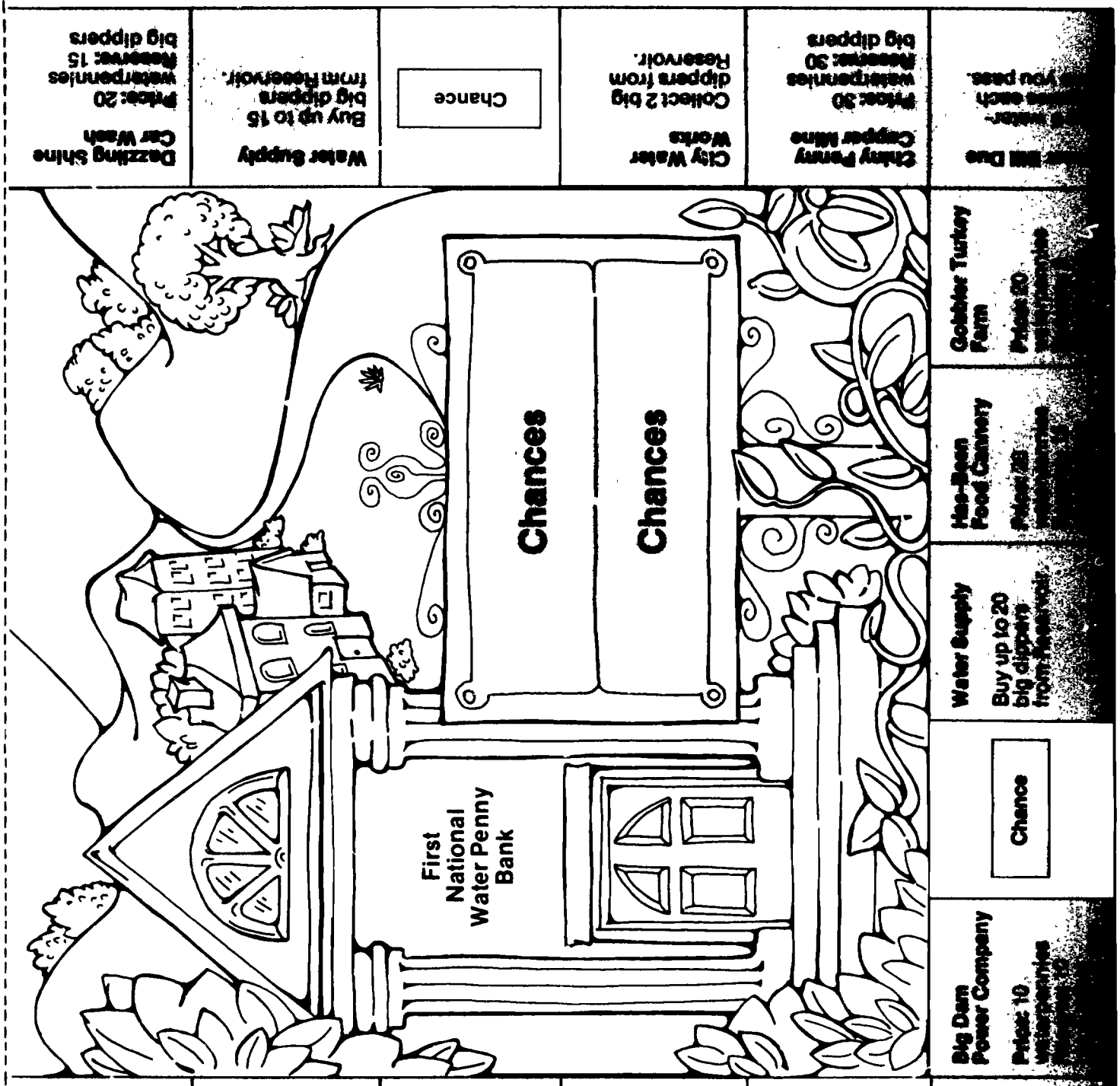
Chance

Cedar Hill Orchard
Price: 15 waterpennies
Reserve: 25 big dippers

Water Supply
Buy up to 15 big dippers from Reservoir.

Rubber Duck Swimming Pool
Price: 15 waterpennies
Reserve: 15 big dippers

Good Rain
Collect 5 big dippers from "extra" pile.



Fish Ladder Advance 7 spaces around the **Big Dam.**	**Poplar Paper Products** **Price:** 15 waterpennies **Reserve:** 20 big dippers	**Water Supply** Buy up to 10 big dippers from Reservoir.	**Paddy's Rice Farm** **Price:** 10 waterpennies **Reserve:** 15 big dippers	Chance	**Drought** Miss one turn.

Warm Spring Fish Farm

Price: 10 waterpennies
Reserve: 5 big dippers
Rent: Each time another player lands on this property

User pays 5 waterpennies to owner,
Owner puts 2 big dippers into Reservoir

Keep Your Reserve Here.
5 big dippers
If Reservoir level is below 50 big dippers, you must increase your reserve to 30 or not collect rent until Reservoir refills.

Linty Towel Laundry

Price: 10 waterpennies
Reserve: 10 big dippers
Rent: Each time another player lands on this property

User pays 5 waterpennies to owner,
Owner puts 2 big dippers into Reservoir

Keep Your Reserve Here.
10 big dippers
If reserve falls below 10, you cannot collect rent.

Cider Hill Orchard

Price: 15 waterpennies
Reserve: 25 big dippers
Rent: Each time another player lands on this property

User pays 10 waterpennies to owner,
Owner puts 3 big dippers into Reservoir

Keep Your Reserve Here.
25 big dippers
If reserve falls below 30, you cannot collect rent.

Gobbler Turkey Farm

Price: 20 waterpennies
Reserve: 8 big dippers
Rent: Each time another player lands on this property

User pays 10 waterpennies to owner,
Owner puts 3 big dippers into Reservoir

Keep Your Reserve Here.
8 big dippers
If reserve falls below 8, you cannot collect rent.

Big Dam Power Company

Price: 10 waterpennies
Reserve: 10 big dippers
Rent: Each time another player lands on this property

User pays 8 waterpennies to owner,
Owner puts 1 big dipper into Reservoir

Keep Your Reserve Here.
10 big dippers
If Reservoir level falls below 50 big dippers, you must increase your reserve to 30 big dippers or not collect rent until Reservoir refills.

Rubber Duck Community Swimming Pool

Price: 15 waterpennies
Reserve: 15 big dippers
Rent: Each time another player lands on this property

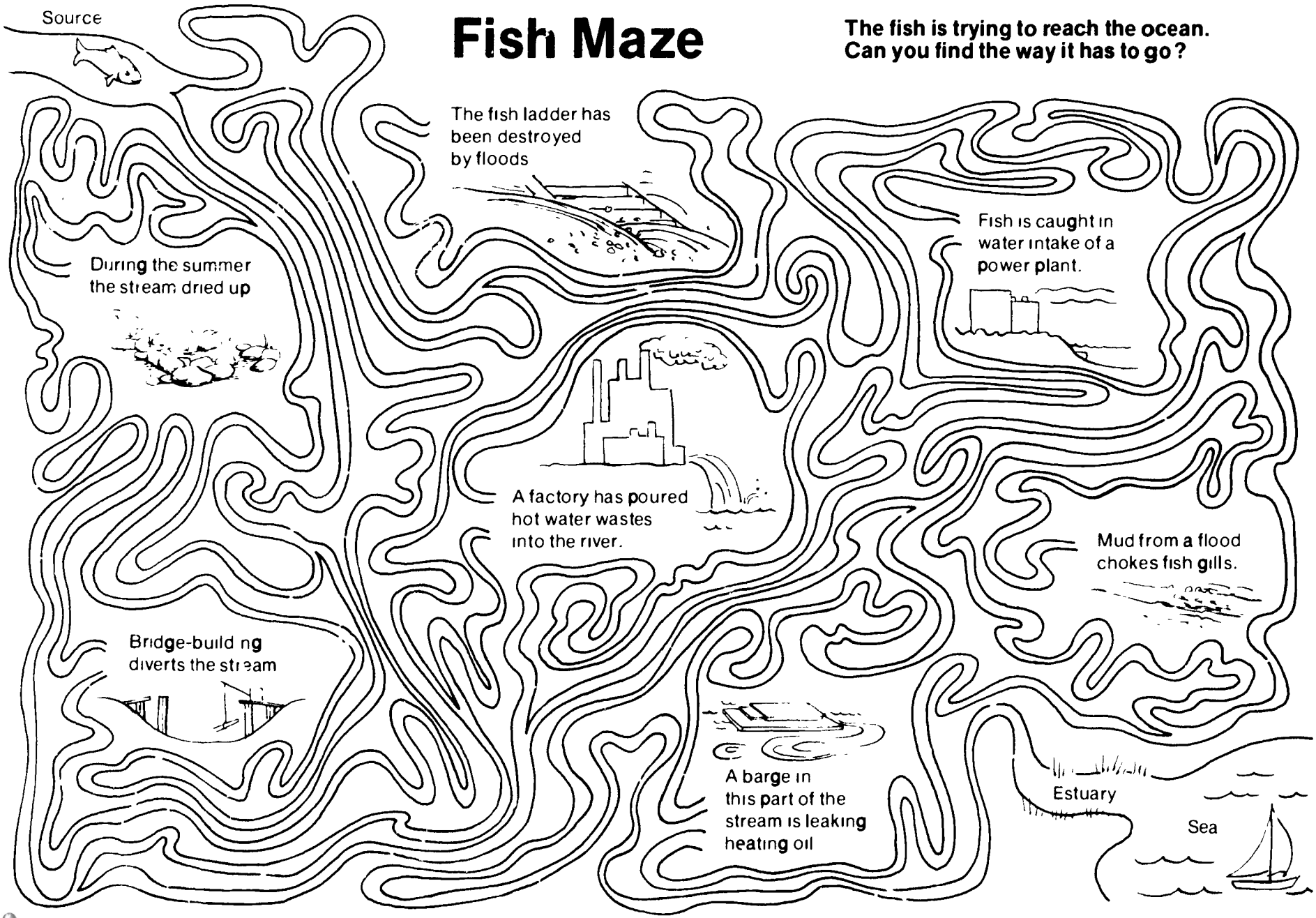
User pays 8 waterpennies to owner,
Owner puts 2 big dippers into Reservoir

Keep Your Reserve Here
15 big dippers
If reserve falls below 15, you cannot collect rent

Name:

Fish Maze

The fish is trying to reach the ocean. Can you find the way it has to go?



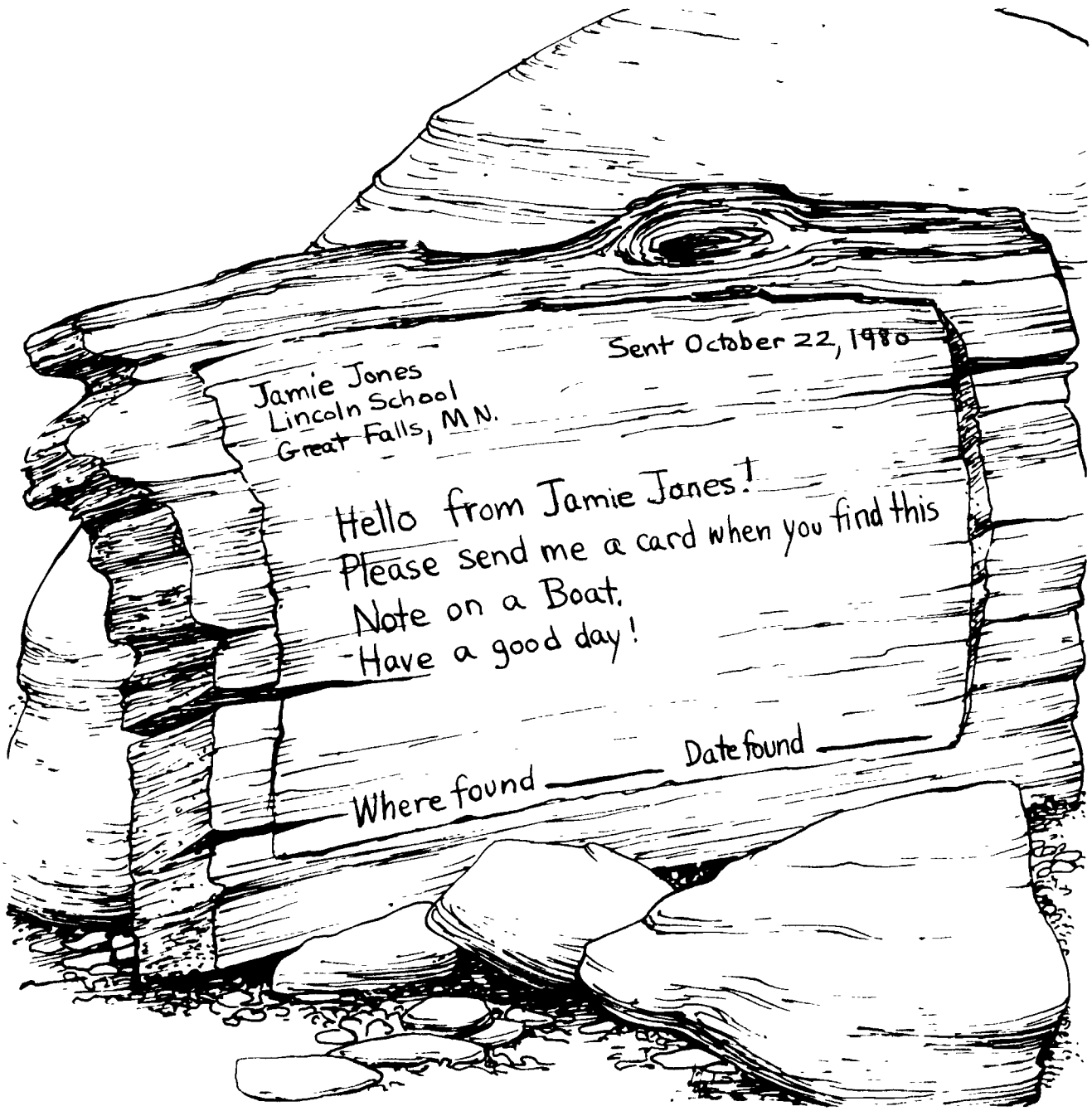
Name:

Pick up a piece of driftwood and send someone a note The driftwood may be a piece of board or tree limb washed up on the bank of a stream or river

Directions Dry the piece of wood Scrape or sand an area large enough to write your message With waterproof markers or pens, write a "Hello" for someone who may find your piece of wood wherever the stream will wash it up again

Coat your message with boat varnish or other clear waterproof coating When thoroughly dry, toss your piece of wood into the middle of the stream Will somebody find it? How far do you think it will travel? You might organize a distance guessing contest in your class

Name:



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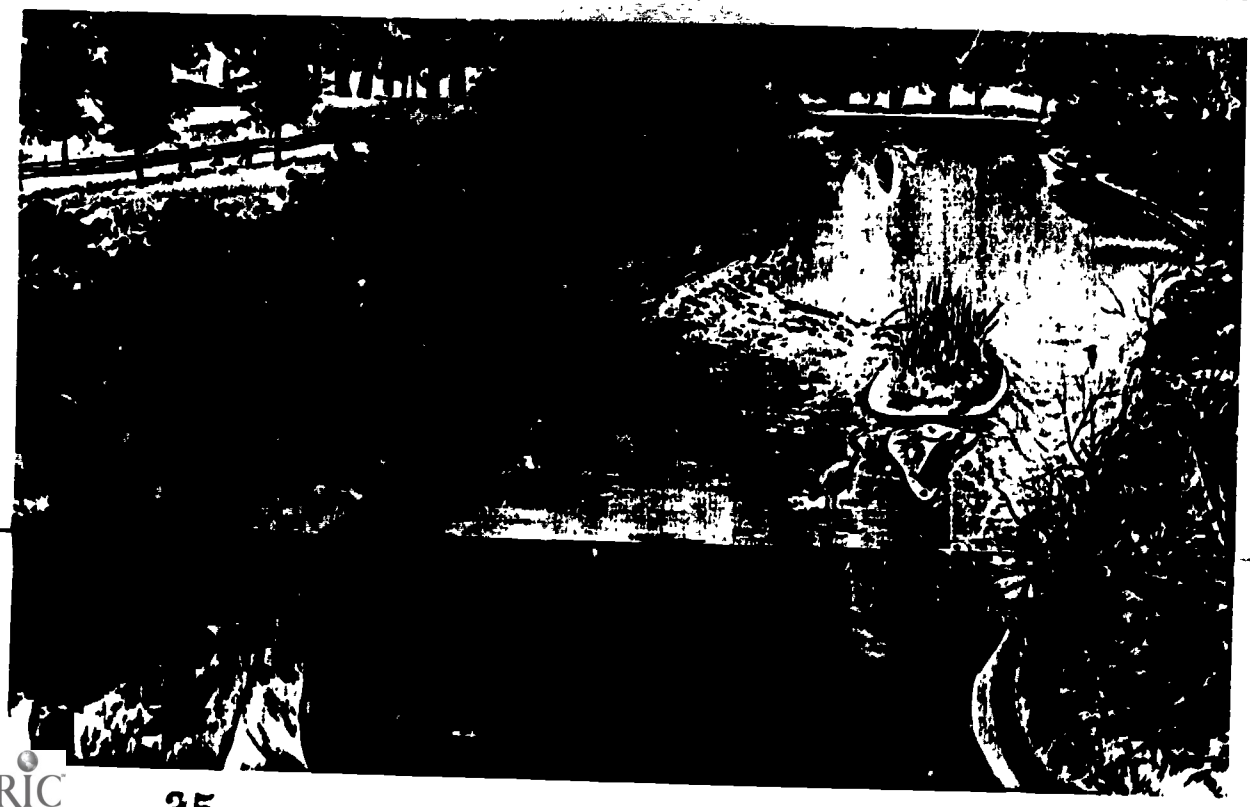

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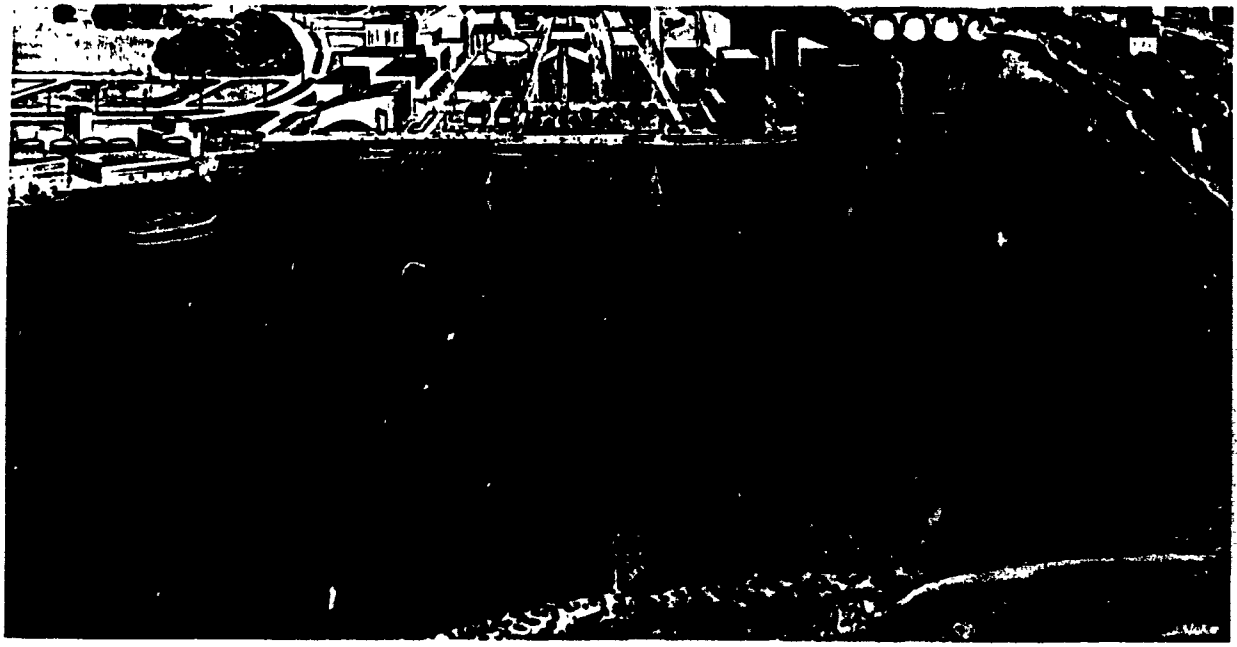
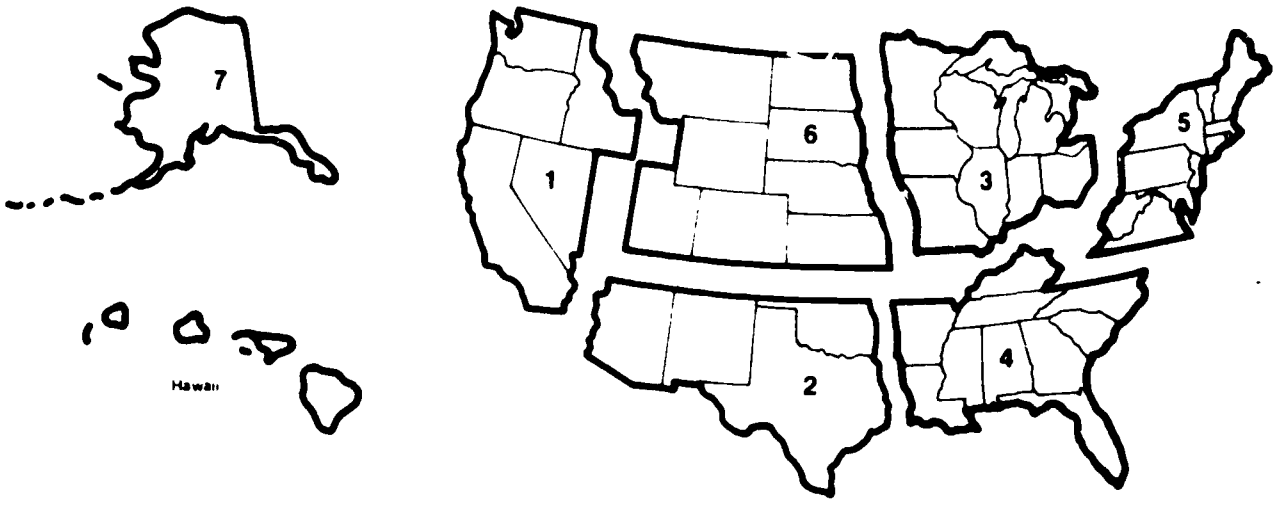


Streams and Rivers

U.S. Fish and Wildlife Service Regions



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Department of the Interior
U.S. Fish and Wildlife Service

National Institute for Urban Wildlife

10921 Trotting Ridge Way Columbia, Maryland 21044

The mission of the National Institute for Urban Wildlife is to be a responsible and effective scientific and educational organization advocating the enhancement of urban wildlife values and habitat and the wise use of all natural resources for the benefit of people in cities, suburbs and developing areas

The Institute is the only private national conservation organization with programs dealing almost exclusively with fish and wildlife in urban and other disturbed areas Funded through private and corporate contributions, grants and contracts, it is filling some of the glaring gaps in information and methodologies needed for the management and enjoyment of wildlife and wildlife habitats in urban areas

The Institute accomplishes its mission by (1) conducting sound research on the relationship between man and wildlife under urban and urbanizing conditions, (2) discovering and disseminating practical procedures for maintaining, enhancing or controlling certain wildlife species in urban areas; and (3) by building an appreciation for, and understanding of, wildlife and a positive conservation ethic at the local community and neighborhood level, and illustrating how all segments of our people have a vested interest in wildlife and the environment we mutually share.

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