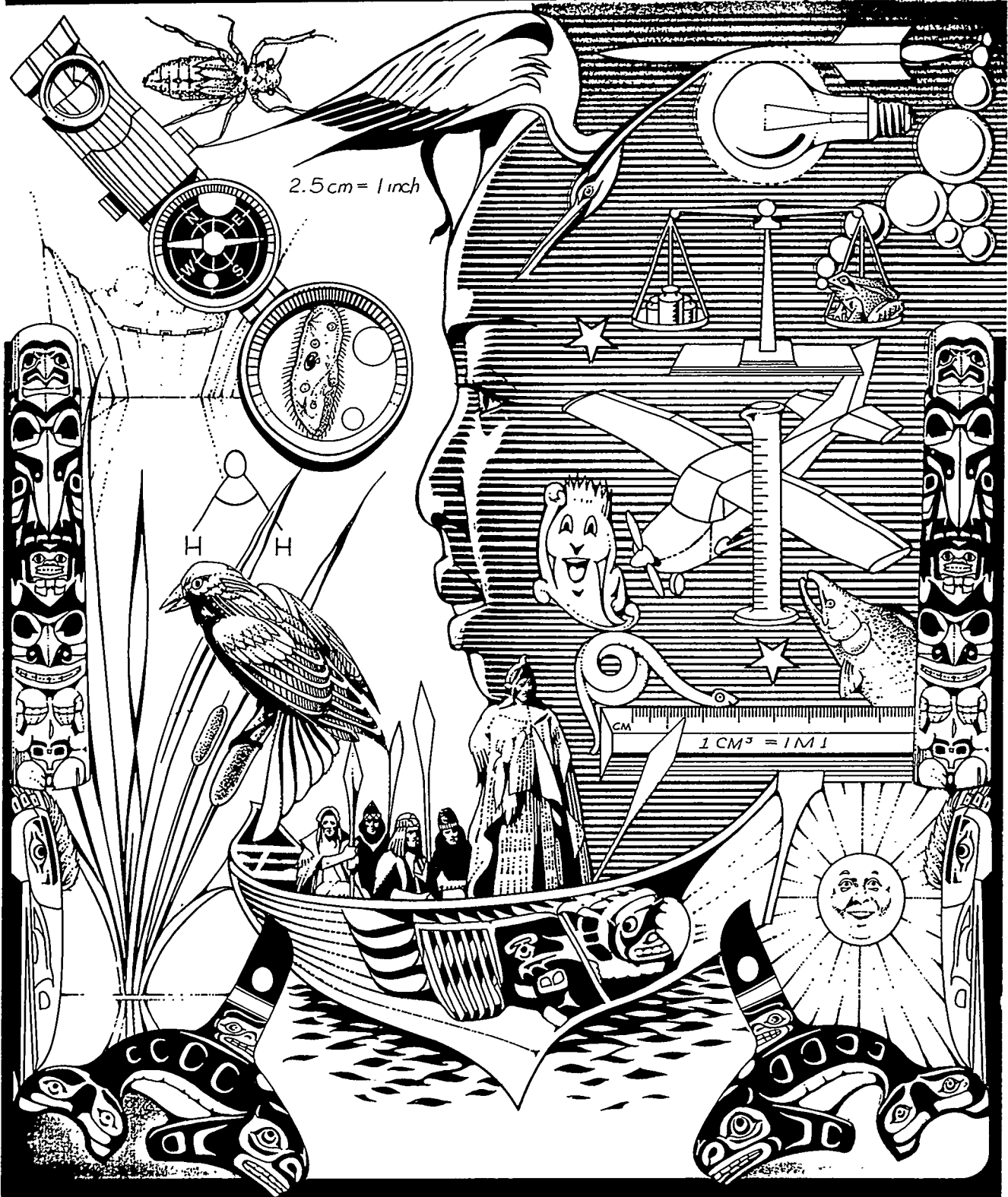


HYDROMANIA II

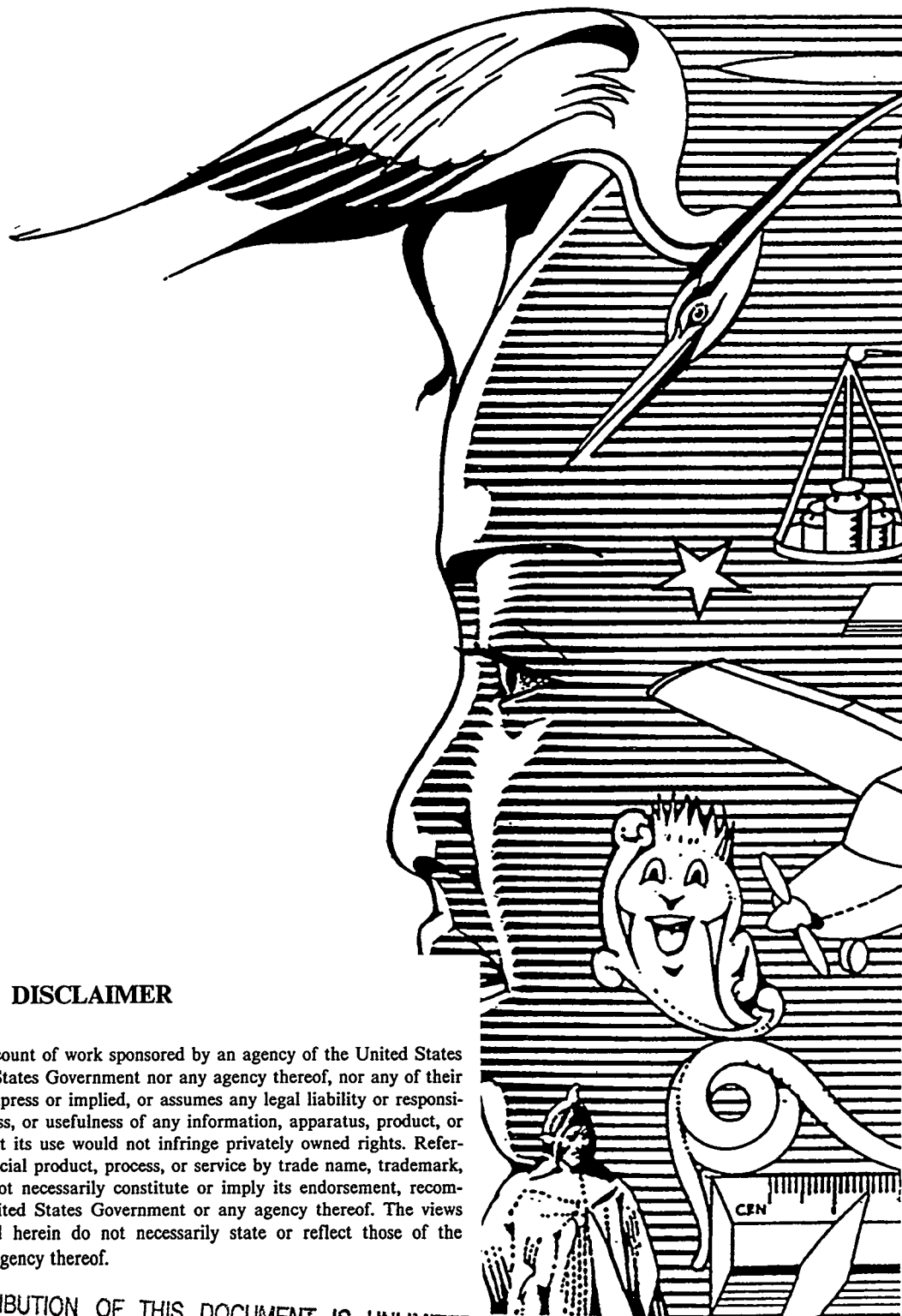


Journey of the *Oncorhynchus*

Sponsored by Bonneville Power Administration
and the U.S. Department of Energy

Hydromania II: Journey of the *Oncorhynchus*

Summer Science Camp Curriculum



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INTRODUCTION

The Hydromania II curriculum was written for the third in a series of summer science camp experiences targeting students in grades 4-6 who generally have difficulty accessing supplementary academic programs. The summer science camp in Portland is a collaborative effort between Bonneville Power Administration (BPA), the U.S. Department of Energy (DOE), and the Portland Parks and Recreation Community Schools Program along with various other cooperating businesses and organizations. The curriculum has also been incorporated into other summer programs and has been used by teachers to supplement classroom activities.


Camps are designed to make available, affordable learning experiences that are fun and motivating to students for the study of science and math. Inner-city, under-represented minorities, rural, and low-income families are particularly encouraged to enroll their children in the program. The science camps are two weeks long and generally run between the hours of 9:00 a.m. to 3:00 p.m., Monday-Friday. Four field trips were included in the 1994 camps with explorations to Oxbow Park, Fort Stevens on the Oregon Coast, Mt. St. Helens and Toutle Fish Hatchery, and Metro's Zoo.

The first summer science camp in 1992 utilized pre-packaged curriculum materials purchased from Hands on Science Outreach, Incorporated in Rockville, Maryland. In 1993, BPA produced its own science camp curriculum entitled, "*Hydromania*." The focus of this curriculum connected to Northwest regional issues of salmon, electricity, and water. The 1994 curriculum, "*Hydromania II*" is a continuation of the themes of "*Hydromania*," however providing a primary focus on the Pacific Salmon, its habitat and life cycle. Two area teachers, Joan Moura and Rod Swerin, were instrumental in putting together both of the "*Hydromania*" curricula.

"*Hydromania*" activities are of uncomplicated design utilizing common household materials to facilitate duplication in the classroom. Parents, teachers, and students alike have praised both curricula for the hands on and fun nature of the activities. The following comment from one of the camp counselors is particularly telling:

"As an African American male growing up in northeast Portland, I have seen many children fall through the cracks of our educational system. Hydromania II gave the kids, who may have fallen....the opportunity to develop the foundation needed to compete regardless of socio-economic impacts present today. It was amazing to see how much influence a positive experience and positive relationships have in such a short period of time." Parents of students shared similar comments about the camps and the curriculum.

If you have questions or would like to receive a copy of either curriculum, please call 1-800-622-4520 for information.


Vickie VanZandt, Vice President
Engineering Services, BPA

ACKNOWLEDGMENTS

The preparation of "Hydromania II" and the facilitation of the 1994 Portland Summer Science Camps would not have been possible without the collaboration of many individuals and organizations. Joan Moura and Rod Swerin planned and developed the 10-day program. Curriculum materials were provided, evaluated, modified, researched, and designed thanks to many contributors. The administrative design and organization can be attributed to many others, who helped by volunteering, teaching, training, coordinating, and providing necessary communication and publicity.

We hope that we did not inadvertently miss the name of a contributor to this years program and curriculum noted below:

Michael Addis, Portland Parks and Recreation Community Schools Program
Jerry Bauer, Bonneville Power Administration
Matt Beyer, U.S. Forest Service
Sharon Blair, Bonneville Power Administration
Dan Bundy, Black Education Center
Charles Clark, Bonneville Power Administration
Amanda Cross, Student Counselor
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Gary Curtis, Bonneville Power Administration
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Melisa Davis, Student Counselor
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Freda Franklin, Student Counselor
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Libby Herrera, Bonneville Power Administration
Ruth and Gordon Hoopes, Fort Stevens State Park Volunteers
Derrol Johns, Bonneville Power Administration
Mark Johnson, Toutle Fish Hatchery
Penny Jordan, Elementary Teacher
Mary Rose Kerg and Staff, Bonneville Power Administration
Mission Packaging Company
Eric Mattson, Washington Department of Wildlife
Elizabeth Moore, Oxbow Regional Park

Rita Owen, Bonneville Power Administration
Pacific States Marine Fisheries Division
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Tony Robertson, Student Counselor
Shannon Rowlett, Student Counselor
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Deb Scrivens, Metropolitan Regional Parks and Green Spaces
Scott Sloan, Washington Department of Wildlife
Gala Smith, Ape Caves National Monument
SOLV - Stop Oregon Litter and Vandalism
Don Swartz, Oregon Department of Fish and Wildlife
Andy Thoms, Bonneville Power Administration
Guy Toedtemeier, Washington Department of Wildlife
Lynn VanderKamp, City of Portland Bureau of Environmental Services
Vickie VanZandt, Bonneville Power Administration

HYDROMANIA II

SUMMER SCIENCE CAMP

PROGRAM GOALS

- ☐ Through the unique design of the camps, teaching staff (certified teachers, college and high school students) will work in a team environment and explore new approaches to teaching science education. This in turn, will have a positive impact on the staff's future teaching methodology and/or curriculum design, particularly for teachers returning to the classroom.
- ☐ Increase science literacy in Grades 4-6 children.
- ☐ Provide young women, minorities, and those students in low income, low achieving neighborhoods with a program which will increase their interest in science and mathematics.
- ☐ Through a fun and exciting learning environment, deliver activities which build self esteem, so that all students feel they have succeeded.
- ☐ Expose students to cultural awareness, so they will learn to celebrate diversity at an early age.
- ☐ Through games, science experiments, and field trips, children will have a better understanding of the Pacific Northwest salmon issues as they relate to energy needs and the environment.
- ☐ Long term goal - to attract women and minorities to careers in science, math, and engineering, which have traditionally been underrepresented by these groups.

CURRICULUM OBJECTIVES

The curriculum was designed to:

- ☐ Present activities which communicate the need to protect, mitigate, and enhance the recovery of the Columbia River Basin fish runs.
- ☐ Provide activities which identify, construct, and/or enhance the science concepts and processes appropriate for grades 4-6.
- ☐ Provide enhancement activities, such as field trips, where students/staff can apply what they learned to their local, regional, and global communities.
- ☐ Provide opportunities to integrate multicultural experiences into science activities.
- ☐ Provide hands-on, exploratory, and fun activities for students in grades 4-6.

The following eight pages correlates Hydromania II activities to the major concepts identified in Oregon's Science Comprehensive Curriculum Goals: A Model for Local Curriculum Development and the Certificate for Initial Mastery (CIM) Outcomes.

1.0 Concepts

Students apply an understanding of fundamental concepts on which science is based.

[illegible][illegible]

2.0 Processes		Students apply problem-solving and inquiry processes.																							
		Activity 1-1 Constructive Communication	Activity 1-2 Sweet Observations	Activity 1-3 Pacific Salmon Hexaflexagon	Activity 1-4 Kingfishers, Smolt, and Caddisfly Larvae	Activity 2-1 Cabbage Chemistry	Activity 2-2 Acid, Base, or Neutral	Activity 2-3 pH a Color Scale	Activity 2-4 Predator Prey Tubes	Activity 4-1 A Slice of Time	Activity 4-2 Fish Bracelets	Activity 4-3 To Cut or Not to Cut?	Activity 4-4 Connections	Activity 6-1 Volcanic Activity	Activity 6-2 SALMO Bingo	Activity 6-3 The Surface Water Video	Activity 6-4 Storm Drain Stenciling	Activity 8-1 Fish Prints	Activity 8-2 Fish Dissection	Activity 8-3 Mt. St. Helens Ash	Activity 8-4 Race to the Redd-game	Activity 9-1 Dancing Rice	Activity 9-2 Magnetic Fields	Activity 9-3 Electricity and You	Activity 9-4 Electrifying Fish Facts
2.1	Observe	x		x		x	x	x	x				x	x				x	x	x		x	x		x
2.2	Measure				x																				
2.3	Use numbers	x																							
2.4	Relate Time-Space																				x				
2.5	Infer																								
2.6	Classify	x	x			x	x												x						
2.7	Define operationally					x	x														x	x			
2.8	Question										x														
2.9	Hypothesize	x		x										x											
2.10	Design	x																							
2.11	Control variables																								
2.12	Interpret data	x				x	x														x				
2.13	Predict	x											x												
2.14	Formulate models													x	x									x	
2.15	Communicate	x	x			x	x		x	x	x	x								x					

2.0 Processes		Students apply problem-solving and inquiry processes.																							
		Activity 1-1 Constructive Communication	Activity 1-2 Sweet Observations	Activity 1-3 Pacific Salmon Hexaflexagon	Activity 1-4 Kingfishers, Smolt, and Caddisfly Larvae	Activity 2-1 Cabbage Chemistry	Activity 2-2 Acid, Base, or Neutral	Activity 2-3 pH a Color Scale	Activity 2-4 Predator Prey Tubes	Activity 4-1 A Slice of Time	Activity 4-2 Fish Bracelets	Activity 4-3 To Cut or Not to Cut?	Activity 4-4 Connections	Activity 6-1 Volcanic Activity	Activity 6-2 SALMO Bingo	Activity 6-3 The Surface Water Video	Activity 6-4 Storm Drain Stenciling	Activity 8-1 Fish Prints	Activity 8-2 Fish Dissection	Activity 8-3 Mt. St. Helens Ash	Activity 8-4 Race to the Redd-game	Activity 9-1 Dancing Rice	Activity 9-2 Magnetic Fields	Activity 9-3 Electricity and You	Activity 9-4 Electrifying Fish Facts
2.1	Observe	x		x		x	x	x	x	x			x	x				x	x	x		x	x		x
2.2	Measure					x																			
2.3	Use numbers	x																							
2.4	Relate Time-Space																				x				
2.5	Infer																								
2.6	Classify	x		x			x	x											x						
2.7	Define operationally						x	x														x	x		
2.8	Question											x													
2.9	Hypothesize	x		x										x											
2.10	Design	x																							
2.11	Control variables																								
2.12	Interpret data	x					x	x													x				
2.13	Predict	x											x												
2.14	Formulate models													x	x									x	
2.15	Communicate	x	x				x	x		x	x	x	x							x					

[illegible]

Students use a variety of materials and equipment in a safe and scientific way.

- Activity 1-1 Constructive Communication
- Activity 1-2 Sweet Observations
- Activity 1-3 Pacific Salmon Hexafluxagon
- Activity 1-4 Kingfishers, Smolt, and Caddisfly Larvae
- Activity 1-5 Cabbage Chemistry
- Activity 2-2 Acid, Base, or Neutral
- Activity 2-3 pH a Color Scale
- Activity 2-4 Predator Prey Tubes
- Activity 4-1 A Slice of Time
- Activity 4-2 Fish Broclets
- Activity 4-3 To Cut or Not to Cut?
- Activity 4-4 Connections
- Activity 6-1 Volcanic Activity
- Activity 6-2 SALMO Bingo
- Activity 6-3 The Surface Water Video
- Activity 6-4 Storm Drain Stencilling
- Activity 8-1 Fish Prints
- Activity 8-2 Fish Dissection
- Activity 8-3 Mt. St. Helens Ash
- Activity 8-4 Race to the Redd-gaune
- Activity 9-1 Dancing Rice
- Activity 9-2 Magnetic Fields
- Activity 9-3 Electricity and You
- Activity 9-4 Electrifying Fish Facts

[illegible]

4.0 Interests

Students develop interest in science.

[illegible]

[illegible]

.....

[illegible]

6.0 Interactions

Students describe interactions among science, society, technology, and earth's environment.

Activity 1-1 Constructive Communication
 Activity 1-2 Sweet Observations
 Activity 1-3 Pacific Salmon Hexaflaxagon
 Activity 1-4 Kingfishers, Smolt, and Caddisfly Larvae
 Activity 2-1 Cabbage Chemistry
 Activity 2-2 Acid, Base, or Neutral
 Activity 2-3 pH a Color Scale
 Activity 2-4 Predator Prey Tubes
 Activity 4-1 A Slice of Time
 Activity 4-2 Fish Bracelets
 Activity 4-3 To Cut or Not to Cut?
 Activity 4-4 Connections
 Activity 6-1 Volcanic Activity
 Activity 6-2 SALMO Bingo
 Activity 6-3 The Surface Water Video
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 Activity 8-3 Mt. St. Helens Ash
 Activity 8-4 Race to the Redd-game
 Activity 9-1 Dancing Rice
 Activity 9-2 Magnetic Fields
 Activity 9-3 Electricity and You
 Activity 9-4 Electrifying Fish Facts

6.1 Describe how society influences science

6.2 Describe how science influences society

6.3 Recognize science's limits/usefulness

6.4 Predict effects of science and society

6.5 Make responsible environmental choices

x

x

x x

x

x

x x

x x

7.0 Characteristics		Activity 1-1 Constructive Communication Activity 1-2 Sweet Observations Activity 1-3 Pacific Salmon Hexaflexagon Activity 1-4 Kingfishers, Smolt, and Caddisfly Larvae Activity 2-1 Cabbage Chemistry Activity 2-2 Acid, Base, or Neutral Activity 2-3 pH a Color Scale Activity 2-4 Predator Prey Tubes Activity 4-1 A Slice of Time Activity 4-2 Fish Bracelets Activity 4-3 To Cut or Not to Cut? Activity 4-4 Connections Activity 6-1 Volcanic Activity Activity 6-2 SALMO Bingo Activity 6-3 The Surface Water Video Activity 6-4 Storm Drain Stenciling Activity 8-1 Fish Prints Activity 8-2 Fish Dissection Activity 8-3 Mt. St. Helens Ash Activity 8-4 Race to the Redd-game Activity 9-1 Dancing Rice Activity 9-2 Magnetic Fields Activity 9-3 Electricity and You Activity 9-4 Electrifying Fish Facts
Students describe the characteristics of scientific knowledge.		
7.1 Describe tentativeness of science		
7.2 Explain the importance of objectivity		
7.3 Analyze scientific explanations	x	

Oregon Certificate of Initial Mastery Outcomes

[illegible]

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Glossary

DAY 1

OUTLINE

<u>TIME</u>	<u>ACTIVITIES</u>	<u>MATERIALS</u> (Based on class of 40)
9:00 a.m.	Breakfast/Welcome/Nametags	40 Salmon Name Tags
9:30	Salmon Survey (Pre-Test)	40 surveys 40 No. 2 Hydromania pencils
9:45	Estimation Game	Pinto Beans (5,000 = ~4 lbs) 8 small plastic beads Plastic storage container (1 gallon) Salmon eggs, preserved
10:00	Journey of the <i>Oncorhynchus</i> : A Story of the Pacific Northwest Salmon Group Names	Mural-Center piece & Section 1 40 Story books (one per student) crayons/color markers
10:15	(1-1) Constructive Communication (Communication Skills)	20 bags of Pattern Blocks (12 pieces per bag) 10 letter-size file folders with colored shapes
11:00	Break	
11:15	(1-2) Sweet Observations (Scientific Method) Workbooks	40 bags of Skittles® candy 40 student workbooks crayons/color markers
12:00	Lunch	
1:00	Salmon Play	Bonneville Power Administration Staff
1:15	(1-3) Pacific Salmon Life Cycle Hexaflexagon (Life Cycle)	40 Pacific Salmon Life Cycle Hexaflexagons 40 student scissors 40 metric rulers 20 rolls of clear tape
2:30	(1-4) Kingfishers, Smolt, and Caddisfly Larvae (Food Web)	stopwatch whistle two 40 foot ropes
3:00 p.m.	Camp ends for students.	



DAY 1

TEACHER NOTES

Welcome: Construct Salmon Nametags for each student. Nametags should be placed on student work tables during the breakfast/welcome activity.

Salmon Survey: This pre-test is designed to evaluate the present knowledge of the students regarding Pacific Salmon. Students should be given approximately **15 minutes** to complete the survey. Students can draw or write information on the survey sheet. It is important that each student complete the bottom portion of the survey which includes their name, camp and date. A post-survey will be administered on Day 9 of the camp. The comparison of the pre- and post-surveys will be an important tool in the evaluation process (a copy of the survey can be found in the Day 1 materials following page 1-18).

Estimation Game: Challenge students to guess the number of pinto beans in the plastic container. Each pinto bean represents a chinook salmon egg. An adult chinook female lays between 3,000 - 8,000 eggs. The number of pinto beans in the container represents approximately 5,000 eggs which is the average number of eggs deposited by a female chinook. The estimation game is conducted each day during breakfast with winners announced later.

Group Names: Group students into teams of 5 to 6. Have student groups name themselves and show how the salmon rubber stamps will document their progress through the activities (Each time a student completes an activity, a salmon is stamped their paper - see page 1-9 for patterns).

Story Time: Journey of the *Oncorhynchus*-Chapter One-**15 minutes** (see **Teachers Guide of Storybook following page 1-18**). Before starting the story, display either the Journey of the *Oncorhynchus* mural with the **salmon life cycle center piece and section one** or use the poster (**posters can be obtained by calling 1-800-622-4520**). Call attention to the mural/poster by having the students search for the hidden salmon in section one. The first student to find the hidden salmon will be awarded a prize. Each student will need their Journey of the *Oncorhynchus* story book which coincides with the mural/poster (**storybooks can also be obtained by calling the above 800 number**). Students may want to color illustrations as they listen to the story. Those needing more time can complete coloring during break or lunch.

ACTIVITY 1-1: CONSTRUCTIVE COMMUNICATION

SKILLS: Listening, Communication

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ improve their listening and communication skills.
- ◆ use their listening and communication skills to work effectively on a team.

MATERIALS:

20 bags of Pattern Blocks (12 pieces per bag) - use two each of 6 different shapes

20 letter size file folders with colored shapes ↑ (legos, unifix cubes, etc. will work well)

BACKGROUND INFORMATION:

How to be an effective listener.

Use **Body Language** and facial expressions that indicate interest.

- ♦ Uses affirmative head nods
- ♦ Calm, yet expressive face
- ♦ Direct eye contact
- ♦ Body turned toward speaker
- ♦ Comfortable spatial distance

Expand conversations.

- ♦ Ask questions that cannot be answered simply by "Yes" or "No."

Clarify messages.

- ♦ Check out if what you heard is what the speaker meant. such as:
"Do you mean that...?"
"I hear you saying...?"

Reflect feelings.

- ♦ Guess the speaker's feelings by making statements such as:
"I'd bet you're glad."
"You seem angry!"

Things to Avoid:

- ♦ Distracting
- ♦ Judging
- ♦ Interrupting
- ♦ Changing the Subject.

Communication

One-way communication occurs when information is provided and the receiver isn't able to ask for clarification or additional information. Two-way communication occurs when both the giver and receiver are able to ask questions and ask for clarification.

PROCEDURE:

1. In this activity, students will use pattern blocks to improve their listening and communication skills. Begin by having students describe some different ways to communicate and the importance for communication skills. The instructor should introduce the difference between one-way and two-way communication.
2. Place students into groups of four. Each group will need two bags of pattern blocks (various geometric shapes) and one file folder with the names of the block shapes for use by students when describing the blocks.
3. The group of four should then be equally divided into Group A and Group B.
4. A file folder should be placed upright as a barrier between Group A and Group B. Each group will need a bag of pattern blocks.
5. Part 1: **One-way communication.** Group A will build a pattern using the following blocks: one yellow hexagon, one green triangle, one orange square and the one red trapezoid (**each block lays flat on the table**). It is important to keep Group B from seeing the finished pattern. It is also important to keep both Groups (A & B) from seeing what each other is working on.
6. One (and only one) of the builders in Group A should give instructions to Group B. These instructions should allow Group B to build the same pattern that Group A has completed. The description can include colors, shapes, and positions of the blocks. The builder in Group A who is providing this information can do so only once (no repeating information). Students in Group B (who are receiving this information) **may not ask any questions**.
7. After Group B has completed their pattern, compare for accuracy. Students should have success with this trial run and understand the process of one way communication.
8. Now, Group A and Group B should switch roles and repeat steps 5-7.
9. Both groups should use one-way communication to complete a pattern made with 6 blocks, one of each color.
10. Part 2: **Two-way communication.** Repeat the process using the same 6 blocks to create a pattern, utilizing two-way communication. In two-way communication, Group A will deliver the information and Group B will receive the information. The difference here is that both groups are able to ask questions and ask for clarification when they don't understand an instruction (remember that all blocks lie flat).
11. Now, Group A and Group B should switch roles and repeat step 10.
12. If time permits, groups may increase the number of blocks and repeat step 10.

CONCLUSION:

Instructors should discuss the differences between one-way and two-way communication and use the following questions to bring closure to this activity:

1. If patterns did not match, why didn't they?
2. Which seemed easier, one-way or two- way communication? Why?
3. In which process, one-way or two-way communication, were the best results achieved?

3. What are the important attributes of a good receiver of information?
4. What are the important attributes of a good communicator or giver of information?
5. Why are communication skills important when working in teams?

ACTIVITY 1-2: **SWEET OBSERVATIONS**

SCIENCE PROCESSES: Observe, Use Numbers, Classify, Hypothesize, Design Experiments, Interpret Data, Predict, Communicate

SKILLS: Counting, Graphing, Averaging

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ understand the basic steps of the Scientific Method.
- ◆ observe, predict and record data.
- ◆ define hypothesis.

MATERIALS:

40 individual bags of Skittles candy
40 student workbooks

40 boxes of crayons

BACKGROUND INFORMATION:

Scientific Method

The Italian physicist Galileo Galilei (1564 -1642) and the English Francis Bacon (1561 - 1626) are usually credited as being the principal founders of the Scientific Method. The Scientific Method is the systematic collection and classification of data, and usually, the formulation and testing of hypotheses based on the data. The parts of the Scientific Method are:

1. Statement of **Problem**
2. Make an **Hypothesis**
3. Design **Experiment**
4. Collect **Data**
5. Form a **Conclusion**

The scientific method is extremely effective in gaining, organizing, and applying new knowledge.

Observations/Inferences

An **observation** is information that is gained by using your senses. An **inference** is deriving a conclusion from past experiences and/or knowledge. Good observations lead to good inferences. For example, students may be quick to conclude that a clear liquid in a beaker is water because the most common clear liquid that they are familiar with is water. However, after closer observations, the students may note a distinctive odor of the clear liquid and form another hypothesis.

GLOSSARY OF TERMS All underlined terms found in the BACKGROUND INFORMATION sections can be found in the glossary.

PROCEDURE:

1. In this activity, students will apply the Scientific Method to find out the amount of Skittles® candy in an individual bag of candy.
2. Students should complete parts 1 through 3 of the Student Activity Sheet 1-2 individually. They may work with a partner for the rest of the activity.
3. To start off, the instructor should hold up 2 bags of Skittles® candy.
4. State the **Problem**: Are the contents in all bags of Skittles® candy the same?
5. Students should **Predict/Hypothesize** how many Skittles® are in each bag.
6. Students should record their individual hypothesis on Student Activity Sheet 1-2. Instructors should assist the class in coming up with a class hypothesis.
7. After the class hypothesis is complete, students should set up an **Experiment** to see if each bag is exactly the same.
8. In groups of 2, students should discuss how to set up their experiments. **Skittles® bags should remain closed until questions 1-3 on the Student Activity Sheet 1-2 have been completed.**
9. Students need to carry out their experiment and record their **Data**, then use centimeter graph paper to create a bar graph (amount-versus-color) of their results. (Graph paper provided in student workbook.)
10. Instructors should allow time for students to present data and discuss class **Conclusions.**

CONCLUSION:

Instructors should use the following questions to bring closure to this activity:

1. Define the steps of the Scientific Method.
2. Explain the difference between an observation and an inference.
3. How do you make good observations? Inferences?
4. Were your Skittles® hypotheses accurate?
5. Discuss how students designed their experiments.

ACTIVITY 1-3: PACIFIC SALMON LIFE CYCLE HEXAFLEXAGON

SCIENCE CONCEPTS/PROCESSES: Cycle, Change, Organism

OBJECTIVE (s): After completing the activity, students will be able to:

- ◆ understand the basic steps in the Pacific Salmon's life cycle.

MATERIALS:

40 Pacific Salmon Life Cycle Hexaflexagon Patterns
40 student scissors

20 rolls of clear tape
40 metric rulers

BACKGROUND INFORMATION:

PACIFIC SALMON

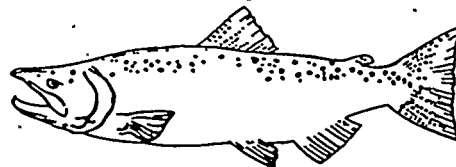
Of all the fish in the Pacific Northwest, migratory or otherwise, salmon have been a cornerstone of human survival for thousands of years. Prepared fresh, smoked, dried, or salted, salmon were the foundation of coastal and Columbia River Indian diets. Native American cultures and spiritual beliefs were also intertwined with the great silver fish. In fact, the chinook salmon takes its name from a Northwest tribe.

Salmon date back to the Miocene geologic epoch (12 to 26 m.y.a. (million years ago)). Scientists believe that salmon migratory behaviors originated over 10,000 years ago. These anadromous (a-nad-re-mes) fish evolved from cold, oxygen rich waters of the Northern Hemisphere. Salmon are called anadromous fish because they can live in both saltwater and freshwater at different times during their life. (Anadromous comes from the Greek words for "up river".) In the Pleistocene epoch (present day to 2 m.y.a.) the great glaciers of the Ice Age melted, revealing safe places for spawning and for rearing young. The salmon's anadromous behavior is thought to be a result of the advancement and receding of continental ice sheets. Also at this time, the Pacific Salmon became separated from the parent stock salmon in the Atlantic.

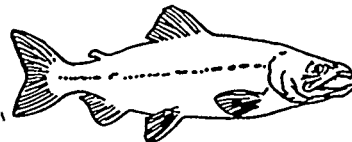
Classification

The Salmonidae family, which include the Pacific Salmon and trout, are naturally distributed throughout most of the Northern Hemisphere, from the temperate zone northwards to beyond the Arctic Circle. There are no native salmon or trout in the Southern Hemisphere but they have been successfully introduced into South America, Southern Africa and Australia. The Pacific salmon, steelhead, and trout also belong

to the genus *Oncorhynchus*. (From Greek, *onko* meaning barbed or hooked and *rhynchos* meaning snout.) Throughout Hydromania II: Journey of the *Oncorhynchus* curriculum, we will focus on five species of Pacific salmon: **Chinook** or King (*Oncorhynchus tshawytscha*), **Chum** or Dog (*Oncorhynchus keta*), **Coho** or Silver (*Oncorhynchus kisutch*), **Pink** or Humpback (*Oncorhynchus gorbuscha*), and **Sockeye** (*Oncorhynchus nerka*). The species names were originally classified by Russian scientists working on rivers on the opposite side of the Pacific Ocean.



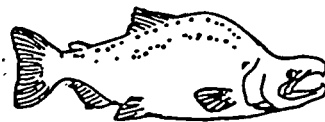
Chinook



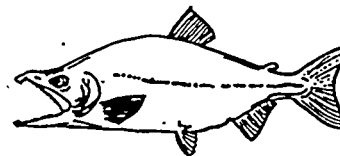
Chum



Coho



Pink



Sockeye

Of the five species of salmon found in the Pacific Northwest, three are common to Oregon: the chinook, the chum, and the coho. Neither sockeye nor pink salmon return to Oregon streams in significant numbers although a major commercial offshore harvest of pinks occurs during the alternate years they spawn. Sockeyes migrate by the thousands up the Columbia River each summer but all spawn in Washington waters. Landlocked versions of sockeye, called kokanee, thrive in many Oregon mountain lakes. With minor differences, the three Oregon inhabitants have similar life and reproductive cycles, which divide neatly into three distinct periods, freshwater, saltwater and spawning phases.

Life Cycle

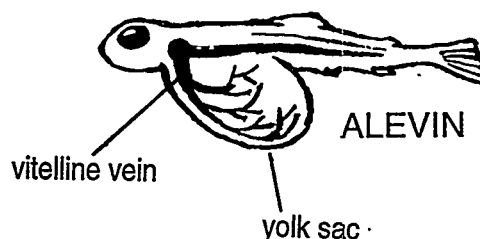
Freshwater Phase

The salmon life cycle begins when the eggs are deposited and fertilized at the bottom of a swift-flowing, freshwater stream in a bed of gravel called a redd. Small salmon eggs, the size of a pea, are clustered in groups and rest just under the top layer of gravel. The gravel provides protection from predators and other hazards during the incubation period. Successful reproduction depends on an adequate supply of gravel with low sediment content.



About one month after being deposited, eyes begin to show. This is called the eyed stage. Incubation may take 50 days or longer, although this varies greatly, depending upon the water temperature. Generally, the colder the water, the longer the incubation period. During incubation, water flow (delivers oxygen and carries away waste products) and temperature (4°-18° C or 40°-65° F) must be suitable. Salmonids are cold-water fish and generally cannot tolerate temperatures above 20° C (68° F).

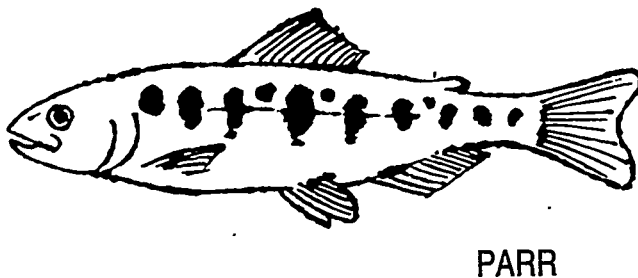
When the baby salmon hatch from the eggs in late winter or spring, they are only about an inch long. At this stage, these young salmon are called alevins (aL-e-vins). An alevin is a fragile creature with huge eyes and a large yolk sac protruding from its belly. The reddish-orange sac contains a completely balanced diet. Oxygen is absorbed (from the water) through the vitelline vein which runs up through the center of the yolk sac. Alevins rapidly grow under the gravel for one to three months.



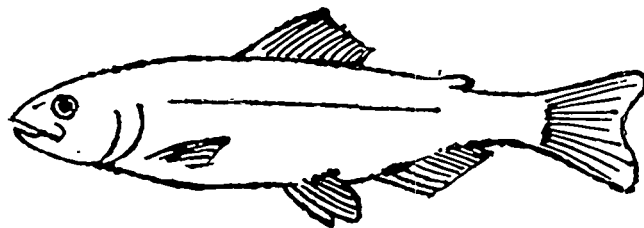
As the alevin develop, the absorption of their yolk sac coincides with the development of the mouth, digestive tract and excretory organs. At this stage, they are called fry. The baby fish work their way up through the gravel and position themselves in a hollow between the stones on the river bed. (A dye test will show that there is a vortex in these hollows which prevents the fry from being washed away and allows them to remain in position with the minimum of effort.) This occurs in late spring and summer. The fry are less than a year old and measure about an inch and a half in length. They feed on zooplankton carried down to them by the current. They are easy prey for larger fish and other predators. Chinook, coho, and sockeye fry spend a year or more in streams or lakes, while chum and pink fry begin to migrate directly to the sea.



When the young fish reach about two inches in length, they are known as parr (fingerlings). Parr spend most of their freshwater life in shallow riffles, where the water is broken and well-oxygenated but the current is not strong. They become voracious feeders on insects, worms, mussels and snails. This growth phase is best recognized by the development of dark bars aligned vertically along each side of the fish. These markings help them hide from enemies along the river banks. The parr stage is the most vulnerable time in a salmon's life. At this stage of their life, they are preyed on by sculpins, bigmouth minnows, minks, raccoons, mergansers, great blue herons, cormorants, ospreys, and kingfishers among others. The greatest mortality in the salmon's life cycle is during the egg-to-parr stage.



As the parr live in the rivers or lakes they continue to grow and soon develop into young salmon called **smolt** or fingerlings. The salmon smolt are about two years old and are over five inches in length. It is at this stage that most young salmon begin a physical change that triggers their downstream migration and allows them to eventually adapt to a salt-water environment. Smolt have shiny, silvery coats and have lost all of the dark markings that helped them to hide in the river. In addition to predators (bears, foxes, birds, fish), smolt must run a barrage of natural (volcanic eruptions, storms) and manufactured (polluted water, erosion, dams) obstacles. Those that are successful will rest in the brackish water of estuaries as they adjust to the salt-water.

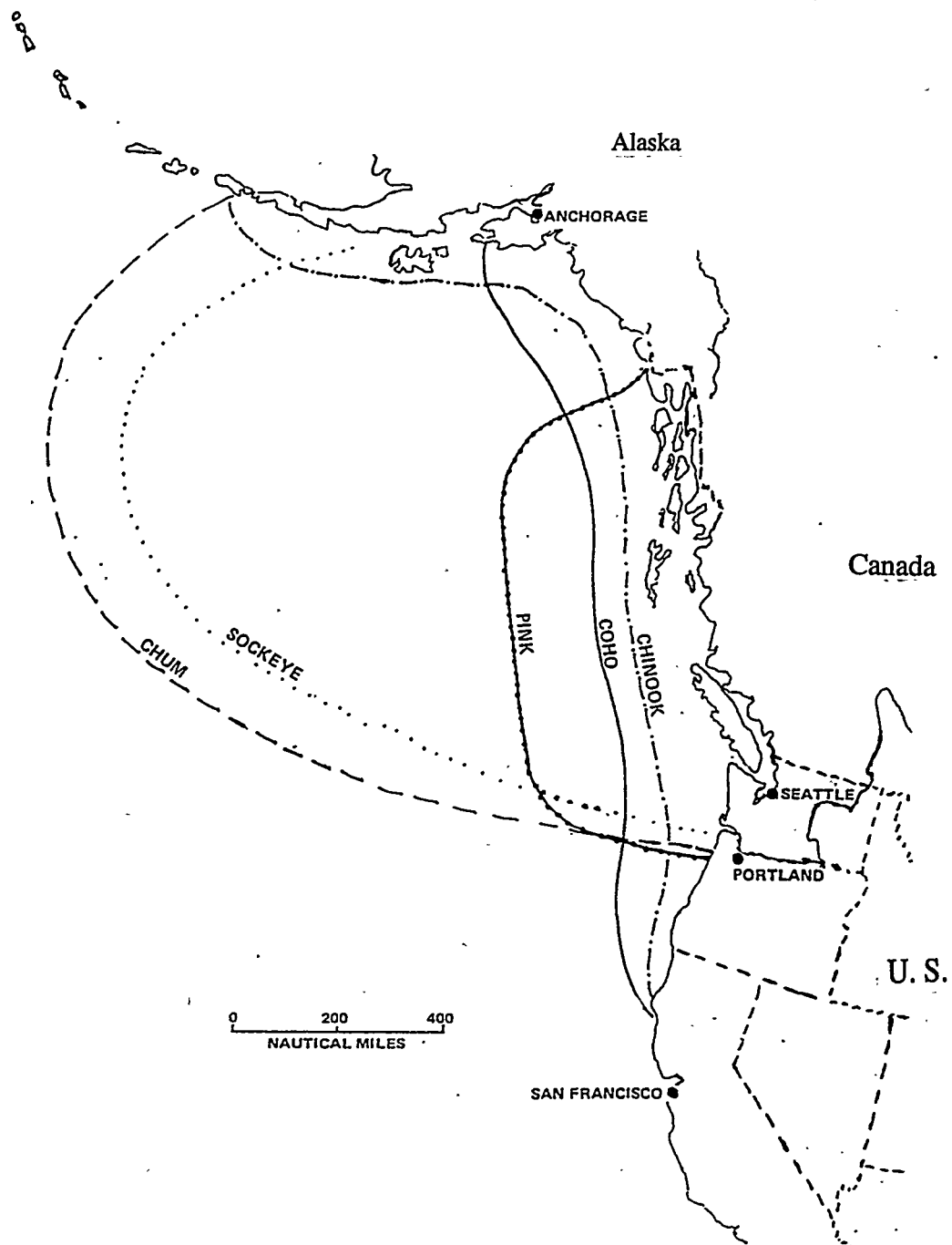


SMOLT

Saltwater Phase

Salmon spend varied amounts of time in the sea, up to five years, depending on the species (pink-15 to 16 months, coho-1 to 2 years, sockeye-2 to 3 years, chum-3 years, chinook-3 to 5 years). As they become young adults, their diet changes from small plants and bugs to small sea creatures and plankton. As the fish grow, krill, anchovies and herring make up the majority of their diet. Sharks, marine mammals, killer whales, sea birds and other predators prey on a portion of the maturing salmon. Commercial and sports fisheries also take their toll on the salmon population.

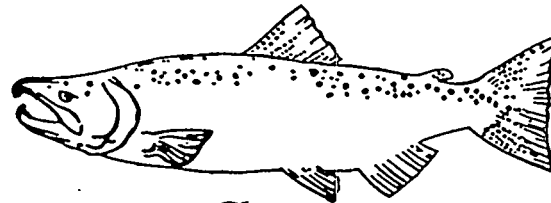
Having reached the sea, the young salmon will head toward their hereditary feeding grounds. Some of these large schools will travel north to Alaska and others will feed in the deeper waters off California.



Migratory paths of five species of Pacific Salmon

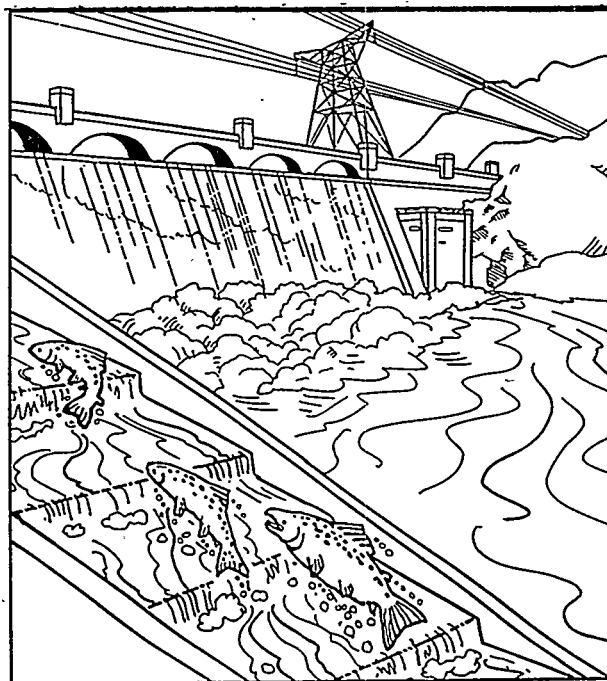
Spawning Phase

Usually in the early summer of their maturing year, salmon begin to head back to their home streams. Researchers believe salmon navigate by electromagnetic signals, the moon and stars, or by the smell of their home stream. Salmon stop feeding when they enter fresh water, and live on stored body fats for the rest of the trip. The salmon's body has changed again; some of their bodies may be red and green instead of silver. They also have a large hooked nose.

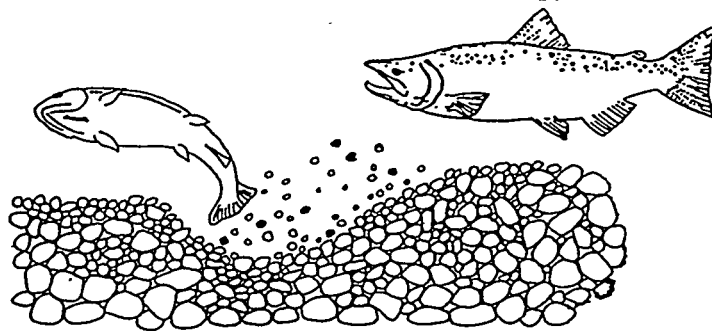


Chinook

As salmon continue their upstream journey to their spawning beds, fishermen and natural predators continue to reduce their numbers. Most hydroelectric dams, which block normal passage upriver, now have fish ladders which allow the salmon to continue their journey. However, as salmon search for these passages they use their limited energy supply. Other barriers such as landslides, log jams, road culverts and low water levels can also cause problems for migrating salmon. When water levels are too low for upstream movement, water temperatures may become quite warm in the holding pools and allow the development of disease organisms. Salmon can rest for days in these holding pools waiting for improved water flows. Restricted flows may delay salmon too long, and reduce the chance of successful spawning when they finally reach the spawning beds.



Upon reaching the spawning grounds, the female digs a nest, or **redd** in the gravel with vertical sweeps of her tail. These redds are approximately 40 centimeters (16 inches) deep. When the nest is ready, which may be weeks or months after they reach the gravel beds, the female begins laying her eggs. The male moves alongside the female and fertilizes the eggs by covering them with milt, a milky substance that contains the sperm. The female does not extrude all her eggs at one time. After a resting period, the female moves a short distance upstream and digs another redd. The clean gravel from the second nest is washed down and covers the eggs deposited during the first shedding. They repeat this process in separate redds until all eggs have been laid. A female chinook deposits between 3,000 - 8,000 eggs. Salmon die within days of spawning. As their bodies decay, they contribute nutrients to the stream from which they originated, which completes their life cycle.



☑ See Backgrounder brochures entitled The Magnificent Journey and The World's Biggest Fish Story: The Columbia River's Salmon for additional information on salmon. They are located at the end of Day One teacher notes section.

PROCEDURE:

1. In this activity, each student will construct a Pacific Salmon Life Cycle hexaflexagon.
2. Using the Journey of the *Oncorhynchus* mural/poster, instructors should introduce the Pacific salmon life cycle using the center portion of the mural.
See background information preceding this section.
3. In order to construct the hexaflexagon, instructors will need to demonstrate the scoring technique necessary to make folding possible. It is important that students score directly on the hexaflexagon lines (use the blunt side of a scissors and a ruler).
4. See the instructions printed on the hexaflexagon for details. A copy of the Pacific Salmon Life Cycle Hexaflexagon is located at the end of Day One teacher notes section.

CONCLUSION:

Instructors should use the completed hexaflexagon to review the Pacific salmon life cycle. Discuss the important stages represented on each side (or turn) of the hexaflexagon.

ACTIVITY 1-4: KINGFISHERS, SMOLT, AND CADDISFLY LARVAE

SCIENCE CONCEPTS/PROCESSES: Change, Organism, Observation, Hypothesize, Discussion

OBJECTIVE (s): After completing the activity, students will be able to:

- understand the components of a food chain and food web.

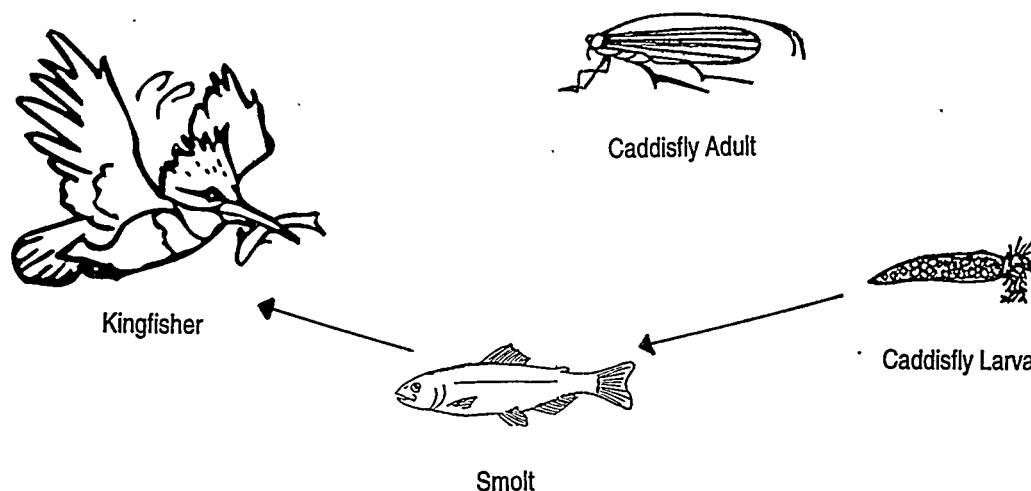
MATERIALS: whistle, stopwatch, and two 40 foot ropes

BACKGROUND INFORMATION:

A food chain is a direct succession of consumers in a feeding hierarchy, with higher organisms feeding on lower ones. A food web is a complex association of food chains (see Activity 4-4: Connections).

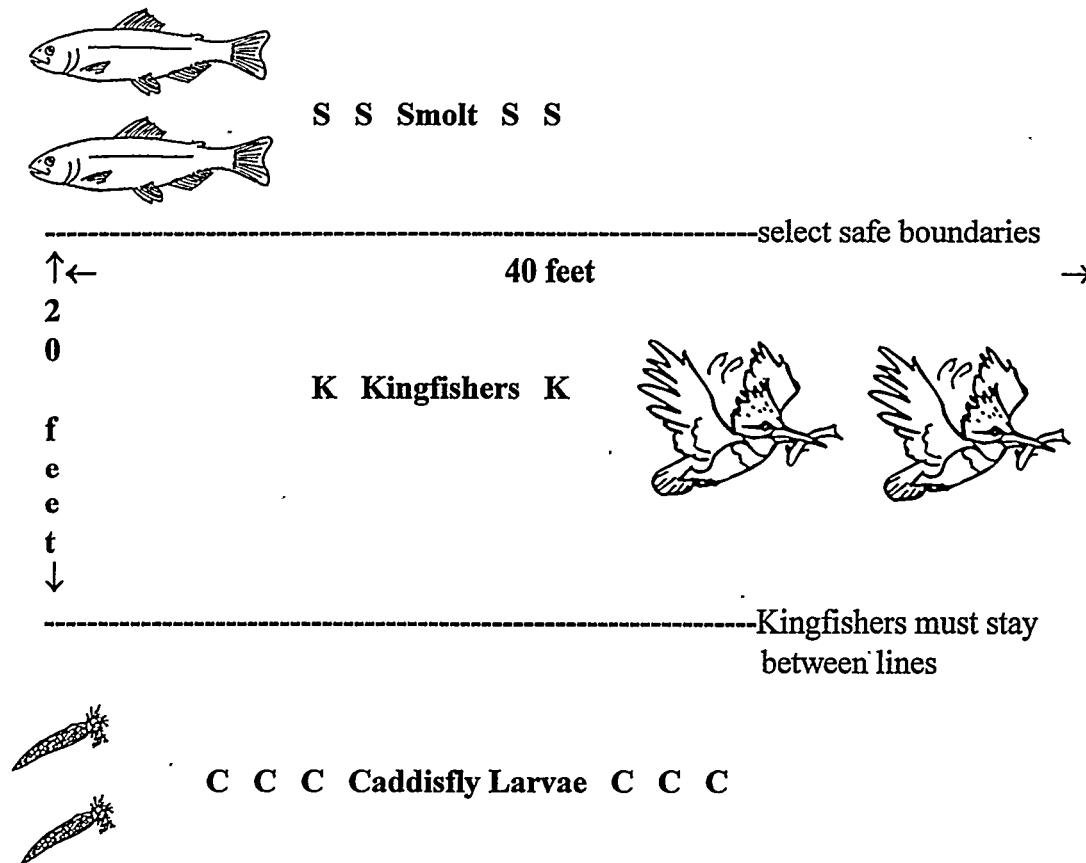
The Belted Kingfisher is the most common kingfisher in North America. Kingfishers are seen singularly or in pairs along streams and ponds. They are large-headed, short-tailed birds that dive for fish, which they catch with their long sharp beaks. They perch motionless in the open, over water and often hover before diving. Females usually lay between 3-8 white eggs in a deep burrow in a steep bank.

Caddisflies have hard-shelled head capsules. In some species, this same hard material makes up the first three segments of the body. The rest of the body is soft and often cylindrical. The larvae possess two small hooks on the last segment. Some species make a case out of silk, sand grains, pebbles, or bits of plant matter to protect their soft bodies. Caddisflies undergo complete metamorphosis and the larvae transform into winged adults in the water. As adult, caddisflies only live a few days and do not eat at all.



PROCEDURE:

1. In this activity, students will learn about food chains and food webs. A change in any part of the food chain affects all other parts of the food web.
2. This activity is best done outside in a large open area. Mark boundaries for the smolt area and the caddisfly larvae area with a rope or string. (See diagram below.) The kingfishers will catch their prey between these two boundaries. The smolt will have to cross the kingfishers area in order to catch their prey, the caddisfly larvae. Each predator must catch their prey by using both hands, tagging isn't enough.



3. Divide a class of 40 students into two groups of 20. Next, have each group subdivide into of 6 smolt, 3 kingfishers, and 11 caddisfly larvae. Set a time limit of 2-3 minutes.
4. Explain how the game works. Emphasize boundary limitations and rules of the game. At the blow of the whistle, the smolt swim to catch a caddisfly larvae and bring it back to their home. Meanwhile, the kingfishers are trying to catch the smolt. If a smolt gets a caddisfly larva back to his/her home without being eaten by a kingfisher, then the caddisfly larva becomes a smolt. If a kingfisher catches both a smolt and a caddisfly larva together, the larva goes back to its home and the smolt becomes a kingfisher.

5. Blow the whistle after 2-3 minutes and count how many there are of each animal. Let each 2-3 minute time period represent a day. Record the number of each animal at the end of each "day." Play the game for about 20 minutes. You may want to discuss the results following each trial or after the game is completed.
6. If you want to focus on the marine part of the salmon's journey, the kingfisher, smolt, and caddisfly larvae food chain can be substituted with the seal, salmon, and krill food chain.

CONCLUSION:

If the kingfishers are too successful, then all the smolt and caddisfly larvae become kingfishers and there is nothing left to eat. If the smolt are too successful, then they eat all the caddisfly larvae and the caddisfly larvae become smolt and again there is nothing to eat.

After the game is over, have the students form a circle and discuss the implications of what they have been doing:

1. How important is it to have enough food to eat?
2. What happens if there are not enough predators (kingfishers)?
3. What happens if there are too many smolt? Too few?
4. Do we need kingfishers, smolt and caddisfly larvae to keep everything in balance? Why?

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY ONE

It's December. Clouds brush against the tip of Mount Hood, 50 miles east of Portland, Oregon. As snow falls on the mountaintop, a gentle rain falls on a small stream low on the mountain's northeast slope. Several drops hit the arching blades of grass shading a shallow pool at the edge of the stream. One hangs at the tip, lingers for a moment then pulls itself into a droplet we'll call "Hydroid."

From its perch, Hydroid has a close view of the world around it. Pine trees shrouded in mist tower overhead. Shrubs grow to the edge of the stream. Clumps of grass and branches hang over the water's edge. Several old logs lie in the stream, slowing its flow and creating pools. The water is shallow, only 12 inches deep. But it is cool and clear, even in the pools where the water is still. It's easy for Hydroid to see through to the gravel bottom. There's something different about the gravel below Hydroid, though. Each rock is placed just so. The rocks are arranged in a circle, about two feet in diameter. Hydroid looks more closely. Hidden among and under the rocks are smaller pebbles. These are red, round and about the size of peas. Hydroid starts counting them and comes close to 5,000 when something startling happens. Some pebbles have a pair of dark spots! Suddenly the pebbles come alive. One turns over and rolls out a tail. Hydroid realizes these aren't rocks, these are eggs. The dark spots are eyes. Each *eyed egg* is a fertile egg. And each *fertile egg* has a chance of becoming a fish – a salmon to be exact. Hydroid landed right over a fish nest. Fish nests are called *redds*. Hydroid knows the salmon in this small stream are all chinook. They also are called king salmon, because, one day they could grow as long as four feet to be the largest of all salmon.

But now, the tiny fish are a little more than one inch long. They are called *alevins*. Each has an orange pouch on its belly. The pouch is a yolk sac that provides food during the first few weeks of the salmon's life. The alevins

stay deep in the gravel, hiding from ducks, raccoons and the large fish that prowl the stream, searching for food. Hydroid decides to linger on the grass blade, watching over the young chinook.

Late one night in March, the young fish slip up through the gravel. The yolk sacs are gone. The young fish, now called *fry*, are hungry and ready to eat, but do not stray far from the clump of grass where Hydroid is perched. Their eyes are bugged out, so they are sensitive to light. They have no marks on their bodies to hide them from their enemies. They stay in the shade for two months, grabbing mosquito larvae and other small insects as they drift by.

Student Activity Sheet 1-2

SWEET OBSERVATIONS

(do not open Skittles® bags until step 4)

1. **Statement of Problem:** What are you trying to find out?
 - a. Are the contents in all bags of Skittles® candy the same?
2. **Make a Hypothesis:** A hypothesis is an educated guess.
 - a. Use your prior knowledge about Skittles® to make an educated guess or prediction about the amount of Skittles® in the bag.
 1. My Hypothesis _____
 2. Class Hypothesis _____
 - b. What other predictions (or hypotheses) can you make about the contents of the bag?
3. **Design an Experiment:** Steps to prove or disprove a hypothesis.
 - a. What can you do to the Skittles bag to prove your hypothesis?

(Open Skittles® here)

4. Collect Data: Information gathered through observations.

a. Fill in the table below.

Color	Amount

b. Make a bar graph of your results using centimeter graph paper and crayons.

c. Other observations: (shape, cracked, smooth, inside color, etc.)

d. Class data:

1. Average total _____

2.

Color	Amount

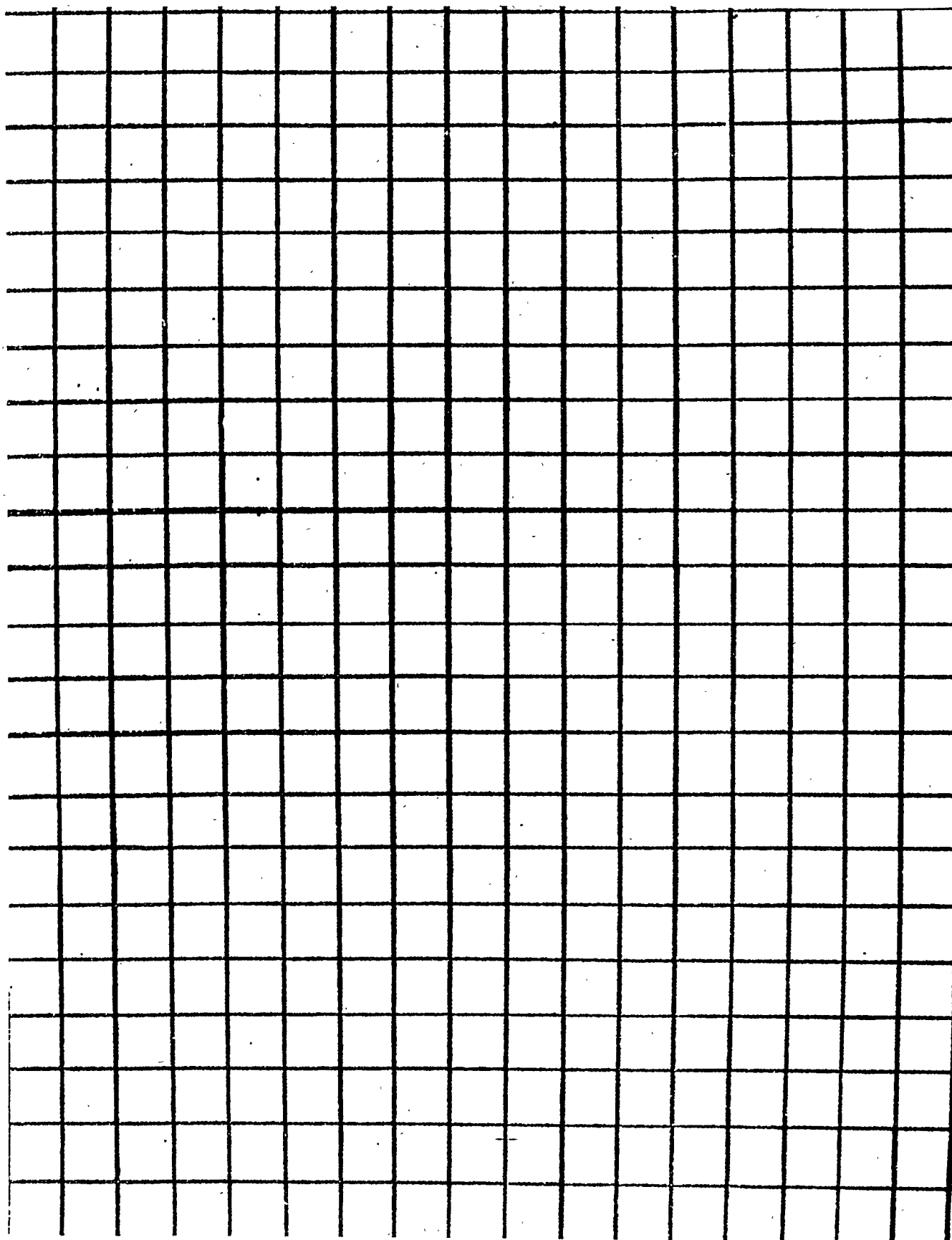
5. Form a Conclusion: Summary of your results.

a. Use your data to make a statement that summarizes your experimental results.

b. How did your predictions add up?

SWEET OBSERVATIONS

(Amount versus Color)

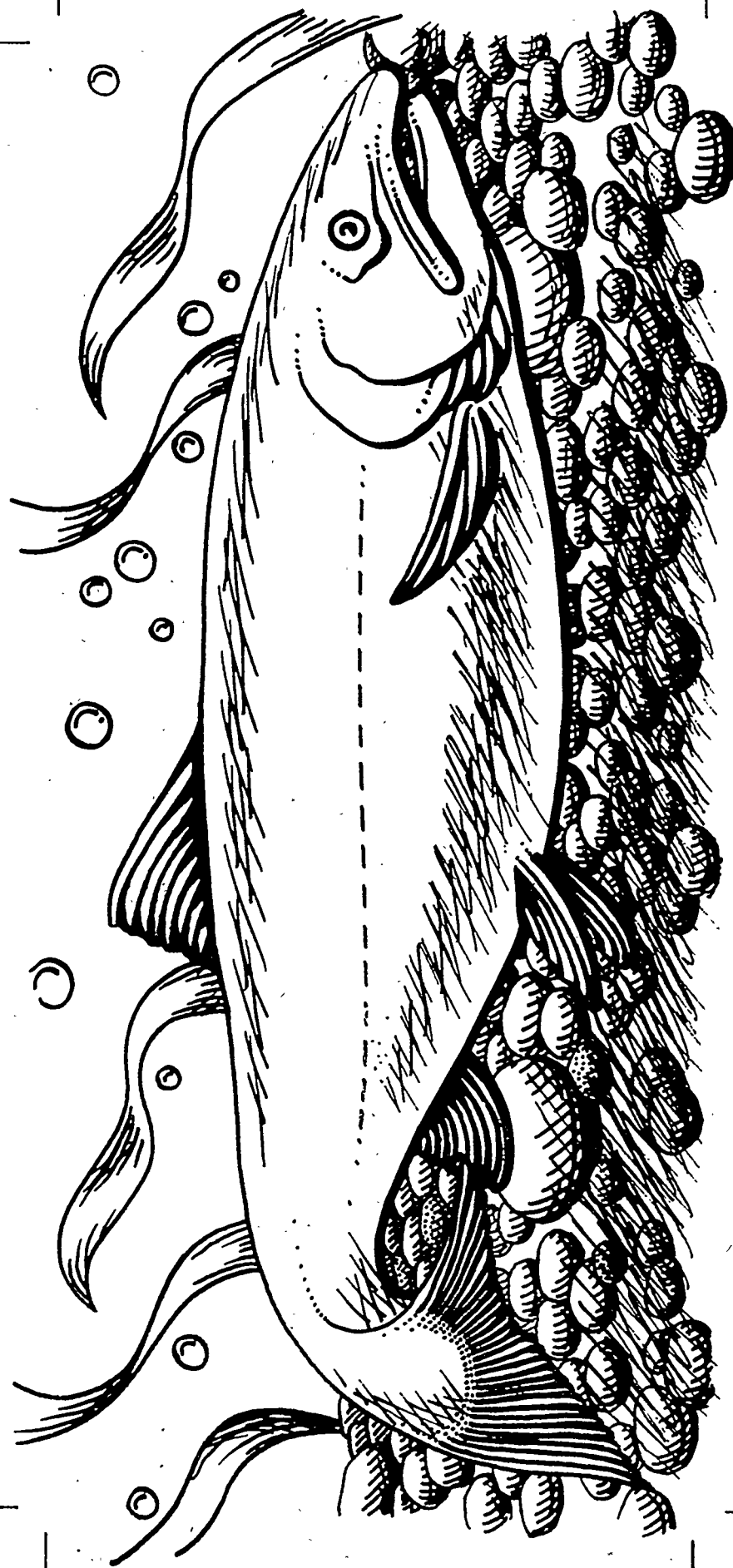


Draw (or write) everything you know about the Pacific Salmon.

(dam, life cycle, environment, saltwater, freshwater, food chain, predators, prey, body parts, and electricity are examples of things to write about)

Name _____ Camp _____ Date _____

SALMON NAME TAG



Reflections Sheet

(in the space provided, write or draw pictures about what you learned in camp today)



NAME: _____ DATE: _____

PACIFIC SALMON LIFE

Salmon, the king of the fish, are one of the great natural resources of the Pacific Northwest. For Northwest Indian tribes, they hold special religious meaning. For all of us in the Northwest, they are a part of our culture and recreation.

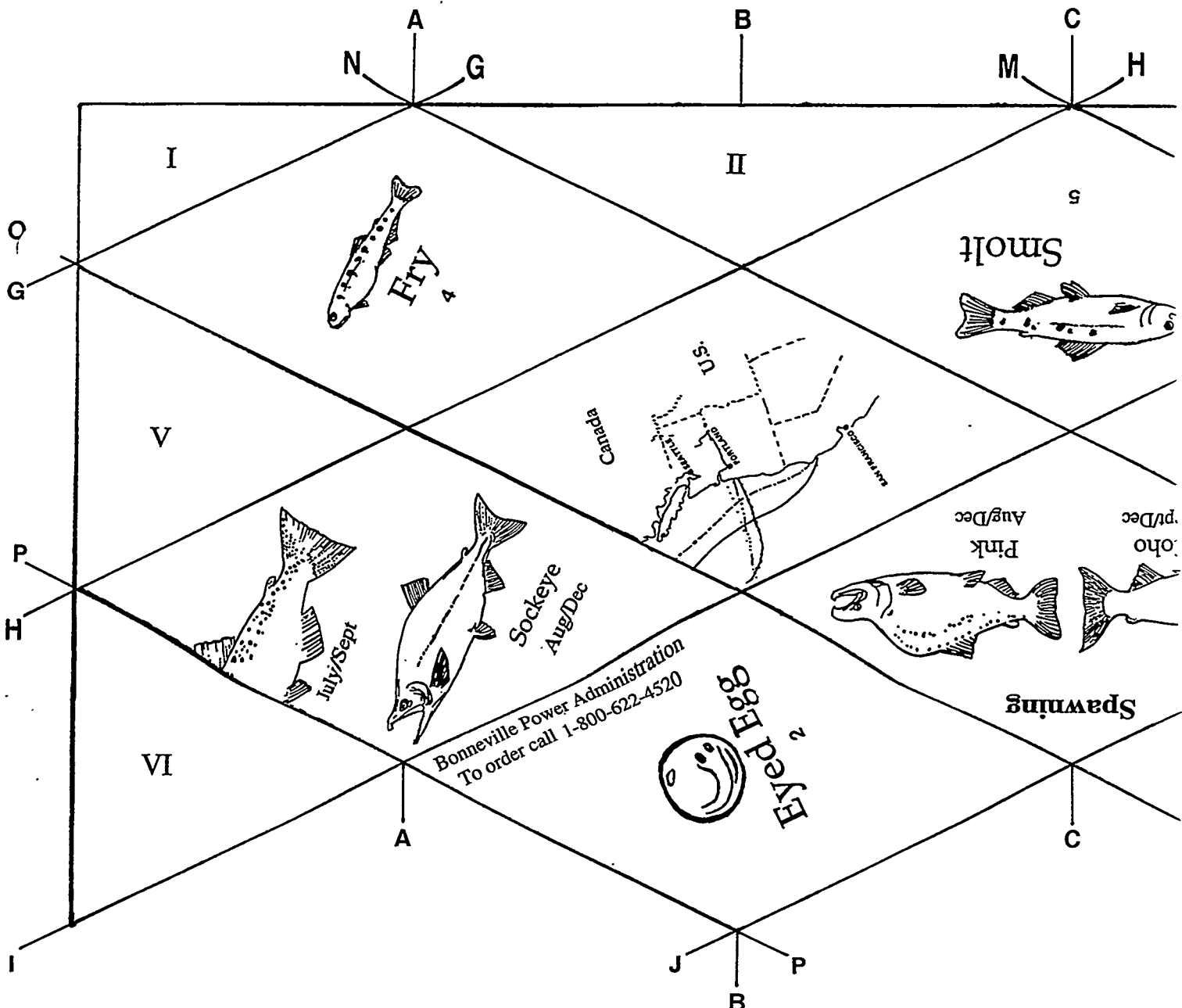
These beautiful creatures have one of the most unusual life cycles in the animal world. They are born in freshwater streams many miles from the Pacific Ocean. When they are strong enough, they swim to the ocean, sometimes traveling hundreds of miles to get there. Fish that are born in freshwater and then migrate to saltwater are called anadromous fish.

Salmon spend their adult lives in the ocean, from one to five years depending on the species. During this time, they may swim as far north as the gulf of Alaska or south to the coastline of California. Then something amazing happens.

In the vast ocean, they manage to find the mouth of the Columbia River. They enter the estuary and head up the Columbia River. With unerring instinct, these majestic fish leap water falls and jump up fish ladders at dams to get back to the exact stream where they were born. Once they reach their birth place, they build nests called redds. Here they lay eggs and spawn, before dying. As the eggs hatch, a new generation of fish will take their place.

The Bonneville Power Administration is working hard to protect these fish at all stages of their life cycle so that future generations can enjoy our majestic salmon. This hexaflexagon uses a special geometric form to show the stages in the salmon's life. It also presents the migration paths of five different species of Pacific salmon: chinook, coho, sockeye, pink and chum.

For additional information call 230-3478 in Portland; or toll free 1-800-622-4519

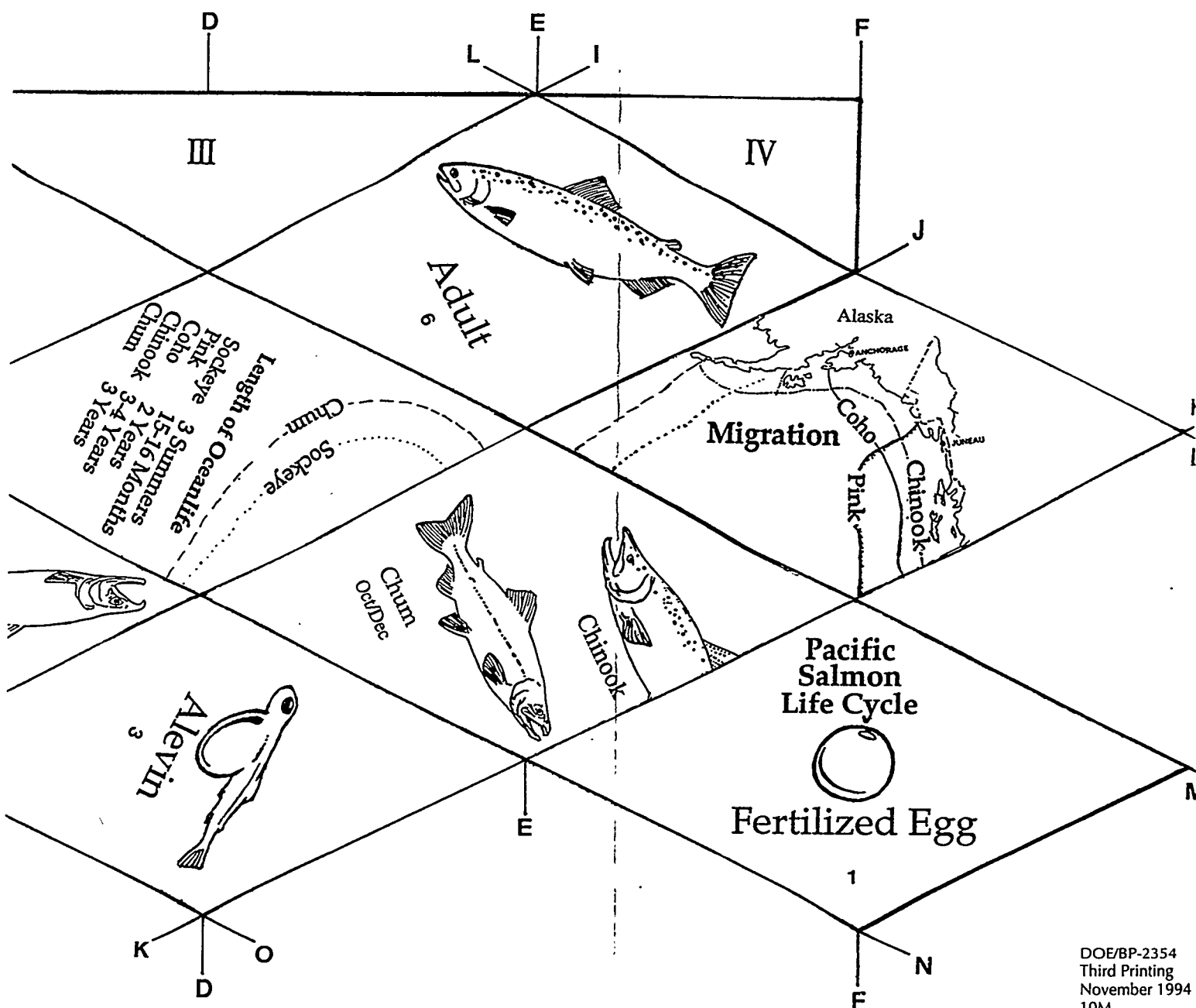


CYCLE HEXAFLEXAGON

To Assemble the Pacific Salmon Life Cycle Hexaflexagon:

Items Needed to Assemble: ruler, scissors, clear tape

- Place drawing with printed side up on a table. Place ruler on paper to connect point A to point A. Using the long edge of one scissors blade, press the scissors on paper and move along the line from point-to-point to make an indent/mark. (This is known as scoring.) Be careful not to cut through paper. Accurate scoring and folding is essential for easy manipulation of the finished hexaflexagon.
- Repeat Step #1 for point B to point B, C-C, through point F-F. When done, A-A through F-F will be vertically scored.
- Repeat Step # 1 for point G-G, H-H, I-I, through P-P. These lines are diagonally placed.
- Cut out the hexaflexagon along the far OUTSIDE border.
- With the printed side up, fold all vertically scored lines face-to-face. (A-A through F-F). Then, straighten out each fold.
- Fold all diagonally scored lines (G-G through P-P) so they are back-to-back. Then straighten out each fold.
- Hold the hexaflexagon with the printed side down and the beak-like flap pointed towards you. Bring the "eyed egg" section to fit over Triangle II. Align and tape open edges.
- Bring the "alevin" section over Triangle III. Align and tape.
- Bring the "fertilized egg" section over Triangle IV. Align and tape upper one-half of section only. Leave two beak-like flaps free.
- Take Triangle VI and align over Triangle I and tape together. Place top-half of beak-like flap showing "fertilized egg" over Triangle VI and place beak-like flap showing "migration" over Triangle V. Align flaps and tape in place.
- Turn hexaflexagon, checking for any open edges. Tape all open edges to allow for maximum use and durability.



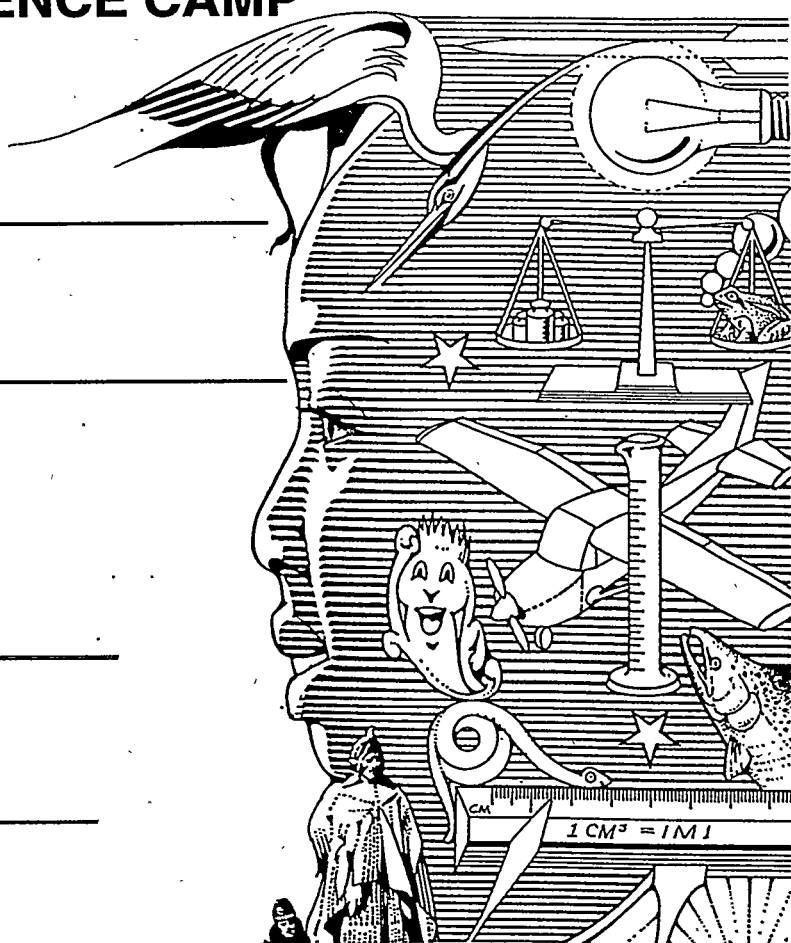
HYDROMANIA SUMMER SCIENCE CAMP

Presented to _____

for _____

(Event)

on this the _____ *day of* _____



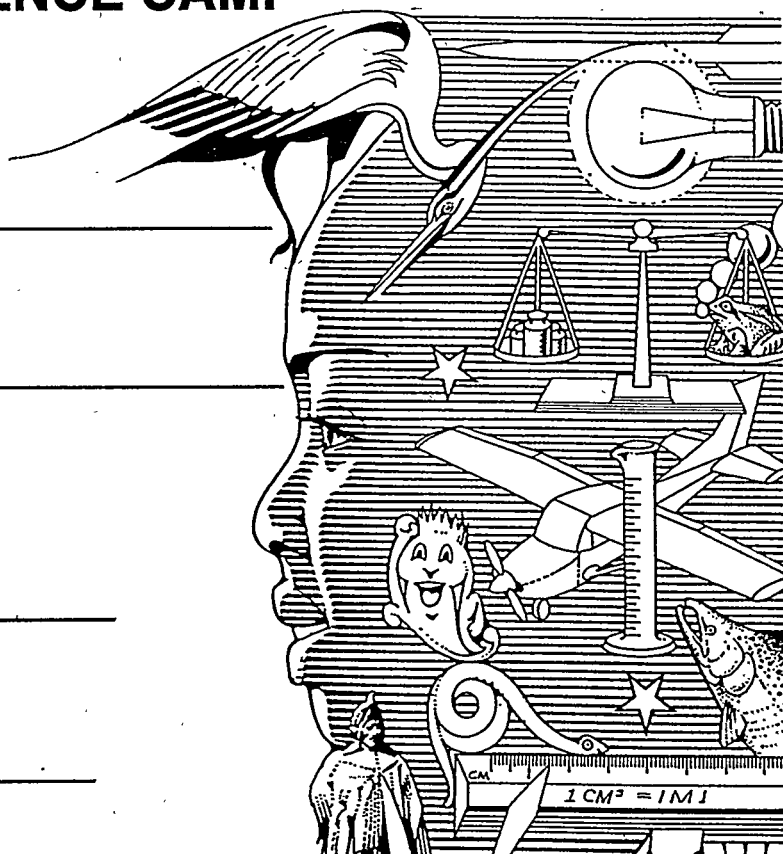
HYDROMANIA SUMMER SCIENCE CAMP

Presented to _____

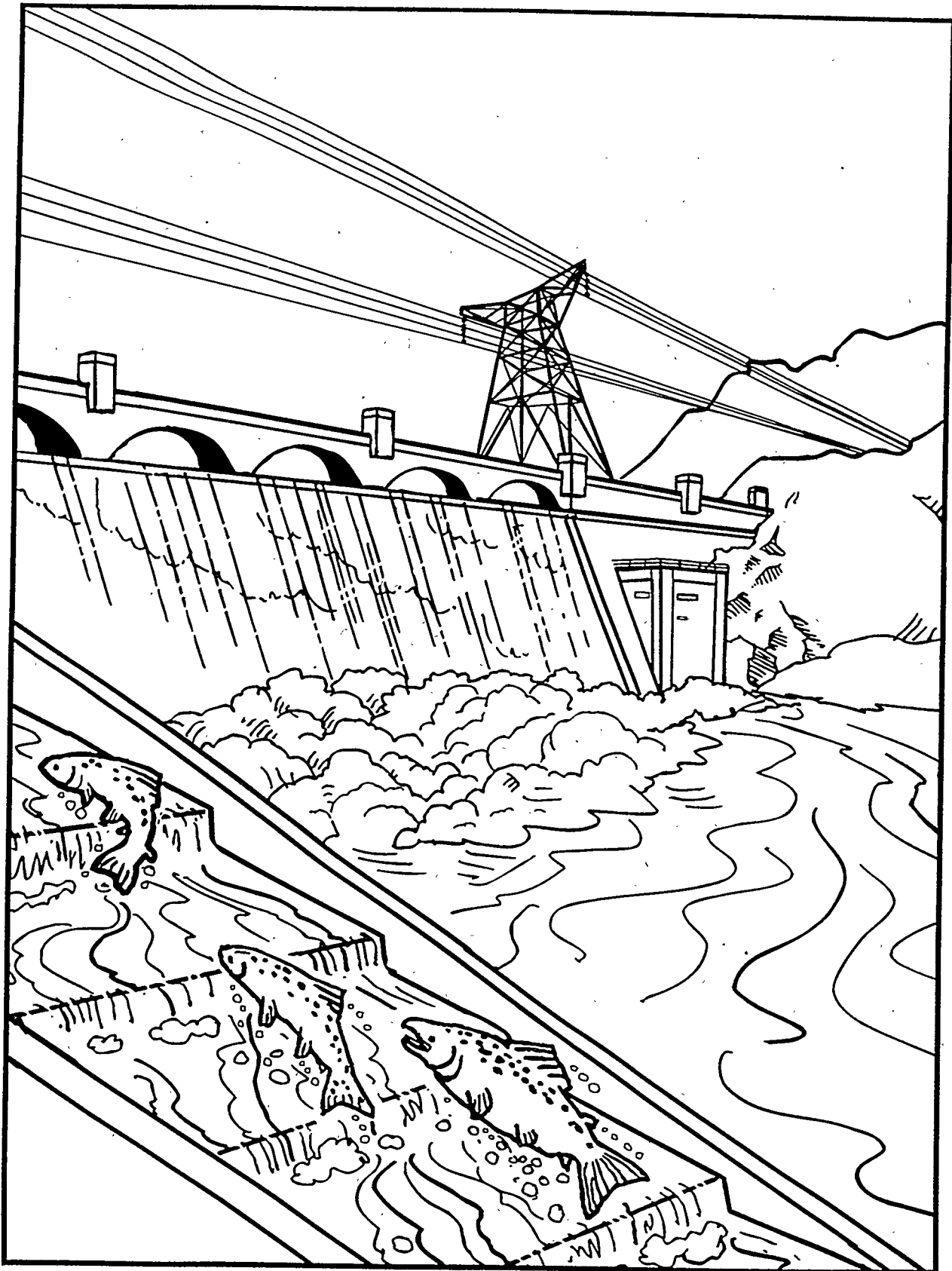
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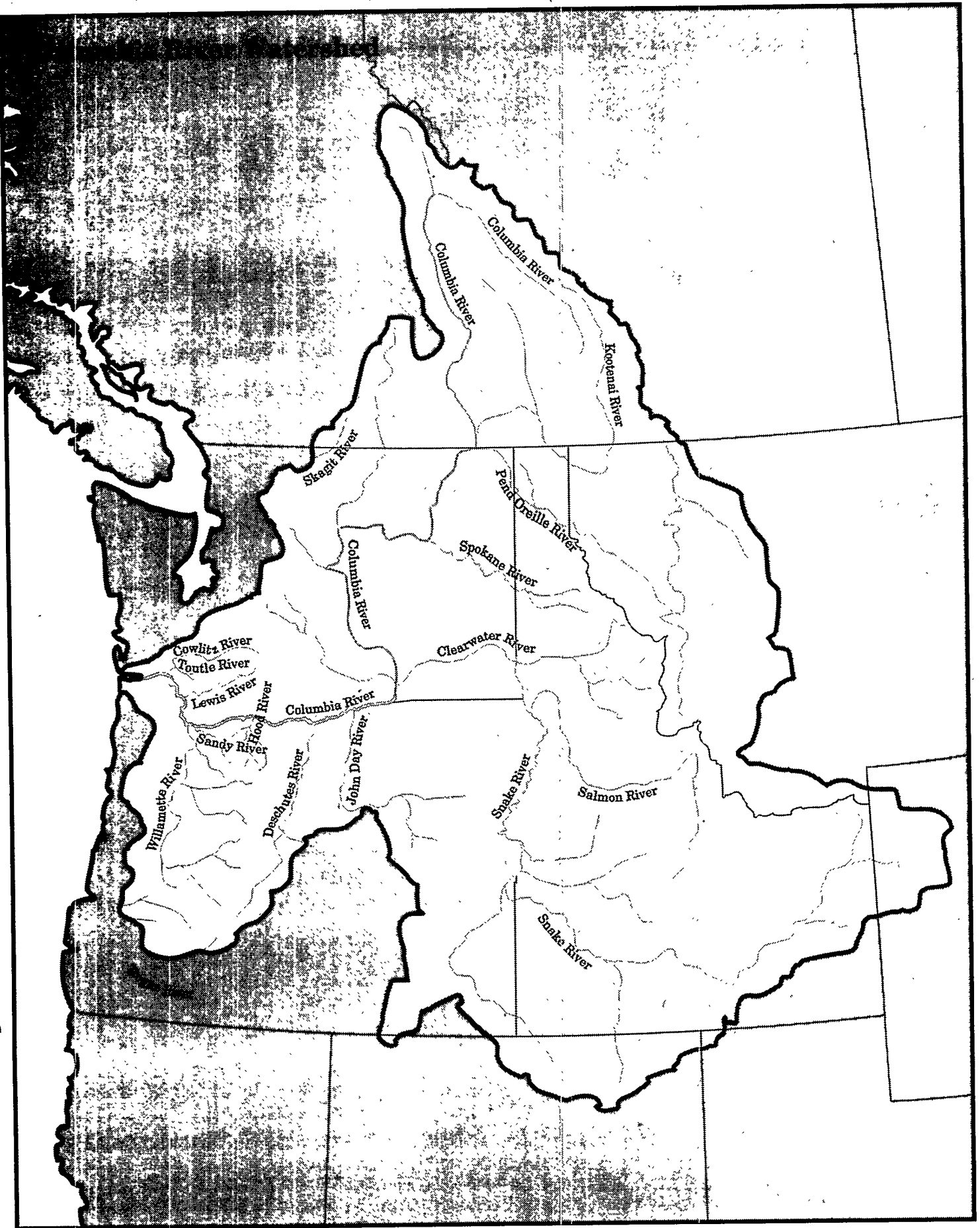
on this the _____ *day of* _____

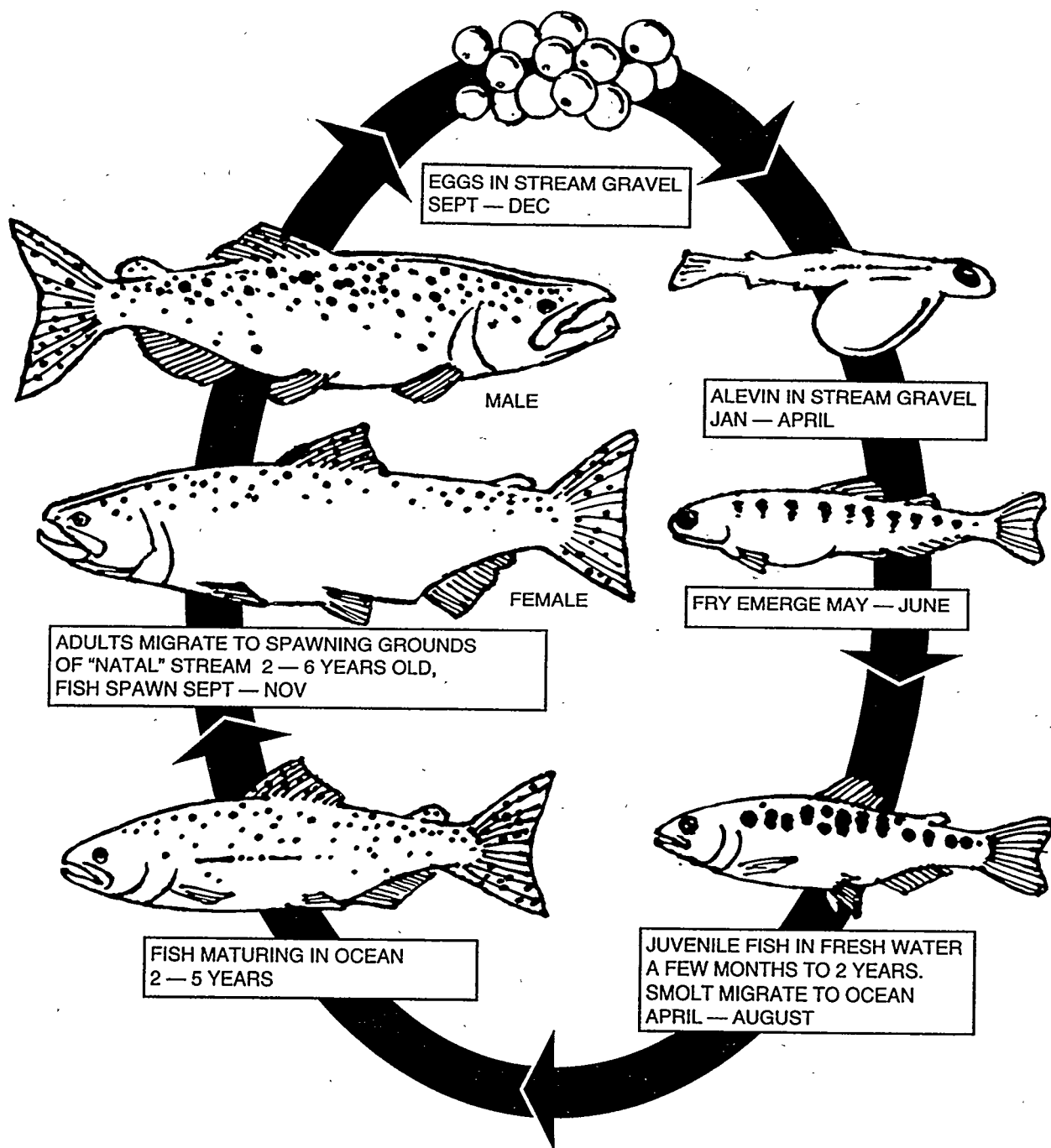


JOURNEY OF THE *ONCORHYNCHUS*

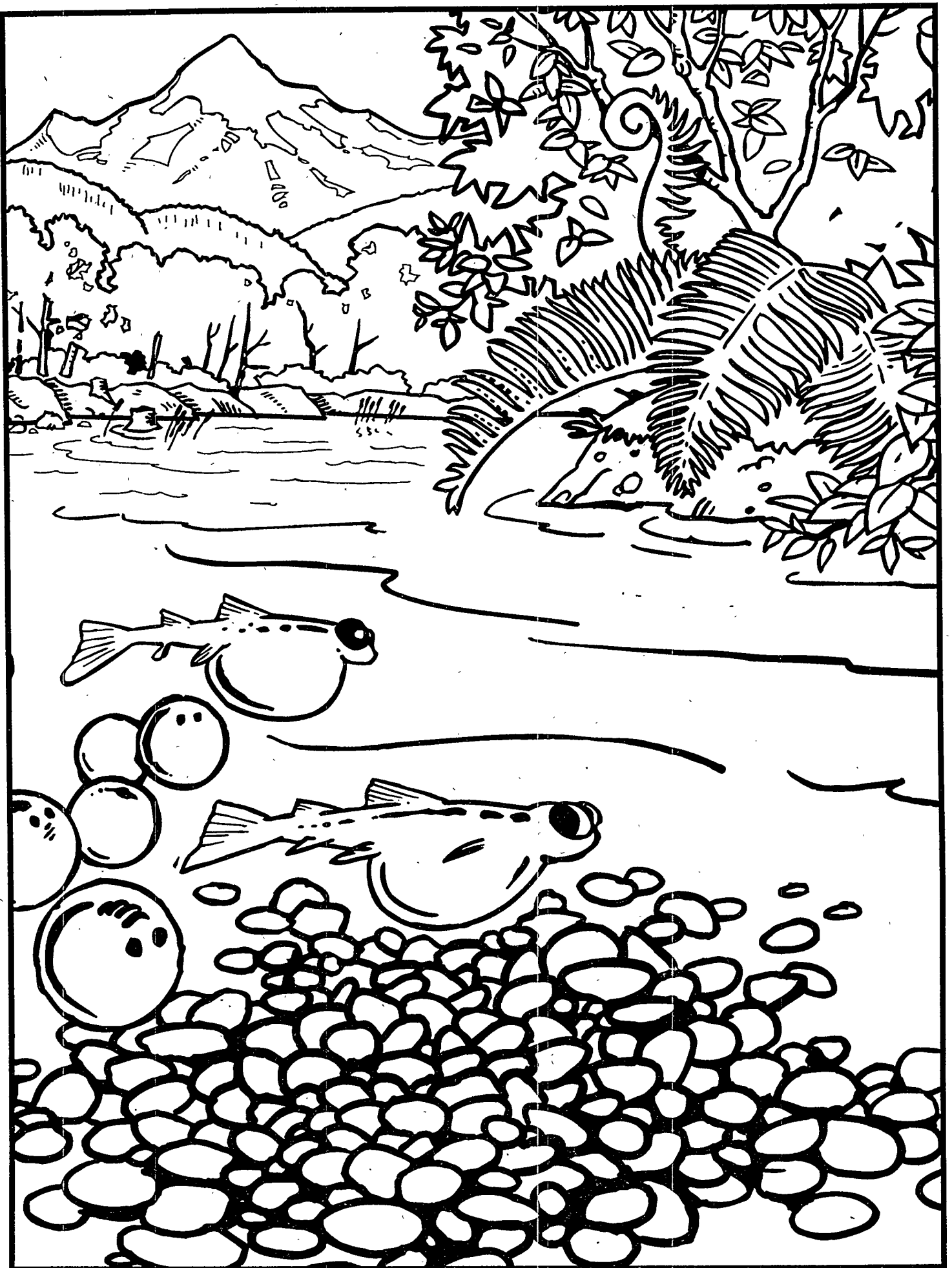


A STORY OF THE PACIFIC NORTHWEST SALMON



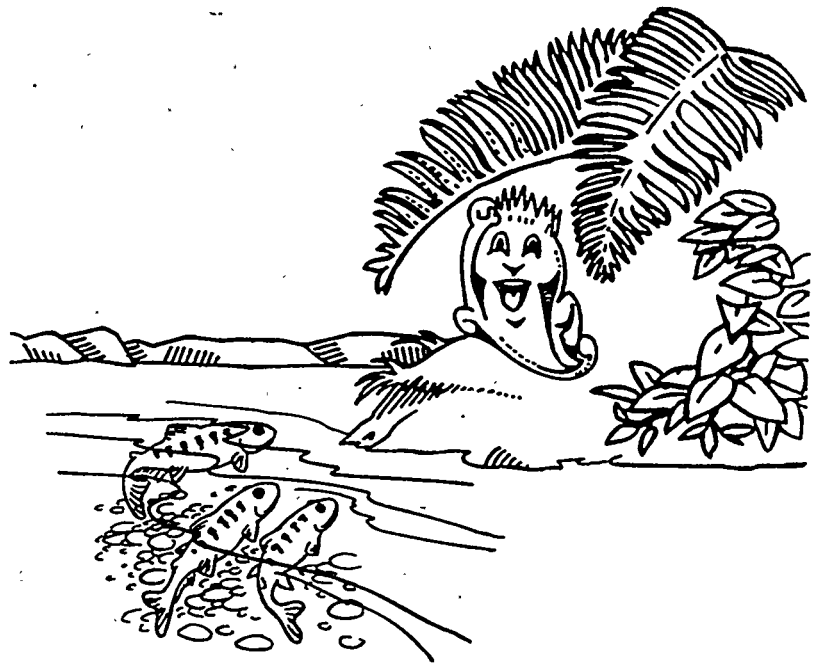


LIFE CYCLE OF CHINOOK SALMON



Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

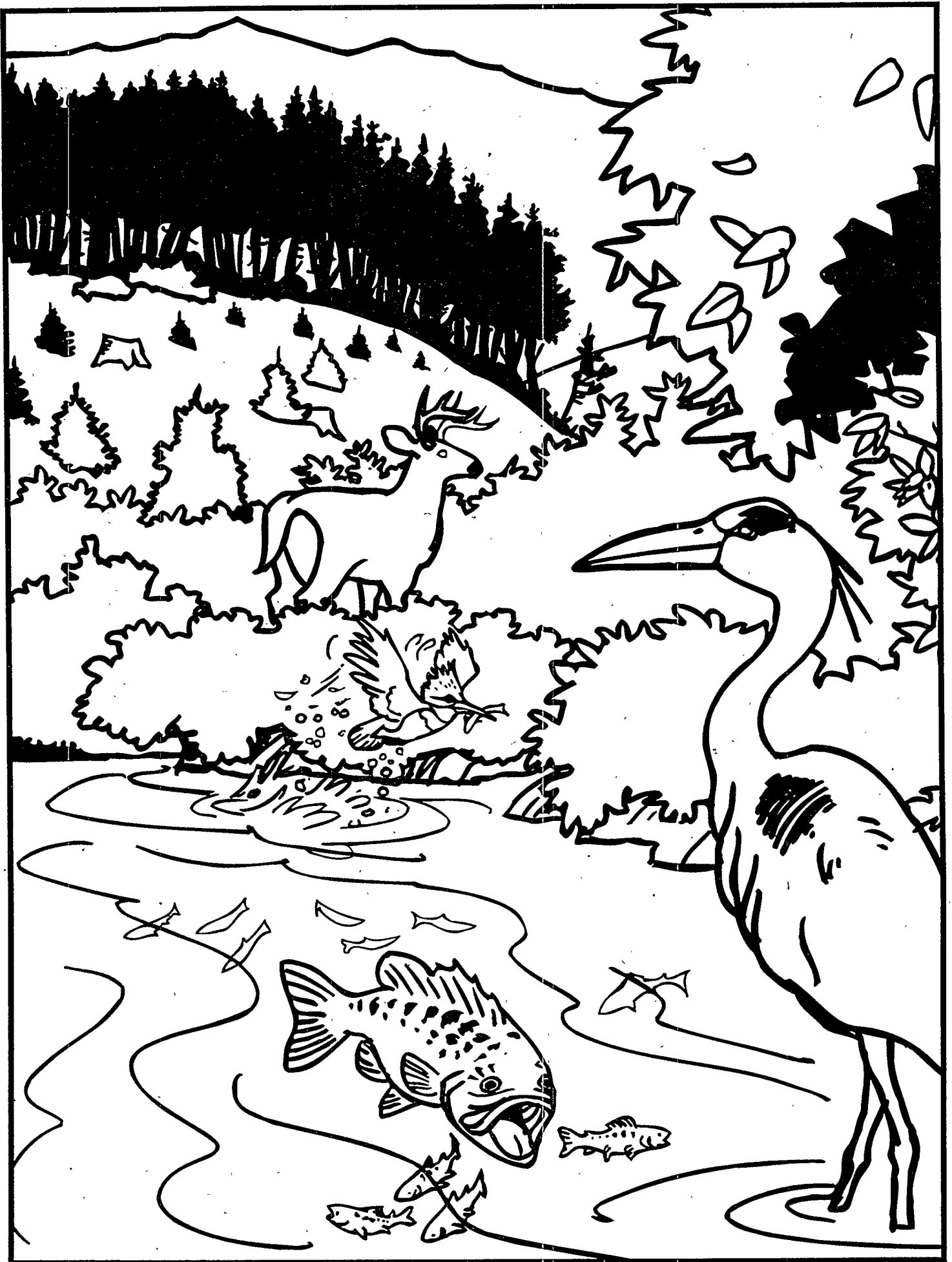


It's December. Rain falls on a small stream low on the mountain's northeast slope.

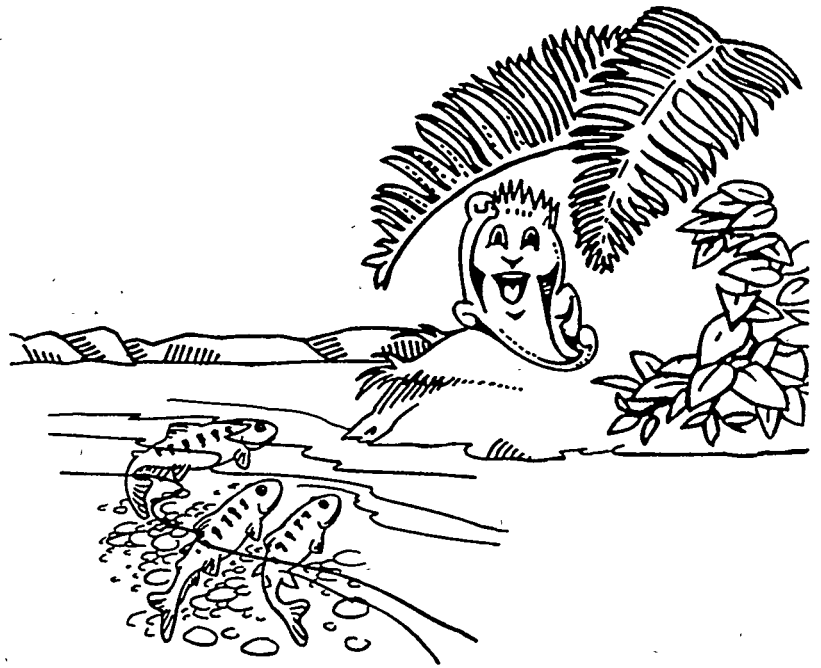
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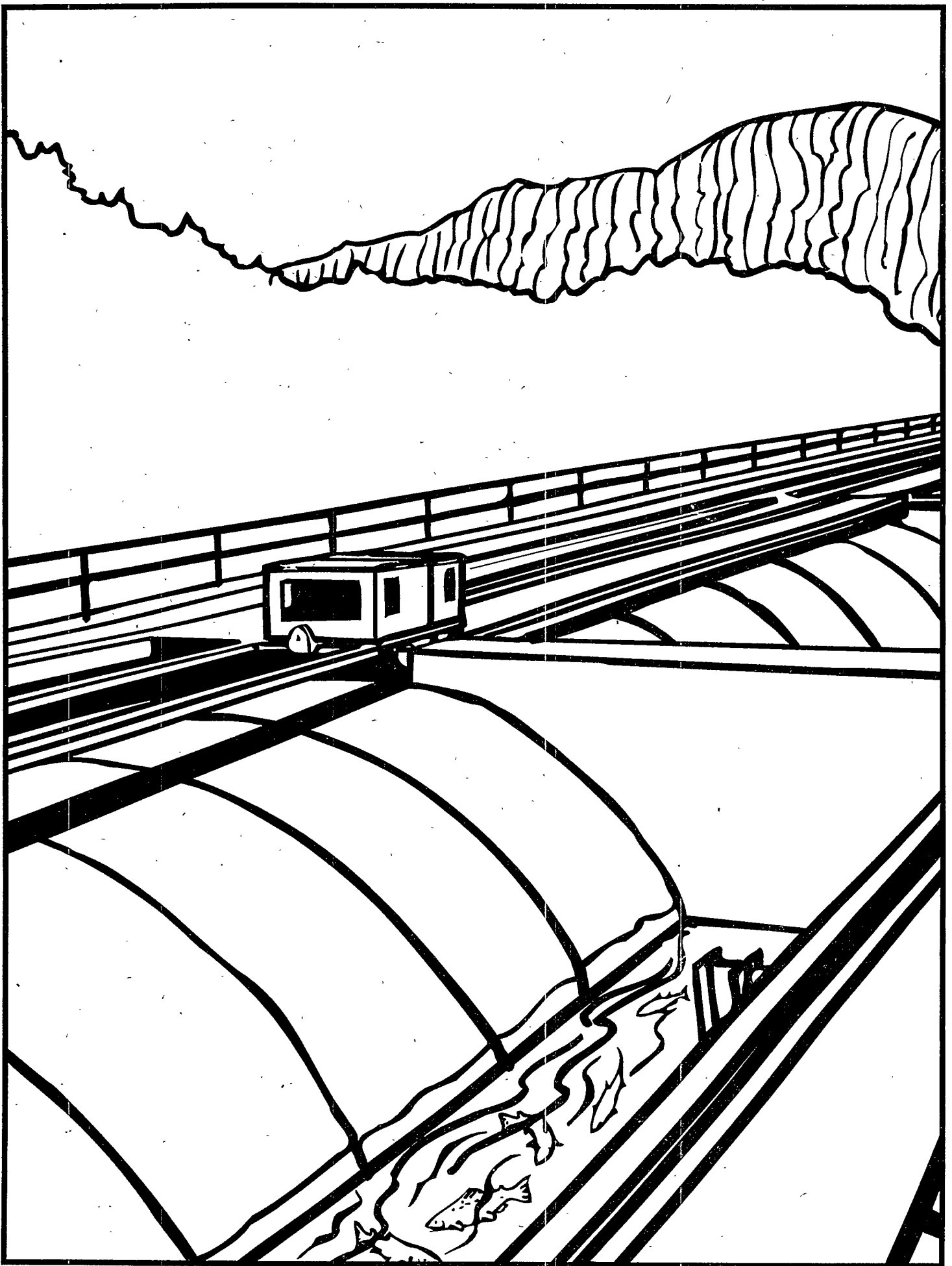
The water below Hydroid is shallow, only 12 inches deep. But it is cool and clear, even in the pools where the water is still. It's easy for Hydroid to see the gravel bottom. Some of the rocks are arranged in a circle, about two feet in diameter. Below the rocks are small red, round pebbles about the size of peas. Hydroid counts 5,000 of them when it sees that some pebbles have eyes! These are eggs. Each *eyed egg* is a fertile egg. And each *fertile egg* has a chance of becoming a salmon. Hydroid landed right over a fish nest. Fish nests are called *redds*. Hydroid knows the salmon in this small stream are all chinook.

The tiny fish are a little more than one inch long. They are called *alevins*. Each has an orange pouch on its belly. The pouch is a yolk sac that provides food during the first few weeks of the salmon's life. The alevins hide deep in the gravel. One night in March, the young fish slip up through the gravel. The yolk sacs are gone. The young fish, now called *fry*, are hungry and ready to eat, but do not stray far from the clump of grass where Hydroid is perched.



It's April. Hydroid's young friends still hide in the pools and slower water. Their sides now have dark bands or *parr* marks to *camouflage* them and to hide them from *predators*. They dart into the stream to grab small insects that live among the stream's rocks. As they move into the stream, they are wide open for attack. Fry are the favorite food of trout and other large fish. Not everything that looks like a branch is a safe hiding place. Some branches turn out to be the legs of great blue herons. Hydroid also warns the young chinook to beware of shapes darting out from trees. The shapes could be kingfishers. The bright blue birds are looking for young fish to feed their own young this time of year. The young chinook learn how to find food and avoid danger.

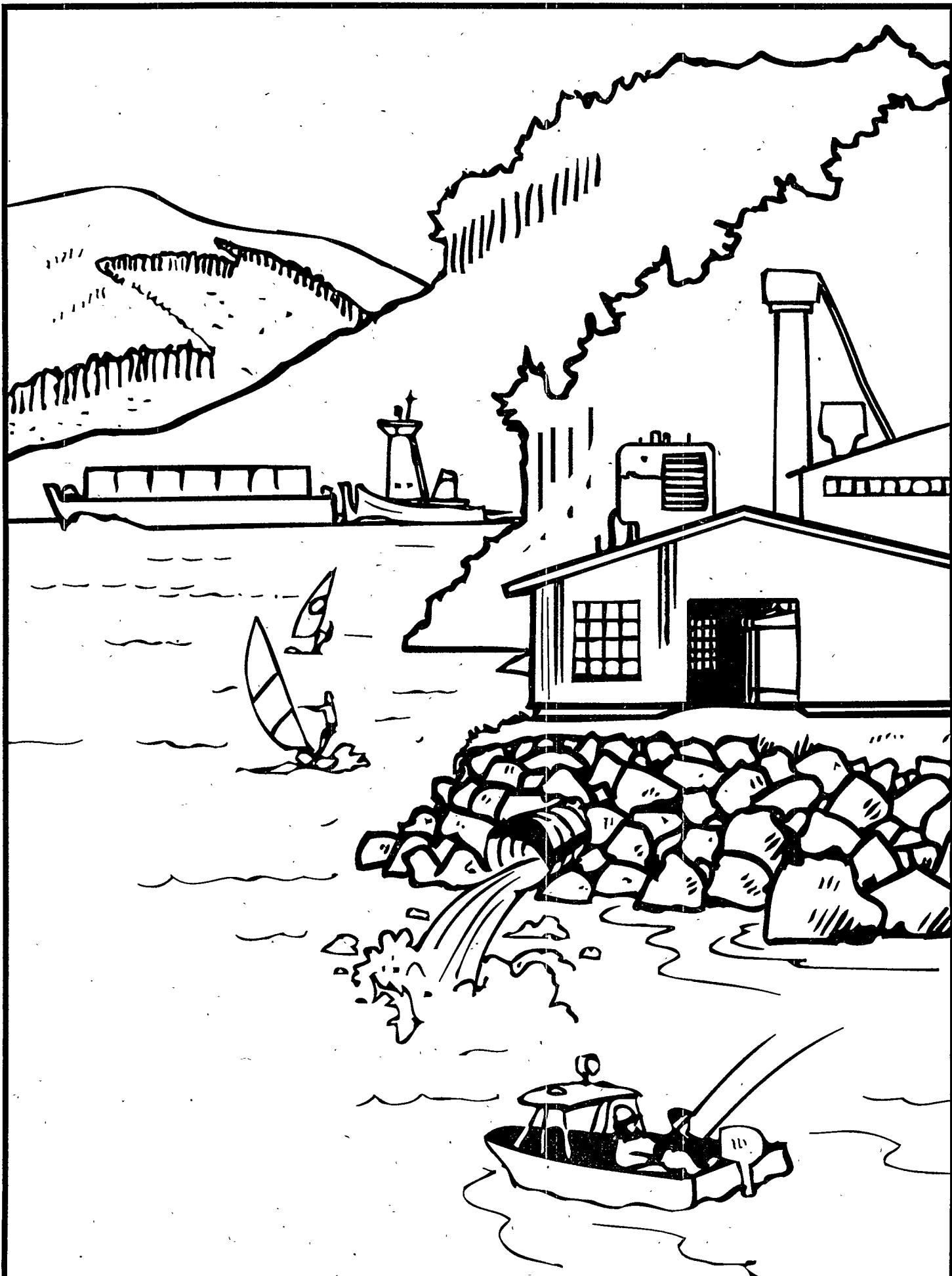




It's April, one year later. Each fish is now about the length of a human finger and are called *fingerlings*. Their parr marks are fading and the young fish are restless. As snow from the mountain above begins melting, the stream rises and the fish move into the swift current. The fish do not swim, they float with their heads pointed upstream. Hydroid travels along with his friends. Their small stream joins Hood River. The fish move down into the water and travel mostly at night to avoid predators. Along the way, they eat worms, flies and larger insects. The fish are growing quickly.

Hood River joins the Columbia River. Hydroid and the fish are in the *reservoir* created by Bonneville Dam. The dam makes enough electricity to heat all the homes and turn on all the lights in Portland. It does this without polluting the air. But the fish are not all that happy with the reservoir. There is no current to tell them which way to go. The slow water is warm. Chinook and other salmon like cold water. Bass, walleye and bigmouth minnows like warm water and they love to eat young chinook. But Hydroid knows the greatest danger lies ahead. Dams produce power by sending water past *turbines*. The blades are not likely to hurt the salmon, but dropping from the top to the bottom of the dam can. It's like falling from the top to the bottom of a nine story building in less than one second.

The current draws the fish to the mouth of a turbine when Hydroid spots a screen wall ahead. Hydroid flattens itself against the screen and cushions the young fish as they ride the screen up, past the turbine into a tunnel within the dam. But the danger is not over. The ride makes some fish dizzy. Gulls and other birds know this. They wait on the lower side of the dam and pick off the stunned fish. Hydroid quickly moves the Hood River chinook low in the river.



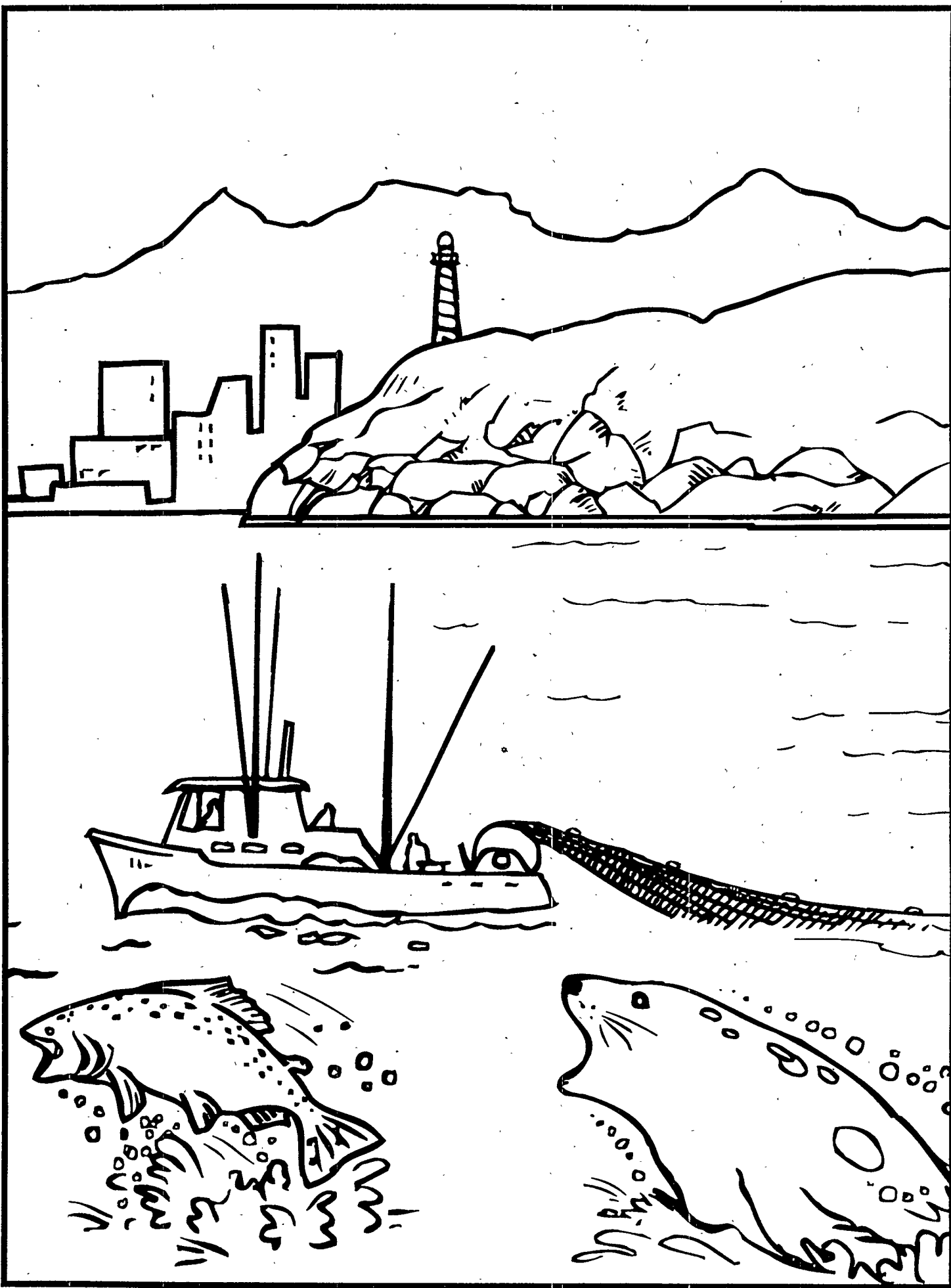
The fish are growing quickly. They are sleek and silver and almost four inches long. They are becoming *smolts*.

By midnight the next day they pass between Portland and Vancouver. In cities, rainwater hits parking lots and streets and shoots straight into the nearest storm drain. Along with it comes water leaking from old garbage dumps, soap from washing machines, chemicals from gardens and lawns. Someone has recently changed the oil in a car and poured the oil down the sewer. Hydroid coughs on the oil fumes and quickly steers the Hood River smolts away.

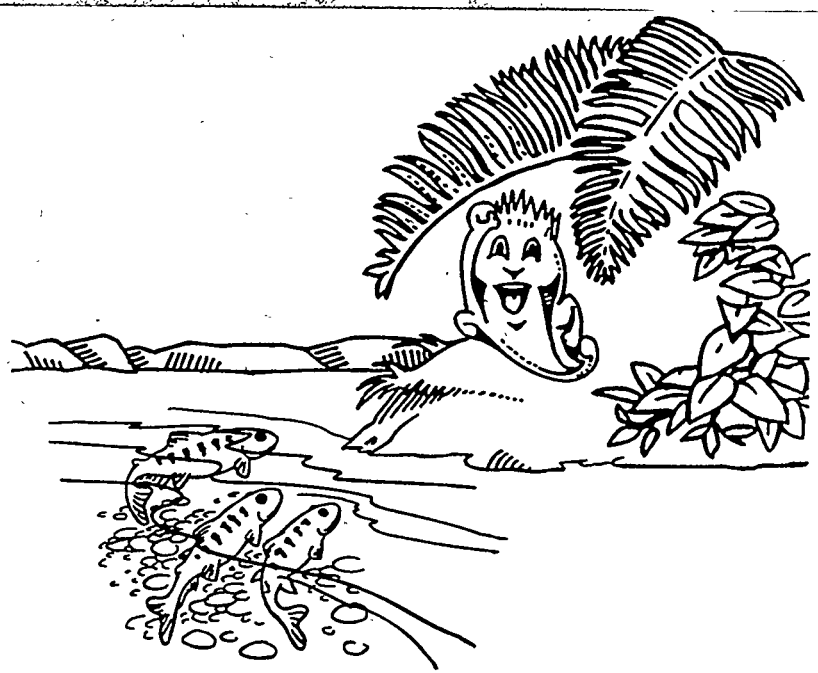
A huge number of fish come swimming in from the left. Most are chinook from the hatcheries of the Willamette River. Fish hatcheries replaced streams that were flooded when dams were built, or were paved over when cities were built. People hoped to replace wild fish with hatchery fish. But hatchery fish are raised in the protection of concrete ponds. Now they are in the stream, they are not as quick to hide from danger or as skillful in finding food. Not as many survive the journey.

Among the Willamette fish are some smaller salmon. These are the wild *coho* salmon of the Clackamas River.

A fat fly bobs on the water above. Hydroid notices a shiny spot on the fly and tries to warn the young fish away. Too late. An angler catches a young salmon. The Hood River chinook learn another lesson.



It's a beautiful day in late June. The river has suddenly become wide and shallow. And it tastes different – it's salty! The Columbia River is meeting the Pacific Ocean. The area where the salt water of the sea mixes with the fresh water of the ocean is called an *estuary*.

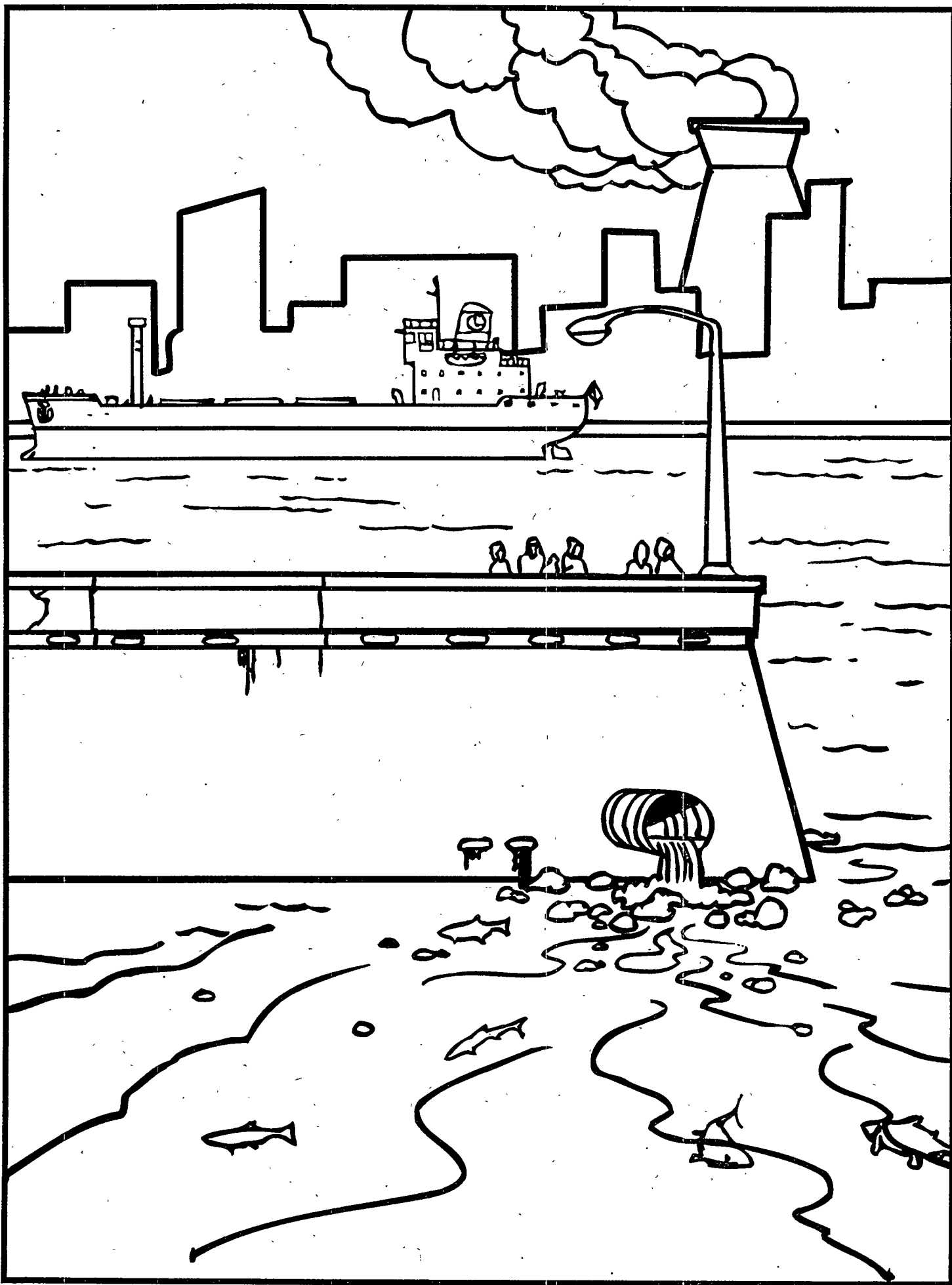


The bright June sun warms the water making Hydroid feel lighter and lighter. Hydroid evaporates and is soon floating in the air above the Pacific Ocean. The chinook swim head on into the cool ocean currents, following the schools of anchovies, herring and shrimp that will lead them north to the waters off Alaska.

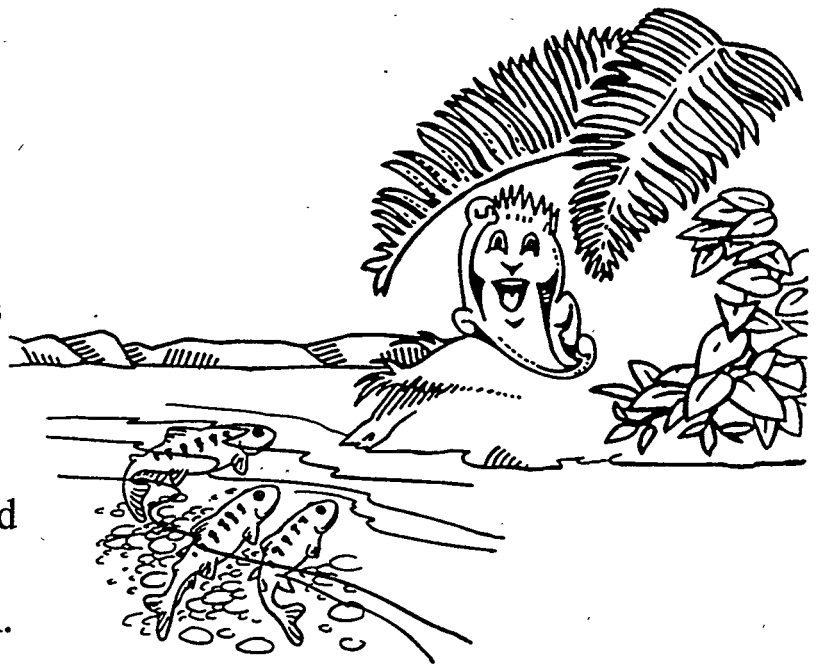
A boat is stretching a long fine net along the water. The Hood River fish are small enough to swim through the openings in the net. This time next year, some will not be as lucky. They will be larger. They will find themselves among the fish now being pulled onto the deck of a fishing boat.

They swim with clouds of bright red *sockeye* salmon getting ready to return to their Alaska rivers. Near shore they meet up with the humpbacked *pink* salmon and *chum*, or dog, salmon. By their third year, Hydroid's friends are three feet long. Their skin is two-toned with a dark greenish back and silver sides and belly. Their backs and sides are freckled with dark black spots as camouflage. The marks on one fish are deep, ugly. These are not spots, but old wounds made by the teeth of a sea lion.

By their third year, a secret signal from Nature turns the Chinook south, back toward the Columbia River.

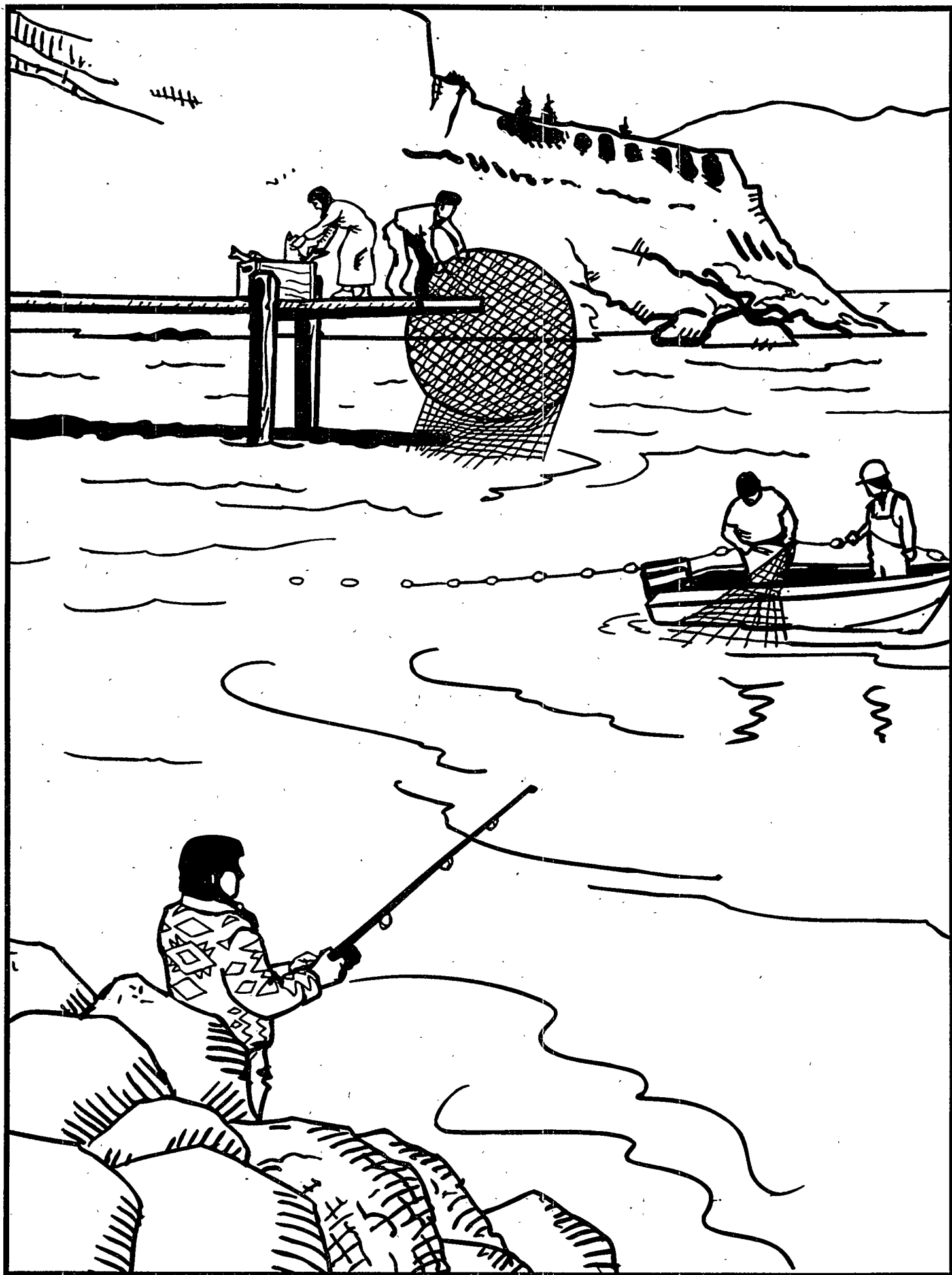


It's April. Below, Hydroid sees that nine of the Hood River chinook have avoided all the ocean's perils to come back to the Columbia. The clouds ahead of Hydroid meet cold air and rain on Oregon and Washington. The river rises and the chinook meet the current head on.



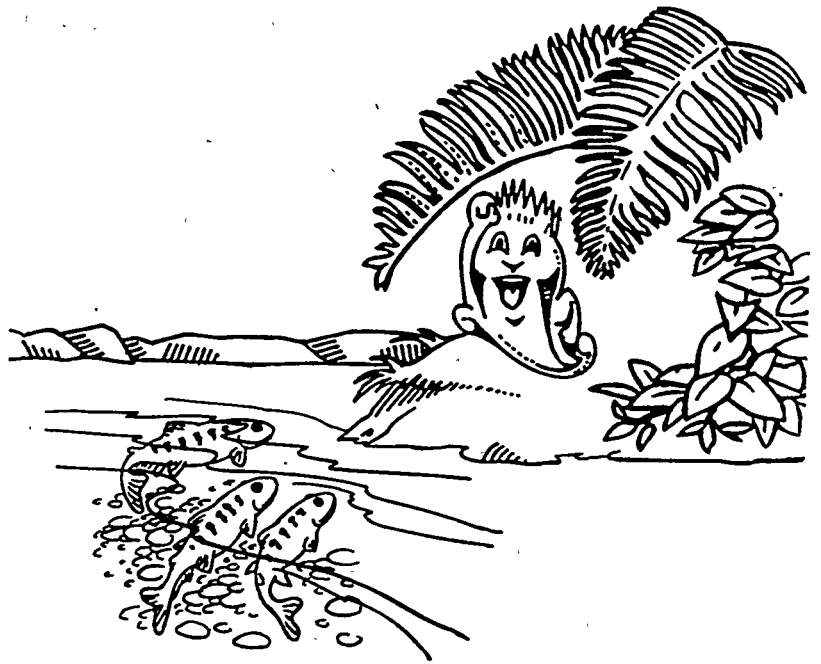
Suddenly, they are no longer hungry. All they want to do is swim, quickly, up the river to home, to their little stream off Hood River. They steer clear of the warm water released by factories and power plants near Longview, Kelso and Rainier.

At Longview, a small group of chinook take a left turn up Washington's Toutle River. At Portland, another group takes a right. The surviving Willamette chinook are heading back to their hatcheries. The Hood River fish push straight ahead, toward home.

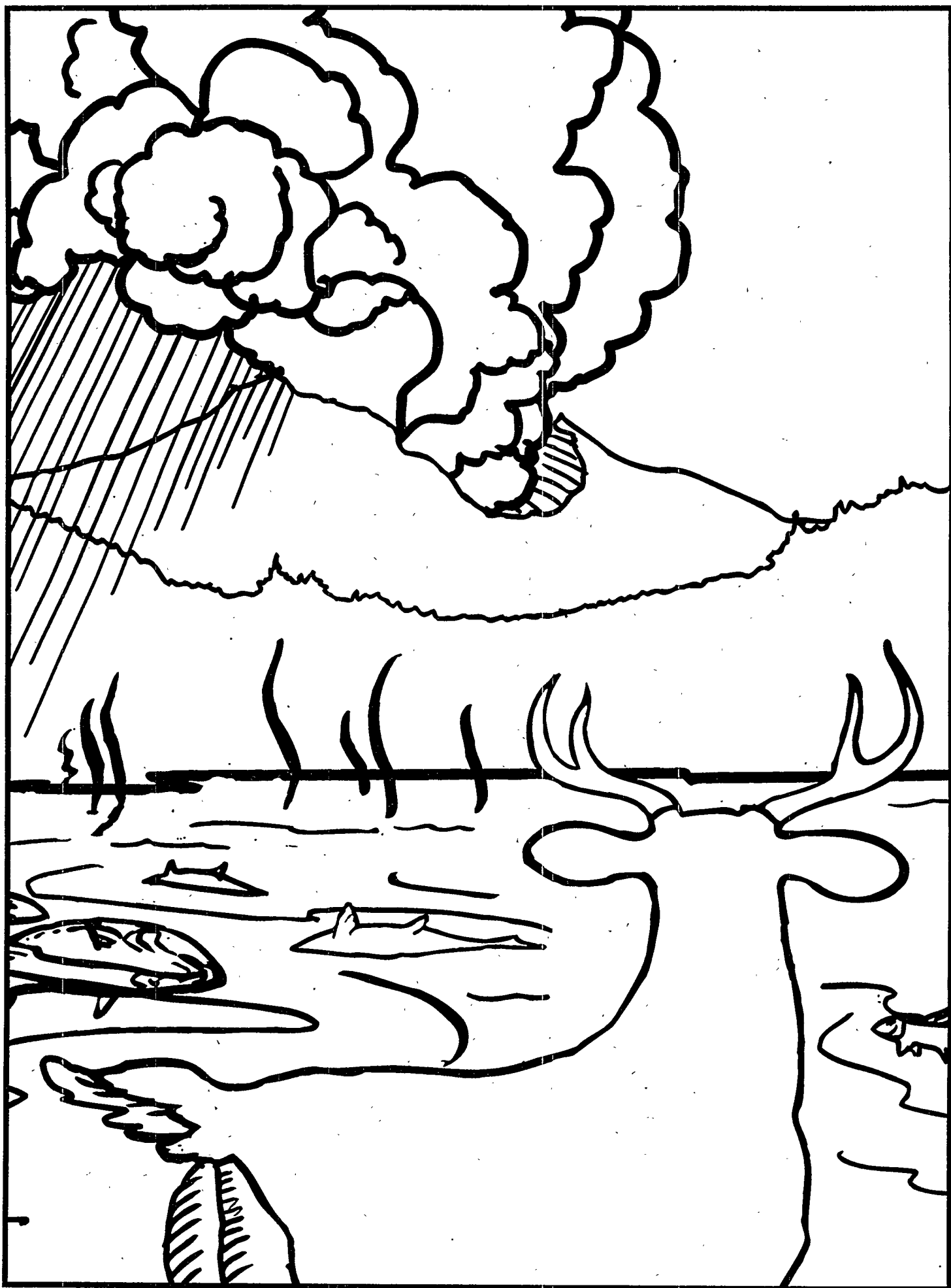


Not all the Willamette River spring chinook make it back to their hatcheries. Just south of Portland is Willamette Falls. But it's not the steep waterfall that worries the fish. It's the shadow of a wall of boats. And there is something new for the Willamette fish.

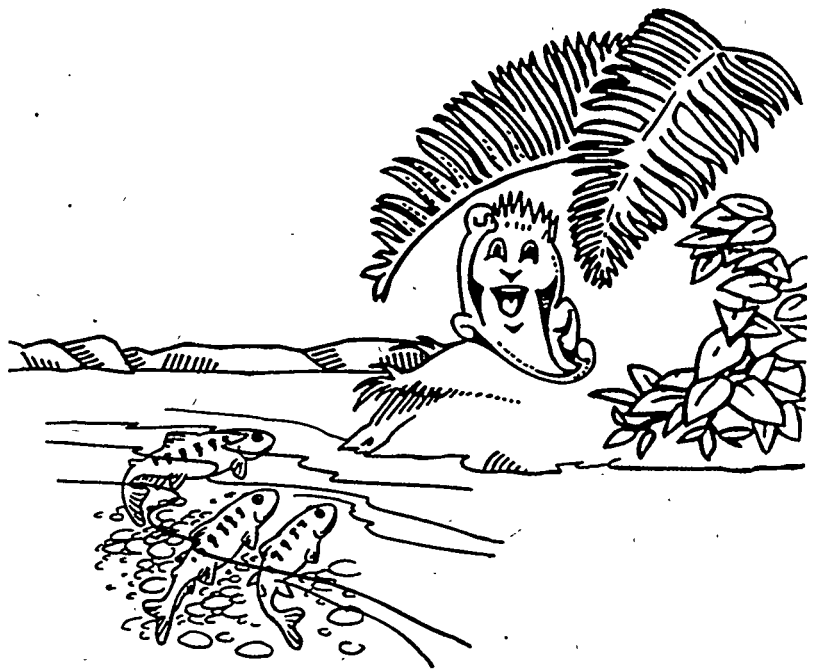
A strange-looking net sweeps through a pool of water at the base of the falls. The person at the other end of the net is a member of the Yakama Indian Tribe. His net is called a dip net. For thousands of years, salmon have been part of tribal culture and religion. The fisherman stands all day, sometimes all night, sweeping the water with a net at the end of a 25-foot pole. He stays until he has enough fish for his family and his tribe.



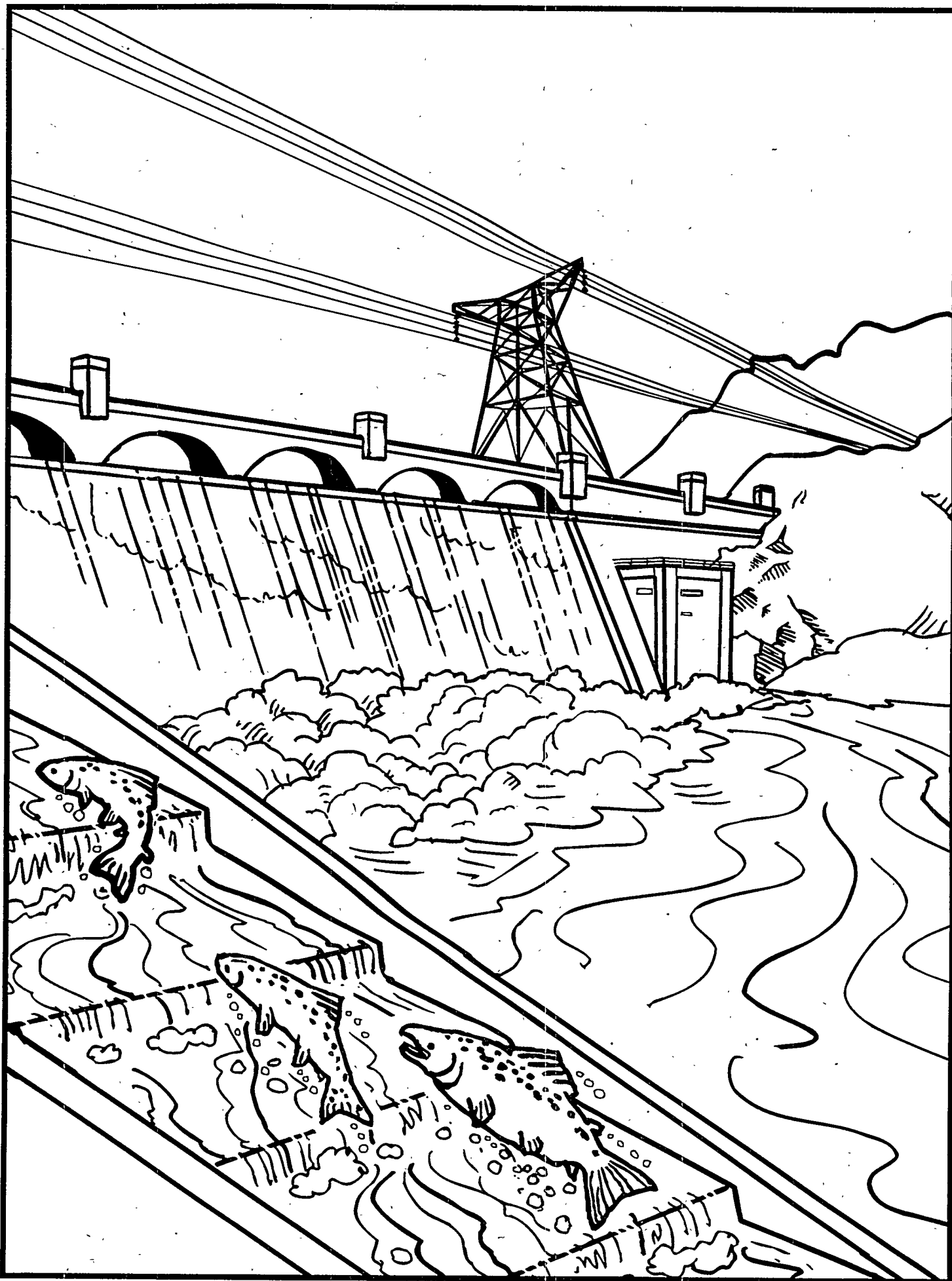
Two years ago, the little coho from the Clackamas River came back as adults. Seventy-five of them made their way to the Clackamas. Fifty of them survived to return to their home streams, build redds and lay eggs. Chinook may spend three years in the ocean. Coho most often spend only two years in the ocean. In fact, the eggs they laid hatched long ago. Another group of wild coho has already left the Clackamas and is on its way to the sea.



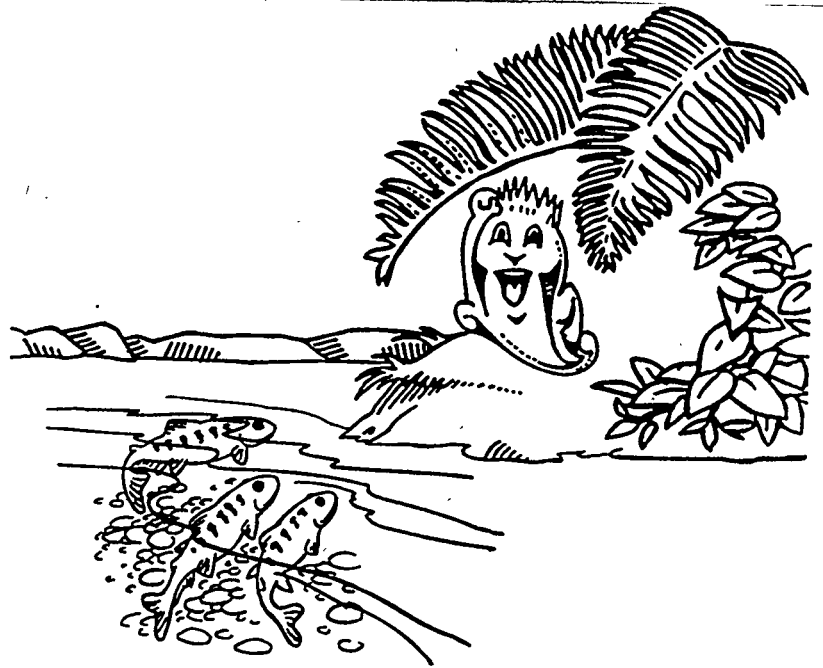
The salmon of the Toutle River have different story to tell. But the chinook that swam up that river 14 years ago did not live to tell the tale. Scientists were keeping a close watch on the mountain they call St. Helens. The Indian Nations have long known this mountain. They called it Loo-Wit, the keeper of the fire. On May 18, at 8:32 a.m., the mountain blew its top. Hot ash covered the Northwest from Washington to Montana. The blast blew down all the trees in its path. The hot mud washed the trees into the Toutle River. It boiled and buried everything in its path, including the river's brave salmon.



No one thought the salmon would ever return to the Toutle. But the salmon proved them wrong. Within two years, chinook found their way again to the river's mouth and began building their nests.



Hydroid has joined other water droplets to form a cloud over Mount Hood. Below, the final seven Hood River chinook are facing the last part of their journey home. They come face to face with a big wall. It is the front of Bonneville Dam. The fish must get past the dam. They search for the fastest water.



The water is flowing over a set of stairs. The fish use all their strength and jump through the water over each smooth flat step. It's hard work. Two of the fish don't make it. Five reach the large lake of Bonneville Dam's reservoir.

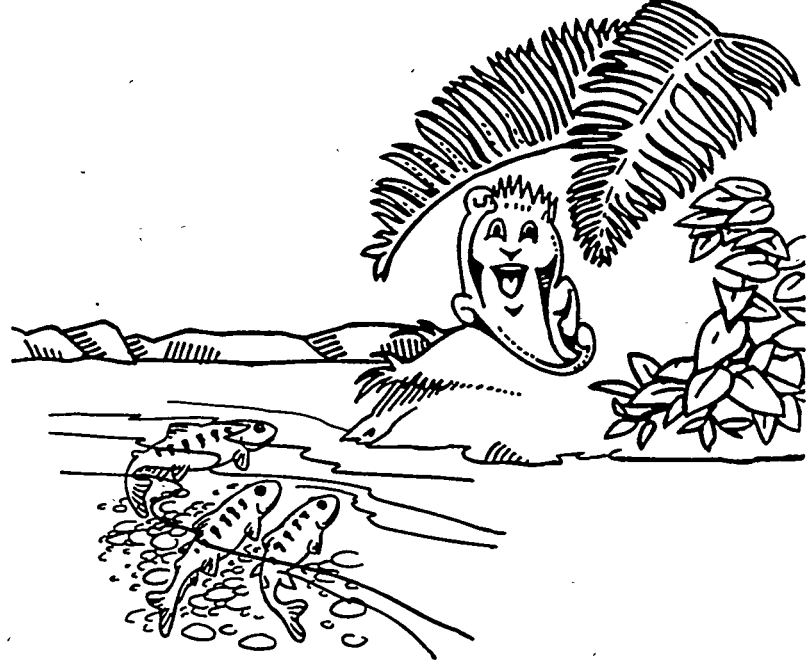
Two of the chinook get lost in the reservoir. The last three chinook make it to the mouth of Hood River. They are weak from their travels. Their skin is dark. The male's snout is curved into a hook. They are thinner than when they entered the Columbia. Yet the sides of two of the fish are bulging. These are females full of eggs. They are in a hurry to build their nests.

Hood River changed in the four years they were gone. This winter, loggers cut a stand of trees from the side of the mountain. A farmer cleared forty acres of land to put in a new orchard. Others sent their cattle into the stream to drink. The cattle hooves trampled the stream bank and killed the plants, leaving a trail of mud. Spring rains washed a heavy load of dirt into the river. The water must run higher to clean the river.

The clouds next to Hydroid brush the top of Mount Hood and rain fresh water down the mountain side, through the streams and to the waiting fish. They begin to move up the river.



One of the females does not make it up Hood River. The other two move on. They have just one mile to go. There is not much time now. They must get home soon.



And there it is. A right turn and they are home at last. The stream of their birth. They were once little fish here.

Now they are adult salmon, nearly four feet long. The female chooses a shallow spot in the shade of a clump of grass. The water runs fresh, but not too fast. She begins to build her nest. For the next hour, she moves over her chosen spot, flipping her tail to move the gravel into place. Finally it feels just right. She settles in one last time. The male swims up close to her and presses her side with his body. She lays her eggs. He fertilizes them. The female moves upstream of the nest. With one last effort, she flips up fine pieces of gravel to cover and protect her eggs.

Their work done, the fish rest in the stream. In a few days, they die. Hydroid watches as their bodies drift down the stream to become food for the crows, raccoons and smaller creatures of the water. The small creatures are food for the Hood River chinook that hatch next year. The droplet has been watching the fish so closely that it has not noticed that its cloud has moved closer to the mountain.

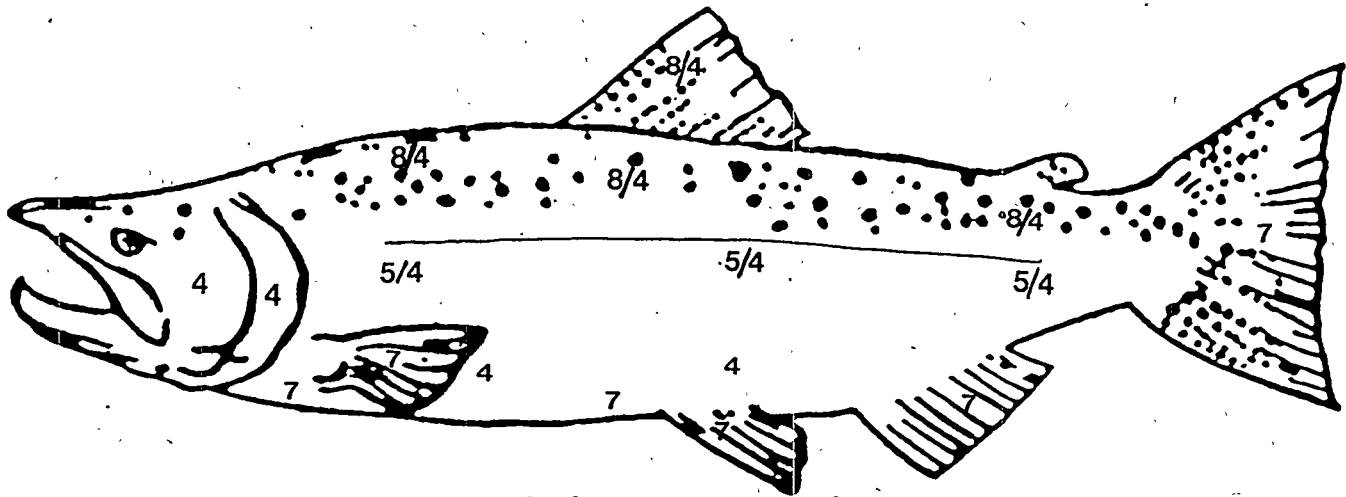
Hydroid's cloud brushes against the tip of Mount Hood. A gentle rain falls on a small stream low on the mountain's northeast slope, 50 miles east of Portland, Oregon. Several drops hit the arching blades of grass shading a shallow pool at the edge of the stream.

Spawning Colors of the Pacific Salmon

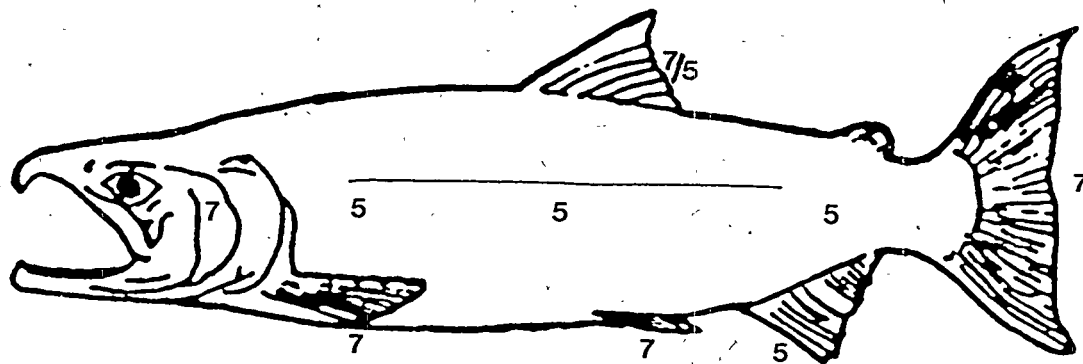
Using the color key provided, color the five Pacific Salmon.

After you are done, the salmon will be wearing their bright spawning colors

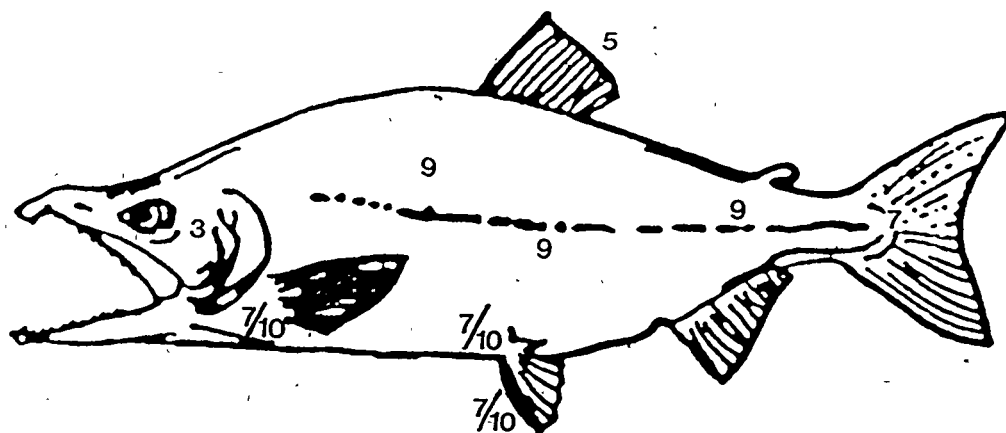
- Color Key:
- | | |
|----------------|-------------------|
| 1. Purple | 6. Turquoise Blue |
| 2. Yellow | 7. Silver/Gray |
| 3. Olive Green | 8. Black |
| 4. Brown | 9. Red |
| 5. Salmon Pink | 10. White |



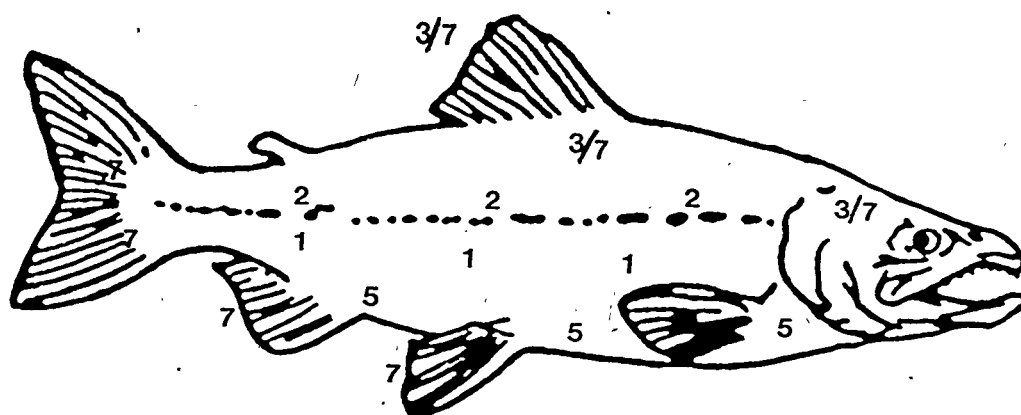
Chinook



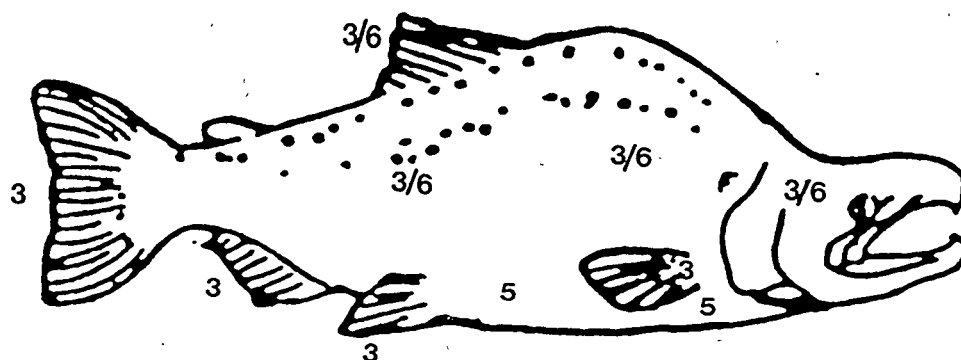
Coho



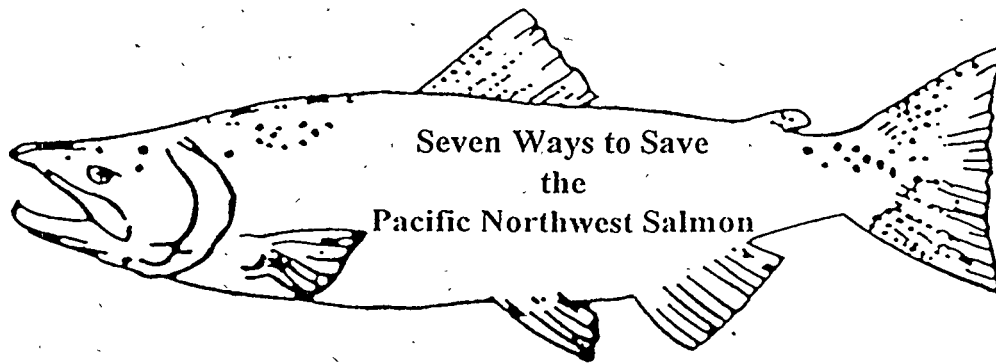
Sockeye



Chum



Pink



Following are seven examples of what each of us can do to help salmon.

1. **Conserve Water.**

Use less at home to save more for fish!

2. **Do NOT dump any waste in streams or ditches.**

Lawn grass, pet droppings, or trash in streams hurts fish and may spread disease.

3. **Do NOT pour anything into storm drains.**

Storm drains lead to streams. Oil, gasoline and chemicals will kill fish.

4. **Use less chemicals.**

Fertilizers, bug and weed killers, detergents and drain cleaners are all poisonous to fish and other wildlife.

5. **Use less electricity.**

The Northwest uses rivers to make hydroelectric power which is our main source of electricity. Using less electricity leaves more water for fish in the rivers.

6. **Plant trees beside streams.**

Salmon and trout need cool shady water to survive. Trees also stop erosion and provide more food for fish.

7. **Ask others to help.**

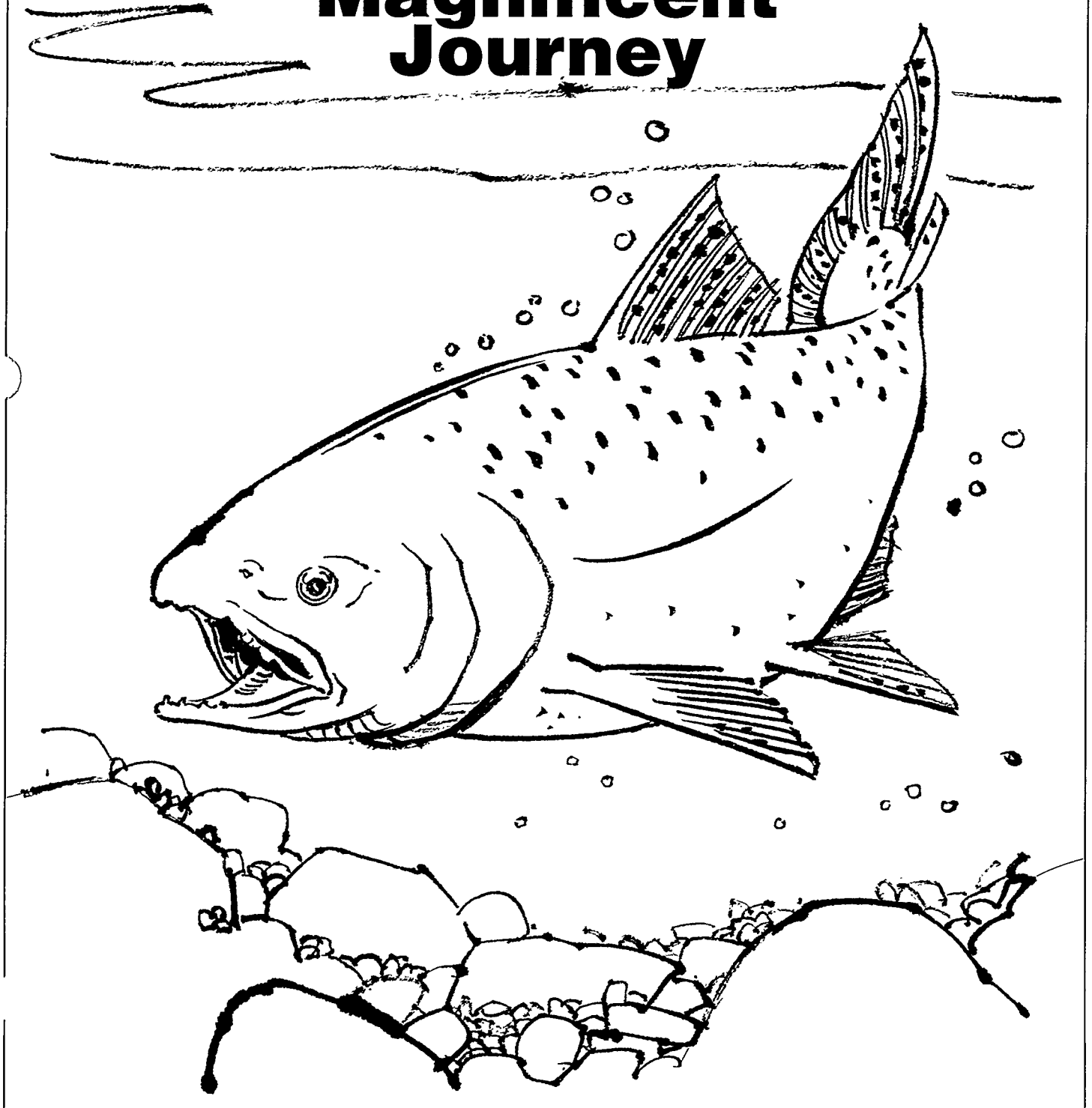
Talk to other people about how to help streams and fish.

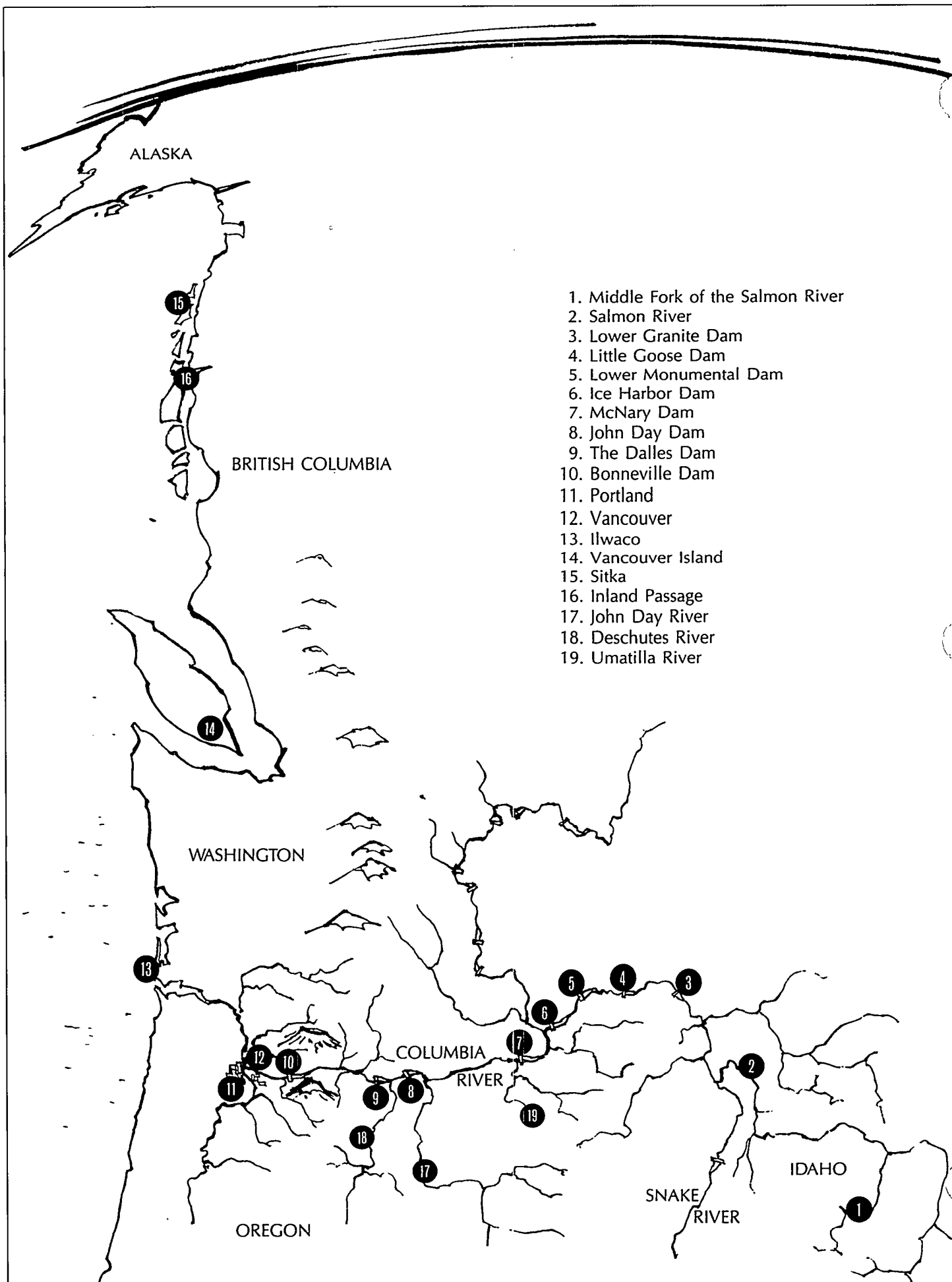
Backgrounder

Bonneville
POWER ADMINISTRATION

November 1993

The Magnificent Journey





The annual run of Northwest salmon—from the vast Pacific Ocean to the mountain streams where their lives began—is one of Nature's most awe-inspiring events. To the Indians, who populated the Northwest first, returning salmon were an annual miracle.

Now that modern science has discovered some of the salmon's secrets, their journey seems even more miraculous.

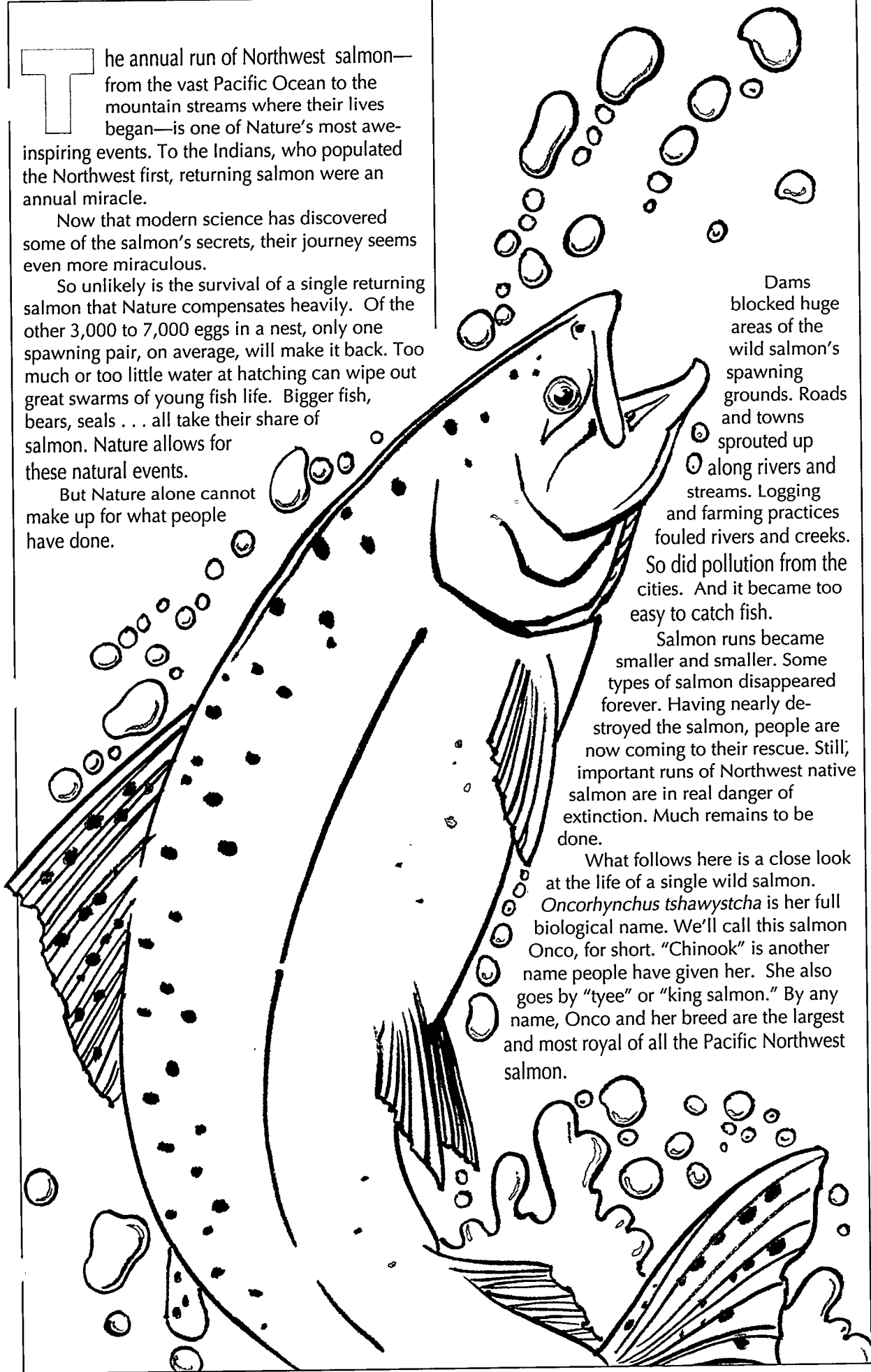
So unlikely is the survival of a single returning salmon that Nature compensates heavily. Of the other 3,000 to 7,000 eggs in a nest, only one spawning pair, on average, will make it back. Too much or too little water at hatching can wipe out great swarms of young fish life. Bigger fish, bears, seals . . . all take their share of salmon. Nature allows for these natural events.

But Nature alone cannot make up for what people have done.

Dams blocked huge areas of the wild salmon's spawning grounds. Roads and towns sprouted up along rivers and streams. Logging and farming practices fouled rivers and creeks. So did pollution from the cities. And it became too easy to catch fish.

Salmon runs became smaller and smaller. Some types of salmon disappeared forever. Having nearly destroyed the salmon, people are now coming to their rescue. Still, important runs of Northwest native salmon are in real danger of extinction. Much remains to be done.

What follows here is a close look at the life of a single wild salmon. *Oncorhynchus tshawytscha* is her full biological name. We'll call this salmon Onco, for short. "Chinook" is another name people have given her. She also goes by "tyee" or "king salmon." By any name, Onco and her breed are the largest and most royal of all the Pacific Northwest salmon.



The Start of a Cycle

High in the mountains of central Idaho runs a creek too remote to have a name. The water flows shallow and cold, clear and swift. Glaciers, receding toward Canada after the Ice Age, left behind this gravel stream bed at the bottom of a broad, U-shaped valley.

In late August, the leaves on streamside trees are yellowing. The smell of fall and colder weather is in the air, and morning frost collects on the bank. A reddish-brown female chinook idles under riffles of rushing water. She looks battered and exhausted. She's just waiting here, maybe resting.

A second salmon appears. He is darker than she is. Cream-colored splotches mark his body. He moves in beside her, upstream and parallel to her body. These salmon are spawning.

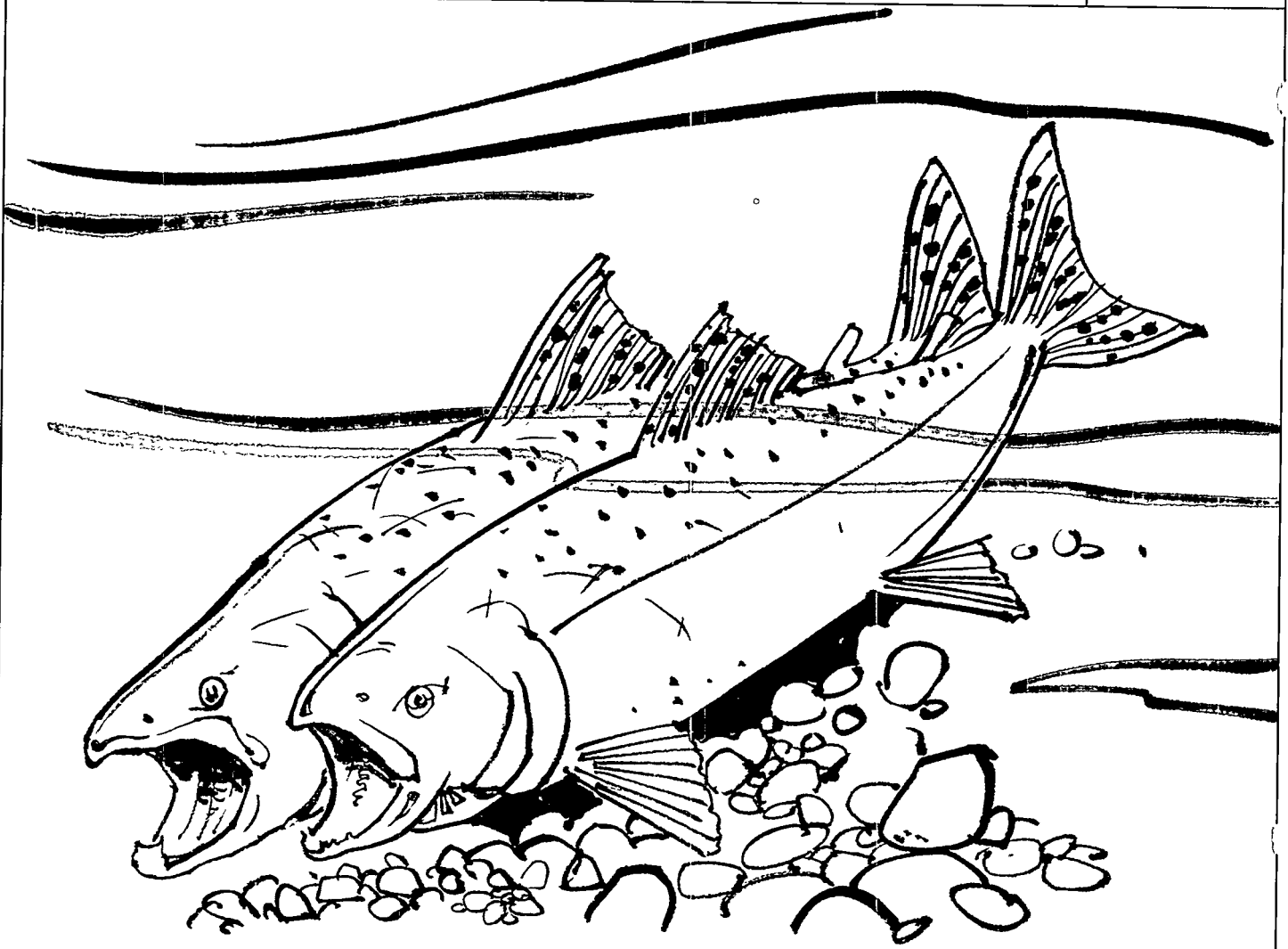
The female chinook deposits about 5,000 bright pink eggs in the gravel bottom of her nest—called a redd. After the male fertilizes the eggs, the female moves upstream from her redd. With her tail, she kicks up pebbles that drift downstream to settle over the redd.

The eggs now are covered. They are protected from direct sunlight and strong current. For the next four weeks or so, the eggs are very fragile. The slightest bumping of the redd can destroy them.

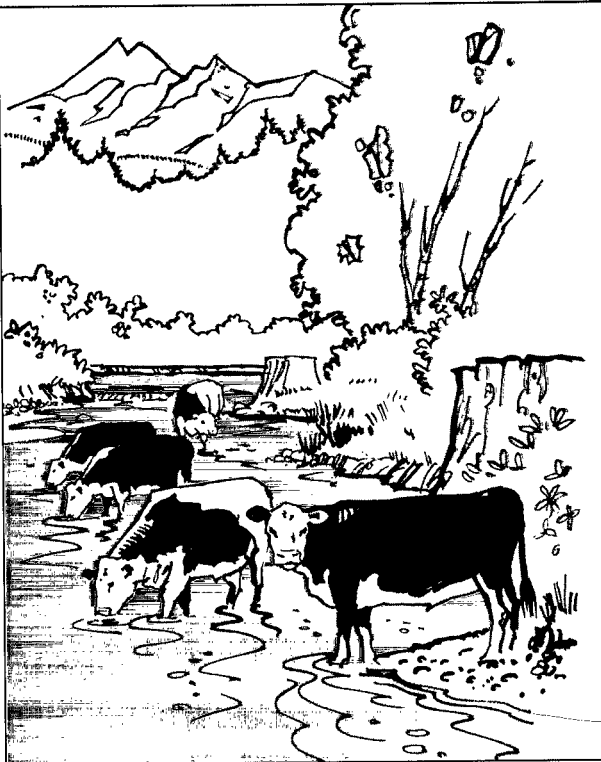
By mid-autumn, the eggs begin to develop. Eyes begin to form. And somewhere among these closely-packed lives in the redd lies Onco. Onco the Lucky.

Onco is fortunate that the water temperature is only 55 degrees Fahrenheit. That's within a few degrees, up or down, of what her system can handle. She's lucky, too, that there is no sudden torrent of water in the creek. A heavy storm could dislodge the stream bed rock and crush her.

A female chinook deposits about 5,000 bright pink eggs in the gravel bottom of her nest, or redd. A male fertilizes the eggs.



Grazing cattle can trample the stream banks, their muddy footprints releasing silt. Silt covers gravel and chokes off the oxygen supply. Eggs suffocate.



Upstream from Onco's redd, riffles mix air with water to give the eggs a rich oxygen supply. Without oxygen, the eggs would die.

Ducks and other birds hunt for salmon eggs. Raccoons find the same reward in shallow gravel. Adult trout, too, love salmon eggs if the trout can get to them. But they do not find Onco in the gravel-covered redd.

Aside from these natural hazards, the developing salmon egg has to survive some unnatural hazards.

In another creek like Onco's, a mining dredge once ripped up the stream bed. Now, each year the loose soil releases silt which spreads far downstream. Silt covers gravel and chokes off the oxygen supply in the water. The eggs suffocate.

Grazing cattle can trample the stream banks, their muddy footprints releasing even more silt. Pesticides applied to upstream crops can drain into a creek and poison fish. A road built alongside a stream can change the way water runs off. The stream is more apt to flood after a big rain. Where once there were trees and shade, the sun hits the water directly. Direct sunlight can warm the water more than salmon eggs can stand.

Careless logging can ruin a salmon spawning stream. Branches and debris can block fish movements. Logs dragged along a slope, or a log truck crossing the smallest trickle, can churn up more silt. Of course logging removes trees and shade. Some of the worst damage was done before people quite understood how shade and plants are important to salmon.

Lucky for her, Onco's creek is in pretty good

shape. For one reason, there are laws now that help protect salmon habitat—the natural environment salmon need to survive.

Dredge mining has been outlawed through most of the Northwest. Road-building codes are tighter.

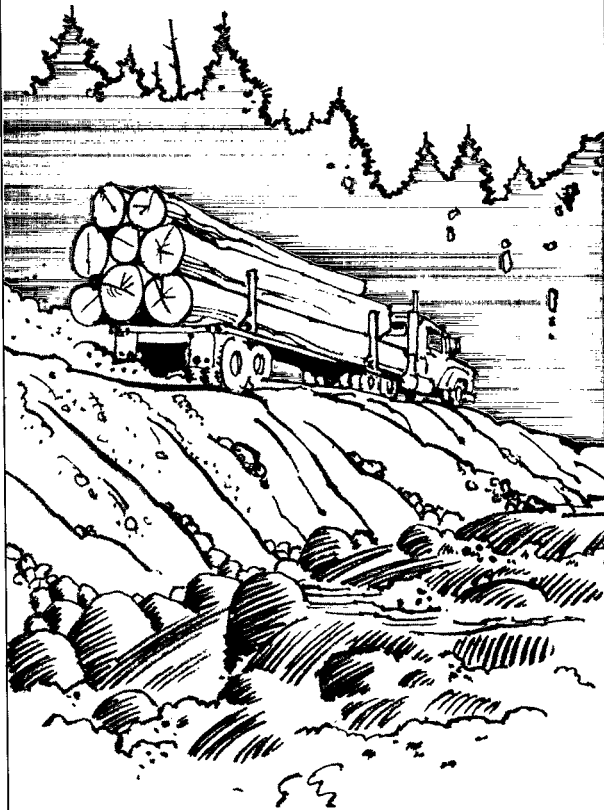
In some places, logging is cleaner. People are working to protect streamside vegetation.

Things have changed. Many now realize that more wild salmon will become extinct if people don't back off and give them some room. We have to strike a balance between our needs and the needs of other living things.

Not that we can strike such a balance without paying for it. If it's tougher for a logger to get to logs, somebody ends up paying more for lumber. Outlaw dredge mining, and it costs more to get the minerals.

On the lower river, irrigators, power producers and bargers are changing the way they work—and having to charge more for their goods—to help protect wild salmon runs. Everybody must pay their share if Onco and her kind are to survive.

Sometimes it takes more than just backing off. People passed laws to rebuild some salmon streams that were destroyed by careless mining or logging. In some places, hatchery fish are being put back into streams where the wild salmon disappeared years ago.

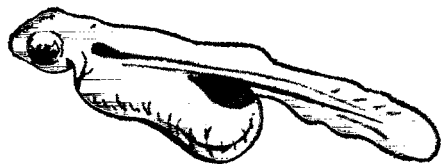


Careless logging can ruin a salmon spawning stream.

From Egg to Fry

Winter sets in at Onco's redd. A light blanket of snow covers the ground. Thin, jagged sheets of ice cling to the banks where water meets the shore. To look at this silent and apparently lifeless scene, you'd never know what's going on within the gravel of the redd. Yet new life is stirring here.

The hatchlings stay under the gravel. Onco, by Valentine's Day, is a homely and helpless little creature called an alevin. Her eyes are huge compared to the size of the rest of her body.



An orange yolk sac, sticking out from her belly, contains a balanced diet of protein, sugars, vitamins and minerals. As Onco grows, the yolk sac gets smaller.

Then one night in March, Onco slips upward through the gravel and emerges as a tiny fish called a fry. She's about the length of a fir needle and not much fatter.

Her eyes are still bugged out, and she avoids sunlight. She stays in shallow pools near the edge of the creek, where the current is not so strong.



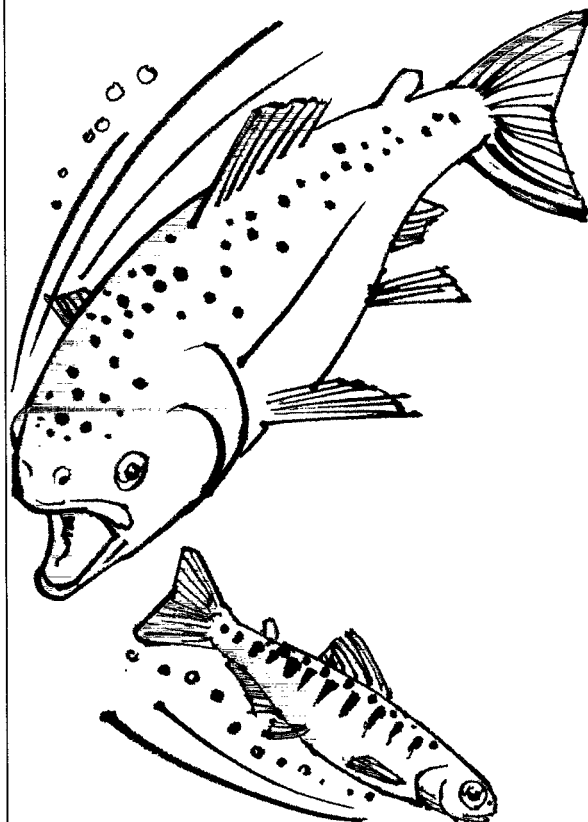
The yolk sac that hangs from an alevin's body gets smaller as the fish grows.

Fry are easy prey for trout and other large fish.

Fry — young fish fresh from the gravel — are about the size of a fir needle.

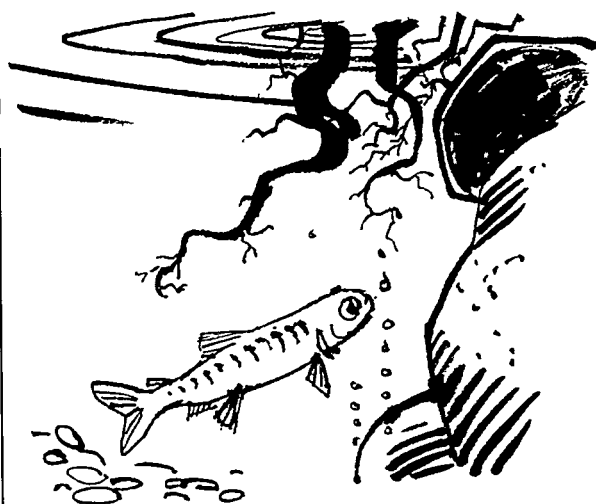
Onco is tiny and she must be very quick. As she darts around feeding on even tinier creatures, she is wide open for sudden death. Fry are easy prey for trout and other large fish. Ducks and herons, even crows, devour fry.

Some chinook fry mature early. They migrate to the ocean in the first May or June of their lives. Others, like Onco, take their time. They stay in fresh water for one more full spin of the seasons before heading out to the Pacific.



Through her first summer, Onco pokes around her shallow home creek. In the fall, with colder water, she lets the current take her downstream. She's in no hurry and makes several stops along the way. Root wads, fallen trees and boulders make good resting and feeding places. By the time winter sets in, she finds herself in the Middle Fork of the Salmon River.

Onco is now about the length of a human adult's finger. Fish her size are called fingerlings. Scales protect the side of her body. The scales are covered by a slimy layer of mucus that protects Onco from disease and helps her slide through the water as if she were greased. She has faint vertical stripes along her silvery sides to help her hide from predators.



**Fingerlings
hide and feed
near root
wads as they
move through
the stream.**

Onco is big enough now to be more of a hunter herself. She snaps up mosquitoes and other insects that come near the water surface. She nabs an ant unlucky enough to have fallen into the stream.

Her mouth is important not only for eating but for breathing as well. She takes in water through the mouth and forces it out through the gills on each side of her head. The feather-like gill filaments are full of blood vessels which—like the lungs in humans—take up oxygen and release carbon dioxide.

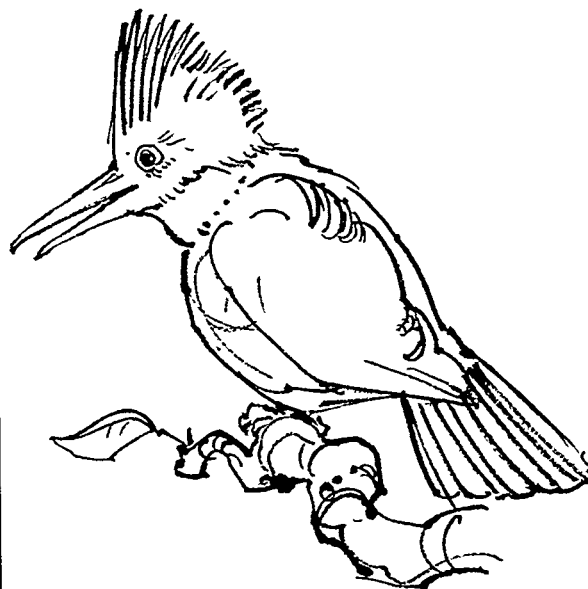
Onco doesn't have ears but she can hear. Low frequency sound waves vibrate through the water to a row of small holes along each side of her body. These holes open to nerves that let her "hear" danger. Salmon have nostrils and a good sense of smell. They can smell predators and food.

Onco can smell home, too. As Onco works her way from the spawning site, she senses where she has been. She's learning how to get back,

**Kingfishers
and other
birds eat
young
salmon.**

**When young
fish reach the
size of a
human finger,
they are called
fingerlings.
Vertical strips
along their
silvery sides
help hide
them from
predators.**

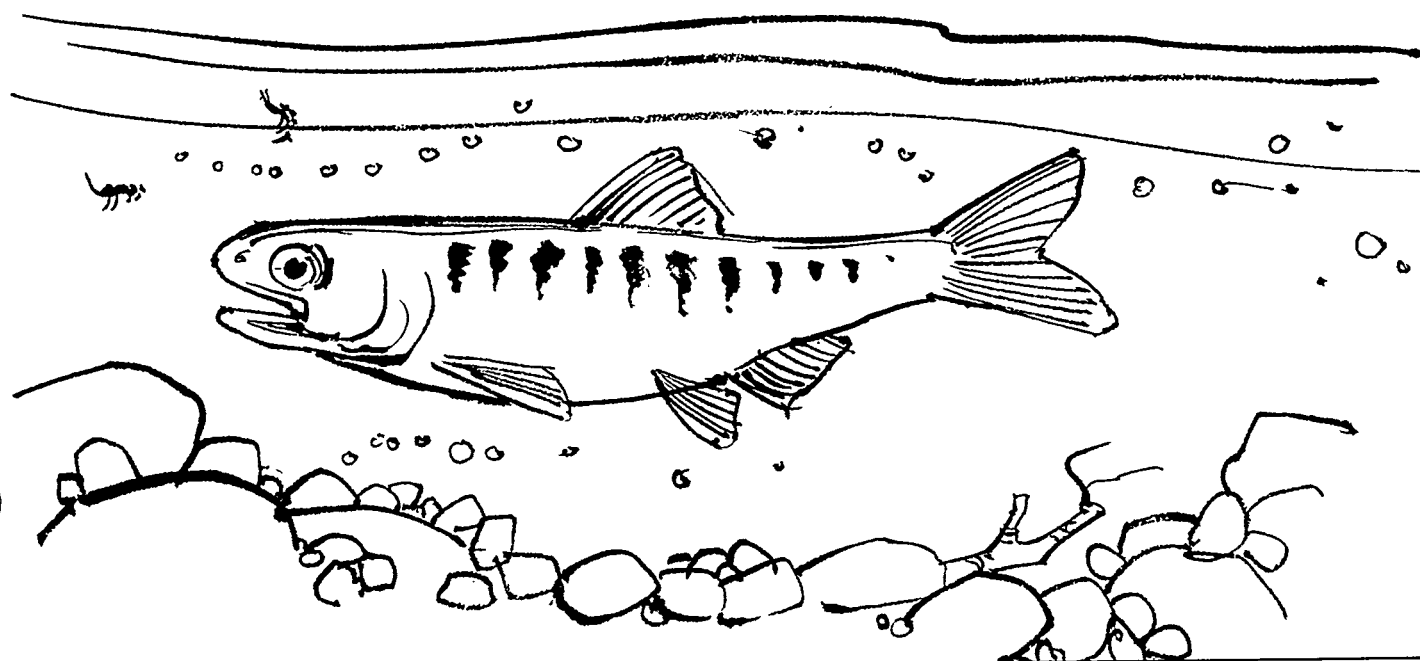
years later. This is called homing. Biologists are not exactly sure how it works. Somehow, the unique chemical qualities of Onco's home stream become lodged in her memory.



Onco must always be alert. In the summer of her first year, a kingfisher perched on a branch above her takes aim and dives. Thanks to Onco's big protruding eyes, she has good vision. Just as the bird hits the water, Onco darts away. She escapes. Not every young salmon is so quick or so lucky.

In fact, only about 10 percent of the eggs in a redd make it through the fry stage. Conditions for Onco and her redd-mates are better than average. Fifteen percent of the eggs grow into fry and survive that first spring and summer.

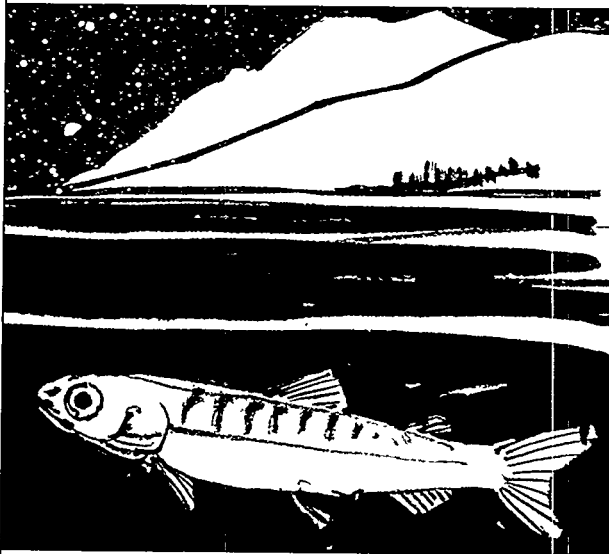
Of the original 5,000 in Onco's "family," only 750 are still alive and feeding.



A fingerling's growth slows in the winter of its first year.

Young fish—known as smolts—drift backward as they migrate downstream. They travel mostly at night to avoid predators. As they go, they feed on midges, worms and snails.

Migrating Downstream



Onco's growth slows in the winter of her first year. Food is less abundant, and she needs less. Her body is idling, waiting for another spring. The snowpack builds in the mountains.

In late April, snow starts melting. Spring rains begin. The water level rises and the annual spring runoff sweeps young salmon downstream.

Onco drifts backward with her head upstream. She travels mostly at night to avoid predators who hunt by sight. As she goes, she feeds on midges, worms and snails. Her fingerling stripes slowly

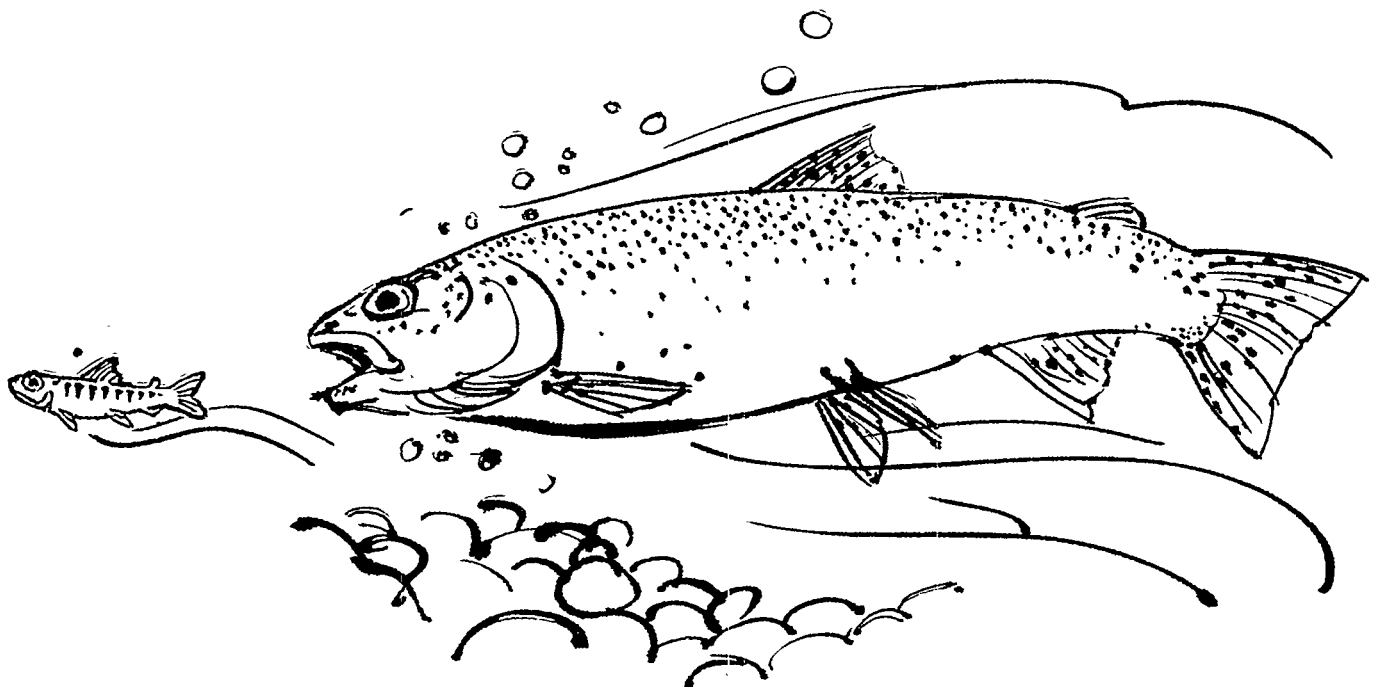


fade. She is changing inside, too, to make the transition from fresh water to salt water. With these changes she is called a smolt.

From the Middle Fork, Onco enters the Salmon River. Then she comes to the Snake, a bigger river that forms the border between Idaho and Oregon. Great crowds of smolts from other tributaries join her in a mass migration to the sea, as if they were rushing out of separate classrooms into one main hall toward recess.

Mingling with Onco now are smolts that look like Onco but got a different start in life. Instead of hatching in the wild, they are the offspring of adult salmon whose eggs and milt were combined at a fish hatchery. They grew to be fingerlings in man-made rearing ponds. Spared the hazards of the wild, a greater percentage of them survived.

But now, released in real streams, they face the same predators and natural perils that Onco



does. And they're not yet as sharp at hiding or finding food as she is.

Hatchery-bred salmon raise the total numbers of returning salmon. But they also compete with wild fish for food and habitat. Because of their genetic diversity, wild salmon are more resistant to disease and carry the mix of genes that are critical to long-term survival of the breed.

The Snake River runs northward, brown and swift. Suddenly the river is no longer rushing. Onco has entered the reservoir upstream from Lower Granite Dam.

This is the first major barrier to her swift migration out to sea. A salmon is designed to expect an unbroken spring flush to the ocean.



From Onco's point of view, however, dams are not at all terrific. The Columbia River becomes a series of flowing lakes instead of the continuous fast river she would prefer. Squawfish thrive in the slower water conditions and they eat smolts. So do walleye and bass.

Just as dangerous for Onco is the act of passing each dam itself. At Lower Granite, a fish screen catches Onco just in time and guides her away from the whirling blades of the turbines.

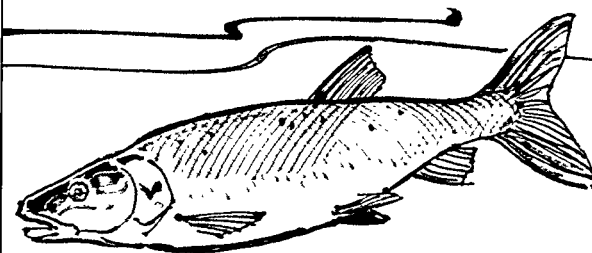
At another dam the water is high enough that it is spilling freely over the dam. Onco is stunned for a second by a fifty-foot drop into the churning pools below. But she regains her senses in time to avoid scavenger gulls that circle and squawk in the air above her, looking for an easy meal.

Onco's luck holds on this dangerous downstream trip. At each of the eight dams, about 10 to 15 percent of the smolts don't make it. But Onco does.

To help salmon along, more screens and better bypass systems are being installed at the dams. From April to June, when smolts need faster flows, extra water is released from reservoirs upstream. People who would otherwise want to save that water—to irrigate farms, float barges and generate power—have to adjust.

Everybody helps pay for salmon passage. When the electric utilities set aside water to help salmon, for example, it means there is less water for power when people need it the most. Electric rates go up.

Efforts to move young salmon safely past the dams are meant to strike a balance between the needs of people and the needs of salmon.



Some fish follow water that is spilling freely over the dam. Others are collected into barges for a free ride downriver.

Dams make electricity by holding back water and then running it through turbines. Screens catch fish and guide them away from the whirling turbine blades.

Squawfish thrive in the slow reservoir waters; they eat smolts.

Before dams, Onco's trip out might have taken three or four weeks. Now it could take closer to two months.

To speed their trip, many smolts are caught in pens at Lower Granite Dam and loaded into barges for a free ride downriver to below the last dam. Onco, ever wary, avoids capture and must do it the hard way.

Beyond Lower Granite Dam on the Snake River, she finds other dams: Little Goose, Lower Monumental and Ice Harbor. When the Snake joins the Columbia River, there will be four more: McNary, John Day, The Dalles, and Bonneville. These dams were all built within the last 50 years and they have been terrific—for people.

Dams make electricity by holding back water and then running it through turbines. Falling water spins the turbines to generate electricity that is clean—no smoke, little pollution—cheap and abundant. Locks at the dams enable tugs and barges to navigate all the way to Lewiston, Idaho. Dams also hold back water to irrigate farms during the dry summer months and help prevent flooding downstream.

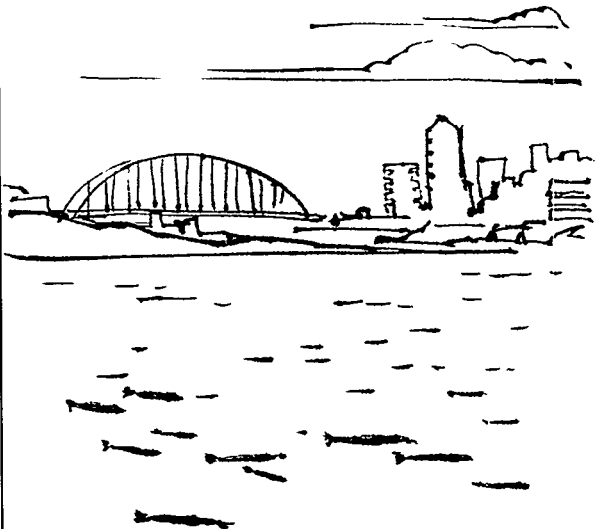
Downstream from Portland, more rivers join the Columbia. More smolts flow in from each of them.

Portland and Vancouver are not the first cities the smolts pass, but they are the largest and produce the most pollution.

Onco makes it past Bonneville, the last dam in her path. From here to the ocean she has free passage. Along the way, she passes between Portland and Vancouver. These are not the first cities on her journey, but they are the biggest and produce the most pollution.

In cities, rainwater hits rooftops and pavement. Instead of soaking gradually into the ground, water shoots off these smooth surfaces and straight to the nearest storm drain. From there it goes into the river. Pollutants are carried with it: grit from rubber tires, the detergent used to wash a car, fertilizers from gardens and lawns. But these days, cities are more careful to clean up industrial waste and human sewage before pouring them into the river.

Downstream from Portland, more rivers join the Columbia. More smolts flow in from each of them. The Columbia, riding high and brown on its springtime banks, is teeming with life. Suddenly — What's this!? — Onco finds herself being carried the "wrong way" by the current. This is the river's estuary, where seawater mixes with fresh water. Twice a day the incoming tide pushes seawater back up the wide throat of the river.



The estuary is rich in food that is new to Onco. Algae, crab larvae, shrimp and small fishes thrive here. She stays here for a couple of weeks.

This is Onco's first experience with salt water. She learns to process the denser salt water for her water supply. She is still only about six inches long and has to avoid larger fish. There are pelicans and other fish-eating birds at the estuary.

In the slack water near Ilwaco, Onco joins a school of thousands of other silvery smolts near the surface of the water. They practice jumping, but not to catch food. It looks very much like play, with no other purpose than to celebrate being a healthy smolt.

Onco deserves to celebrate. She had to be lucky and a good survivor to get this far. From the 750 fry from her redd, only 200 smolts survive.

Out to Sea

After a shimmering blue day in June, something triggers an alarm in Onco's inner clock. It is time to begin the next stage of her life cycle. She rides the night tide across the Columbia River bar and swims into the ocean. Onco will not see this place again for another three years.

In the sea, there is new food to catch. At first Onco's diet is heavy with zooplankton—tiny animals suspended in the ocean water. Later she eats shrimp and other crustaceans. Her body absorbs the shrimp shells' pink color, changing her flesh from white to pink. As she grows, she begins to feed on anchovies, herring and other fish.

Predators lurk everywhere. Sea birds, tuna and even larger salmon feed on seawater smolts. As she grows into adulthood, Onco becomes vulnerable to one other group of predators: people.

In her first August at sea, Onco passes the Strait of Juan de Fuca off Puget Sound. She is the size of a pan-sized trout, about a pound and a half. Suddenly, she finds herself in the midst of a thick group of fish of all sizes, getting drawn together by a huge net. Above her, like a dark cloud, looms the broad shadow of a fishing boat.

Onco slithers among trapped bodies within the net. Just barely, she manages to slide through one of the square openings in the net. Saved only by her small size, she escapes.

Yet fishermen will be a factor from now on. As she grows she becomes more valuable to



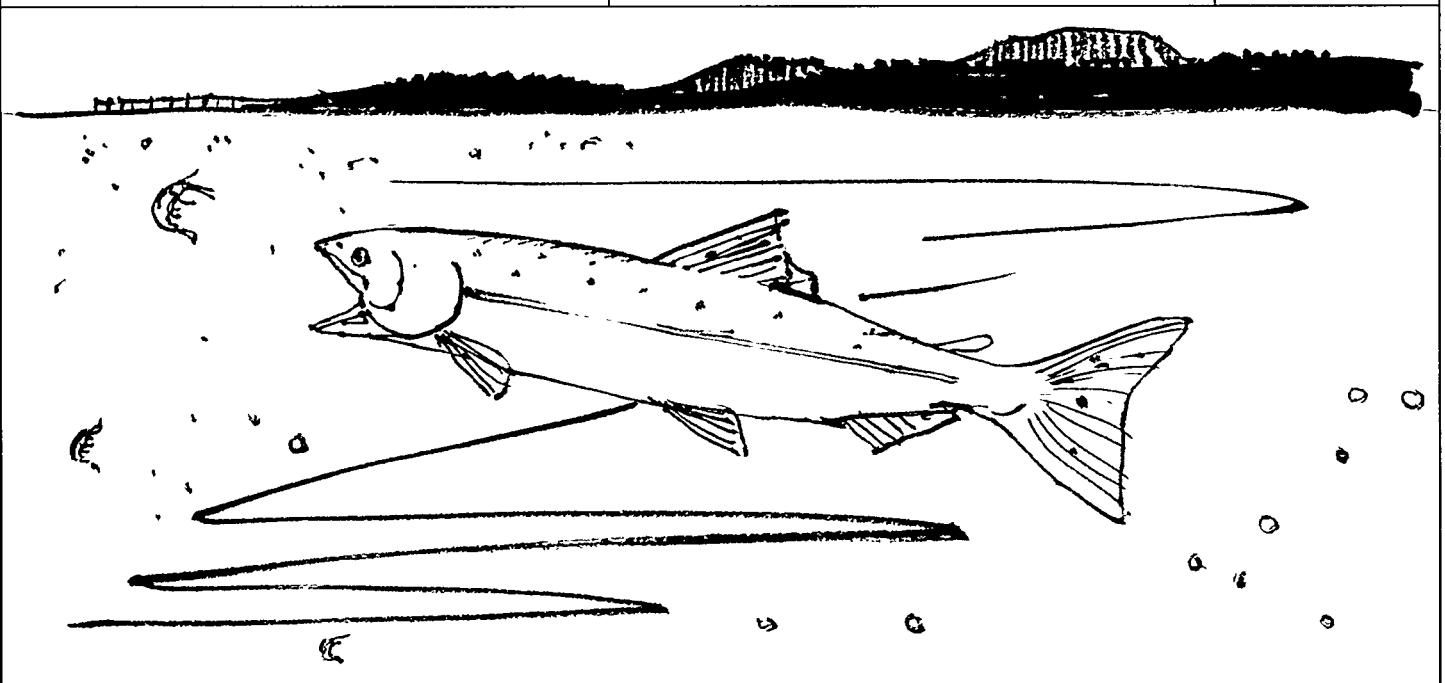
Salmon ride the night tide across the Columbia River bar and swim into the ocean. Predators lurk everywhere.

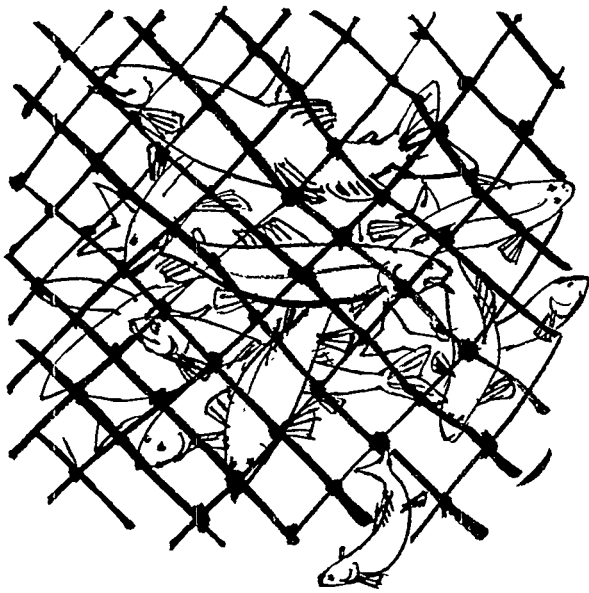
commercial and sport fishermen. The well-placed net or the well-disguised hook can take her.

Fishing is not meant to be "bad." Humans have always taken fish. The earliest people in the Northwest left behind fish bone knives, fish bone combs and other evidence that salmon were an important part of their lives. As long as they did not take too many, Nature could keep the balance.

But the number of people in the Northwest has grown at a rapid rate over the last two hundred years. People found better and better ways to catch more and more fish. Huge fish wheels scooped up great numbers of fish running up the rivers. Larger boats took fishermen farther out to sea. Nets were made bigger and stronger. Over the years, the balance was tipped.

The growing salmon eat shrimp. Their bodies absorb the shrimp shells' color, changing their flesh from white to pink.





In 1941, the commercial fishing industry took over 23 million pounds of chinook. Today, they take about one-sixth of that amount.

In 1941, the commercial fishing industry took over 23 million pounds of chinook from Columbia River runs. Today, they take about one-sixth of that amount each year. It is not because fishermen are losing their touch, but because fewer fish are available. Many laws regulate how many of the remaining salmon can be harvested each year.

Everyone argues about the laws. Indians argue for their share of returning fish. Americans blame Canadians for taking too many Columbia River salmon. Canadians, in turn, say that Americans harvest too many of their salmon. Russians, Japanese and Americans haggle about who should fish where and for how many fish.

Sport fishermen complain about commercial fishermen, and vice versa. You would think everybody was being cheated.

Yet the basic idea is understood by all. There must be limits. If too few salmon get back to their spawning sites, everybody loses. So the laws set limits on how much can be harvested, in what seasons, where and by whom. It is complicated, and no doubt sometimes unfair. But Onco benefits from strict new fishing laws and international treaties that give her a fighting chance.

Onco, unaware of all this, forges steadily northward. She passes the north tip of Vancouver Island off the coast of British Columbia. A clever hunter and a voracious eater, she doubles her weight every three months in her first year in the ocean. By the time another August rolls around, she is a sassy 12-pounder roving off the coast of Sitka, Alaska.

As far as scientists can tell, most chinook stay fairly close to shore during their ocean journey. Some take the Inland Passage.

Ocean Routes

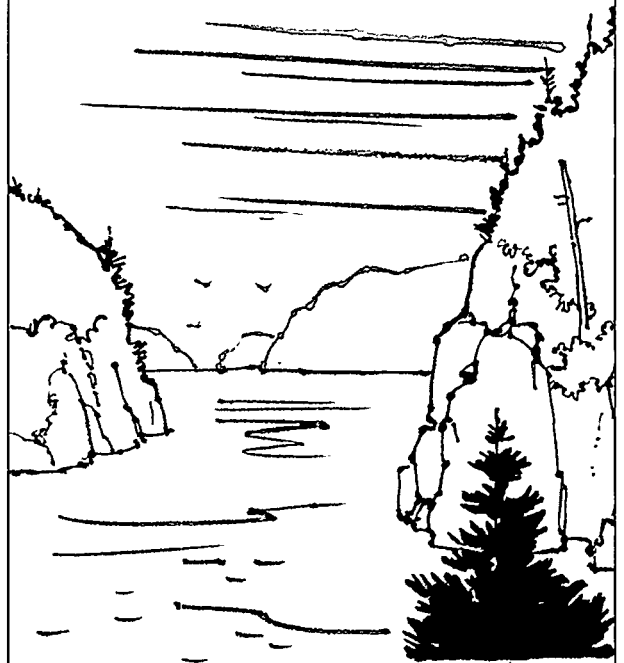
One of the great mysteries in the cycle of salmon is how these fish know where to go when they get to the ocean. They couldn't have "remembered" their ocean migration route, because they have never been there.

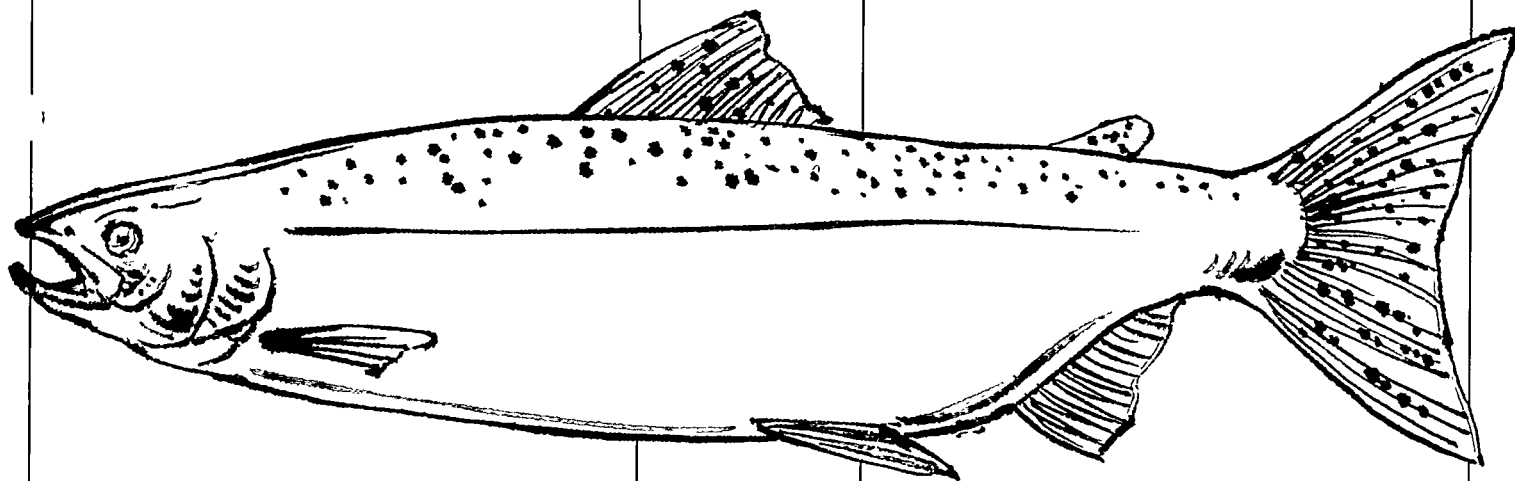
Scientists have learned some things about where they do go, by tagging the fish and by monitoring their ocean movement with electronic instruments. Yet very little is known about how salmon navigate. Onco may take day-to-day directions from the angle of the sunlight as it penetrates the seawater, or from water temperatures and ocean currents. The earth's magnetic fields might have something to do with it.

But the best guess seems to be that they have a basic instinct imprinted in their genes. They just know without ever having had to learn.

Different breeds of salmon follow different migration routes in the Pacific. Chinook are different from chum, sockeye or coho. Even among chinook, not all follow the same route as Onco. As far as scientists can tell, most chinook stay fairly close to shore. Some even take the Inland Passage, protected by green-wooded islands, up the coast of British Columbia and off the tail of Alaska.

That's where Onco goes, swimming up to 15 miles a day. After two years in the Pacific—during the third year of her life—she has passed Anchorage and the Kenai Peninsula.





At 21 pounds, she measures two and a half feet long and has a blue-green back and silvery-white belly. The two-tone coloring helps conceal her from enemies. Seen from above, she blends with dark ocean waters; from below, she blends with lighter sky.

By now, she knows sea lions by sight and smell and avoids them. She has been chased by killer whales. Onco survives.

During her third year in the ocean, she turns around and heads back down the coast. Traveling in a counter clockwise loop, she stays farther out at sea than before, but not by much. Less than 200 miles separate her from land's edge. As if responding to mysterious natural music that only salmon can hear, Onco knows to return to the Columbia River. She swims faster now. She is still eating and gaining weight. The cold ocean current is going her way and she covers up to 30 miles a day for months on end.

Every salmon has its own time to return to fresh water. Not all kinds of salmon stay in the ocean three years. Sockeye and steelhead trout stay two or three years. Coho salmon seldom stay out that long. Even among chinook, the time spent at sea varies. Some chinook stay in the Pacific as much as five years before heading back home to spawn, but most stay out two or three years.

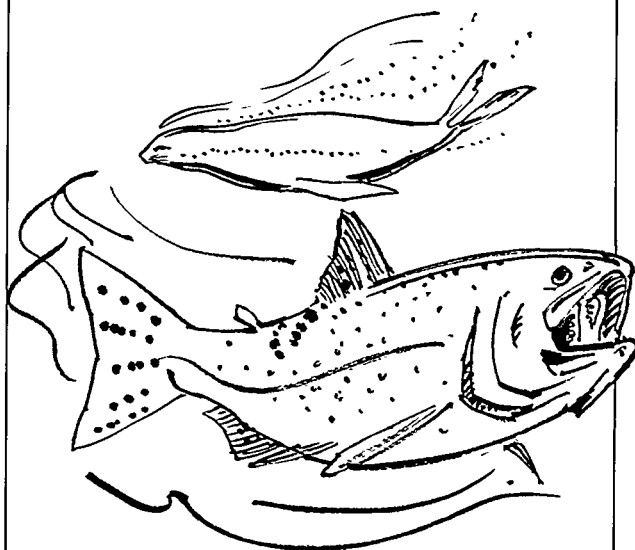
And not all chinook come in at the same time of year. There are spring, summer and fall chinook. These are different runs of chinook. Each is named according to the season they return from the sea.

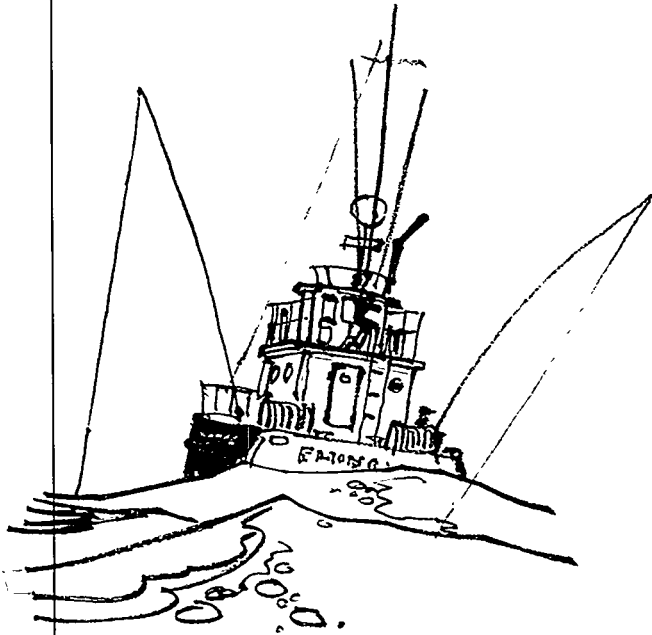
Onco is a spring chinook. Just before Easter in her third year at sea, she enters the mouth of the Columbia.

Firm, plump, pink-meated, she's at the prime of her life. She weighs 28 pounds and is just a little less than three feet long. Onco is not the biggest fish here, but she is large.

She carries scars from her adventures at sea. Behind the large fin on her back are tooth marks from a sea lion that just missed. A row of sea lice clings to her body, like tiny barnacles to the hull of a ship. Still, she is strong and healthy.

Two-tone coloring helps conceal the salmon from enemies. Seen from above, they blend with dark ocean waters; from below, they blend with lighter sky.





Of the 200 smolts from Onco's redd that made it out to sea, only nine managed to avoid all the ocean perils and came back to the Columbia.

That's not bad, considering the odds. In fact, it's better than average in recent years for adult fish returning. But not all of these fish will return to spawn.

Luckily, Onco misses a short gill-netting season by one day. But she has not yet escaped the hooks of other fishermen.

Sportsmen patrol these waters waiting for the salmon. Their boats crowd together over "hot spots" where the fish are biting and where the law allows fishing. Onco would be a prize catch.

Onco snaps at an apparently disabled anchovy. Sure enough, the anchovy has double hooks in it. A line is attached!

Onco's first reaction is to dive deep and to swim away from the pressure on the line. That sets the hook deeper into the flesh of her mouth. At least she did not swallow it. Only one of the two hooks got her.

When her deep dive doesn't work, Onco rises toward the surface. She slashes and twists, sometimes breaking the surface of the water, to rid herself of the hook. Whenever she rests, she gets reeled in closer to the boat. She dives again, rises again, trying to get loose. In fact, the hook is working loose. If only she can muster enough strength to keep this fight going.

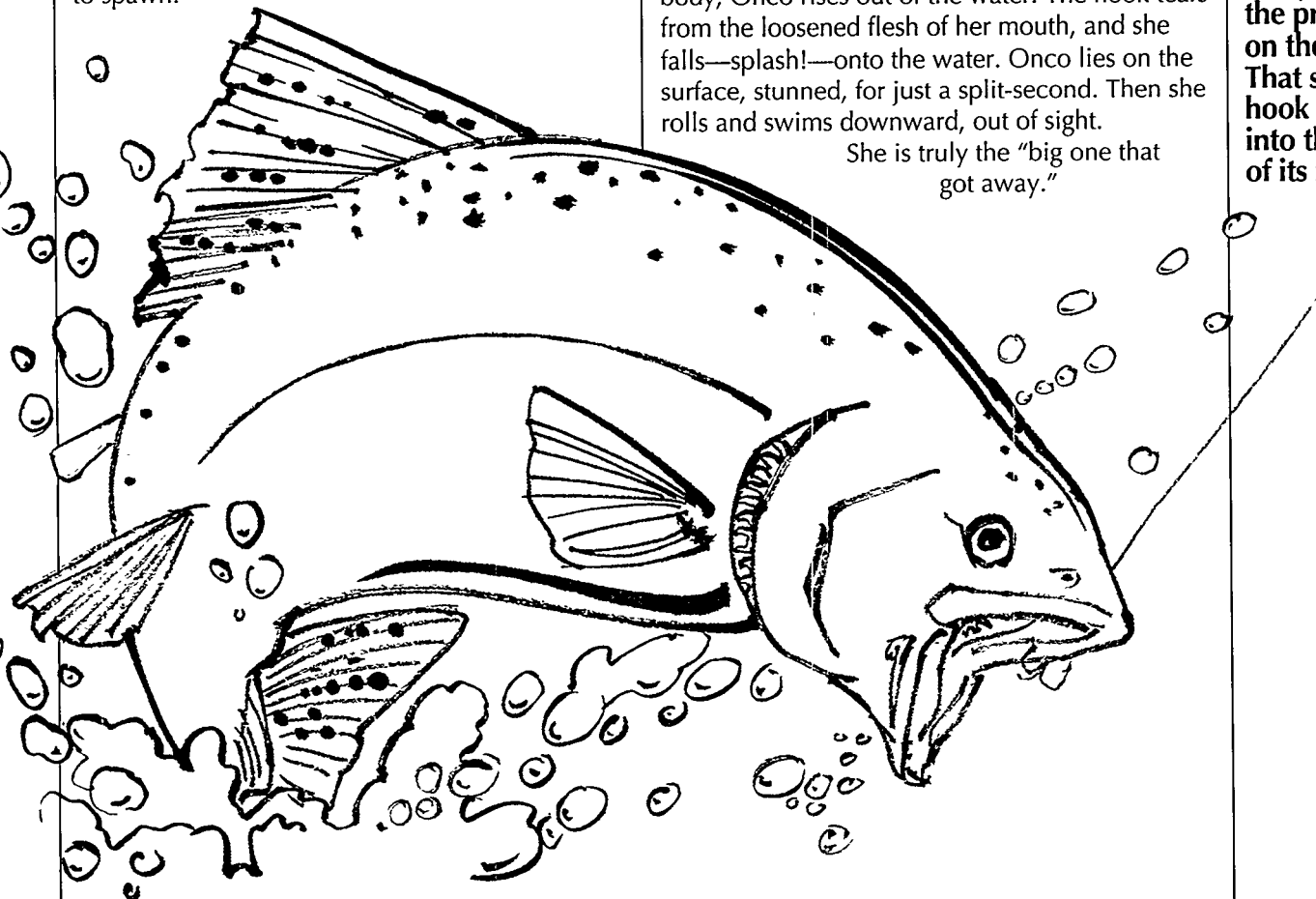
After 20 minutes, Onco is exhausted. She's very close to the boat, now. She sees a large silver hoop-on-a-handle, with green nylon netting, pointed her way.

With one ferocious leap and twist of her body, Onco rises out of the water. The hook tears from the loosened flesh of her mouth, and she falls—splash!—onto the water. Onco lies on the surface, stunned, for just a split-second. Then she rolls and swims downward, out of sight.

She is truly the "big one that got away."

Sportsmen patrol the lower Columbia River. Their boats crowd over "hot spots" where the fish are biting and where the law allows fishing.

The salmon's first reaction is to dive deep and swim away from the pressure on the line. That sets the hook deeper into the flesh of its mouth.



Race to the Redd

Fish climb up Bonneville fish ladder's broad, flat, smooth-flowing water stairs.

The female chinook starts on a race upriver. She has one purpose—to get back home and spawn. Eggs are growing inside of her.

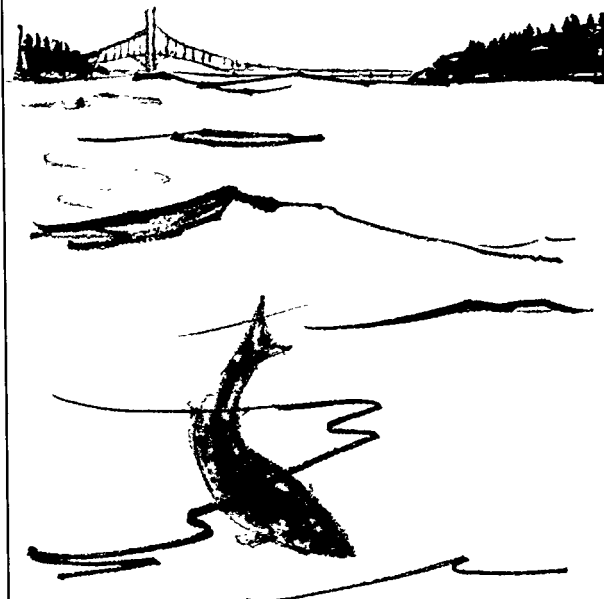
Onco wastes no more time in the lower Columbia. With the first good rain the river rises. Its smell and color change and the magnificent final push of Onco's journey begins.

Onco starts on a race upriver. Bucking strong current, she is like a fish with blinders on. She has one purpose—to get back home and spawn. Eggs are growing inside of her.

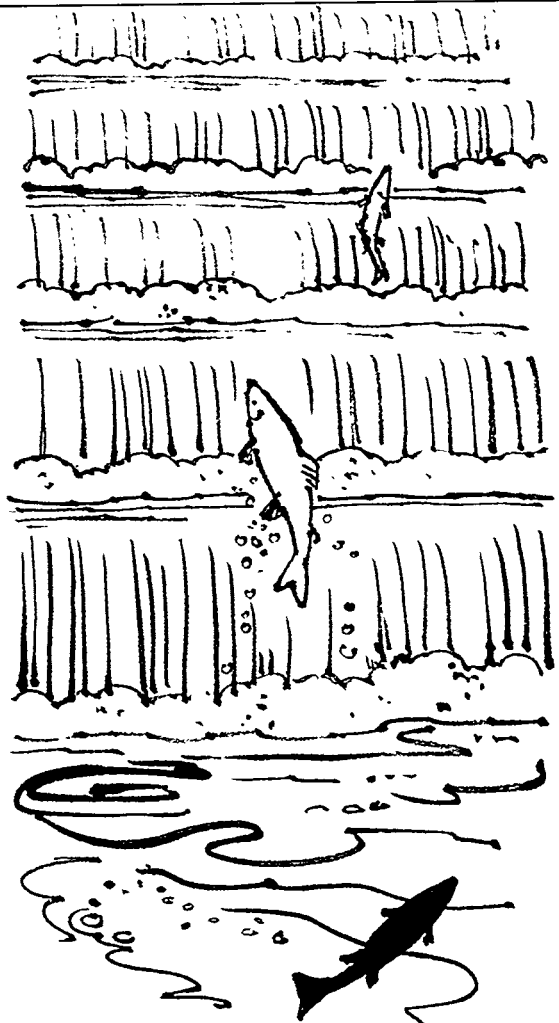
She does not eat along the way. She might snap as if in anger at a fisherman's bright lure, but she is no longer interested in food. She has stored up enough energy to make it all the way back to Idaho. Now is the time to spend that energy.

On April 20, she finds the entrance to the fish ladder at Bonneville Dam. She climbs up the broad, flat, smooth-flowing water stairs. Alongside a window below water level, she passes a woman whose job is to count fish as they pass. Onco is spring chinook number 28,669 this year. The spring chinook total will reach about double that number before the end of May.

The numbers sound good. In fact they are better in the late 1980s and early 1990s than 20 years ago. But most of these adults are hatchery fish. The total numbers mask the fact that wild runs like Onco's are still in serious trouble. For all the tougher fishing laws, habitat improvement and special water releases, the wild salmon still need help.

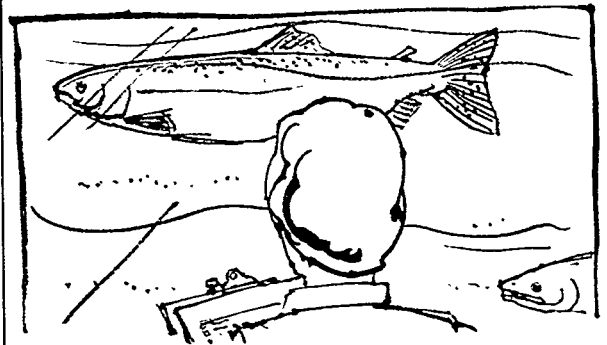


Over 123,000 spring chinook swim past the Bonneville fish counter's window this year. Spring chinook are running stronger up the Columbia in the 1980s than they did in the 1970s.



Onco is far from being home free. After Bonneville, she enters the reservoir behind the dam. The lake-like conditions confuse her, but she finds another fish ladder at the The Dalles Dam.

Although the flow of the river is different than it was before dams, it is not necessarily harder work for salmon. After all, before dams there were cascades and rapids in the Columbia. At one time, one of the biggest problems with dams was that water spilling over the top took on too much nitrogen. A fish absorbing too much nitrogen is like a diver getting the "bends." Nitrogen in the bloodstream can kill. But for the most part, fish biologists and engineers have solved this problem.





An Idaho chinook travels some 900 miles downstream to the ocean, over 4,000 miles at sea, and another 900 miles to battle its way back to the stream of its birth.

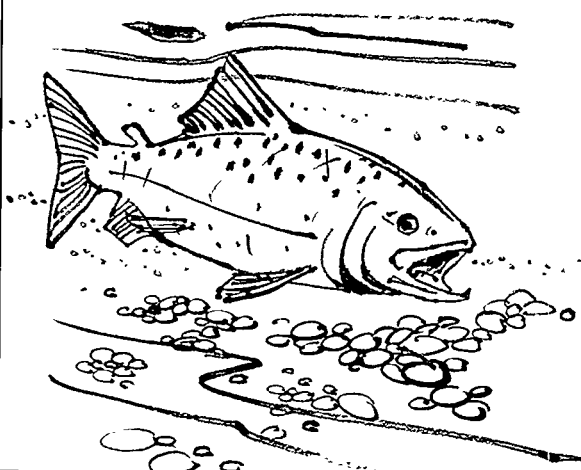
Along the way there is some fishing, but it is severely restricted. Mostly it is Indian people taking fish for food or ceremonial rites.

As Onco fights her way upriver, she uses up her energy reserves. She becomes haggard and skinnier.

At every fork in the river, she knows which stream to take. Guided by her homing instincts, Onco says no to the Deschutes River, no to the John Day, no to the Umatilla. Then comes the Snake River. The Snake River "smells" right to her. She leaves the Columbia to follow the Snake.

One hundred fifty miles later, she comes to the mouth of the Salmon River. She waits a couple of days for rain to make the river right. Her stomach is empty. She has not eaten for a month. It's June now, and she is little more than a cargo vessel for a load of ripening eggs.

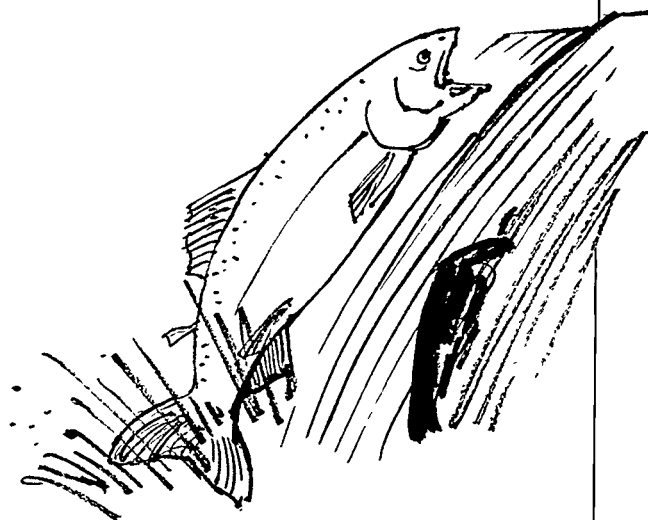
She swims up the Middle Fork of the Salmon River. A week later she heads into the tiny no-name creek in which her life began. Onco has traveled roughly 900 miles downstream to the ocean, over 4,000 miles at sea, and another 900 miles to battle her way back to this shallow creek.



Of the nine redd-mates that made it back into the Columbia, five are left.

Now she has to leap one last four-foot shelf—not quite a waterfall, but a steep little rapid—in the creek.

It hardly seems possible that a fish in Onco's gaunt condition could leap over a distance nearly



twice her body length. But she does, just as she has conquered all the other hurdles on her heroic journey to and from the sea.

Of Onco's nine redd-mates that made it back into the Columbia, two ran head-on into a gill net and couldn't back out. One other was caught on a fisherman's hook. Another became disoriented at a dam. Instead of climbing the fish ladder, she died of exhaustion trying to find a way through the concrete.

Five are left. These five salmon are not just the luckiest, but also among the fittest. Only the genes from good strong fish will be passed to the next generation.

Spawning

The river runs low and clear this July, and Onco returns in good time to the place she began life. She idles, waits. She is ripening.

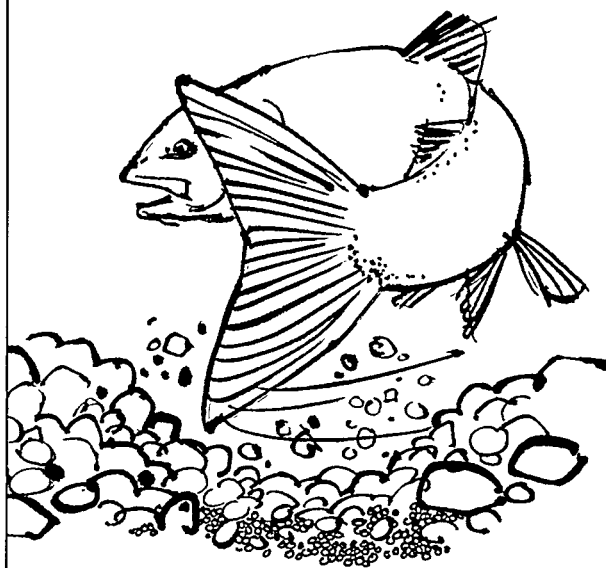
In late August, male and female salmon pair off to spawn. Since there are three males and only two females here, there is rivalry in the shallow riffles of the creek. The males jockey for position, trying to run each other off.

There is also a much smaller male called a jack. The jack returned after only one year in the ocean. In spite of his size, he is fully capable of spawning, in case full-sized males don't make it back to fertilize the eggs.

The bigger males are dark and blotchy and have hooked snouts. They consider the jack a nuisance. When he drifts into their range, they lunge and nip at him. They send him scampering upstream over and over again until he seems to get the idea that he is not wanted here.

Onco ignores this contest. She has her own job. She builds the redd.

She chooses a ripply spot where the stream bed gravel is clean and fine. With her broad tail she begins sweeping gravel aside. She scoops out a kind of trough, in the general shape of her body and twice as long. She tests it by settling into the depression. Then she moves upstream and

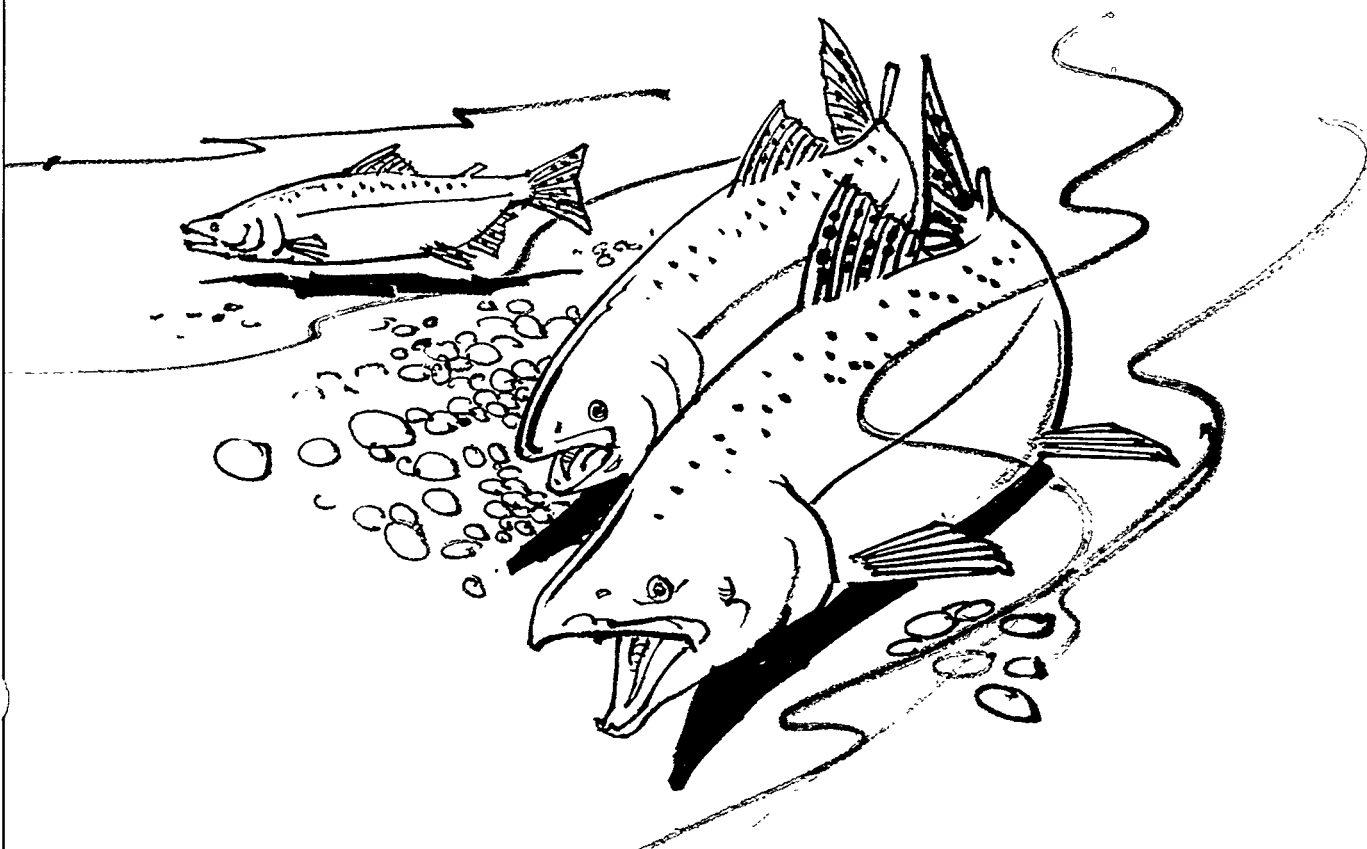


The female builds a redd. She chooses a ripply spot where the stream bed gravel is clean and fine.

swishes more gravel around until it feels just right. The redd has a downstream ridge where she can rest.

Meanwhile, two of the males, having driven off the others, begin a courtship dance around Onco and the other female. They circle slowly. They approach and move away again. This goes on for hours around the purplish-brown form of Onco, who idles in her redd.

The big males are dark and blotchy and have hooked snouts. There is also a smaller male called a jack. In spite of his size, he is fully capable of spawning.



These salmon are not just the luckiest, but also among the fittest. Only genes from good strong fish will be passed to the next generation.

With one last effort, the female struggles out of the redd. Just upstream, she swishes her tail in the water. Fine gravel now covers and protects her eggs.

Finally, a male swims in beside Onco, just upstream from her. His body presses hers against the ridge of the redd. Both adult fish seem to shudder at this moment which ushers in both life and death.

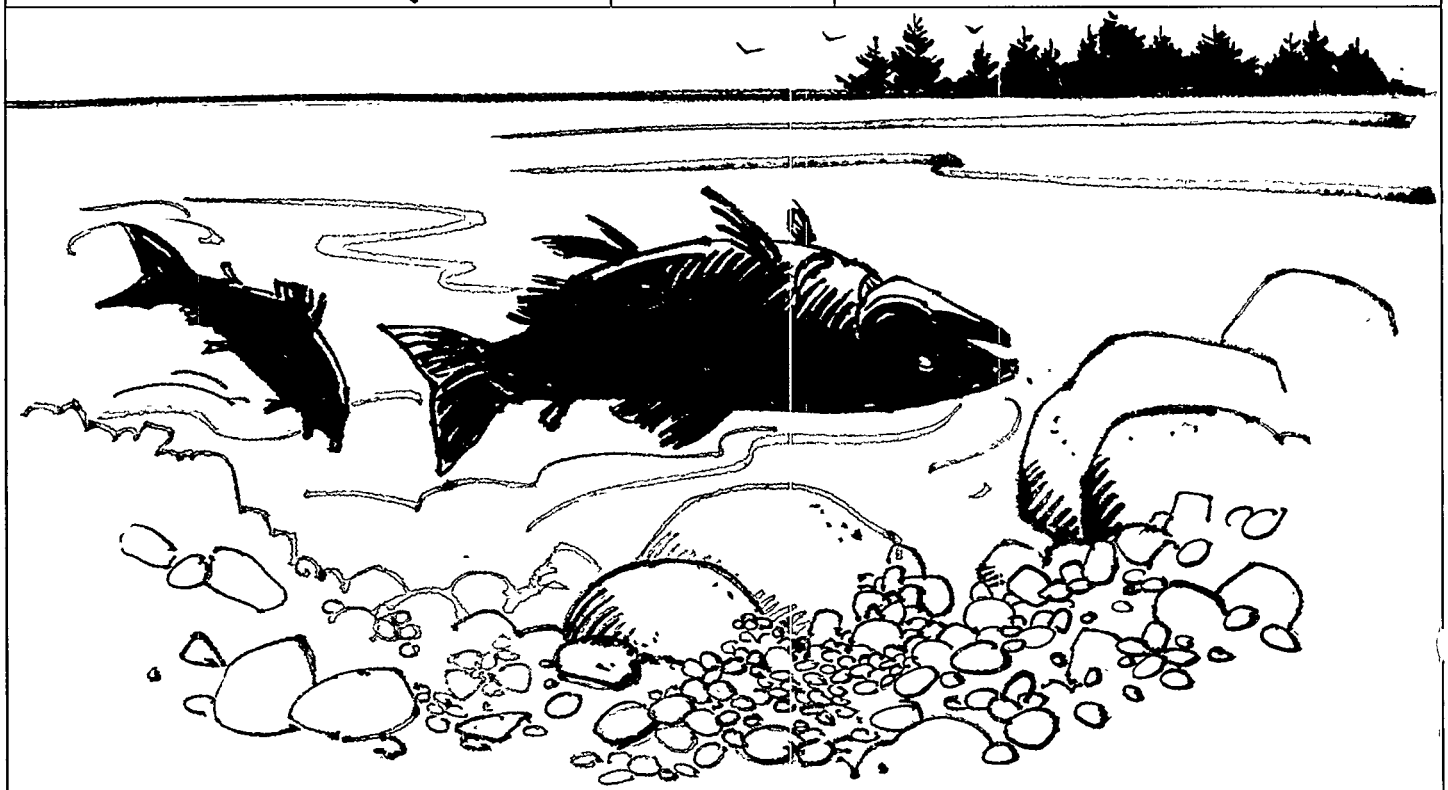
Onco trembles. Her body deflates. The pink eggs come out and drift down into the redd. Almost immediately, a white cloud of sperm, or milt, issues from the underside of the male. Milt spreads to cover Onco and the eggs. The eggs have been fertilized, and the whole cycle will begin again.

Leaves on the surrounding trees are turning yellow. It is the same time of year that this story began. Onco is five years old.

Onco, with one last tired effort, struggles out of the redd. Just upstream, she swishes her tail in the water. The action of the water lifts small pieces of gravel up and into the redd. Fine gravel now covers and protects the eggs.

Then Onco dies. The current she has fought all the way has become her master. Reduced to just skin and bone, she is so dry that her flesh falls apart in the beak of a crow. Her body, decomposing, drifts downstream. It provides nourishment to the smaller life forms that Onco once fed upon as a fry.

And so Nature's circle closes in on itself. With death comes life. The magnificent journey of Onco the Lucky is complete.



Steelhead

Steelhead are rainbow trout that migrate to the sea. Their bodies are solid silver gray until spawning time, when their skin darkens. Occasionally a reddish streak shows up on their sides. Unlike the salmon, the adults' snouts do not grow longer.

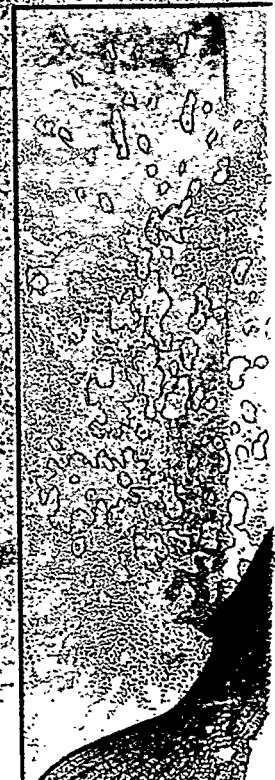
No matter what time of year you are reading this, there are young steelhead in the river swimming to the sea. Some migrate to the sea after their first year, but most wait until after two years. As the young go downstream, they pass adults moving upstream to spawn. Most steelhead return after two years at sea. More return in the summer than in the winter.

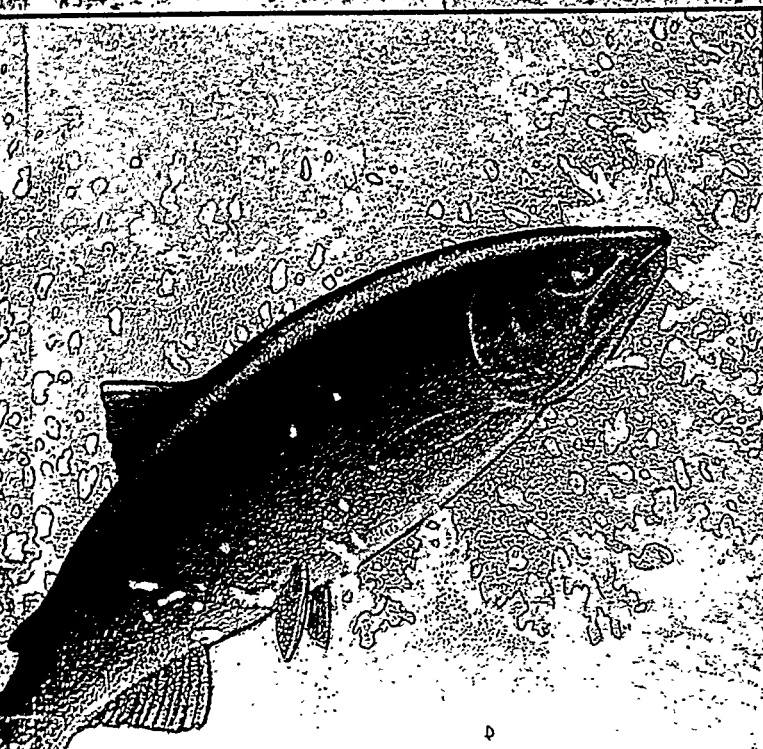
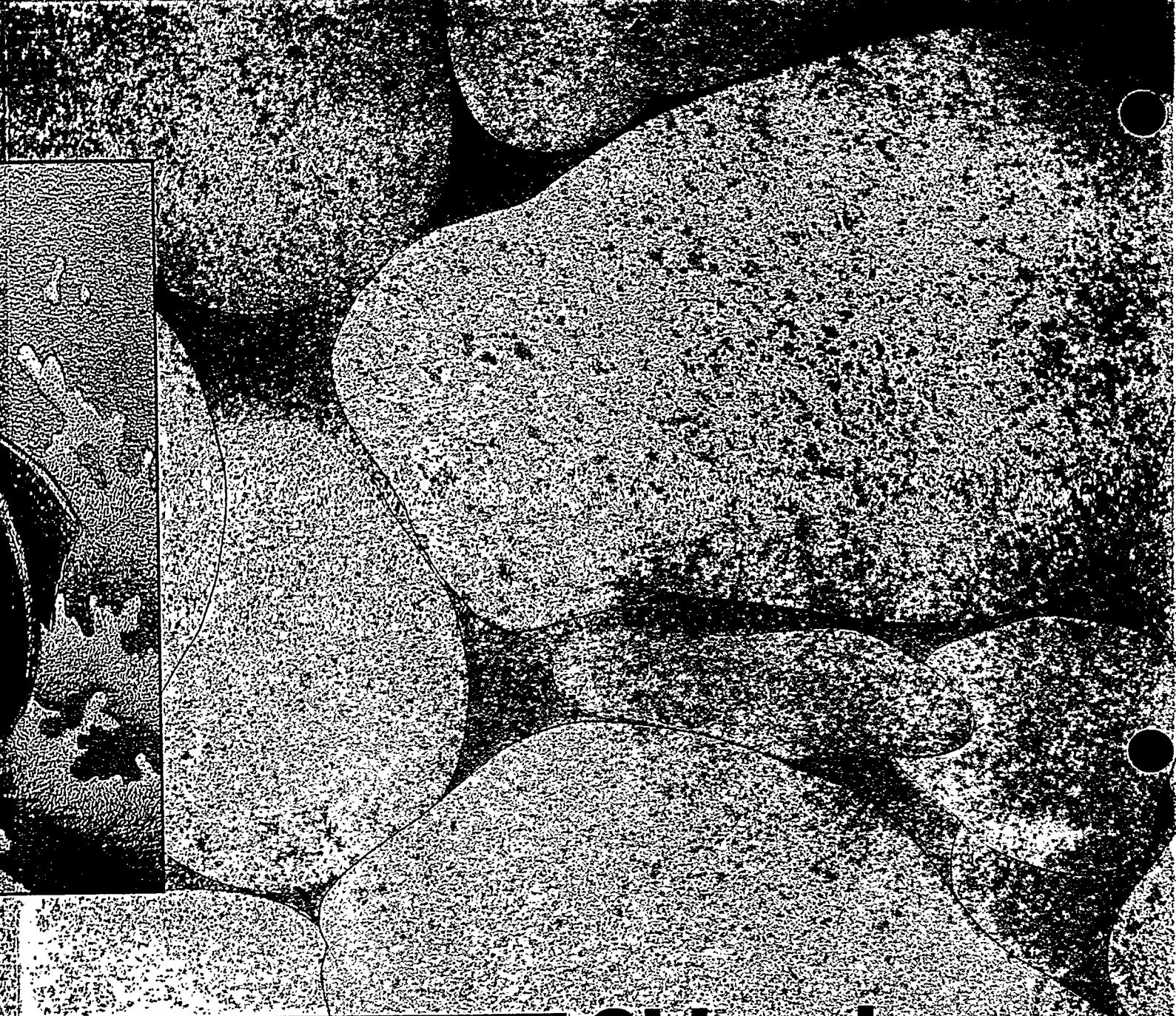
Winter fish spawn within one or two months. Summer fish may wait as long as six months. The female digs a huge redd. It can cover an area of 58 square feet. She will bury the eggs in up to a foot of gravel. The female will release from 200 to 9,000 eggs. It depends on her size and the type or stock of fish; that is, whether she is from a stream in Idaho or from the coast of Oregon.

Unlike salmon, steelhead don't die after spawning. They can swim back to sea and return to spawn again. But only 10 to 15 percent survive the trip. The oldest steelhead ever caught in the Pacific was nine years old.



Oncorhynchus mykiss



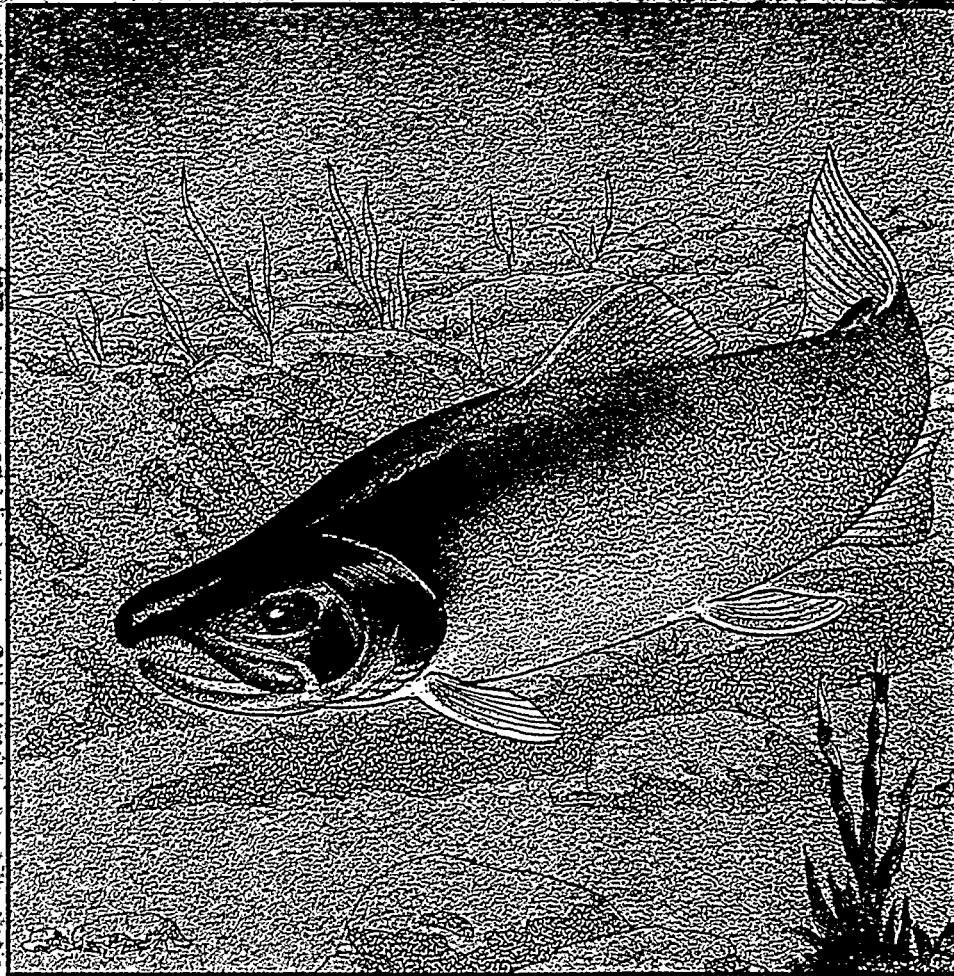


Chinook

These are the largest of the salmon and are sometimes called "king" salmon. Adult fish can grow to over four feet in length. Average weight is 40 to 45 pounds, but the record is 126 pounds. The chinook has a greenish back, silver sides and a silver belly. It is covered with black spots on its back, back (or dorsal) fin and tail (or caudal) fin. Its mouth is black. The fish darken as they mature. By the time the males are ready to spawn, they are almost black and their snouts have twisted into grotesque hooks.

Chinook usually mature in their third or fourth year. However, it can be as early as the second year or as late as the eighth. The fish return to the Columbia in the fall, spring and summer. Some types of chinook linger in deep pools in the river until the water is just right for moving on to their spawning grounds. Chinook are known as long-distance swimmers and will travel to the farthest reaches of the Columbia to

Oncorhynchus nerka



Sockeye

Immature sockeye have silvery sides and bellies and greenish-blue backs. As they mature, they turn bright red. The males' faces become olive-green. The upper jaw and snout turns black, the lower jaw, light gray. Adults weigh 12 pounds, on average.

Sockeye will return to the river between their third and fourth year of life, but most of them return as four-year-olds. They require a lake at the headwaters of their chosen stream to spawn. The adults pass through the lake to smaller tributary streams where the females dig their redds. The female releases an average of 3,500 eggs. After hatching in early spring, the young can move immediately into the lake. Most will spend a full year there before migrating to the ocean.

Oncorhyr

Oncorhyr

Oncorhynchus tshawytscha



Oncorhynchus kisutch

Coho

The coho, or "silver salmon," has a metallic blue back and silver sides and belly. The adults turn muddy red as they begin their spawning run. Black spots are scattered along the back and upper tail. Their mouths are black except for a thin white line along their gums. Fishermen have caught coho heavier than 30 pounds, but the average is eight pounds.

Coho spawners return to the spawning area in the fall of their third year. Almost all spawn in Washington and Oregon. You would rarely see a coho in Idaho. The female may dig several redds and will deposit a total of 3,000 to 4,000 eggs.

After hatching, the young fish gather in schools in shallow areas near the stream bank. As they grow older, they disperse and become very aggressive, even toward each other. Most make the journey to the sea when they are in the spring of their second year but can migrate anytime between one and three years of age.

For More Information

For more copies of this brochure or more information on BPA's fish and wildlife effort, contact your nearest BPA Area or District office, the BPA Division of Fish and Wildlife, or the BPA Public Involvement Office. BPA maintains a mailing list of people who want to keep abreast of the agency's fish and wildlife activities. If you want to be on that list, contact the BPA Division of Fish and Wildlife at the number listed below.

BPA Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208
(503) 230-4981

BPA Public Involvement Office
P.O. Box 12999
Portland, Oregon 97212
(503) 230-3478
800-622-4519
Voice/TTY available for the speech and hearing impaired.

BPA Area and District offices:

Portland (503) 230-4558

Eugene (503) 465-6958

Seattle (206) 553-4130

Spokane (509) 353-2515

Missoula (406) 329-3060

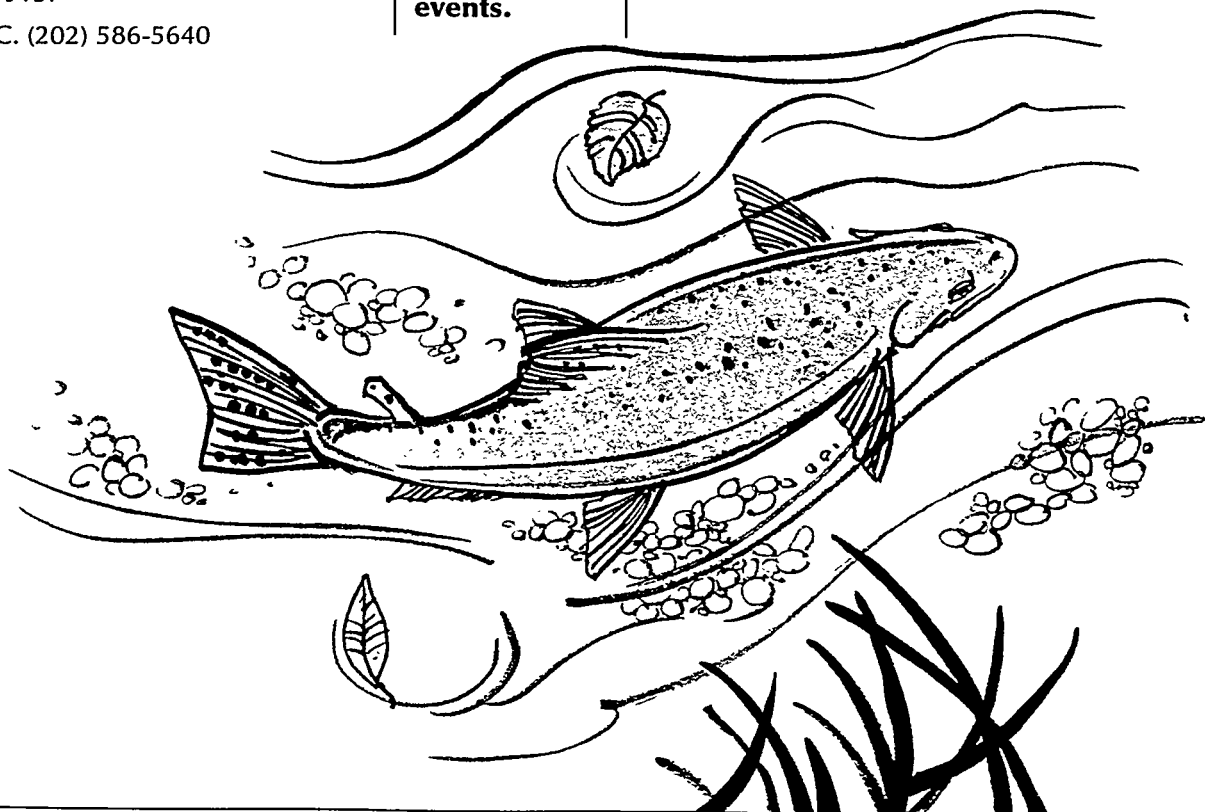
Walla Walla (509) 527-6225

Idaho Falls (208) 523-2706

Boise (208) 334-9137

Washington, D.C. (202) 586-5640

**The annual
run of North-
west salmon
— from the
vast Pacific
Ocean to the
mountain
streams
where their
lives began
— is one of
Nature's most
awe-inspiring
events.**



Day 2

OUTLINE

TIME

ACTIVITIES

MATERIALS

(Based on class of 40)

9:00 a.m.

Breakfast/Estimation Game

Pinto Beans (5,00 = ~ 4 lb.)
8 small plastic beads
Plastic storage container (1 gallon)

9:15

Journey of the *Oncorhynchus*:
A Story of the Pacific Northwest Salmon

Mural-add Section 2

9:30

(2-1) Cabbage Chemistry
(Indicator Solution)

10 Balances/50 gram masses
2 red cabbages (shredded)
1 gallon tap water
2-5 quart sauce pan (non-aluminum)
2 hot plates
40-250 mL plastic beakers
20-50 mL graduated cylinder
hand grater
6 plastic pitchers (1 liter)
2 wooden spoons
1 plastic colander
20 thermometers
20-9 oz plastic cups

10:00

Demo: Where's the Oxygen?
(Dissolved Oxygen)

1 hot plate
beaker tongs
2-600 mL glass beakers
food coloring-assorted colors
20 thermometers
20-250 mL plastic beakers
2 gallons of water

10:30

Break

10:45

Demo: Acids and Bases
(Acids and Bases)

3-9 oz plastic cups
200 mL of white vinegar
200 mL of ammonia solution
200 mL thymol blue indicator solution
red and blue litmus paper
medicine dropper
100 mL of tap water

11:00

(2-2) Acid, Base, or Neutral?
(Acids and Bases)

40 medicine droppers
cabbage indicator solution
20-9 oz plastic cups
20 white plastic ice trays
20 sheets of white paper

		24 oz of Crystal Pepsi® 24 oz of lemon juice 12 oz of white vinegar 1 can of cream of tartar 1 box of baking soda 24 oz of tap water 40 grams of Ivory Snow® 24 oz of milk red and blue litmus paper 12 oz of clear dish washing detergent 26-250 mL plastic beakers 20 aspirin tablets 30 grams of Borax 100 mL of Milk of Magnesia 20-10 mL graduated cylinders 24 oz of isopropyl alcohol 40 safety goggles
12:00	Lunch	
1:00	(2-3) pH: A Color Scale (Acids and Bases)	10 pH paper and color chart rolls 40 medicine droppers 20-9 oz plastic cups 20 white plastic ice trays 20 sheets of white paper 24 oz of Coke 24 oz of lemon juice 12 oz of white vinegar 1 can of cream of tartar 1 box of baking soda 24 oz of tap water 40 grams of Ivory Snow® 24 oz of milk 12 oz of clear dish washing detergent 26-250 mL plastic beakers 20 aspirin tablets 30 grams of Borax 100 mL of Milk of Magnesia 20-10 mL graduated cylinders 24 oz of isopropyl alcohol 40 safety goggles
1:45	Journey of the <i>Oncorhynchus</i> : A Story of the Pacific Northwest Salmon Snack	Mural-add Section 3
2:00 p.m.	(2-4) Predator Prey Tubes (Predator/Prey Relationships)	40 tornado tubes 80-1 liter, clear plastic pop bottles 2 packets of green confetti 2 packets of fish confetti 40 fish predator patterns 1 bottle of blue food coloring Clear tape Scissors
3:00 p.m.	Camp ends for students	

DAY 2

TEACHER NOTES

Estimation Game: Estimate the number of adult chinook salmon that will grow into mature adults from 5,000 eggs. (Answer-Eight salmon eggs will mature to adults. These salmon will be represented by eight red beads in the jar of pinto beans.) From these eight adult salmon, estimate the number that will make it back to their river to spawn. (Answer-Four adult salmon will return to their river to spawn. These salmon will be represented by red beads with black dots in the jar of pinto beans. The winners will be announced during the break.)

Story Time: Journey of the *Oncorhynchus*-Chapter Two. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up either the Journey of the *Oncorhynchus* mural by adding **section two** or referring to section two of the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section two. The first student to find the hidden salmon will be awarded a prize.

ACTIVITY 2-1: CABBAGE CHEMISTRY

SCIENCE CONCEPTS/PROCESSES: Measure

SKILLS: Thermometer Reading

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ use balances to measure mass in grams.
- ◆ use a graduated cylinder to measure liquid volume using proper metric units (mL).

MATERIALS:

10 balances	10-50 gram masses
2 red cabbages-(shredded)	1 gallon tap water
1 hot plate	1-10 quart sauce pan (non-aluminum)
35-250 mL plastic beakers	18-50 mL graduated cylinders
hand grater	6 plastic pitchers (1 liter)
1 wooden spoon	1 plastic colander
18-9 oz plastic cups	18 thermometers

BACKGROUND INFORMATION:

The Metric System

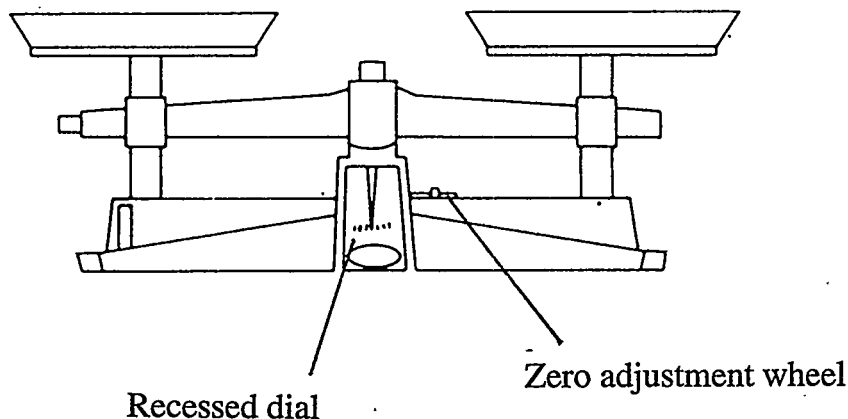
The metric system is a standard system of measurement used worldwide by the scientific community. The United States is one of three countries that still use the English system of measurement for everyday uses, although the U. S. is in the process of converting over to metric. The other two countries using the English system are Liberia and Myanmar (Burma).

The metric system came into existence after the French Revolution. The new government decided to produce a rational set of units for all measurements, the everyday, as well as those used in science and technology. The metric system is a decimal system based on the number ten. This system is used to measure length, volume, mass, and temperature. The base unit of length is the meter (m), derived from the Greek word *metron*, meaning "to measure." A meter is one ten-millionth of the distance between the equator and the North Pole. The volume of an object is measured in liters (L) and cubic centimeters (cm³ or cc). Metric mass is measured by the units (g) or kilograms (Kg). One kilogram equals 1,000 grams.

Mass - Using the Balance

Before massing an object on the balance, the balance indicator should line up with the center graduation on the recessed dial. If adjustment is necessary, rotate the zero adjustment wheel located to the right of the dial. After obtaining a zero balance, place the object to be weighed on the red (left-hand) pan. Place brass masses on the yellow (right-hand) pan until the pointer again lines up with the center graduation on the recessed dial. The mass of the object is equal to the sum of the weights needed on the right-hand pan to center the pointer.

The kilogram (Kg) is the basic metric unit used to measure mass. Some equal arm balances will use the gram (g or 1/1000 Kg) as its metric unit of measurement.

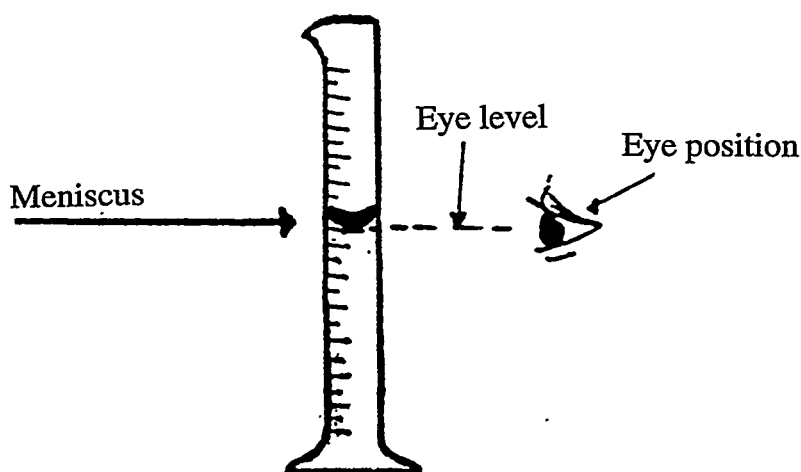


Volume - Graduated Cylinder

The graduated cylinder is an instrument used to measure liquid volume. It is a cylindrical tube calibrated in milliliters. There are three basic rules that must be followed in order to ensure accurate measurement when using a graduated cylinder:

1. Make sure the graduated cylinder is on a flat, horizontal surface,
2. Read the calibrations at eye level,
3. Read the volume at the bottom of the meniscus. The meniscus is the dip that forms in the graduated cylinder due to the adhesive characteristic of water (surface tension).

The liter (L) is the basic unit of measurement for liquid volume in the metric system. It is a little larger than the English system, quart. The milliliter (mL) is used to measure volumes that are less than one liter. There are 1000 milliliter in one liter.



PROCEDURE:

1. In this activity, students will prepare red cabbage indicator solution for Activity 2-3. Using balances and graduated cylinders, students will practice their measurement skills using the metric units (grams and milliliters).
2. Each student should use the balance to mass out 50 grams of shredded red cabbage. Place the 50 grams of cabbage in a 250 mL beaker.
3. Each student should use the graduated cylinder to measure 100 milliliters of tap water. Pour the water over cabbage in the beaker. Instructors should monitor the accuracy of the measurements.

4. Each student should pour their cabbage/water mixture into the large pan for boiling.
5. Instructors will boil the cabbage/water mixture for 10 minutes. Allow the mixture to cool before straining. All the pieces of cabbage should be removed before using this liquid as an indicator solution.
6. After the solution has cooled for about 15 minutes, students should record the temperature of the heated cabbage solution. Instructors should make sure that the students know how to obtain accurate thermometer readings in degrees Celsius. This step should be done after the following teacher demo-Where's the Oxygen?

TEACHER DEMO: WHERE'S THE OXYGEN?

OBJECTIVE(s): After completing this demo, students will be able to:

- ◆ use thermometers to measure the temperature of water in degrees Celsius ($^{\circ}$ C) and in degrees Fahrenheit ($^{\circ}$ F).
- ◆ understand that oxygen is dissolved in the water.

MATERIALS:

18 thermometers	food coloring-assorted colors
2 gallons of water	1 hot plate
20-250 mL plastic beakers	2-600 mL glass beakers
beaker tongs	5 quart sauce pan

BACKGROUND INFORMATION:

DISSOLVED OXYGEN

Dissolved oxygen (DO) refers to the amount of oxygen (O_2) that is dissolved in water. The presence of oxygen in water is essential for the maintenance of healthy lakes, rivers and streams. Most aquatic plants and animals need oxygen to survive. Fish and some aquatic insects have gills to extract oxygen from the water. Some aquatic organisms, like salmon and trout, require medium-to-high levels of dissolved oxygen to live. Other animals, like carp and catfish, thrive in waters with low dissolved oxygen.

The amount of dissolved oxygen can range from high to very low levels. In some cases, the DO is so low that the water is practically devoid of aquatic life. The absence of oxygen is a signal of severe pollution. Waters with consistently high dissolved oxygen are usually considered healthy and provide stable ecosystems capable of supporting many different kinds of aquatic organisms.

Physical Influences

Much of the dissolved oxygen in water comes from the atmosphere. Waves on lakes and tumbling water on fast-moving rivers act to mix atmospheric oxygen with water. Dissolved oxygen can also be affected by the rate of photosynthesis carried on by freshwater plants such as algae and rooted aquatic plants.

The solubility of oxygen varies with both temperature and mineral content of the water. The oxygen content of water decreases with a rise in temperature and density and increases with a decrease in water temperature and density. The rate of flow also affects the DO content of the water. The rate of flow or river discharge is related to the climate of an area. During dry periods, flow may be severely reduced and air and water temperatures are often higher, resulting in reduced DO levels. Wet weather or melting snows increase flow, with a resulting greater mixing of atmospheric oxygen.

Human Influences

Organic waste which consist of anything that was once part of a living plant or animals (food, leaves, feces), is the main factor contributing to changes in dissolved oxygen levels in river systems today. Organic waste can enter rivers in many ways, such as in sewage, urban and agricultural runoff, dairies, meat-packing plants, and other industrial sources. Fertilizers, a significant ingredient in urban and agricultural runoff, stimulate the growth of algae and other aquatic plants in lakes and rivers. As these plants die, aerobic bacteria consume oxygen in the process of decomposition. Many kinds of bacteria also consume oxygen while decomposing sewage and other organic material in the river.

Depletion of dissolved oxygen can cause major shifts in the kinds of aquatic organisms found in lakes, streams, and rivers. Species that cannot tolerate low levels of dissolved oxygen such as beetle larvae, caddisfly larvae, mayfly nymphs, and stonefly nymphs, will be replaced by a few kinds of pollution-tolerant organisms, such as worms and fly larvae. Nuisance algae and anaerobic organisms may also become abundant in water with low levels of dissolved oxygen.

TEMPERATURE

Temperature represents the quantity that tells how warm or cold a body is with respect to some standard. We express the temperature of matter by a number which corresponds to the degree of hotness on some chosen scale. Nearly all materials expand when their temperature is raised, and contract when it is lowered.

A thermometer is a common instrument that measures temperature by means of the expansion and contraction of a liquid, usually mercury or colored alcohol. As the liquid in a thermometer gets warmer, the molecules move faster and farther apart causing the liquid to rise in the tube. As the liquid is cooled, molecules slow down and get closer together causing the liquid to contract and move down the tube.

In the metric system, temperature is measured on the Celsius scale ($^{\circ}\text{C}$). On this scale the number 0 is assigned to the temperature at which water freezes, and the number 100 to the temperature at which water boils (at standard atmospheric pressure). The space between is divided into 100 equal parts, called degrees. Each Celsius degree represents 1/100 of this temperature range. This scale is called the Celsius scale in honor of the man who first suggested the scale, the Swedish astronomer Anders Celsius (1701 - 1744). (The Celsius scale used to be called the centigrade scale, from centi ("hundredth") and gradus ("degree"). Normal body temperature in humans is 37°C (98.6°F). Comfortable room temperature is 21°C (70°F).

In the English system, 32 is assigned to the temperature at which water freezes, and the number 212 is assigned to the temperature at which water boils. This scale is called the Fahrenheit scale, after the German physicist Gabriel Fahrenheit (1686 - 1736).

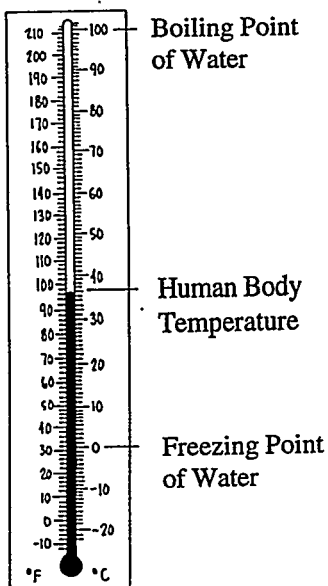
Conversion

To convert degrees Celsius to degrees Fahrenheit, multiply degrees Celsius by 1.8 (or 9/5), then add 32.

$$(^{\circ}\text{C}) \times 1.8 + 32 = ^{\circ}\text{F}$$

To convert degrees Fahrenheit to degrees Celsius, subtract 32, then multiply by .555 (or 5/9).

$$(^{\circ}\text{F} - 32) \times .555 = ^{\circ}\text{C}$$



PROCEDURE:

1. In this demo, students will observe the process of boiling. Students will observe a liquid changing from a liquid to a gas. They will also use a thermometer to measure and record the temperature of different liquids.
2. Obtain two 600 mL glass beakers (600 mL beakers are used only for demonstration). Fill each beaker half full of water and place them on a hot plate. Use a large pot to boil water for student use.
3. Allow the water in the beakers to boil. Students should make observations about what is going on in the beakers. Instructors should discuss dissolved oxygen and how it affects salmon.
4. Questions that should be asked:
 1. Where do the bubbles come from?
 2. What are the bubbles?
 3. How would water temperature affect the breathing of fish?
 4. Why is the temperature of stream water important to salmon?
 5. List some factors that would increase or decrease the temperature of stream/river water.
5. After the dissolved oxygen discussion, introduce the thermometer as the instrument used to obtain the temperature of a liquid. The following exercise will provide practice in reading the thermometer.
6. Obtain 20-250 mL plastic beakers and group them in sets of four. For each set of beakers, place different amounts of hot water into each beaker (for example: 15 mL, 25 mL, 50 mL, and 75 mL of hot water).. Then add water (at room temperature) to each beaker so that they are all 3/4 full.
7. Add one drop of food coloring to each beaker. Use four different colors of food coloring (blue, green, red, yellow) to distinguish the different beakers (temperatures).
8. A group of 6 students should use a set of four beakers and four thermometers to complete the exercise. Have students record the temperature of each liquid on their Student Activity Sheet-Where's the Oxygen? Use this exercise to familiarize students with the Celsius scale.

TEACHER DEMO: ACIDS AND BASES

OBJECTIVE(s): After completing this demo, students will be able to:

- ◆ recognize that all chemicals/substances can be grouped as either an acid, a base, or neutral.

MATERIALS:

3-9 oz plastic cups	200 mL of white vinegar solution
200 milliliters (mL) of ammonia solution	200 mL of tap water
Thymol Blue indicator solution	medicine dropper
red and blue litmus paper	

BACKGROUND INFORMATION:

Acids and Bases

A chemical is a substance characterized by definite molecular composition. All chemicals are classified as either being an acid, a base, or neutral. The water molecule (H_2O or HOH) contains two hydrogen atoms and one oxygen atom. The majority of the water molecules that make up a cup of water have this composition (HOH). A certain percentage of the molecules in water are known to dissociate or separate, forming pieces of molecules, such as H^+ and OH^- . These electrically charged pieces of molecules are called ions. The hydrogen ion (H^+) has a positive charge and the hydroxyl ion (OH^-) has a negative charge.

The percentage of molecules that are ionized in water at any one time is extremely small--about two ten-millionths of a percent. More importantly, when the number of hydrogen ions present in water is equal to the number of hydroxyl ions (hydrogen-accepting groups), a substance is considered neutral--neither acid nor base. **Acids** are substances that contain a greater number of hydrogen ions (H^+) than hydrogen-accepting groups. **Bases** are substances that contain a greater number of hydrogen-accepting groups (OH^-) than hydrogen ions.

Indicators

There are a variety of chemicals called indicators, whose color depends on the presence of an acid or base. There are natural indicators that can be used, such as red cabbage juice or commercially prepared indicators like Thymol Blue. Scientists use a mixture of indicators dissolved in water and/or alcohol or chemicals absorbed into paper such as litmus paper or pH paper to measure acidity. Litmus paper is made with paper impregnated with a powder made from certain lichens. This dye turns red in acids and blue in bases. It is unchanged in neutral solutions. An easy way to remember this relationship is:

Bases are Blue, aciDs are reD.

PROCEDURE:

1. In this demo, students will observe how an indicator changes color to identify the acidity of certain substances.
2. Obtain three 9 oz plastic cups and label them "A," "B," and "C."
3. Add 100 mL of vinegar to cup "A," and 100 mL of ammonia solution to cup B and add 100 mL of tap water to cup "C."
4. Students should make observations about the contents of each cup. Instructor should remind students that observations are made by using your senses. However, it is **very important** that students **never** taste substances unless specifically told by the instructor.
5. This would be the appropriate time to explain how to smell chemicals. Smelling a chemical can be dangerous because the chemical may react with your body tissue to cause discomfort. You can easily inhale too much of a chemical before your body notices and reacts. See the diagram below for proper smelling technique called wafting.



6. Using visual observations, ask students if the three liquids could be identical? different? Discuss student observations and responses.
7. Add a few drops of thymol blue indicator solution to each of the liquids. Students will note a change in color. Thymol blue indicator solution turns a red/orange color in acidic solutions (vinegar), turns blue in basic solutions (ammonia), and turns yellow in neutral solutions (tap water).

8. Discuss how an indicator distinguishes between acidic, basic, and neutral substances. Generally indicators use color changes to distinguish between acids and bases (pH scale).
9. Introduce the concept that an indicator can be put on strips of paper and used to identify acids and bases. Litmus paper is one example of a paper indicator.
10. Obtain a strip of blue litmus paper. Touch a blue strip of litmus paper to each of the liquids. Students should record results on Student Activity Sheet - Acids and Bases Demo (have students describe results as either blue or red, no other colors).
11. Obtain a strip of red litmus paper. Touch a red strip of litmus paper to each of the liquids. Students should record results on Student Activity Sheet - Acids and Bases Demo.

CONCLUSION:

Instructors should discuss the color changes and their meanings using the following questions:

1. What color does blue litmus paper turn in an acid? in a base? in a neutral solution?
2. What color does red litmus paper turn in a base? in an acid? in a neutral solution?
3. Which cup contains an acid? a base? a neutral solution?

ACTIVITY 2-2: ACID, BASE, OR NEUTRAL?

SCIENCE CONCEPTS/PROCESSES: Observe, Classify, Define Operationally, Interpret Data, Communicate, Interactions, Replication

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ identify a common acid.
- ◆ identify a common base.
- ◆ use an indicator to determine if a solution is an acid, base or neutral.

MATERIALS:

40 medicine droppers	cabbage indicator solution
20-9 oz plastic cups	20 white plastic ice trays
20 sheets of white paper	24 oz of clear Crystal Pepsi®
24 oz of lemon juice	24 oz of white vinegar
1 can of cream of tartar	40 grams of Ivory Snow®
20 aspirin tablets	100 mL of Milk of Magnesia®
1 box of baking soda	24 oz of tap water
30 grams of Borax®	24 oz of milk
26-250 mL plastic beakers	red and blue litmus paper
24 oz of clear dish washing detergent	24 oz of isopropyl alcohol
20-10 mL graduated cylinders	40 safety goggles

PROCEDURE:

1. In this activity, students will use cabbage indicator solution and litmus paper to test common household substances. They will determine if each substance is an acid, a base, or neutral.
2. Instructors should prepare the following solutions prior to starting the activity.

Acids

Lemon Juice	Use at full strength, 473 mL (16 oz). (pH~2.1)
Aspirin	Dissolve 20 aspirin tablets with 1 liter of tap water. (pH~2.8)
Pepsi®	Use 473 mL (16 oz) of non-diet cola. (pH~3)
Vinegar	Mix 500 mL of vinegar with 500 mL of tap water. (pH~3)
Cream of Tartar	Dissolve 10 grams of cream of tartar with 1 liter of tap water. (pH~4)

Neutrals

Milk	Use at full strength, 473 mL (16 oz). (pH~6.9)
Isopropyl Alcohol	Use at full strength, 473 mL (16 oz). (pH~7)
Tap water	Use 473 mL (16 oz). (pH~7)

Bases

Ivory Snow®	Mix 40 grams of Ivory Snow® with 1 liter of tap water. (pH~8)
Baking Soda	Mix 20 grams of baking soda with 1 liter of tap water. (pH~8.4)
Milk of Magnesia®	Dissolve 150 mL of Milk of Magnesia® in 1 liter of tap water. (pH~9.5)
Detergent	Mix 300 mL of clear dish washing detergent (non-phosphate) with 1 liter of tap water. (pH~8)
Borax®	Mix 30 grams of Borax with 1 liter of tap water. (pH~10)

3. Students should work in groups of two.
4. Each group will need:

- 1 white plastic ice tray
- 1 sheet of white paper
- 2 medicine droppers
- 1-9 oz plastic cup
- cabbage indicator solution

5. Each group should place their ice tray on a sheet of white paper. Use pre-made labels for each solution placed on the white sheet of paper. The instructors will pour about 10 mL of each solution into separate compartments in the ice tray.
6. Students will add the same amount (10 mL) of cabbage indicator solution to each of the common household solutions. Gently jiggle the ice tray to mix the two solutions.
7. Students should record their results (use purple, green, and pink for colors) on their data table on Student Activity Sheet 2-2.
8. After completing this section students should test each common household solution with red and blue litmus paper and record their results on their data table.
9. Students should rinse their ice trays out with water and dry them for the next activity.

CONCLUSION:

Instructors should assist groups in determining which common household substances were acids, bases, and neutrals. Students should share their results with the class. Instructors should write class results on chalkboard or a large piece of butcher paper. Questions to ask students:

1. Which substances are acids?
2. Which substances are bases?
3. Which substances are neutral?
4. How did you determine if a substance is an acid, a base, or neutral?---using cabbage indicator solution?---using red and blue litmus paper?
5. What happens if you mix an acid and a base together?

ACTIVITY 2-3: pH: A COLOR SCALE

SCIENCE CONCEPTS/PROCESSES: Observe, Classify, Define Operationally, Interpret Data, Communicate, Interactions

OBJECTIVE(s): After completing the activity, students will be able to:

- use pH paper to determine if a solution is an acid, base or neutral.

MATERIALS: (use the solutions from Activity 2-2)

35 medicine droppers	pH paper/color charts
18-9 oz plastic cups	18 plastic ice trays
18 sheets of white paper	1-16 oz bottle of Crystal Pepsi®
1-16 oz bottle of lemon juice	1-16 oz bottle of white vinegar
16 oz of cream of tartar solution	1-16 oz bottle of ammonia
40 aspirin tablets	40 antacid tablets (Tums®)
1 box of baking soda	16 oz of tap water
8 oz of sea salt	16 oz of milk
1-16 oz bottle of clear dish washing detergent	24-250 mL plastic beakers
18-10 mL graduated cylinders	1-16 oz bottle of isopropyl alcohol
35 safety goggles	

BACKGROUND INFORMATION:

pH

Acidity is measured in terms of pH (the **p**(ower) of **H**(ydrogen)) and is a measure of the number of hydrogen ions in a given volume of a substance. The pH scale ranges between zero and fourteen. The number in the middle, 7, describes neutrals, neither an acid nor a base. Numbers less than 7 are used to quantify acids. The lower the number the "more acidic" the acid. Numbers greater than 7 are used to quantify bases. The higher the number the "more basic" the base.

The pH scale is logarithmic scale, like the Richter scale used to measure the extent of ground movement in earthquakes. Each whole number on the pH scale represents an increase or decrease by a factor of 10. This means that a substance of pH 6.0 is ten times more acidic than a substance of pH 7.0, and so on.

APPROXIMATE pH OF SOME COMMON SOLUTIONS

	<u>pH</u>	<u>SOLUTIONS</u>
	0	battery acid
	1	stomach acid (1.3-3.0)
↑	2	lemon juice (2.1) acid fog (2-3.5) aspirin (2.9)
increasing acidity	3	vinegar, wine, beer, soft drinks orange juice cream of tartar
	4	tomatoes
	5	black coffee pH-balanced shampoo (4.0-6.0) distilled water (5.0-5.5)
	6	saliva (6.3-7.5) milk (6.9)
Neutral	7	tap water, rubbing alcohol egg white (7.6-9.5)
increasing <i>basicity</i>	8	sea water (7.8-8.3) non pH-balanced shampoo baking soda (8.4)
	9	phosphate detergents antacids
	10	milk of magnesia (9.9-10.1)
	11	household ammonia (10.5-11.9) non phosphate detergents
	12	hair remover
	13	oven cleaner
↓	14	

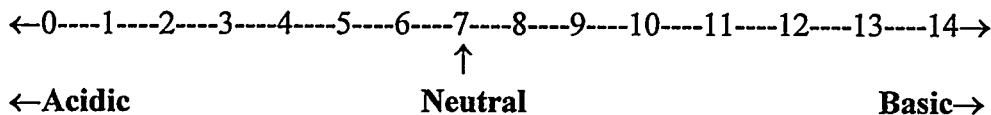
PROCEDURE:

1. In this activity, students will use pH paper as an indicator to test common household substances. Instructors should discuss the pH color scale.
2. Students should work in groups of two.
3. Each group will need:
 - 1 plastic ice tray
 - 1 pre-labeled sheet of white paper
 - 2 medicine droppers
 - pH paper and color chart
4. Each group should place their ice tray on the pre-labeled sheet of white paper. Place each solution next to the correct label on the white sheet of paper. The instructors will pour about 10 mL of each solution into separate compartments in the ice tray.
5. Students should test each solution with pH paper and compare the color change with the pH color chart. Record their results on their data table on Student Activity Sheet 2-3.

CONCLUSION:

Instructors should discuss the relationship between the colors and the pH numbers, in general terms. For example, numbers 1-6 represents an acidic solution, 1 being a "stronger" acid than 6. Number 7 represents a neutral solution. Numbers 8-14 represent a basic solution, 14 being a "stronger" base than an 8.

Instructors should set up a large sheet of butcher paper with a pH scale on it.



Have students add their common household solution's pH to the scale as part of the discussion.

Story Time: Journey of the *Oncorhynchus*-Chapter Three. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up either the Journey of the *Oncorhynchus* mural by adding **section three** or the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section three. The first student to find the hidden salmon will be awarded a prize.

ACTIVITY 2-4: PREDATOR-PREY TUBES

SCIENCE CONCEPTS/PROCESSES: Cause and Effect, Force, Observe

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ identify some of the fish predators that prey on young salmon.
- ◆ explore the process that creates a vortex (water spout).

MATERIALS:

80-1 liter, clear plastic pop bottles	40 tornado tubes
2 packets of green confetti	2 packets of small confetti (fish)
40 fish predator patterns	blue food coloring
20 packs of clear tape	40 scissors

BACKGROUND INFORMATION:

THE VORTEX

In order for a fluid like air or water to flow from one place to another, a force must act on it. In open systems like a riverbed, this force is provided by gravity. In a closed system like your pop bottle predator-prey tube or a drain pipe, other factors, in addition to gravity, come into play. For a fluid to flow in a closed system, it must always go from a region of high pressure (greater concentration of molecules per unit volume) to an area of low pressure (lower concentration of molecules per unit volume).

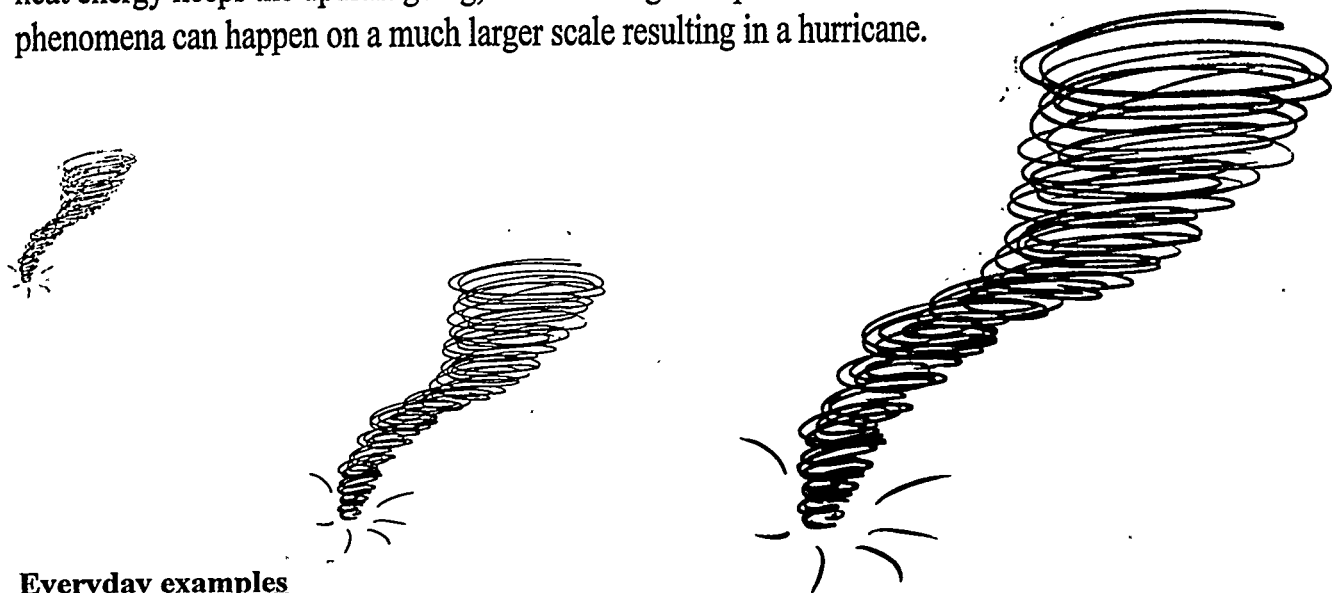
When you turn the predator-prey tube so that the full bottle is on top, the force of gravity pulls the water into the lower bottle. As the water flows, some of the air in the lower bottle is pushed out and bubbles up to the top. As long as the air can make it out of the lower bottle, gravity alone provides the pull or pressure to keep the water flowing down. Because the opening between the two bottles is made narrow by the tornado tube, the air and the water have a difficult time getting past each other. Eventually, the pressure of the air inside the lower bottle exactly equals the pressure of the water in the upper bottle, which stops the exchange of water and air.

To get the water moving again, another force is needed. That new force comes from the spin you create as you rotate the predator-prey tube. The force of the spin pushes the water toward the walls of the bottle. This force increases the pressure on the water near the walls of the bottle and lessens the pressure on the water in the center of the bottle. The higher pressure near the walls forces the water upwards, forming a depression in the top surface of the water. As the spin increases, the depression increases and eventually

reaches the opening of the bottles. The reduced pressure at the center, and the opening of the depression, "unclogs" the drain allowing air to move freely from the bottom bottle to the top bottle. Once this occurs, gravity quickly drains the water in the top bottle into the lower bottle.

Tornadoes and Water Spouts

Everyday common experiences such as water running out of your bathtub and water running down your toilet, usually get started because of differences in pressure. Tornadoes and water spouts get their energy from differences in air pressure. In tornadoes, this pressure difference is caused by unequal heating and cooling of air by the ground below. As air gets warm, it expands, becomes less dense (less molecules per unit volume), which causes a drop in pressure. A tornado begins when a narrow band of air expands so rapidly that it forms an area of extremely low pressure and suddenly rises, causing an updraft. Air from outside the updraft rushes into the low pressure zone to try and fill empty space. As air rushes in from all directions, it begins to spin. As long as heat energy keeps the updraft going, the tornado gains speed and moves. This phenomena can happen on a much larger scale resulting in a hurricane.



Everyday examples

The direction of the water's flow inside your bathtub drain or toilet bowl creates a vortex. If you feel the drain area of the bathtub, you'll notice that it is not flat. This uneven surface is specifically designed to direct the water into the drain and get it spinning. The water flowing in the vortex may swirl in either a clockwise or counterclockwise direction. You have probably heard the statement or read it in some books that water will swirl in one direction above the equator and the opposite direction below the equator because of the Earth's rotation. Unfortunately, this is not true. The Coriolis force, which explains why wind patterns on Earth change direction north and south of the equator, has little if anything to do with how water travels down bathtubs or toilets.

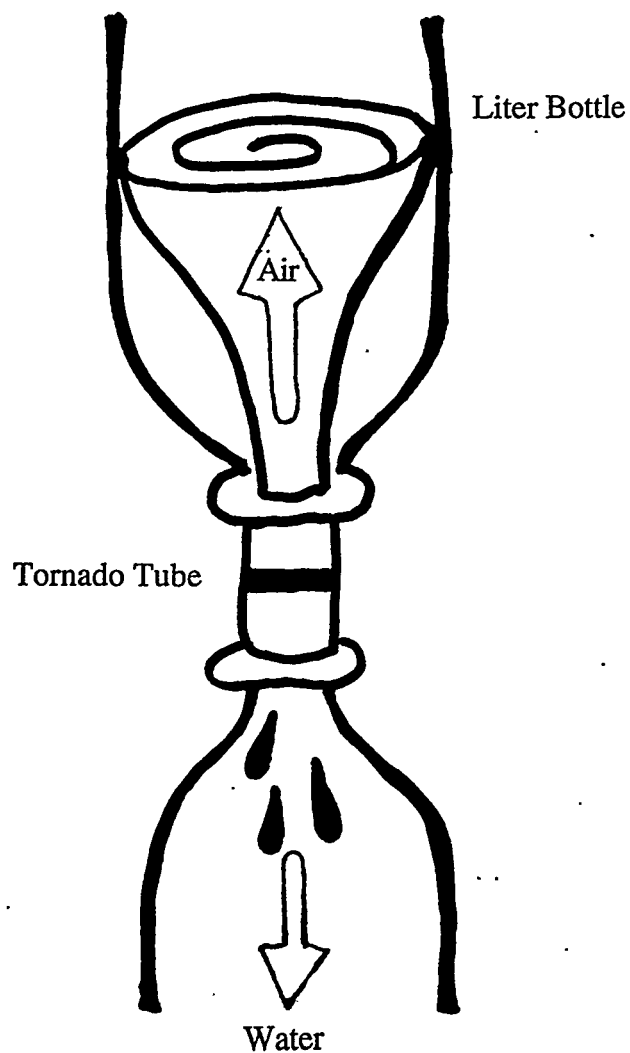
NATURAL PREDATORS

Young salmon are preyed on by sculpins, mink, raccoons, mergansers, and kingfishers, among others. When salmon reach the smolt stage they are preyed upon by larger fish, generally, walleye, largemouth bass, smallmouth bass and bigmouth minnow. The bigmouth minnow eats millions of young salmon smolt each year. Reducing the number of native bigmouth minnow may increase dramatically the number of salmon in the Columbia River Basin. A program sponsored by the Bonneville Power Administration, Oregon Department of Fish and Wildlife and the Washington Department of Wildlife, pays anglers to catch the native bigmouth minnow. The program removes these predators that feed on young salmon and other fish. Researchers are developing practical uses for bigmouth minnow, including fertilizers, fish meal, and food. This program aims to restore a more natural balance between the bigmouth minnow and its prey. Anglers earn \$3 for each bigmouth minnow measuring 11 inches or longer. Generally, fishing techniques used for walleye or bass work well for bigmouth minnow (The Bigmouth Minnow is more commonly called the Northern Squawfish).

PROCEDURE:

1. In this activity, students will make a predator-prey tube using a tornado tube, two one-liter clear plastic pop bottles and water. The predator-prey tube will provide the students with a model of a vortex. By adding a fish predator pattern and fish-shaped confetti, it will also be used to symbolize the relationship between certain fish predators (walleye, largemouth bass, smallmouth bass, bigmouth minnow) and their prey (smolt).
2. Instructors should assist students in building their predator-prey tubes. Pour light blue water (one drop of blue food coloring per bottle-do not over color) into one of the liter bottles until it is approximately 3/4 full.
3. Before connecting the two one-liter pop bottles together, add a pinch of green glitter confetti to represent algae and five to ten fish-shaped confetti to represent the young salmon (smolt).
4. After connecting the two bottles together with the tornado tube, it is important to dry the outside of the bottles before attaching the predator pattern. Instructors should assist students with the cutting and taping of the patterns. The stomach of each of the predators should be cut out so that students can see the young salmon (smolt) after they are eaten. The patterns should be taped to one of the liter pop bottles.
5. Twirl the water in the predator-prey tube apparatus to form a vortex. The spin of the water will flush the young salmon into the waiting mouths of the four fish predators.

Predator-Prey Tube



CONCLUSION

Instructors should ask the following questions to bring closure to this activity:

1. What is a vortex?
2. Give common examples of a vortex
3. Define the terms predator and prey.
4. Name a predator of the salmon smolt.

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Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY TWO

It's April. Hydroid's young friends still hide in the pools and slower water. Their sides now have dark bands or *parr* marks to *camouflage* them and to hide them from *predators*. They are not strong swimmers, but they are bolder and a little more adventurous. They dart into the stream to grab small insects that live among the stream's rocks. Not all the young fish make it back to the safety of the stream bank. As they move into the stream, they are wide open for attack. Fry and parr are the favorite food of trout and other large fish. Not everything that looks like a branch is a safe hiding place. Some branches turn out to be the legs of great blue herons. Hydroid also warns the young chinook to beware of shapes darting out from trees. The shapes could be kingfishers. The bright blue birds are looking for young fish to feed their own young this time of year.

Not all the young chinook survive the first few weeks of life. But those that do live learn quickly how to find food and avoid danger.

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY THREE

It's April, one year later. Each fish is now about the length of a human finger. That's why they are called *fingerlings*. Their parr marks are fading to faint vertical stripes along their silvery sides. The young fish are restless. They are ready to move. As the snow from the mountain begins melting, the stream rises, the fish move into the swift current and let it pull them downstream. The fish do not swim, they float with their heads pointed upstream. Hydroid flips into the water and travels along with his friends. Their small stream joins Hood River. Not too far from the stream, they slip down the face of a four-foot waterfall. A kingfisher swoops in and snaps up one of the fish. They are far from the shelter of the stream bank now. The fish move down into the water and travel mostly at night to avoid predators. Along the way, they eat worms, flies and larger insects. The fish are growing quickly. They are changing inside as well. Hydroid notices that, as the days pass, the current becomes stronger and the fish seem more eager to move downstream. They are heading for the ocean.

The river angles north, then west and suddenly becomes wide, brown and slow. Hood River has joined the Columbia River. Hydroid and the fish are in the *reservoir* created by Bonneville Dam. The dam makes enough electricity to heat all the homes and turn on all the lights in Portland. It does this without polluting the air. But the fish are not all that happy with the reservoir. The reservoir is like a big lake. There is no current to tell the fish which way is upstream and which way is downstream. They are lost. They swim around looking until they find the flow. They need to get to the ocean and the reservoir is slowing them down. The slow water is warm. Chinook and other salmon like cold water. Bass, walleye and bigmouth minnows like warm water. These fish love to eat young chinook. Bigmouth minnows can eat as many as 25 young salmon a day. The salmon stay low in the water and move at night to try to avoid danger. But Hydroid knows the greatest danger lies ahead. Dams produce power by sending water past *turbines*.

Within the 2,000-foot long concrete wall of Bonneville Dam, there are 18 whirling turbine blades. The blades are not likely to cut the salmon. What hurts the fish is the sudden change in pressure in going from the top to the bottom of the dam. The young fish could drop 90 feet in less than one second.

The water speeds up as Hydroid and the fish get closer to the dam. The current draws the fish to the mouth of a turbine when Hydroid spots a screen wall ahead. Hydroid flattens itself against the screen and cushions the young fish as they ride the screen up, past the turbine into a tunnel within the dam. The tunnel guides the fish around the turbines and into a tube on the other side. The fish are safe from the turbines. But the danger is not over. The ride makes some fish dizzy. Gulls and other birds know this. They lurk overhead on the lower side of the dam, waiting to pick off the stunned fish. Hydroid quickly moves the Hood River chinook low in the river. They find the current and continue their journey downstream.

Activity Sheet 2-1

WHERE'S THE OXYGEN?

1. List observations of the liquid being heated on the hot plate.

2. Fill in the table below.

LIQUID COLOR	TEMPERATURE ° C
BLUE	
RED	
YELLOW	
GREEN	

Student Activity Sheet

ACID AND BASE DEMO

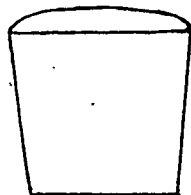
1. Make three observations about the contents in each cup: A, B, and C.

Cup A	1.
	2.
	3.

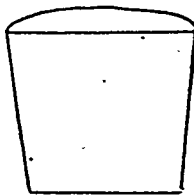
Cup B	1.
	2.
	3.

Cup C	1.
	2.
	3.

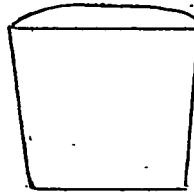
2. What happened to each solution when the indicator was added to the cup?
(use crayons to show the color of each solution below)



A.



B.



C.

3. Explain how to properly smell a chemical solution.

4. Fill in the table below.

Cup	Blue Litmus turns...	Red Litmus turns...
A		
B		
C		

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1. Fill in the data table below.

Name of Chemical	Color it turns Cabbage Juice	Litmus Paper Test Turns blue paper...	Litmus Paper Test Turns red paper...	Acid (A), Base (B), or Neutral (N)
Rubbing Alcohol				
Lemon Juice				
Vinegar				
Milk of Magnesia®				
Tap water				
Baking Soda				
Crystal Pepsi®				
Borax®				
Ivory Snow®				
Aspirin				

2. Which substances are acids?

3. Which substances are bases?

4. Which substances are neutral?

5. How did you determine if a substance is an acid, a base, or neutral---using cabbage indicator solution? using red and blue litmus paper?

1. Fill in the table below.

SUBSTANCES	pH
Cream of Tartar	
Milk of Magnesia®	
Milk	
Lemon Juice	
Coke®	
Vinegar	
Isopropyl Alcohol	
Detergent	
Borax®	
Ivory Snow®	
Baking Soda	
Tap Water	
Aspirin	

2. List the acids from strongest to weakest?

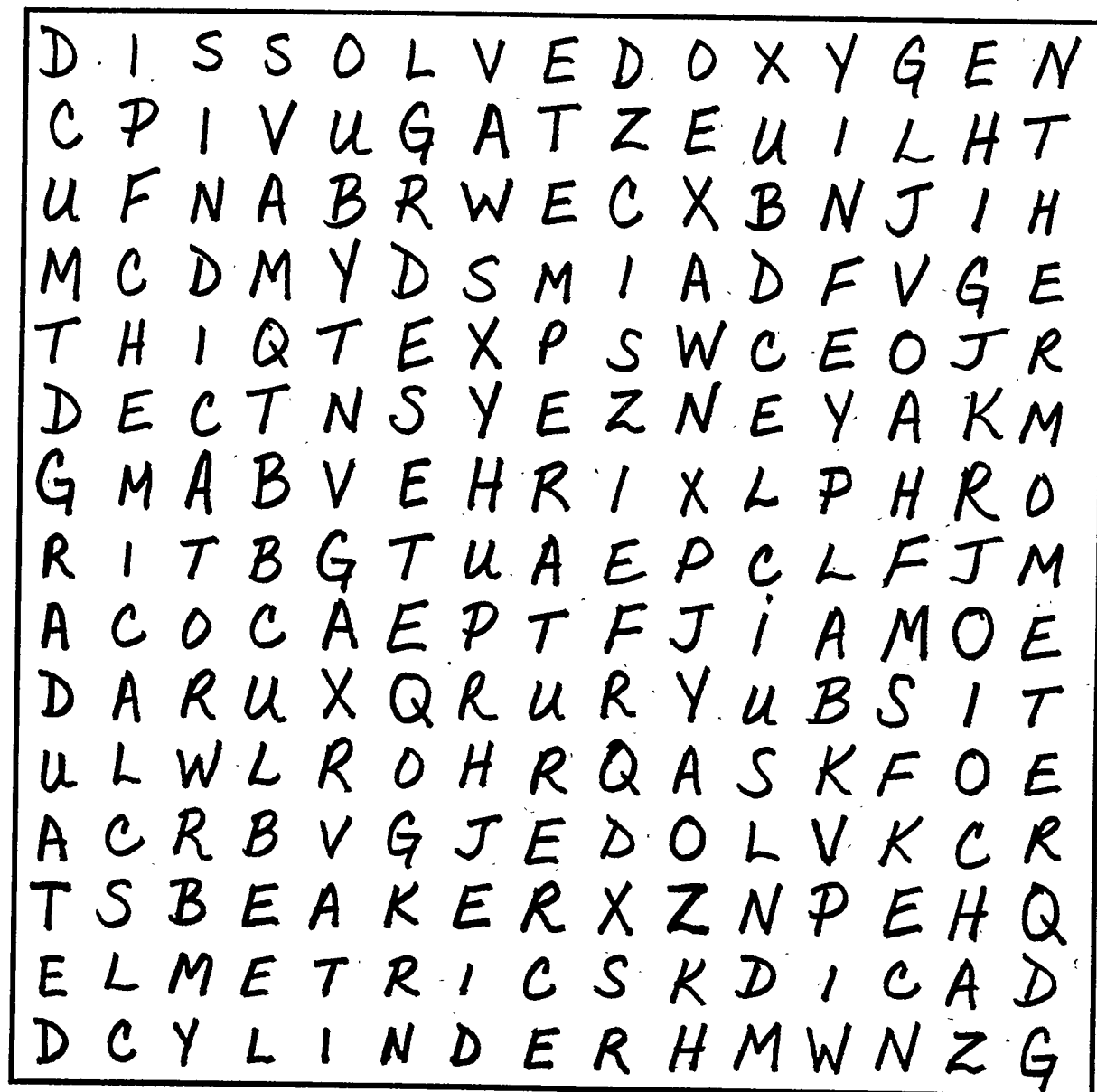
3. List the bases from strongest to weakest?

4. Which substances were neutral?

Student Activity 2-3B

Blank White Paper

CHEMISTRY WORD SEARCH

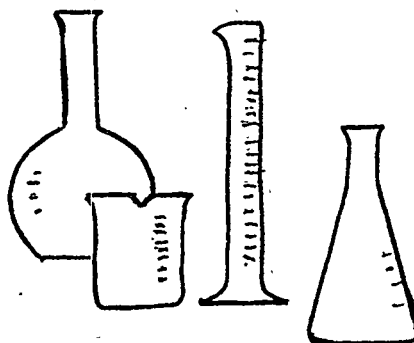
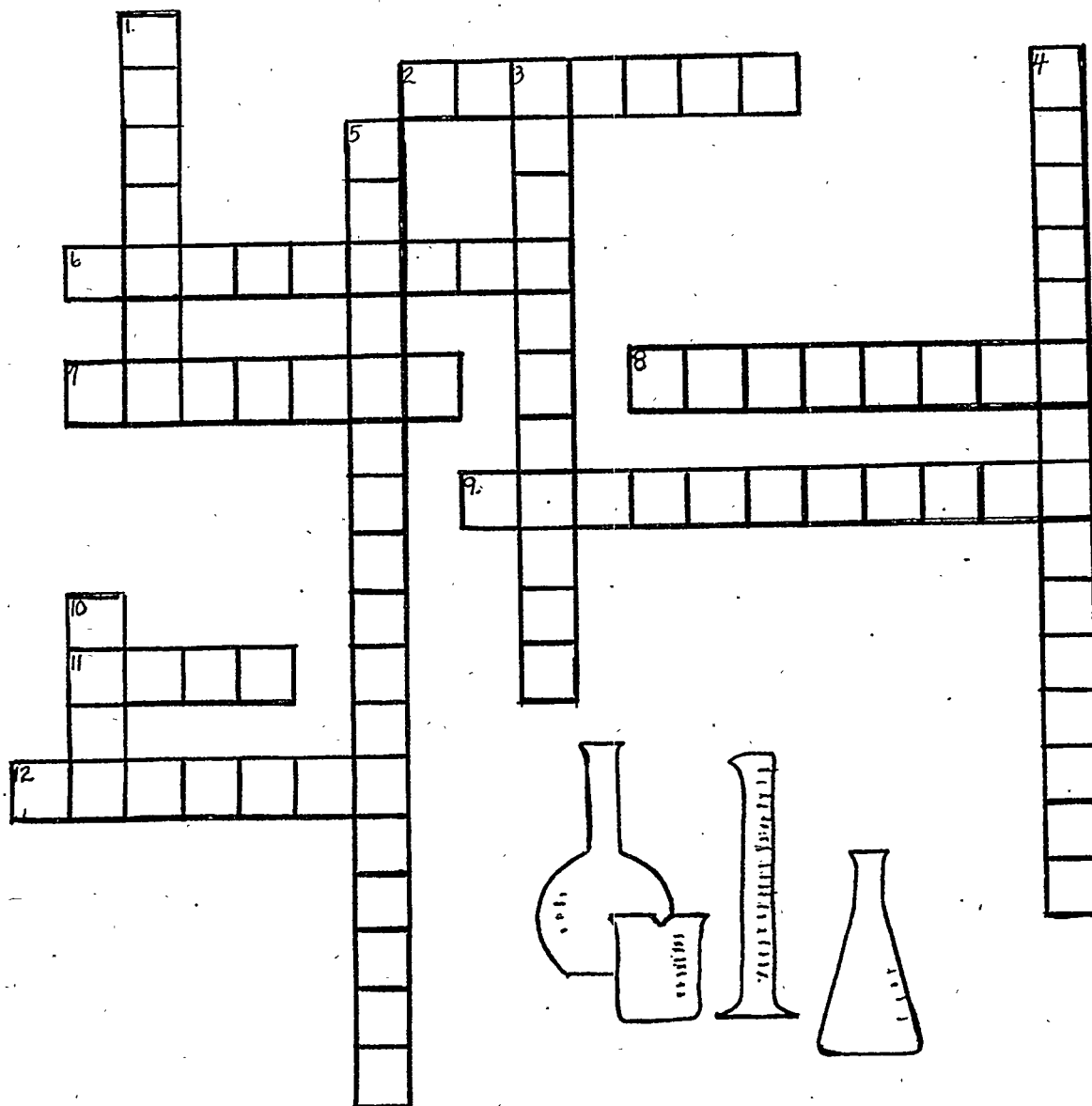


Temperature
Base
Neutral
pH
Graduated Cylinder

Beaker
Dissolved Oxygen
Celsius
Thermometer
Chemical

Metrics
Vortex
Acid
Indicator

CHEMISTRY CROSSWORD

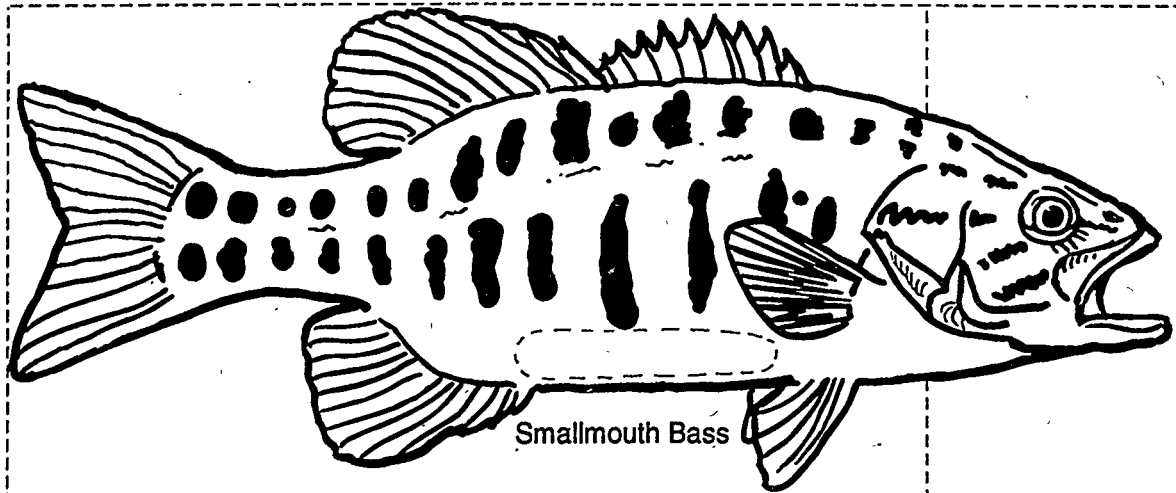


ACROSS

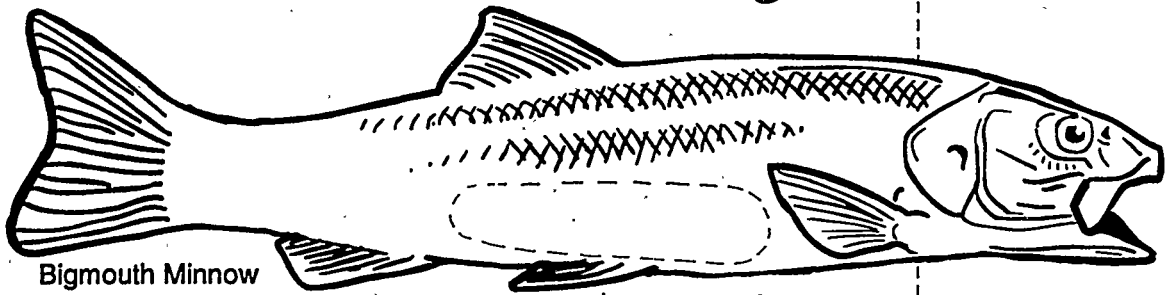
2. System of measurement used by scientists.
6. Chemicals used to determine if substances are acidic, basic, or neutral.
7. Temperature scale used the metric system.
8. Unscramble hecmlici to get this word.
9. Measurement of how hot or cold something is.
11. Turns blue litmus paper red.
12. pH of seven. Not acidic or basic.

DOWN

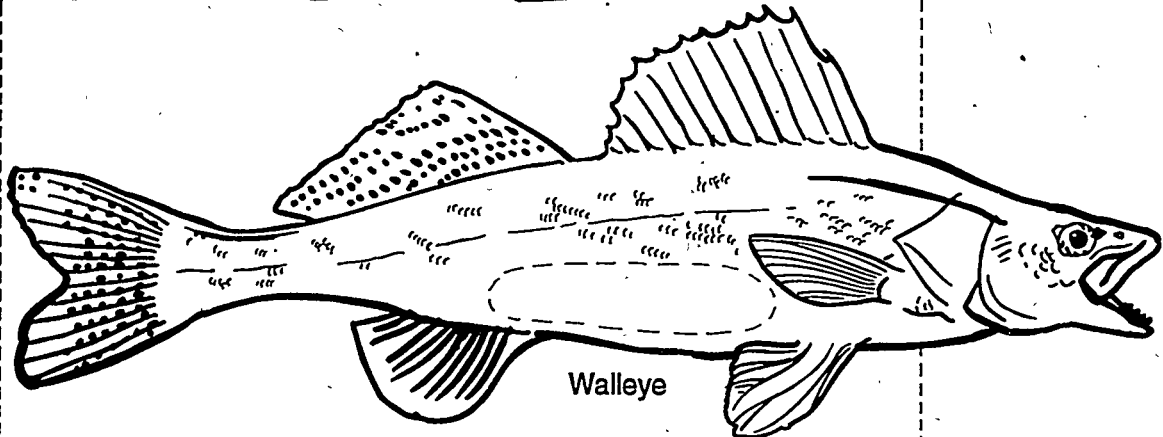
1. Instrument used to measure mass in the metric system.
3. Instrument used to measure temperature.
4. For of oxygen found in water.
5. Instrument used to measure liquid volume in the metric system.
10. Turns red litmus paper blue.



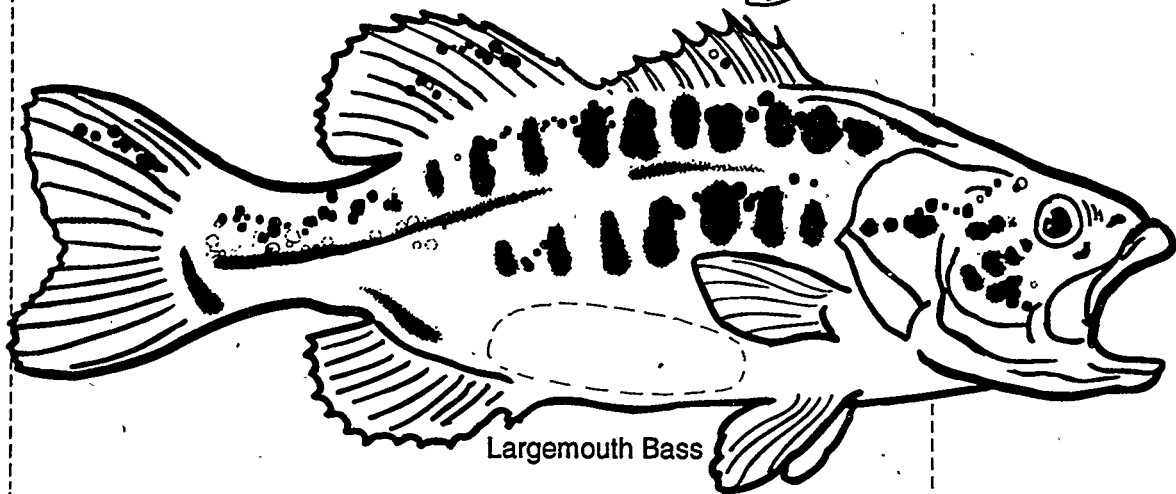
Smallmouth Bass



Bigmouth Minnow



Walleye



Largemouth Bass

Day 3**OUTLINE****TIME****ACTIVITIES****MATERIALS**

(Based on class of 40)

8:30 a.m.

Leave Camp site

Breakfast

9:30

Arrive at Oxbow Park

Student Workbooks

Meet at Park Office

40 adhesive name tags

Group Picnic Areas A & B are Reserved

First Aid Kit

Introduction to Oxbow Park

Insect Repellent

Suntan lotion

ACTIVITY STATIONS:**1. STREAM DETECTIVES (~60 minutes)**Salmon Life Cycle, Temperature,
pH, Dissolved Oxygen (DO),
Streamwalk Game

16 thermometers

DO meter

5 pH paper rolls/charts

10 Streamwalk Games

10-9 oz plastic cups

16 clip boards

red and blue litmus paper

**2. WILDLIFE WATCHING (~60 minutes)
AND TRACKING**Provided by Oxbow Park
Naturalist**3. OLD GROWTH FOREST (~60 minutes)**Provided by Oxbow Park
Naturalist**4. ECOSYSTEM ART (~30 minutes)**

Insect Collection

16 watercolors sets

16 paint brushes

45 sheets of white paper
(8½" x 11")

16-9 oz plastic cups

2 gallons of water

40 bug boxes

2. SALMON GAME (optional)

2 ropes (each ~25 feet)

500 feet of string

2 cardboard boxes

4 traffic cones

50 white (3"x5") index cards

50 colored (3"x5") index cards

9:45 - 10:25

Session A

10:30 - 11:10

Session B

11:15 - 11:45

Lunch

11:50 - 12:20

Session C

12:25 - 1:05

Session D

1:10 - 1:50

Session E

2:00

Leave Oxbow Park

3:00 p.m.

Arrive back at Camp Site

DAY 3

TEACHER NOTES

OXBOW PARK FIELD TRIP

EMERGENCIES

Oxbow Park Office phone number (503) 663-4708 or 797-1850 (METRO Park Office)

Pay phone located on Park Office porch.

Sheriff's Office (255-3600) or the Fire District #10 (232-2111).

Estimation Game: Challenge students to estimate the length of a piece of string in centimeters. (Winners will be announced at the beginning of lunch.)

Bus Activities: Students can complete games and/or activities in their student workbook during the bus ride to Oxbow Park.

OBJECTIVE(s): After completing the activities on this field trip, students will be able to:

- ◆ apply what they have learned in the classroom to their local and regional communities.

MATERIALS:

35 student workbooks	20 thermometers
Dissolved Oxygen meter	5 pH paper rolls/color charts
10 Streamwalk Games	35 bug boxes
2 ropes (each ~20 meters long)	20 watercolor sets
20 paint brushes	45 sheets of white paper
20-8 oz plastic cups	2 gallons of water
50 white (3" x 5") index cards	500 feet of string
50 pink (3" x 5") index cards	2 cardboard boxes
1 jump rope (10-15 feet long)	35 adhesive name tags
10-8 oz plastic cups	First Aid Kit
15 clip boards	4 traffic cones

BACKGROUND INFORMATION:

Oxbow Park, located 20 miles east of Portland, is a 1,000 acre natural area with recreational facilities. The Sandy River flows through the Park for three miles. The Sandy River supports spawning populations of coho, fall chinook, winter steelhead, spring chinook and summer steelhead.

The diverse topography and vegetation make Oxbow a haven for wildlife and provides an ideal setting for environmental education activities. The Park supports old growth and second growth forests. Some 220 varieties of native plants, 99 species of birds, 38 species of mammals, and 15 species of reptiles and amphibians make their home in the Park. Some commonly seen residents include, deer, osprey, pileated woodpecker, beaver, and great blue heron.

PROCEDURE:

1. Each group of students (A, B, etc.) will include one team from each of the two camps. Each group of students will experience five activity stations. The order in which each group will go through the stations is listed below.

<u>Group</u>	<u>Morning Stations</u>	<u>Afternoon Stations</u>
A	1, 2,	3, 4, 5
B	2, 3,	4, 5, 1
C	3, 4,	5, 1, 2
D	4, 5,	1, 2, 3
E	5, 1,	2, 3, 4

2. OXBOW PARK ACTIVITY STATIONS

STATION 1: STREAM DETECTIVES

Pacific Salmon Life Cycle Review

Stages of growth: fertilized egg, eyed egg, alevin, fry, parr, smolt, adult.

The Streamwalk Game

The Murky Water Mystery

Investigation Report

The Clue Cards

The Stream Detective Map

Stream Conditions

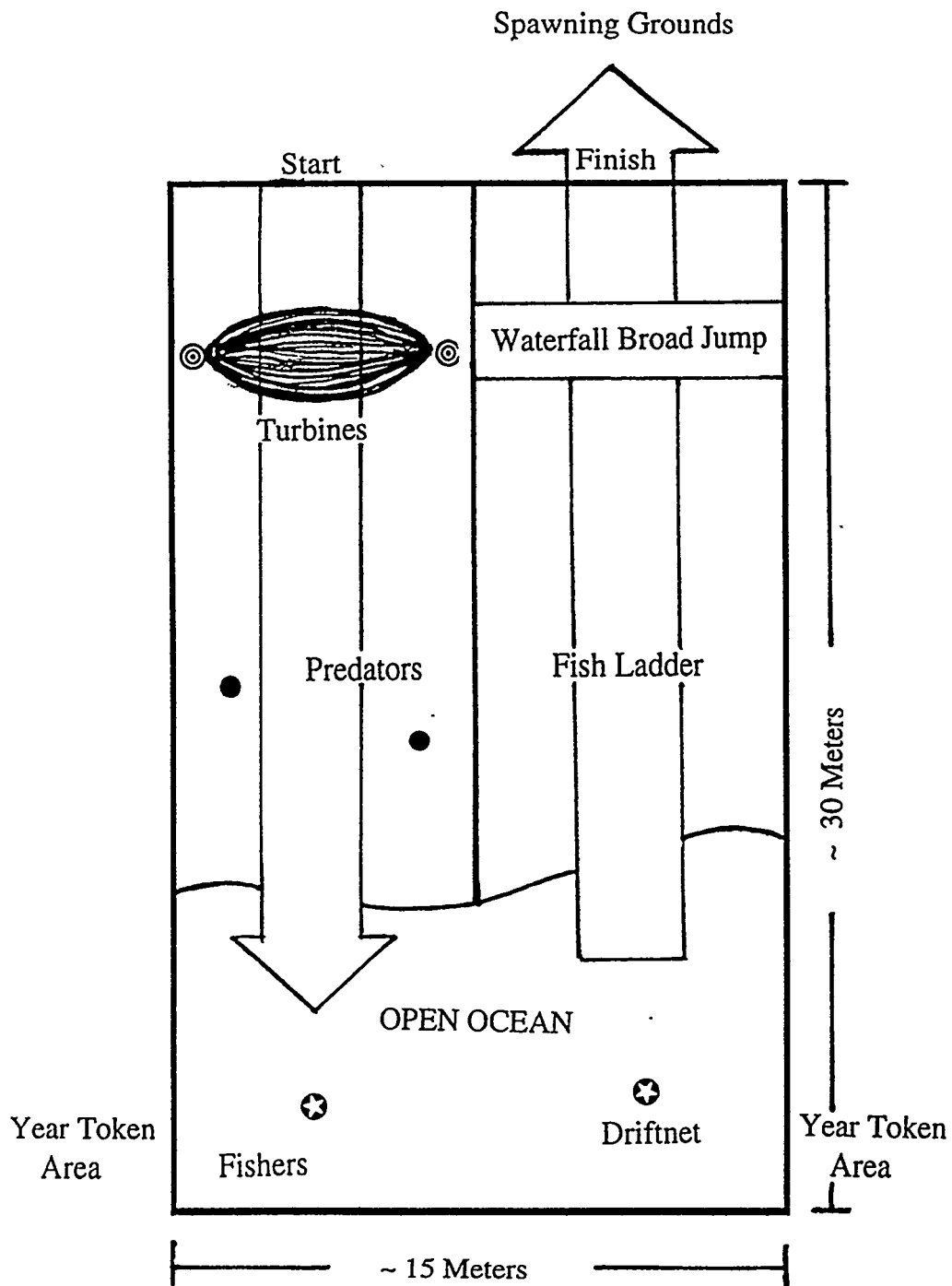
Temperature

pH

Dissolved Oxygen

STATION 2: THE SALMON GAME

(Adapted by permission from Aquatic Project WILD, © 1992 Hooks and Ladders activity.)



1. Set up the playing field as shown in the diagram. The area should be about 30 meters by 15 meters. Use string/rope to mark the boundaries. (See diagram.) The waterfall broad jump should be approximately three to four meters in length.
2. Assign roles to each of the students in the recommended numbers listed below.
 - Choose **two** students (or adults) to be the **turbine team** (these recommended numbers are based on a class size of 30 students, if your group is larger or smaller, adjust the numbers accordingly). These two students will operate the jump rope which represents the turbines in hydroelectric dams. Later in the game, when all the salmon have passed the turbine going downstream, these two students should move to the upstream side to become the waterfall-broad jump monitors (this activity works best with 30 or more students).
 - Choose **one** student to be a **predator** (kingfisher, bigmouth minnow, great blue heron, etc.). At the start of the game the predator will be below the turbines where he/she will catch salmon headed downstream. Later in the activity when all the salmon are in the sea, the predator will patrol the area above the "broad jump" waterfall. There she/he will become a bear and feed on salmon just before the salmon enter the spawning ground.
 - Choose **one** student to be a **human** in a fishing boat catching salmon in the open ocean. This student in the fishing boat must keep one foot in a cardboard box to reduce his/her speed and maneuverability.
 - Choose **one** student to use a **drift net** to capture salmon. This student will have to capture the salmon by wrapping his/her arms around the shoulders of the student salmon.
 - All remaining students represent salmon.
3. The activity begins with all the salmon starting their journey downstream. The turbines (jump ropes) at the dam will be their first hazard. The student salmon cannot go around the jump rope swingers, but they can slip under the swingers' arms if they do not get touched while doing so. A salmon dies if it is hit by the jump rope (turbine). **Any salmon that "dies" during this activity must immediately become part of the fish ladder.** The students who make up the fish ladder should kneel on the ground with a body-wide space between them.

4. After successfully passing the turbines, the salmon encounter native predators. The predators must catch the salmon with **both hands**, tagging isn't enough. The salmon that are caught are escorted by the predator to become part of the fish ladder.
5. After reaching the open ocean, the salmon can be caught by fishing boats and drift nets. The salmon must move back and forth across the ocean area in order gathering four tokens (two white and two pink). The white year tokens will be located on one side of the ocean and the pink year tokens will be on the other side. Each token represents one year of growth. Once each salmon has four tokens, that fish can migrate upstream. The year tokens can only be picked up one token at a time on each crossing. Remember, the salmon must cross the entire open ocean area to get a token (two white and two pink).
6. When the student salmon has obtained four of the year tokens, the salmon can begin its upstream journey. The salmon must **walk** through the entire pattern of the fish ladder. In the fish ladder, predators may not harm the salmon.
7. Once through the fish ladder, the salmon faces the broad jump waterfall (~4 meters in length). The waterfall represents one of the natural barriers the salmon must face going upstream. If the salmon fails to make the jump, then it must return to the bottom of the fish ladder and come through again.
8. Above the falls, the person who started the game as the predator is now the last set of limiting factors faced by the salmon. This predator can represent a bear or dipnet fisherperson. Again, remember that the predator must catch the salmon with **both hands**. If he/she does catch a salmon, they must then take the student they caught to become part of the structure of the fish ladder.
9. The activity (cycle) ends when all the salmon are captured before the spawning ground is reached or when all surviving salmon reach the spawning ground.
10. Some discussion topics to talk about after the game is completed:
 - A. The survival-mortality ratio of salmon
 - B. The student's feelings throughout the game
 - C. The role of the barriers
 - D. The role of the predatory wildlife and the people fishing
 - E. Where the losses were least.
 - F. Where the losses were greatest
 - G. The causes for variation of the salmon population.

STATION 3: OLD GROWTH FOREST

Introduction

Wake up your senses!

Define Old Growth Forest

Did you notice changes/differences in the forest while driving through?

Four part definition (size/age of trees, standing and downed dead wood, diversity of species, layered canopy).

Overview of Site

Identify four visible plant communities, introduce succession.

Identify osprey nest, it's life cycle and eating habits.

How to Walk in the Woods

Introduce or review first line of defense (freezing), splatter vision, focused listening, and fox walking.

Identify three tree species (Douglas Fir, Western Red Cedar, Western Hemlock, Indian legends, shade tolerance)

How it all fits together - Story of what happened at this site.

Volcanic flood in 1750

Douglas Fir forest, now old growth

Flood in 1964

Other activities along hike

Deer chews

Edible plants (*Oxalis*)

Examine 800-year old stump, estimate age

Look for fish bones under osprey tree.

STATION 4: WILDLIFE WATCHING AND TRACKING

How animals protect themselves ("freezing"). Camouflage.

Concepts of Awareness

Splatter Vision

Focused Listening

Fox walking

FREEZE GAME

Where and when to see animals.

Animal SIGNS

lays, chews, scat, hair, feathers, dens, etc.

Animal TRACKS

Clear print identification (go through formulas and families)

Pattern Identification

PRACTICE

STATION 5: ECOSYSTEM ART

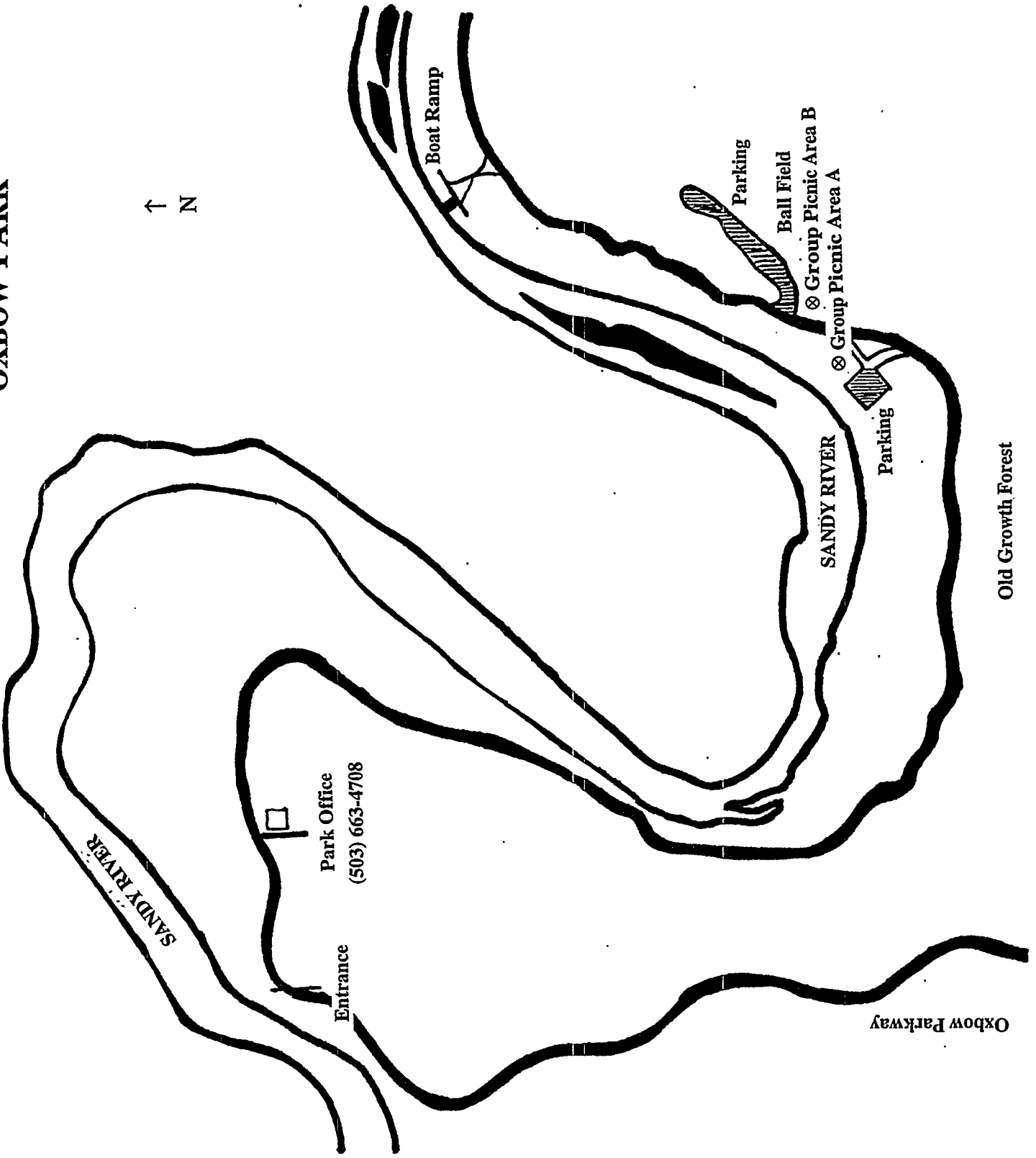
Students are to use watercolors to paint a habitat scene.

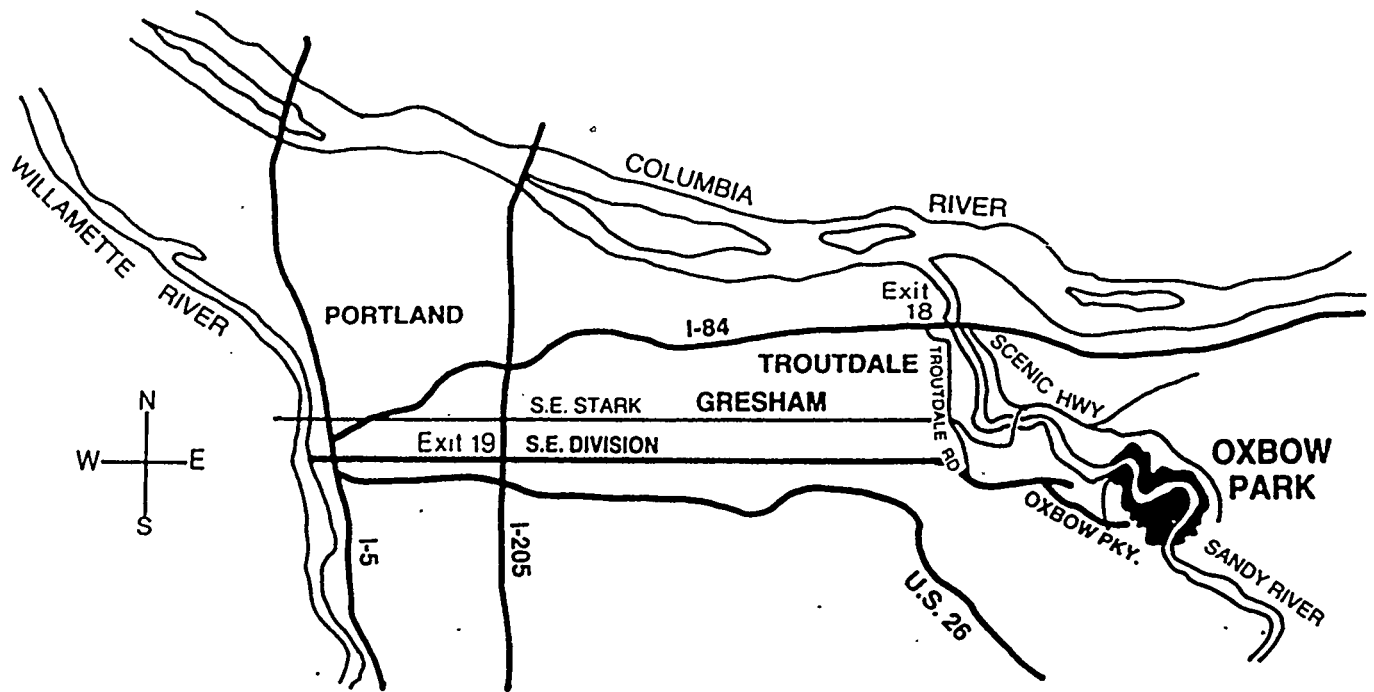
Review food chains and food webs.

Identification of native plants and animals.

Insect collection and identification - insect boxes.

OXBOW PARK





OXBOW PARK ATTENDANCE SHEET

GROUP A:

(Stations 1, 2, 3, 4, 5)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

GROUP D:

(Stations 4, 5, 1, 2, 3)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

GROUP B:

(Stations 2, 3, 4, 5, 1)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

GROUP E:

(Stations 5, 1, 2, 3, 4)

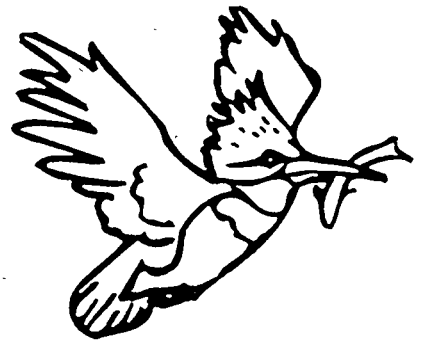
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

GROUP C:

(Stations 3, 4, 5, 1, 2)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

WILDLIFE WORD SEARCH



Predator
Douglas fir
Old Growth
Dissolved Oxygen
Tracking
Wildlife

Snag
Kingfisher
Great Blue Heron
Chinook
Temperature
Huckleberry

Osprey
Ecosystem
Silt

WILDLIFE WORD SCRAMBLE

Directions: Unscramble the words below.



1. EWFIILDL

1. _____

2. GSAN

2. _____

3. TSLI

3. _____

4. YOESRP

4. _____

5. RPROETDA

5. _____

6. KCHOION

6. _____

7. MEECTOSSY

7. _____

8. YHRURCEKBLE

8. _____

9. SDAOLUG RFI

9. _____

10. GTNRIAKC

10. _____

11. RKEIHNSGIF

11. _____

12. TGARE EBUL NHOER

12. _____

13. ETREUMTPARE

13. _____

14. DDEIVSLSO NOEXYG

14. _____

15. RPYE

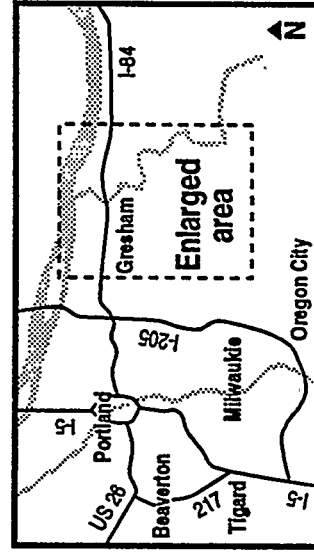
15. _____

Oxbow Park & Blue Lake Park Vicinity Map

Legend

- 1 Mt. Hood Medical Center
- 2 Mt. Hood Community College
- 3 Grocery
- 4 Grocery/gas/bait (open 24 hours)
- 5 Oxbow Park office
- 6 Oxbow Park campground
- 7 Blue Lake Park
- 8 Chinook Landing

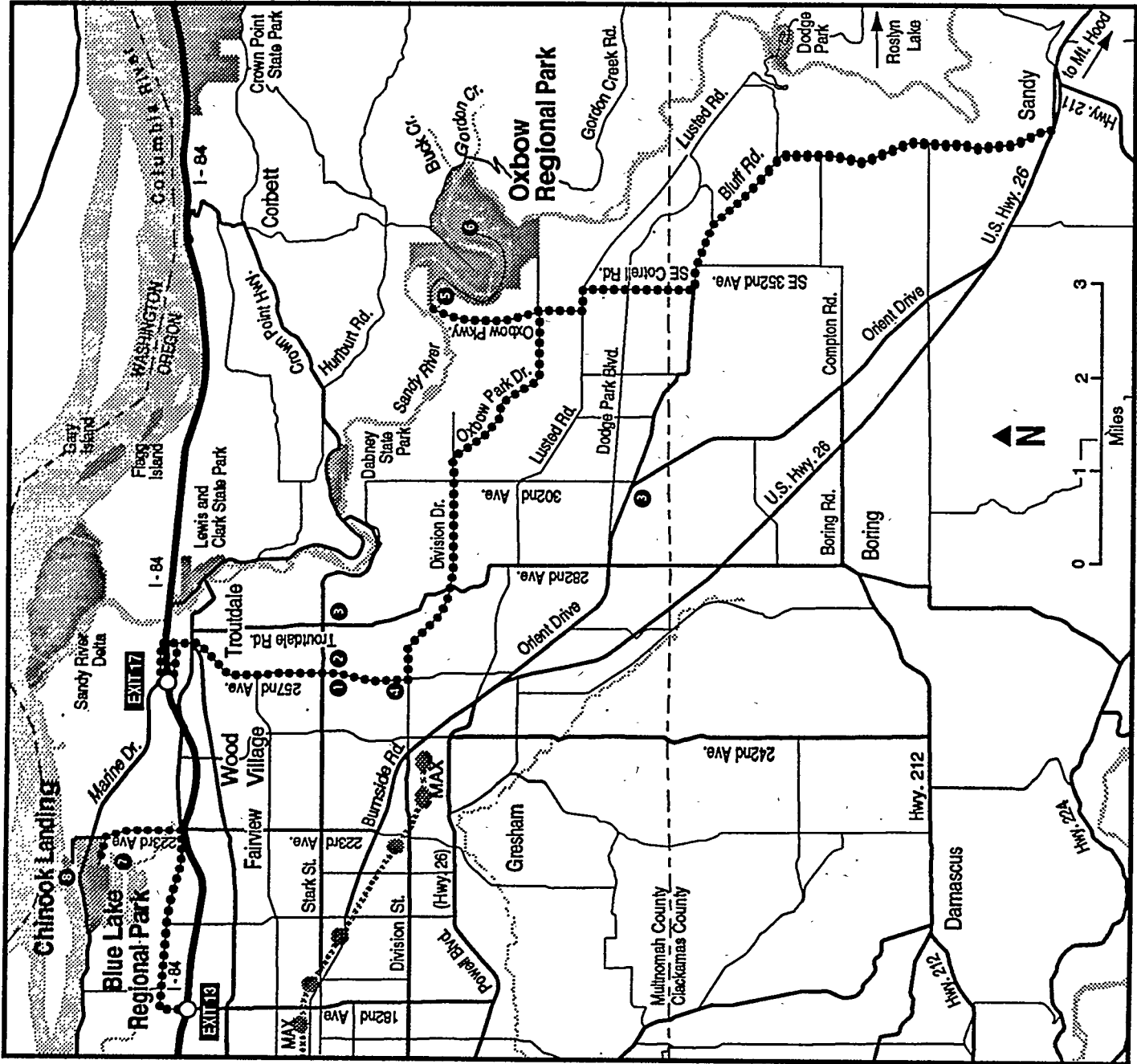
- Preferred routes
- MAX Light Rail
- Park
- River or lake



Metro Regional Parks and Greenspaces

600 NE Grand Ave., Portland, OR 97232
(503) 797-1850
Oxbow Park: (503) 663-4708
Blue Lake Park: (503) 665-4995

METRO





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Wildlife Watching

Stop **Stop talking** – become a tree, a rock, an animal ...

Stop – when there is an alarm call.

Stop – when an animal looks at you.

Stop – learn to **freeze**.

Look Look – with **splatter vision** to see movement.

Look – for edges of fields and near water.

Look – for tracks and signs.

Look – at **dawn and dusk**.

Listen Listen – what are the birds saying?

Listen – for **alarms** or **concentric** rings.

Listen – for a rustle, snuffle, swish, crunch ...

Listen – can you hear your breathing?

Move Move – with the **foxwalk**.

Move – in **slow motion**.

Move – when an animal looks away from you.

Move – with the wind.



METRO

The Freeze Game

Would you like to know how it feels to be invisible?

At the word **freeze!** – stay perfectly still. You can breathe and you can blink – but that is all.

Stay “frozen” for a moment . . . Pretend that you have become a statue, a rock or a tree. If a rabbit or a deer is scared, this is what *they* do. Their colors blend in with the forest and allow them to disappear (camouflage).

If you are looking at a deer who has “frozen,” you should try to stay still as long as the deer can. You may have to stay still for a long time! Finally, the deer will forget that you are there. It will look away from you. Now is your chance to move closer to it! Any time the deer looks at you – **freeze!**

Use the freeze game when you are watching wildlife and also when you hear an **alarm call**. This is a short, choppy call given by a bird or squirrel to let the other animals know there is danger nearby. Even a hummingbird has an alarm call! Is the alarm call nearby? Wait for it to stop before you move. Is it far away? Perhaps another animal or person is moving in the woods and the birds have spotted them. Soon you can learn to understand the birds.

Invent a hand signal for **freeze!** to use on your walks. You don't want to shout “freeze!” and scare everything away!

If you have an hour or two, try finding a nice spot in a park, forest or your backyard. Then sit down, get comfortable and **freeze!** After a while, the birds begin to sing and come closer to you. Soon you will be in a new world full of surprises – animals walking, eating, playing or hunting. That's the way the forest is when there are no people around!

You have become invisible!



Splatter Vision

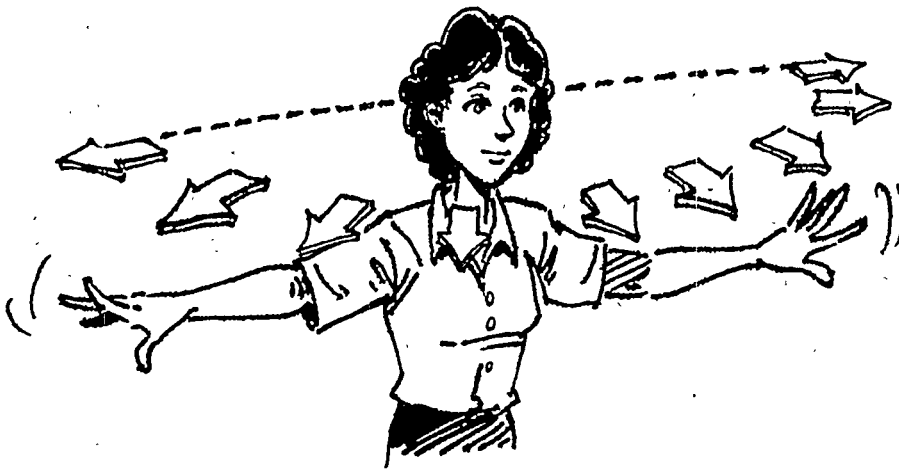
Would you like to see twice as much – even in your own back yard?

Most people have learned to focus on one small area at a time. We look at a person's face, a book or a television and blot out the surrounding areas. It is like looking through a little tube all the time.

Most animals see in a different way. They have to be aware of what is moving in the forest – is it food or will it eat me? They need to see and hear in all directions – not just in front of them. Their lives depend on this.

We can learn from our animal friends how to see much more – try **splatter vision**.

First put your arms straight out to the sides at shoulder level.
Then point your fingers forward and wiggle them.
By looking straight ahead – get so that you can see both hands:



Think of seeing out of the corners of your eyes.

Everything may seem a little blurry – but you will now be able to catch the slightest *movement* around you – even at your sides. If a bird blinks, you'll see it! A blade of grass moving differently than the others – is there a mouse there? Every bug in the vicinity will be seen too! If you spot something you want to look at – then you can focus as you normally do.

After a few tries **splatter vision** becomes automatic and easy for anyone to do.

The next step is to sit down in your back yard, field or forest and try **splatter vision**.
Welcome to a new world!

Focused Hearing

How much can you hear? As much as a deer, a fox or an owl?

Close your eyes, take a deep breath, relax and listen . . .

Take your time and focus:

What is the most distant sound you hear?

What is the nearest sound you can pick out?

How about all the sounds in between the near and far?

Can you hear your own breathing?

Can you hear your heart beating?



Listen closely to what the birds are saying.

Are they making long and musical sounds? If they are – they are *singing* and all is well with them.

Are they making a short, choppy and hard to locate sound? That is called an *alarm call*. Birds use alarm calls to warn other birds and animals of approaching danger. Some alarm calls are loud and easy to hear – like a jay or a crow. But even very small birds have alarm calls – it may be tiny chirp that is hard to hear. Even the smallest alarm call is the birds' way of shouting, "There is danger coming! Hide! Run away!" to all other animals in the forest.

If you hear an alarm call near you, chances are that the bird is warning other animals in the forest that *you* are approaching! If you hear an alarm call not in your immediate area, it could mean that there is another animal moving. Or it could be that there is a disturbance being made even further away . . .

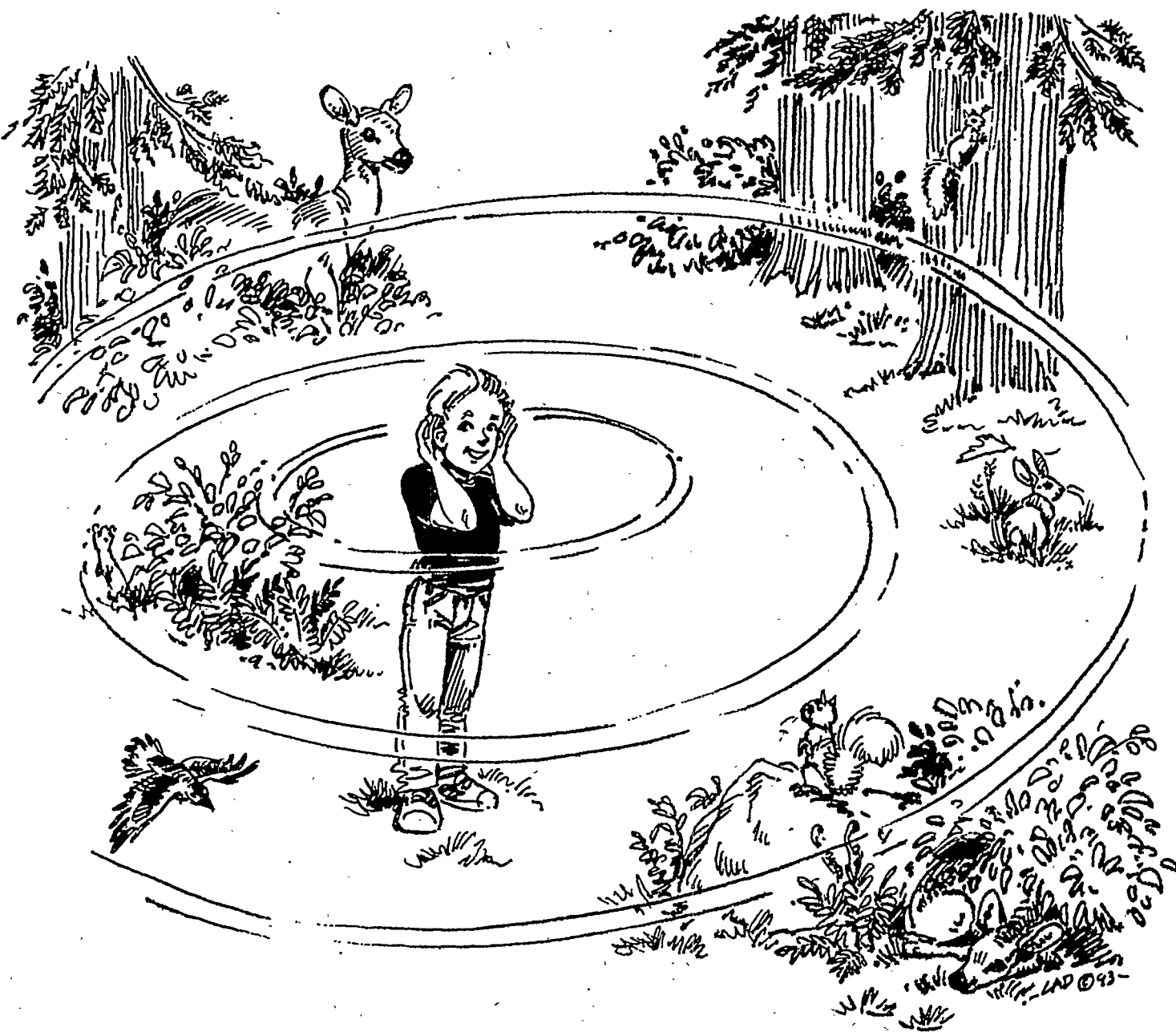
You see, if a loud, scary, dangerous animal moves through the forest (like a *human* for example), the alarm calls will move outward from the source of the danger. It is like dropping a rock in a pond – the **concentric rings** of disturbance move out in larger and larger circles.

Can you detect any **concentric rings**?

Birds will make different types of alarm calls for different dangers – people, deer, fox, snake, etc. You can learn to understand them!

Another type of **concentric ring** is a bird flying rapidly. Or if the forest is very quiet it means that some danger is near, passed through recently, or that you are creating a disturbance.

Try putting on **deer ears**. Just cup your ears with your elbows pointed *forward*. This will let you focus and amplify the slightest rustle, swish or sound in the forest.



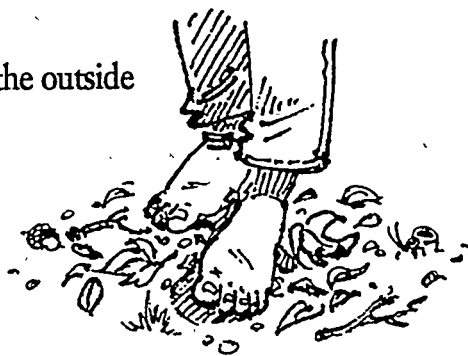
The Fox Walk

We can learn from our four-legged friends how to walk silently and unseen. The fox is especially good at sneaking softly through the forest.

First – **stop talking!**

Then – try the **Fox Walk**:

1. Try taking a short slow step and place only the outside edge of your foot on the ground.
2. Gently roll your foot down flat.
3. Then slowly move your weight forward.
4. Repeat with the other foot . . .



With this walk you can **freeze** easily (if an animal looks towards you or you hear an alarm call). If you feel a twig that might break – just pick up your foot and place it in a new spot. You don't need to look down – just feel the way.

It is best to use **slow motion**.

Try the **Rabbit Game**: Have your group form a circle with one person in the center pretending to be a rabbit. When the rabbit looks at you **freeze!** When the rabbit is not looking at you, **Fox Walk** toward it. See who can reach the rabbit first. Try two rabbits. This is the same way to sneak up on a real animal.

Try the **Fox Walk** at home. See if you can sneak up on a cat or dog. Don't scare them. Just try to get near them, and then let them know that you are there and just practicing.

Then go outside and try the **Fox Walk** on beetles, bugs, birds, frogs, chipmunks, squirrels, deer or anything else. With care you can get close to lots of different animals. Remember just get near and enjoy watching them, don't touch them or startle them. This is part of becoming invisible and enjoying the world of the four-legged and winged creatures!

Day 4

OUTLINE

TIME

ACTIVITIES

MATERIALS

(Based on class of 40)

9:00 a.m.	Breakfast/Estimation Game	Cross section piece of wood
9:15	Journey of the <i>Oncorhynchus</i> : A Story of the Pacific Northwest Salmon	Mural-add Section 4
9:30	(4-1) A Slice of Time (Tree Rings/History) Part A-Family Tree	20 small tree cross section pieces 1 large tree cross section piece 50 sheets of white paper crayons 50 sheets of construction paper 40 metric rulers 40 glue sticks
	Part B-History of the Columbia River Salmon	box of push pins 50 labels (1" x 2" cardstock)
10:30	Break	
10:45	(4-2) Fish Bracelets (Native American Bead Work)	40 needles (size 13) beads-(white, light blue, red, black) 40 snaps (size 1 or size 2/0) thread (00) 1 bag of porcupine quills 10 scissors
12:00	Lunch	
1:00	(4-3) To Cut or Not To Cut? (Forest Management)	Video: <u>The Lorax</u> (25 minutes) TV/VCR
2:00	(4-4) Connections (Food Webs)	3 sets of organism cards 3 large balls of yarn 3 scissors hole punch
2:45 p.m.	Journey of the <i>Oncorhynchus</i> : A Story of the Pacific Northwest Salmon	Mural-add Section 5
3:00 p.m.	Camp ends for students	

DAY 4

TEACHER NOTES

Estimation Game: Estimate the age of a tree using a cross section piece of wood. The age of the cross section piece will vary with each piece of wood. Instructors need to count the rings prior to starting this activity. (The winners will be announced during the break.)

Story Time: Journey of the *Oncorhynchus*-Chapter 4. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up the Journey of the *Oncorhynchus* mural by adding **section four** or the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section four. The first student to find the hidden salmon will be awarded a prize.

ACTIVITY 4-1: A SLICE OF TIME

SCIENCE CONCEPTS/PROCESSES: Change, Interactions, Perception, Symmetry, Observe, Question, Communicate

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ understand the relationship between tree rings and tree age.
- ◆ perceive time from the prospective of tree growth.
- ◆ understand the difference between old and second growth forests.

MATERIALS:

50 sheets of white paper (8½" x 11")

40 metric rulers

50 labels (1" x 2" cardstock)

20 small tree cross-section pieces (20-30 years old)

1 large tree cross-section piece (100-150 years old)

50 sheets of assorted colored construction paper (12" x 18")

crayons

1 box push pins

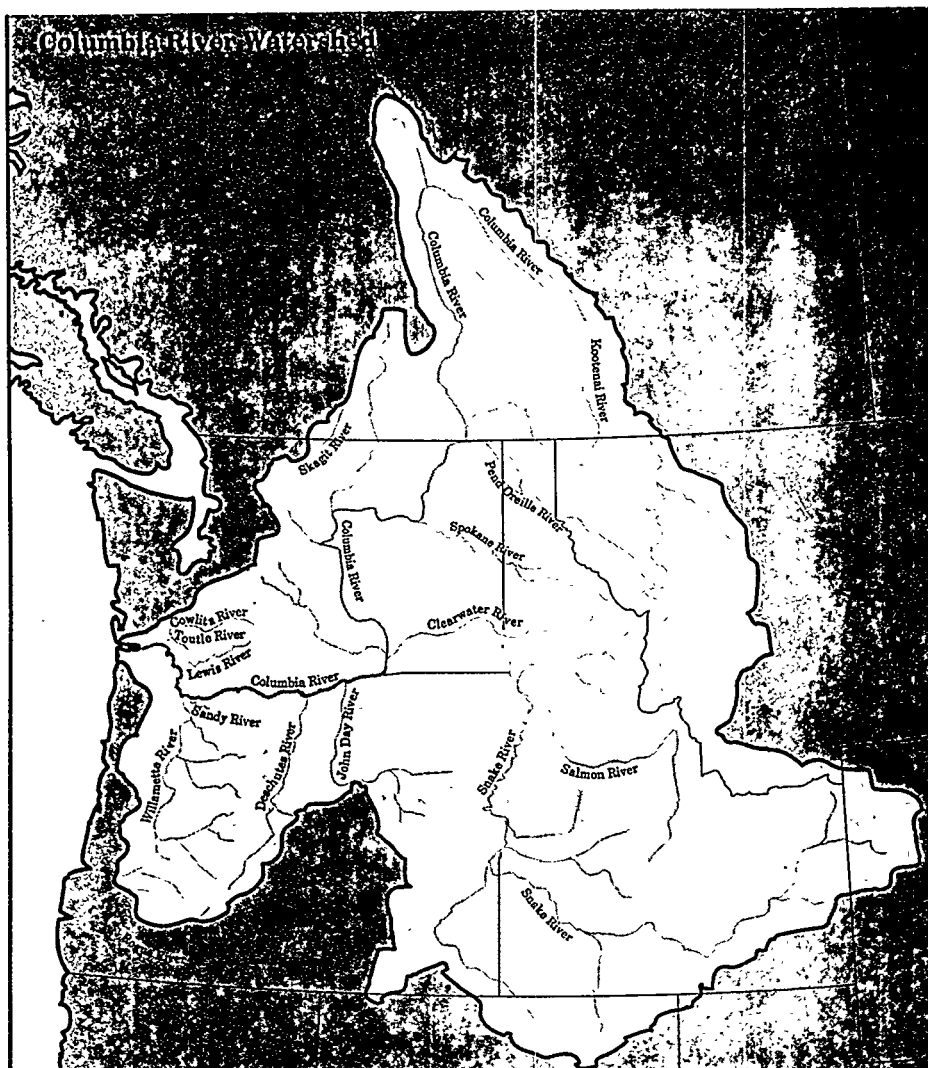
40 glue sticks

BACKGROUND INFORMATION:

WATERSHED

A watershed is the whole region from which a river or stream receives its supply of water. It includes all the land that carries rainfall to the same stream or river. Pacific salmon live in watersheds. The common assumption that salmon live in streams and not watersheds has contributed to the demise of fisheries in the Pacific Northwest. We need to understand that 99% of what happens to a stream occurs outside of its corridor in the watershed. By only protecting activities in or immediately along the stream doesn't assure the protection of salmon habitat. Once damage is done to a watershed, repairing the stream corridor does not necessarily assure the survival of fish.

Unfortunately, watersheds are very complex, subtle systems. Each one is unique and will respond differently to interference. Scientists have not determined the threshold levels of watersheds. For example--what percent of vegetative cover can be removed before a significant adjustment will occur in the river or stream? Much of the watershed is out of sight--unknown are the subsurface drainage patterns resulting from springs, soils, geology and aquifers.



CHRONOLOGY OF PACIFIC NORTHWEST EVENTS

Event	Date	Years Ago (1994)
Lewis & Clark Expedition - To the Pacific Northwest	1805	189
Columbia River Chinook - peak harvest 43 million pounds	1883	111
Fort Stevens - Founded during the Civil War	1887	97
Peter Iredale - Wrecked, sailing from Australia to Portland to pick up a load of wheat.	1906	88
Bonneville Dam - Constructed	1938	56
Pearl Harbor -United States enters World War II	1941	53
Ape Cave - Discovered by logger	1946	48
Celilo Falls - Sacred Native American fishing and trading spot, flooded due to The Dalles dam construction	1957	37
Boldt Decision - Native American fishing rights - entitled to 50% of salmon destined to pass the usual and accustomed places (includes hatchery fish and native).	1970	24
Mount St. Helens - Most recent eruption	1980	14
Northwest Electric Power Planning and Conservation Act - Measures aimed at protecting salmon runs.	1980	14
Columbia River Chinook - Harvest 1.2 million pounds	1983	11

PROCEDURE:

1. In this activity, students will trace tree rings and compare them to events in their lives (Part 1) and the history of the Columbia River salmon (Part 2). Provide a short explanation of how annular tree rings can tell a tree's life story (tree ring study is called dendrochronology).
2. Each group of 2 students should obtain a small evergreen cross-section, 2 sheets of white paper and crayons.
3. Instructors should demonstrate how to trace the tree rings. Place a piece of paper on top of a cross-section and lightly rub the long side of the crayon over the cross-section (paper must be peeled off the crayon). For the best results, start from the center of the ring and work outward following the grain of the wood.
4. When tracing is completed, students should mount their cross-section on a piece of colored construction paper using glue sticks.

5. Using the wooden cross-section for reference, students should count the rings on their tracings to determine the age of the tree it came from. Instructors should assist students by placing an "X" on the center growth ring. For the best results, students should start counting from the center of the cross-section.
6. Students should make a short list (5-6 items) of important dates to plot on their tracings. These could include: the year they were born, siblings and parents birth dates, when they started school, the year the tree was planted, etc.
7. To plot the events, students should count the appropriate number of rings matching the event and place a small "x" on the ring. Using a ruler, draw a line from the "x" to a place outside the tracing where the event can be labeled.
8. For Part 2, instructors should use the large cross-section piece of wood. Throughout the rest of the camp, students should use push pins and paper labels to identify the significant dates/events pertaining to the Columbia River salmon and other pertinent information learned during Hydromania II. Examples can include the following: wreck of the Peter Iredale, Fort Stevens history, World War II, eruptions of Mount St. Helens, Ape Cave discovered, flooding of Celilo Falls. (See Chronology of Pacific Northwest Events table in the Day 4 teacher notes section.)
9. The term watershed should be discussed here. Students should refer back to their Oxbow Old Growth Forest experience--the Sandy River watershed. It is important to stress that 99% of what happens to a stream or river occurs outside of its boundaries in the watershed. In other words, what happens in the watershed affects the life cycle of the Pacific salmon. In order to save the salmon we must protect their watersheds.

CONCLUSION:

Instructors should assist students with Part 2 throughout the camp. Instructors should lead the discussion using the following questions:

1. Are all tree rings equally spaced?
2. What do you think causes the different spacing between tree rings?
3. How many rings would you have if you were a tree?
4. What is a watershed?
5. Why is it important to protect watersheds to save the salmon?

ACTIVITY 4-2: FISH BRACELETS

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ experience the art of Native American beading.
- ◆ understand the history, importance and use of beads in Native American culture in the Pacific Northwest.

MATERIALS:

40 looms	red, blue, white, and black beads
40 needles	40 barrel fasteners
70 crimp beads	40 bracelet patterns
thread or fishing line	

BACKGROUND INFORMATION:

BEADS

All North Americans Indians seem to have shared an appreciation for beads. At least eight thousand years before the Europeans crossed the Atlantic, Indians were making, wearing, and trading beads of shell, bone, pearl, teeth, stone, clay, metal, and fossil crinoid stems.

In North America, the grandmother of beadwork is quillwork. Quillwork is an intricate process of stitching the dyed hollow quills of porcupines onto hide in detailed patterns. Quillwork is unique to North America. A similar art form never developed in Europe or Africa although the hedgehog, a relative of the porcupine, is native to these continents. The grandmother of quillwork is paint, originally earth ochers rubbed into hide in broad color areas or finely delineated in pictographic forms of animal relatives and sacred images.

The best known shell bead was wampum: small, cylindrical, centrally drilled white and purple bead made primarily of the quahog clamshell. Strung on leather thongs, or woven into belts with sinew thread, wampum was sometimes worn as decoration but later developed far greater significance as currency. Wampum also was used for objects commemorating major political and ceremonial events.

Europeans exchanged glass beads for beaver pelts in North America, for spices in Indonesia, and for gold, ivory, and slaves in Africa. Beads mirrored the culture of which they are a part that they tell us a great deal about the social, political, economic, and religious lives of the people who have made and worn them.

Imported glass beads were first introduced to the North American native populations by Christopher Columbus in 1492. This exchange had a significant economic and aesthetic impact on Indian material culture. The earliest glass beads were gifts from explorers and missionaries, but in the sixteenth century the small seed beads became an important medium of exchange in the expanding North American fur trade. The availability of these small beads, along with the introduction of trade cloth and thin steel needles, led to the decline of age-old decorative techniques, including quillwork. Beadwork became the predominant Indian craft.

Two types of common glass beads are the pony bead and the seed bead. A pony bead is any bead of size 8/0 or larger. The pony bead got its name because these beads were shipped in packs on horses to hard to reach mountain and plateau regions. The most prominent colors were white, light blue, black, and red. Seed beads are any small colored bead which falls between sizes 18/0 to 10/0, the latter being the larger size.

PROCEDURE:

1. In this activity, students will learn the art of Native American beading. Each student will make a bracelet using a fish pattern design.
2. Instructors will need to assist students in setting up their looms. Students should follow the fish pattern design to create their bracelet. Students will need to be extra careful when using the needles.

CONCLUSION:

Instructor should discuss the history, importance, and use of beads in the Native American culture. Instructors should lead the discussion by using the following questions:

1. How were beads introduced into the Pacific Northwest Indian culture?
2. What did the Indians of the Pacific Northwest use before beads were introduced?
3. What did the Indians trade with the Europeans in order to get beads?
4. How was this trade harmful to native salmon runs?

ACTIVITY 4-3: TO CUT OR NOT TO CUT?

SCIENCE CONCEPTS/PROCESSES: Cause & Effect, Change, Population, Interactions, Communicate

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ understand the delicate balance of an ecosystem.
- ◆ identify how the parts of an ecosystem are inter-related.
- ◆ identify the similarities between the story and the Pacific Northwest clear-cutting issue.

MATERIALS:

The Lorax (Dr. Seuss) video

TV/VCR

BACKGROUND INFORMATION:

THE LORAX

In the story The Lorax, the Once-ler settled in a beautiful truffula forest. The creative Once-ler found a use for the truffula trees. He used the trees to make garments called thneeds. Thneeds were wanted by everyone because of their versatility. These useful garments were used as socks, shirts, gloves, pillows, sheets, curtains, and even bicycle seat covers. As the demand increased the Once-ler needed some help, so he contacted many of his relatives. Even with the help, it was very difficult to keep up with the demand for thneeds, so a factory was built. More and more truffula trees were being cut down to supply the factory. The Lorax, a strange creature who lived in the truffula trees, kept begging the Once-ler to stop destroying the tree population. In the manufacturing process, the air and water were being polluted, destroying the wildlife habitat in the truffula forest. The Swomee Swans could no longer sing, the Brown Bar-ba-loots had no truffula fruit to eat, and the Humming fish could no longer swim in their water and were consequently forced to leave. As time went on, all the truffula trees were cut down. The factory closed and all that was left was a ring of stones in a barren landscape. Upon one of the stones is written the word "Unless." The Once-ler tells a boy that "Unless someone like you cares, nothing is going to get better." The last truffula seed is then tossed to the boy which represents the last hope for the truffula forest.

PROCEDURE:

1. In this activity, the students will watch the video The Lorax by Dr. Seuss.
2. Following the video, students should work in small groups to complete the table on Student Activity Sheet 4-3.
3. Each group will be presented with their own truffula forest and thneed factory. The group will make decisions/policies that will change the ending to the story.
4. Student groups should share their results with the class.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. What are the similarities and differences between the story endings?
2. How can we control pollution and waste caused by factories?
3. Where do you think factories should be located in our society?
4. Did your decisions/policies try to create a balance between the environment and industry? If so, how?
5. How does this story relate to the logging practices in the Northwest?

ACTIVITY 4-4: CONNECTIONS

SCIENCE CONCEPTS/PROCESSES: Cycle, Organism, Population, Order, Observe, Hypothesize, Predict, Communicate

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ understand that living things are dependent upon each other and upon their non-living environment.
- ◆ understand the sun is the ultimate source of the energy used by living systems.

MATERIALS:

2 sets of organism cards
hole punch

2 large balls of yarn
2 scissors

BACKGROUND INFORMATION:

ECOSYSTEMS

An ecosystem represents a community of organisms and the physical environment that they occupy. Within an ecosystem, living and non-living things interact with one another and materials are recycled. Examples of ecosystems are forests, lakes, rivers, ponds, and meadows. The boundaries of a river system may not be as easy to define as those of a lake. As ecosystems are units of the biosphere, they are dependent on one another and on an important physical factor, energy. All the basic energy of an ecosystem is provided by the sun.

The pathway of energy flow in ecosystems begins with the autotrophs or food producers. Autotrophs or producers use the energy from the sun to synthesize its needed organic nutrients from inorganic substances. Examples of autotrophs are phytoplankton, algae, and plants. Energy is transferred from producers to consumers or heterotrophs when the plants are eaten. Herbivores, which feed on plants, are the primary consumers. The carnivores that feed on the plant-eating animals are secondary consumers. For example, field mice feed on plants and are primary consumers. The snake that eats a field mouse is a secondary consumer, while the hawk that eats the snake is a third level consumer. Since many consumers have a varied diet, they may be second, third, or higher level consumers, depending on their prey. Each of these feeding relationships forms a food chain, a series of organisms through which food energy is passed.

Feeding relationships in an ecosystem are never just simple food chains. There are many types of organisms at each feeding level, and there are always many food chains in an ecosystem. A food web is a complex relationship formed by interconnecting and overlapping food chains in an ecosystem.

At every level in an ecosystem there are decomposers. The decomposers make use of the wastes and remains of all organisms in the system. They use the energy in these materials for their own metabolism. At the same time, they break down organic compounds into inorganic ones and make substances available for reuse in the system. As part of the cycle, decomposers can be thought of as the final consumers in every food chain and food web. They provide an essential step in returning nutrients to the soil.

PROCEDURE:

1. In this activity, students will learn that living things are dependent upon each other and upon their non-living environment. They will also learn that the sun is the source of the energy used by living systems.
2. Divide the group of students in two equal teams.
3. This activity should be done outside if weather permits. Each student should choose a name card. Turn the name cards face down and make a game of each student selecting a card. The names on the cards include: sun, algae, caddisfly larva, mayfly larva, zooplankton, huckleberry bush, bear, smolt, great blue heron, bacteria, salmon, killer whale, seal, human, salmon fry, kingfisher, beetle, soil.
4. Each team should form a large circle. The students should wear their name cards.
5. The instructor should start the game by giving one student a large ball of yarn. That student is instructed to run the string to another "thing" that is directly related to it. For example, the sun's energy is used by plants, so the student sun could connect the string to the student huckleberry bush.
6. Challenge the students to create the longest food chain. Students should take turns using the string to connect things one to the other.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. Where does all of the energy in an ecosystem come from?
2. What happens to the fish if all the insects die?
3. What other connections or food chains can you come up with?
4. Is there anything that is not connected directly or indirectly to everything else?
5. What would happen to the predators if there were a large population of insect larvae present in a river?

Story Time: Journey of the *Oncorhynchus*-Chapter 5. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up the Journey of the *Oncorhynchus* mural by adding **section five** or the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section five. The first student to find the hidden salmon will be awarded a prize.

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY FOUR

By midnight the next day, Hydroid and the Hood River chinook are moving past Portland and Vancouver. Other young salmon have joined them, including wild spring chinook from the Sandy River. The fish are growing quickly. By now they are able to catch and eat small freshwater shrimp. Their bodies seem to be changing by the minute. They are sleek and silver and six inches long. They are becoming *smolts*.

The smolts have traveled past many other cities, but none as large – and with as much pollution – as Portland and Vancouver. In cities, rainwater hits parking lots and streets. Instead of soaking into the ground, water shoots straight into the nearest storm drain. From there it goes into the river. Along with it comes water leaking from old garbage dumps, detergent from washing machines, fertilizers and poisons from gardens and lawns. Hydroid sniffs the water. Someone has recently changed the oil in a car and poured the oil down the sewer. Hydroid coughs on the oil fumes and quickly steers the Hood River smolts away.

Just past Portland, a huge number of fish come swimming in from the left. Most are chinook from the hatcheries of the Willamette River. Hydroid and the Hood River smolts have seen these kind of fish before. They came from the Washington and Oregon along the Columbia River. Hatcheries replaced streams that were either flooded when the dams were built, or were paved over when cities were built. People hoped to replace the wild fish they lost with hatchery fish. But hatchery fish don't learn how to find food or hide from danger. Not as many survive the journey compared to the wild chinook from Hood River.

Among the Willamette fish are some smaller salmon. Hydroid realizes these small fish are wild *coho* salmon. The coho may be smaller, but they are just as smart as the Hood River fish. They spend a year in the ponds and side

streams of the Clackamas River learning the ways of the wild before they begin their journey to the sea.

It's close to dawn. Hydroid spots a fat fly bobbing on the water above. One of the hatchery fish sees it too. Hydroid notices a shiny spot on the fly and tries to warn the young fish away. Too late. An angler catches the young salmon. It's really too small to be eaten. But the stress of being caught on a hook and hauled out of the water is enough to kill the young fish. The Hood River chinook learn another lesson.

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY FIVE

It's a beautiful day in late June. The river has suddenly become wide and shallow. And it tastes different – it's salty! The Columbia River is meeting the Pacific Ocean. The area where the salt water of the sea mixes with the fresh water of the ocean is called an *estuary*. By now the silvery salmon have changed completely inside. The salt water feels good to them. And there is so much to eat. So many tiny animals float in the water, it looks like soup. The young chinook dash this way and that, snapping at all the fat fine food in front of them. As they do they move further and further out into the Pacific. Suddenly, from the depths comes a huge fish. The Hood River fish scatter, but not before one ends up in the mouth of the predator.

The bright June sun warms the water making Hydroid feel lighter and lighter. Hydroid evaporates and is soon floating in the air above the Pacific Ocean. Far below, Hydroid sees the ocean currents welling up, bringing even more food to the Hood River chinook. The fish are so filled with joy, they leap right out of the water, wriggling and jumping on the ocean waves. Of the 5,000 eggs in their nest, only 200 made it to the sea. The survivors are glad to be alive. They are big enough now to eat small fish and other sea creatures. The chinook regroup and swim head on into the cool ocean currents, following the schools of anchovies, herring and shrimp that will lead them north to the waters off Alaska.

Hydroid drifts north too, joining the water vapor in the air. Hydroid knows the salmon's trip will be a long one. Most of those entering the sea will not survive to be adults. Look! There below, a boat is stretching a long fine net along the water. The Hood River fish are small enough to swim through the openings in the net. This time next year, some will not be as lucky. They will be larger. They will find themselves among the fish now being pulled onto the deck of a fishing boat.

Over the months, the chinook swim past Vancouver Island and the Queen Charlotte Islands off the British Columbia coast. That summer they reach the Gulf of Alaska where they will stay for the next two years. Once each year, clouds of bright red *sockeye* swim through the school of chinook. The sockeye are returning to rivers in southern Alaska and in British Columbia. When the chinook swim close to shore, they sometimes run into *chum* and *pink* salmon. Chum and pinks spawn along the coast of Alaska and Canada. Chum are sometimes called dog salmon. Alaskans used to feed the fish to their sled dogs. Pinks have strange humped backs. The sockeye, chum and pink salmon are about half the size of the growing chinook.

By their third year, a secret signal from Nature turns the chinook south, back toward the Columbia. Hydroid's friends are now three feet long. Each weighs 20 pounds or more. Eating sea creatures like shrimp – shells and all – has turned their flesh bright pink. Their skin is two-toned with a dark greenish back and silver sides and belly. Their backs and sides are freckled with dark black spots as camouflage. The marks on one fish are deep and ugly. These are not spots, but old wounds made by the teeth of a sea lion. That was a narrow escape.

The fish follow the shoreline south. They are a few miles off the coast, but they can almost taste the waters of the Columbia River. They are swimming fast and eating faster.

Student Activity Sheet 4-3

TO CUT OR NOT TO CUT?

1. Fill in the table below.

Organisms	How affected?	Alternatives
Truffula Trees		
Brown Bar-ba-loots		
Swomee Swans		
Humming Fish		
Humans		

2. A truffle forest is growing in your neighborhood. You and your team members are put in charge of managing the forest. A tinned factory opens down the street and provides your community with jobs. It is the team's responsibility to develop a plan which includes: harvesting guidelines, replanting of trees, providing a safe and healthy habitat for plants and animals, recreation area, working factory, and a clean environment for everyone.

Day 5**OUTLINE****TIME****ACTIVITIES****MATERIALS**

(Based on class of 40)

8:00 a.m.

Leave Camp Site

Breakfast

Student workbooks

40 adhesive name tags

First Aid Kit

Suntan lotion

10:00

Arrive at Ft. Stevens State Park
(Gates to the park open at 10 am.)

\$3 per vehicle

(10:00-10:15)

Group A - Tour of Museum and War Games Building
Group B - Film: The Firing of the Gun (8 min)

(10:15-10:30)

Group A - Film: The Firing of the Gun (8 min)
Group B - Tour of Museum and War Games Building

(10:30-11:00)

Group A - Tour of the Outside Batteries
Group B - Tour of Underground Battery

(11:00-11:30)

Group A - Tour of Underground Battery
Group B - Tour of the Outside Batteries

11:30

Lunch
(Picnic tables available outside the Museum area.)

12:30

Sand Castle Contest
by Peter Iredale Ship wreck

6 buckets

40-9 oz plastic cups

40-16 oz plastic cups

1:30

Salmon game

4 traffic cones

2 ropes (25 feet long)

2 cardboard boxes

50 white (3"x 5") index cards

50 colored (3"x 5") index cards

2:15

Beach Clean-up

100 pairs of latex gloves

30 large SOLV* plastic trash bags

10 gallon size plastic bags

3:00

Leave Ft. Stevens State Park

5:00 p.m.

Arrive back at Camp Site.

***Stop Oregon Litter and Vandalism**

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DAY 5

TEACHER NOTES

OREGON COAST FIELD TRIP

EMERGENCIES

Historic Museum (503) 861-2000, Manager's Office (503) 861-3170.
Columbia Memorial Hospital in Astoria located between 21st & 22nd,
on Exchange Street.

Estimation Game: Challenge students to estimate the length of the bus in meters. (Winners will be announced at the beginning of lunch.)

Bus Activities: Students can complete games and/or activities in their student workbook during the bus ride.

OBJECTIVE(s): After completing the activities on this field trip, students will be able to:

- ◆ apply what they have learned in the classroom to their local and regional communities.

MATERIALS:

35 adhesive name tags	First Aid Kit
2 ropes (each ~20 meters long)	36-8 oz plastic cups
36-12 oz plastic cups	4 traffic cones
1 jump rope (10-15 feet long)	2 cardboard boxes
50 white (3' x 5") index cards	50 pink (3" x 5") index cards
100 pairs of latex gloves	10 gallon size plastic bags
60 large SOLV plastic trash bags	6 buckets

BACKGROUND INFORMATION:

FORT STEVENS

Fort Stevens was constructed during the Civil War and remained active until shortly after World War II. From 1887 to 1904, the fort experienced a massive development program, including the construction of eight concrete gun batteries. Although the guns have all been removed, nearly all the batteries remain. After the army coast artillery abandoned Fort Stevens, nearly all of the buildings in the fort area were demolished.

The Museum and War Games Building constructed in 1911 was first used as an enlisted men's dormitory. After World War II, it was converted to a War Games center with plotting equipment and communications with the various artillery batteries. When the fort became inactive, this building was used by the Corps of Engineers as their offices; and presently houses the military museum and historical office.

THE PETER IREDALE (viewing point to see the mouth of the Columbia River)

The Peter Iredale was built in Maryport, England in 1890. The ship was 287 feet long, 30 feet wide and 23 feet deep and could carry 1994 tons. It was a frequent visitor to the Puget Sound and the Columbia River. On the final trip in 1906, the Peter Iredale was sailing from Australia to Portland to pick up a load of wheat. Captain H. Lawrence offered his crew a bonus if they could trim five days off the journey between Salina Cruz, Mexico and Portland, Oregon. From Mexico to approximately 100 miles south of the mouth of the Columbia River brought perfect weather. However, the ship encountered dense fog as they approached the mouth of the Columbia. The final sequence of events on October 24 and 25, was later described by Captain Lawrence:

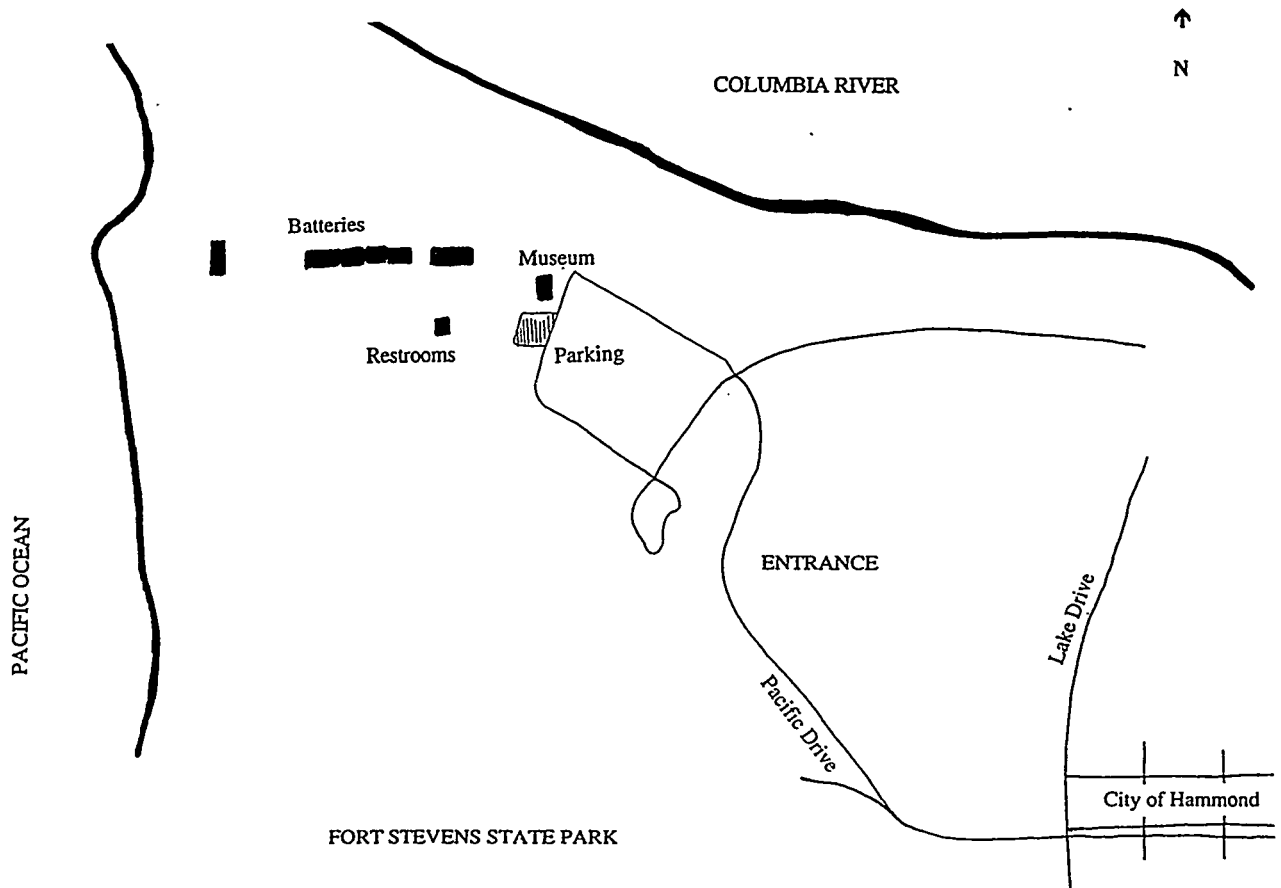
"I picked up Tillamook Light at 2 am and immediately called all hands to set all sails, intending to stand off for the mouth of the Columbia and pick up a pilot by day. A heavy southeast wind blew and a strong current prevailed. Before the vessel could be veered around, she was in the breakers and all efforts to keep her off were unavailing.

The first shock sent the mizzen top hamper overboard, and when she struck again, parts of other masts snapped like pipe stems. It was a miracle that none of the crew was killed by the falling masts as the ship pounded in the surf. After the crew had escaped the danger of the falling debris, all hands were summoned aft as the vessel ran up on the shelving sands with little violence. I told them to abandon ship. The Point Adams surf boat was soon alongside and took all hands quickly and safely ashore."

PROCEDURE:

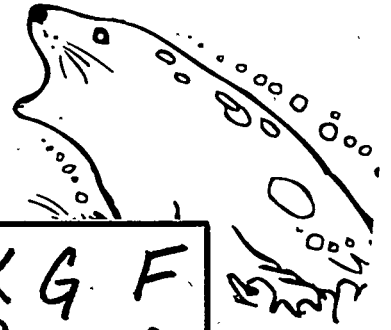
1. Upon arrival at **Fort Stevens State Park**, students tour the Museum and the War Games Building as well as view an eight minute film entitled The Firing of the Gun. Immediately following, each group will tour the underground battery and the surrounding outside batteries. Each group will be led by a historian from the Museum.

2. **Sand Castle Contest** - Each team will work with their counselor to create an animal out of sand. The sand sculpture should not exceed the dimensions of two meters long, two meters wide, and one meter height (2 meter x 2 meter x 1 meter). Each team will have the same materials to start with: 1 bucket, 6-8 oz plastic cups, 6-12 oz plastic cups. The team members can use any other item found at the beach to decorate their animal. For example, shells for eyes, drift wood for arms/legs, etc.
3. **The Salmon Game** - Refer to Day 3, the field trip to Oxbow Park, to review the instructions for this game. Materials needed are: 4 traffic cones, 1 jump rope, 2 cardboard boxes, a whistle, and 50 white (3" x 5") index cards, 50 pink (3" x 5") index cards, 2 ropes (each ~20 meters long).
4. **The Beach Clean-Up** - Each team will be given three large SOLV garbage bags. Each person will need to wear latex gloves during the clean-up. It is very important to stress to each student that if they find any dangerous debris such as medical waste, syringe, nails, glass, dead animals, etc. that they **do not** pick it up. They need to alert the adult in their group who should make the decision whether to pick it up or contact the director. It is also important that after the clean-up is over, that all the latex gloves be collected and disposed of. All trash bags should be piled together for pick up by the Fort Stevens State Park personnel. The competition will be won by collecting the most trash. Extra points will be given to the team that finds the most cigarette butts, one of the most numerous types of trash on the beach (gallon size plastic bags will be provided for this part). Extra points will be given to the team that finds the most Styrofoam and plastic.





OREGON COAST WORD SEARCH

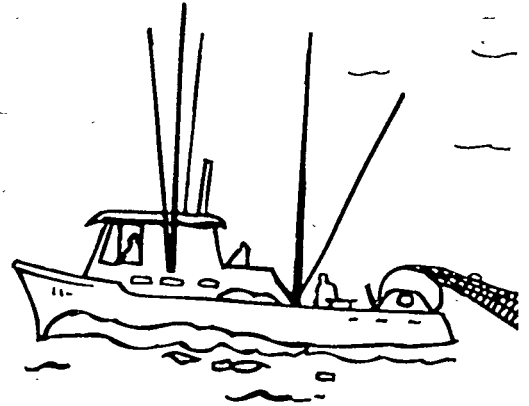


Ocean
Gill Netter
Smolt
Killer Whale
Waves
Seal

Estuary
Columbia River
Tides
Kites
Sand Castles
Fort Stevens

Seagull
Seashells
Driftwood
Peter Iredale

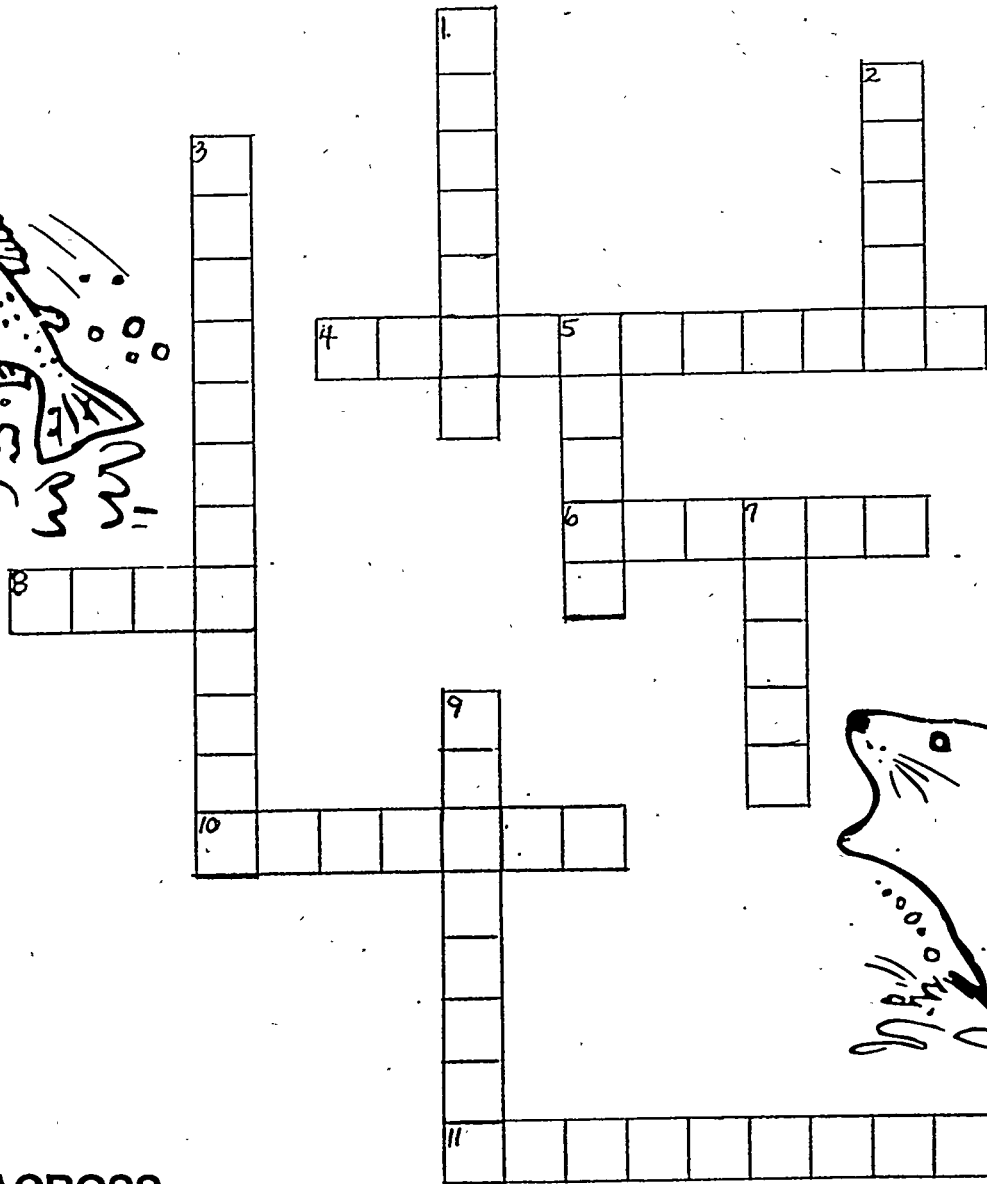
OREGON COAST WORD SCRAMBLE



Directions: Unscramble the words below.

- | | |
|-------------------|-----------|
| 1. LSLEUAG | 1. _____ |
| 2. STEID | 2. _____ |
| 3. SKEIT | 3. _____ |
| 4. LSAE | 4. _____ |
| 5. SWEAV | 5. _____ |
| 6. YERSATU | 6. _____ |
| 7. DDOROIWFT | 7. _____ |
| 8. NOACE | 8. _____ |
| 9. ACIOBLMU RREIV | 9. _____ |
| 10. DSNA SCEALST | 10. _____ |
| 11. TSLMO | 11. _____ |
| 12. RPEET EIRLADE | 12. _____ |
| 13. SSLELAESH | 13. _____ |
| 14. TFRO SSNTEEV | 14. _____ |
| 15. RKEILL EWLHA | 15. _____ |

OREGON COAST CROSSWORD



ACROSS

4. The place we will tour today is _____.
6. Another name for garbage.
8. Surfers surf on a _____.
10. Where salt water and freshwater meet at the mouth of a river.
11. What you collect on the seashore--also used to protect soft-bodied sea life,

DOWN

1. Concrete buildings or gun houses. Used in a flashlight.
2. Large body of salt water.
3. Ship that wrecked near Fort Stevens.
5. The stage of a salmon's life cycle when they reach the sea.
7. The rise and fall of the ocean, either high or low.
9. White and grey birds present on the coast.

SALMON LIFE CYCLE WORD SCRAMBLE

Directions: Unscramble the salmon life cycle words below.

1. WAPNSNGI

1. _____

2. NKIOHOC

2. _____

3. LMSOT

3. _____

4. IEAVNL

4. _____

5. YEDE GEG

5. _____

6. LKOY ASC

6. _____

7. CEKESYO

7. _____

8. AGMINIROT

8. _____

9. DEDR

9. _____

10. YFR

10. _____

11. ARPR

11. _____

12. RTYTBARUI

12. _____

13. DOOSNRMUAA

13. _____

14. IKPN

14. _____

15. OUCH

15. _____



Day 6

OUTLINE

TIME

ACTIVITIES

MATERIALS

(Based on class of 40)

9:00 a.m.

Breakfast/Estimation Game

9:15

Journey of the *Oncorhynchus*:
A Story of the Pacific Northwest Salmon

Mural-add Section 6

9:30

Demo: The Pressure Zone
(Plate Tectonics)

1 hot plate
2 bottles diet root beer
2-600 mL glass beakers
pumice rock samples

10:00

(6-1) Volcanic Activity
(Volcanoes)

40 volcano patterns
40-8 oz paper cups
40-4 oz plastic cups
40-1 oz plastic cups
5 pounds of modeling clay
40-9 inch plastic plates w/lip
22 oz clear dish washing detergent
1 bottle red food coloring
5 pounds of dry ice
1 hammer
1 pair of leather gloves

10:30

15 Minute Break

Prizes/Bug Boxes

11:30

(6-2) SALMO Bingo
(Vocabulary Review)

SALMO Bingo Cards-extras
500 Poker Chips

12:00

Lunch

1:00

Journey of the *Oncorhynchus*:
A Story of the Pacific Northwest Salmon

Mural-add Section 7

1:15

(6-3) The Surface Water Video
(Water Pollution)

Surface Water Video (9 minutes)
VCR/TV
Snacks

1:30

(6-4) Storm Drain Stenciling
(Community Awareness)

6 traffic cones
100 door hangers
12 stencils
6 cans of spray paint
12 safety vests
40 pairs of latex gloves

2:45 p.m.

Field Trip Information

Handouts

3:00 p.m.

End of Camp for Students

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DAY 6

TEACHER NOTES

Estimation Game: Estimate the number of major volcanoes present in the Cascade Range. The answer is thirteen major volcanoes: Mt. Garibaldi (British Columbia), Mt. Baker, Glacier Peak, Mt. Rainier, Mt. St. Helens, Mt. Adams (Washington State), Mt. Hood, Three Sisters, Crater Lake (Oregon), Mt. Shasta, Lassen Peak (California).

Story Time: Journey of the *Oncorhynchus*-Chapter Six. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up either the Journey of the *Oncorhynchus* mural by adding **section six** or the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section six. The first student to find the hidden salmon will be awarded a prize.

TEACHER DEMO: THE PRESSURE ZONE

SCIENCE CONCEPTS/PROCESSES: Cause and Effect, Change, Cycle, Evolution, Force, Observe, Predict

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ to describe basic Plate Tectonics Theory and relate it to the Pacific Northwest.
- ◆ understand how the Cascade Volcanoes were formed.

MATERIALS:

2-16 oz bottles of diet root beer
1 five quart sauce pan
2 medium size nails
2 rolls of paper towel
safety goggles for instructor(s)

1 hot plate
ice
hammer
pumice rock samples

BACKGROUND INFORMATION:

Plate Tectonics/Continental Drift

The Plate Tectonic Theory states that the earth's crust or lithosphere is made up of several huge moving plates. The plate tectonic model of the earth looks like a huge jigsaw puzzle. The jigsaw pieces or crustal plates "carry" all the continents and the ocean floors. Scientists have been able to trace the movement of the earth's plates back into time. They have pieced together a picture of how the earth might have looked before the continents drifted apart to their present positions.

The process that supports this crustal plate movement is explained by the theory of Continental Drift. Approximately 200 million years ago scientists believed the earth's land was joined together to form a super continent called Pangaea (meaning all land). The rest of the earth was covered by the ocean called Panthalassa (meaning all seas). Then Pangaea began to split into two land masses, Laurasia in the north and Gondwana in the south. Between these two land masses the Tethys sea came into existence. Over time, the continents drifted to their present positions. One of the examples that is most often used to support this theory is the close fit of the South American continent and the African continent.

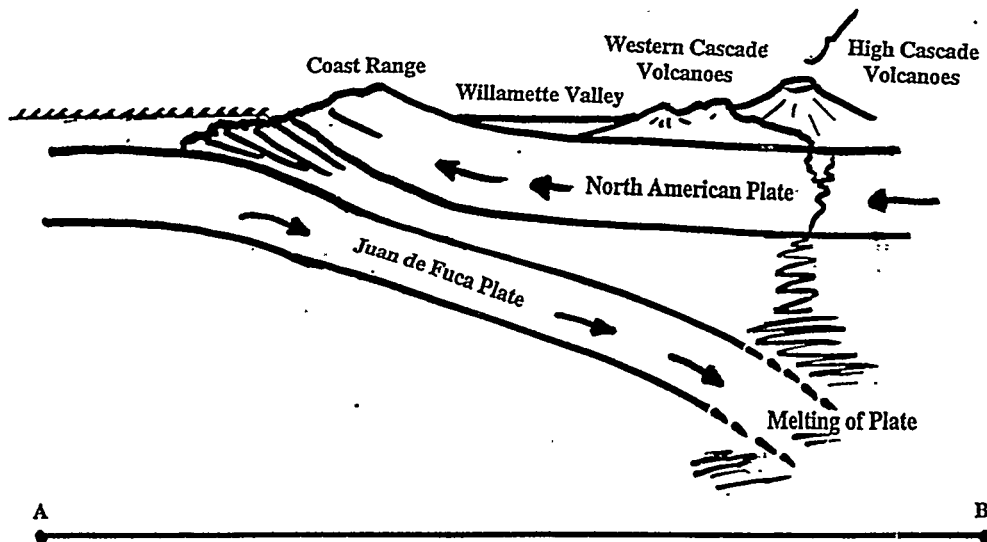
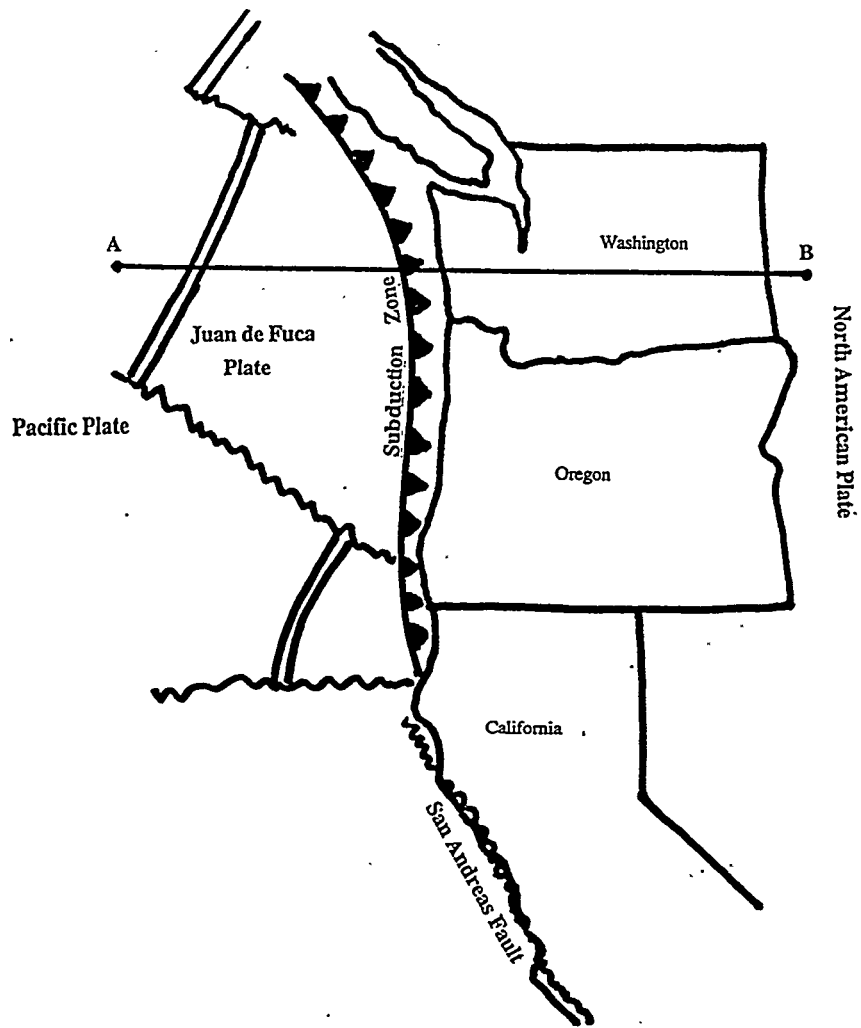
The Pacific Northwest

The boundaries of these plates are defined by locations of volcanoes and earthquake activity. In the Pacific Northwest, one of these boundaries is responsible for most of the volcanic and seismic activity in the area. The Juan de Fuca plate which is covered by the Pacific Ocean is moving towards and subducting under the North American plate. The North American plate carries the North American continent which includes Canada, the United States, and Latin America. Where these two plates meet a subduction zone is formed (see figure on page 6-5). The Juan de Fuca plate is going underneath or subducting under the North American plate. Earthquakes occurs as these plates move pass each other. As the Juan de Fuca plate descends deeper and deeper into the earth, the rock that makes up this oceanic crust heats up. This hot, molten rock rises to find an opening to release the pressure that has built up. This tremendous pressure is released when the molten rock or magma finds an opening or vent in the earth's crust. The structures that are formed around these pressure vents are called volcanoes.

The Cascade volcanoes are composite volcanoes. Composite volcanoes have very large symmetrical cones of alternating layers of solidified lava and rock particles. Mount St. Helens, Mount Hood, Mount Adams, and Mount Shasta are all composite volcanoes. Cinder Cone and Shield are the two other main types or forms of volcanoes.

The Juan de Fuca plate is named for a Greek who sailed in the service of Spain and may have visited the Juan de Fuca Strait passage in 1592. The Juan de Fuca Strait is a narrow passage of the eastern North Pacific Ocean between the Olympic Peninsula of Washington State, U. S. , and Vancouver Island, British Columbia, Canada. Part of the United States--Canadian international boundary lies in mid-channel.

PACIFIC NORTHWEST SUBDUCTION ZONE



PROCEDURE:

1. In this activity, students will learn about the Plate Tectonic Theory and how it relates to the Pacific Northwest volcanoes. They will also witness what can happen when pressure builds up underneath these volcanic vents.
2. Instructors should first discuss the Plate Tectonic Theory and the theory of Continental Drift and how they relate to the Pacific Northwest. Students should refer to their Student Activity Sheet 6-1 as you present this information.
3. During the discussion of the Plate Tectonic Theory/Continental Drift, the Pressure Zone demonstration should be set up. One diet root beer bottle should be placed in a 600 mL beaker of ice water. Another bottle of diet root beer should be placed in a 600 mL beaker of hot water. The root beer should be kept in the beakers for approximately 15 minutes before the demonstration. When ready, **this demo must be done outside!**
4. When outside make sure that the students are at a safe distance away (~3 to 5 meters away) from the bottles. The students should hypothesize what will happen to each of the bottles when you puncture the cap with a nail. Ask the students "What do you think will happen when the bottles are punctured and do you think the results of the two bottles will differ?" Then puncture the cap of the bottle in ice water with a medium size nail and hammer and observe the results. Puncture the cap of the bottle in hot water and stand back!! Were their hypotheses correct?
5. Many violent volcanic eruptions produce a rock called pumice. Pumice is a glassy rock with a lot of air holes. It weighs so little that it floats on water. Think about the froth produced in this demonstration, how do you think pumice is formed?
6. Allow the students to test this out with a few pieces of pumice and a tub of water.

CONCLUSION

Instructors should bring closure to this activity by asking the following questions:

1. Which bottle has the least amount of liquid remaining?
2. Where was the gas before the bottles were opened?
3. Why did the gas rush out?
4. Why did one bottle produce froth more violently than the other?
5. In terms of pressure, what causes a volcano to erupt?

ACTIVITY 6-1: VOLCANIC ACTIVITY

SCIENCE CONCEPTS/PROCESSES: Model, Replication, Observe

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ build a model of a volcano.
- ◆ understand the relationship between a lava tube and a volcano.

MATERIALS:

40 volcano patterns	40-8 oz paper cups
40-4 oz plastic cups	40-1 oz plastic cups
5 pounds of modeling clay	40-11 inch plastic plates w/lip
clear dish washing detergent	red food coloring
5 pounds of dry ice	1 hammer
40 scissors	1 pair of leather gloves
20 packages of clear tape	

PROCEDURE:

1. In this activity, students will build a model of a composite volcano. They will also include a lava tube in their model.
2. Each student will need a 4 oz plastic cup, 8 oz paper cup, a 11 inch plastic plate, a volcano pattern and directions to get started. Student will construct their volcano with these materials. After they are done, **they should name their volcano.**
3. The instructors should mix clear dish washing detergent, water and red food coloring together to make a magma solution. Be very careful while mixing to minify the amount of bubbles produced. Each student will need approximately 100 mL of the magma solution.
4. After pouring the magma solution into the caldera of their volcanoes, add a quarter-size piece of dry ice. (The dry ice should only be handle by an adult using leather gloves.) The addition of the dry ice will start the eruption.
5. The eruptions should be staggered so that the students can observe all of them.
6. The students will judge all of the eruptions, presenting prizes to the students who have constructed volcanoes that exhibit the following: best shaped volcano, best lava flow, best overall eruption, best of the show, etc.
7. After all eruptions are complete and clean-up has occurred, each student should obtain approximately 50 grams of modeling clay and a one ounce plastic cup. Students will shape the clay to create a lava tube and cave next to their volcano. Obviously created after that tremendous volcanic eruption which was very similar to how the Ape Cave was formed.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. What type of volcano is Mount St. Helens?
2. Describe a composite volcano.
3. What shape are most of the volcanoes in the Pacific Northwest?
4. How are lava tubes formed?
5. Name one type of rock produced by Mount St. Helens.
6. What happens to the Earth before a volcanic eruption?

ACTIVITY 6-2: SALMO BINGO

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ review vocabulary presented throughout the curriculum.

MATERIALS:

500 poker chips

extra game cards

PROCEDURE:

1. In this activity, students will create their own SALMO bingo cards with the vocabulary words used throughout the curriculum. Students will play bingo by matching the terms on their cards with the definition that is read out loud by the instructor.
2. Before beginning the game, have students randomly write the following 24 words in the squares on their SALMO card located in the student workbook. There are two SALMO cards in their student workbooks. The SALMO game words and definitions are:

WORDS	DESCRIPTIONS
fry	tiny salmon which are about an inch long.
acid	lemon juice and orange juice are examples of this.
alevin	small fish that uses a yolk sac for its food.
metric	a system of measurement based on the number ten.
chinook	largest of the Pacific Salmon.
pH	a color scale that describes how acidic or basic a substance is.
prey	an organism that is eaten by a predator.
pumice	a volcanic rock that floats on water.
redd	a nest where salmon lay their eggs.
predator	organism that kills and eats another organism.
volcano	a vent in the earth's crust through which lava and ash are ejected.
scale	able to tell the age of a fish.
smolt	silver colored fish traveling towards the ocean.
magma	molten rock that is under ground.
Loo-Wit	Mount St. Helens, Keeper of the Fire.
swim bladder	helps a fish move up and down in the water.
parr	small salmon with distinct stripes on its sides.
lava	molten rock that is on the surface of the ground.
estuary	place where a river or stream meets an ocean.
Celsius	metric unit for temperature.
gills	used by fish to breath.
hypothesis	an educated guess.
Lorax	wants you to save the forests.
Bigmouth Minnow	predator of young salmon.

- You may play as many games as time permits. Students should use poker chips to mark each selection. Their game cards can be reused for additional games. Instructors should be reminded to scramble the order in which they read the definitions.

CONCLUSION:

Instructors should bring closure to this activity by reviewing the terms that seem difficult for the students.

ACTIVITY 6-3: THE SURFACE WATER VIDEO

SCIENCE CONCEPTS/PROCESSES: Cause and Effect, Cycle, Interactions

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ understand that nature and humans can be the cause of surface water pollution.
- ◆ understand the difference between non-point source and point source pollution.

MATERIALS:

Surface Water Video

40 "After the Flush" brochures

VCR/TV

2 "After the Flush" Posters

BACKGROUND INFORMATION:

The most common type of surface water pollution is called non-point source pollution. Non-point source pollution is defined as pollution that doesn't enter surface water at one particular spot. Examples of this type of pollution are fertilizing crops, rain that carries oil from city streets to storm drains, and acid rain.

Point source pollution can be defined as pollution that gets into surface water at a particular point. Examples of point source pollution are pipes depositing waste into rivers, illegal dump sites, and landfills.

PROCEDURE:

1. In this activity, students will view The Surface Water video (contact City of Portland Environmental Services (503) 823-7740 for video information). The video covers the many causes of pollution and discusses the terms non-point source and point source pollution.
2. This video provides an introduction to the next activity, storm drain stenciling. After the video, hand out a copy of the "After the Flush" brochure and using the poster size copy review the information presented.

CONCLUSION:

Instructors should bring closure to this activity by asking students to do the following:

- ◆ Define non-point source pollution and point source pollution and give examples of each.

ACTIVITY 6-4: STORM DRAIN STENCILING

SCIENCE CONCEPTS/PROCESSES: Cause and Effect, Cycle, Interactions

OBJECTIVE(s): After completing the activity, students will be able to:

- inform their community of the importance of ensuring a clean water resource for salmon as well as all living things.

MATERIALS:

6 traffic cones
12 stencils
12 safety vests
6 brooms

informational door hangers
6 cans of spray paint
40 pairs of latex gloves

PROCEDURE:

1. In this activity, students will be locating storm drains in their community and marking them with a sign stating: **"Dump No Waste --Drains to Streams."** The sign also includes a picture of a fish. As some students stencil the storm drains, others will deliver informational door hangers that will explain why the storm drains are being stenciled. This activity is designed to heighten their awareness of the fact that what goes down the storm drains eventually ends up in the streams and rivers.
2. Students will be in their groups with their counselor. Each group will need: a supply of door hangers, two safety vests, a traffic cone, a can of spray paint, brooms, a fish stencil, a pair of latex gloves for each student, and a plastic garbage bag.
3. A map will be provided to each group. On the map you will find the designated storm drains and area that your group is responsible for. It is very important that the students who are stenciling the drains wear the safety vests. Place a traffic cone two-three feet from the storm drain to alert oncoming motorists. Clean off the drain before stenciling.
4. The spray paint you will be using is a non-toxic water soluble and will wash off in about a year.
5. The students delivering door hangers are to always be in sight of their counselor. When delivering the door hangers, hook them on the door knobs of homes. **Do not ring the door bell or knock.** If there is a fenced yard, hook the hanger on the gate of the fence, **do not enter the property.**
6. This activity educates the students and the community about protecting our surface water. Long after the camp is over, the storm drain stenciling will remind students of their contribution to save the salmon.

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY SIX

It's April and another rainy spring season in the Pacific Northwest. Hydroid has completed its circle in the air above the Pacific Ocean. Ahead, it sees a group of clouds forming, ready to hit the coast with rain. Below, Hydroid sees that nine of the Hood River chinook have managed to avoid all the ocean's perils to come back to the Columbia.

Their timing is just right. One month earlier, they would have found an occasional shadow of a boat overhead or a person standing on the shore. They would have found anchovies, shrimp and other tasty treats. But each treat would hide a hook with a line attached, a line waiting to pull a prize chinook into a net, onto the deck of a boat and in front of a camera as a trophy in the hands of a happy angler. The boats and anglers left less than two weeks before the Hood River chinook came into the river.

The clouds ahead of Hydroid meet a cold draft of air and a heavy rain drenches Oregon and Washington. The river rises and the chinook meet the current head on. It's been four years since they've been in fresh water. Suddenly, they are no longer hungry. Their seafood feast has made them fat. All they want to do is swim, quickly, up the river to home, to their little stream off Hood River. The chinook around them have the same desire. As they move up the Columbia, they stay low to avoid barges and boats. They steer clear of the warm water released by factories and power plants near Longview, Kelso and Rainier.

At Longview, Hydroid sees a small group of chinook take a left turn up Washington's Toutle River. At Portland, another group takes a right. The surviving Willamette chinook are heading back to their hatcheries. The Hood River fish push straight ahead, toward home.

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY SEVEN

The Willamette River spring chinook run is the pride of Portland. Anglers boast that Portland is one of the few cities in America where you can take your pole, head to a bridge downtown and catch a salmon. That wouldn't have happened twenty years ago. In the 1970s pollution made the Willamette a stinking mess. Sewers overflowed and dumped waste into the river. Chemicals made water plants grow like weeds. The weeds choked the water and the fish that tried to swim through them.

Scientists worked with the mayor and the people of Portland to clean up their river. New hatcheries were built to bring back the river's salmon. Today, people play and ski and try to live as close to the river as possible. And as many as 200,000 adult salmon return each year to the Willamette.

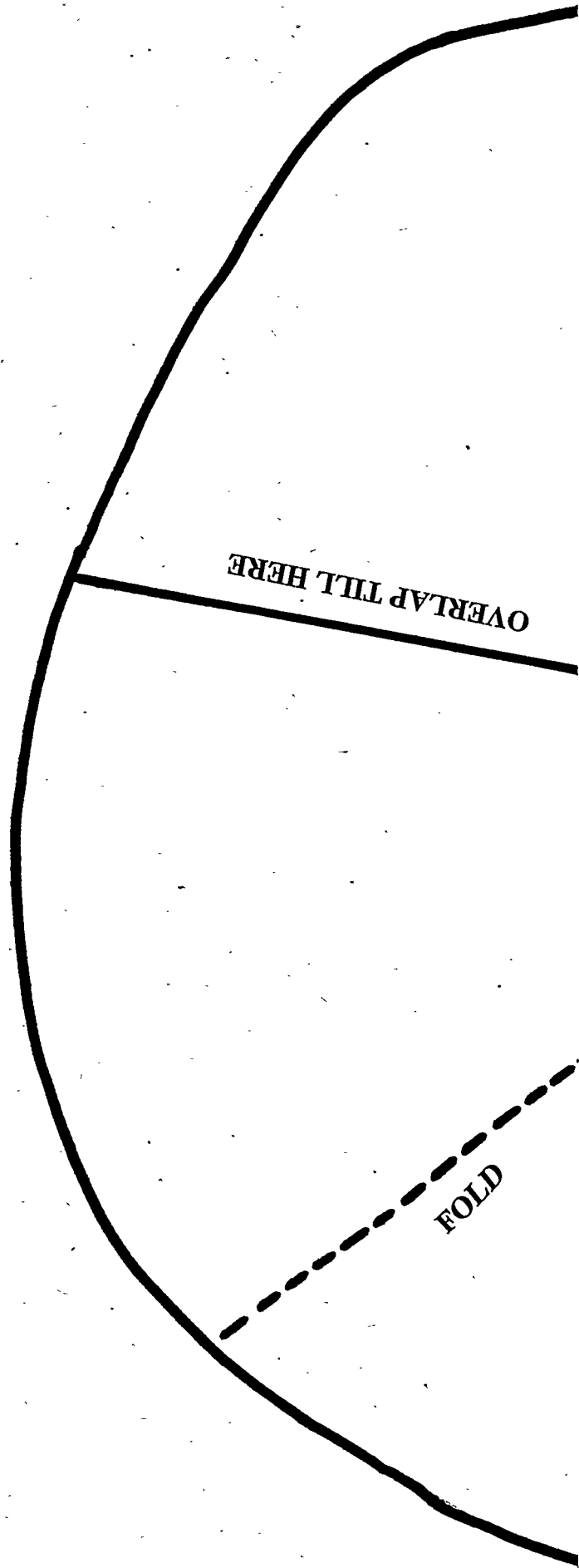
Not all make it back to their hatcheries. Just south of Portland is Willamette Falls. But it's not the steep waterfall that worries the fish. It's the shadow of a wall of boats filled with fishermen. And there is something new for the Willamette fish. A strange-looking net sweeps through a pool of water at the base of the falls. The pool is the best place for a salmon to leap over the first step of the falls. The person at the other end of the net knows what he is doing. That person is a member of the Yakama Indian Tribe. His net is called a dip net. For thousands of years, the tribes have used their nets on the Columbia River. The salmon they catch are part of their culture and religion. This year they hope to take more than 2,000 salmon back to their longhouses. But salmon runs have never been lower. They catch 1,000. They hope to catch a few more from the Willamette for their sacred ceremonies.

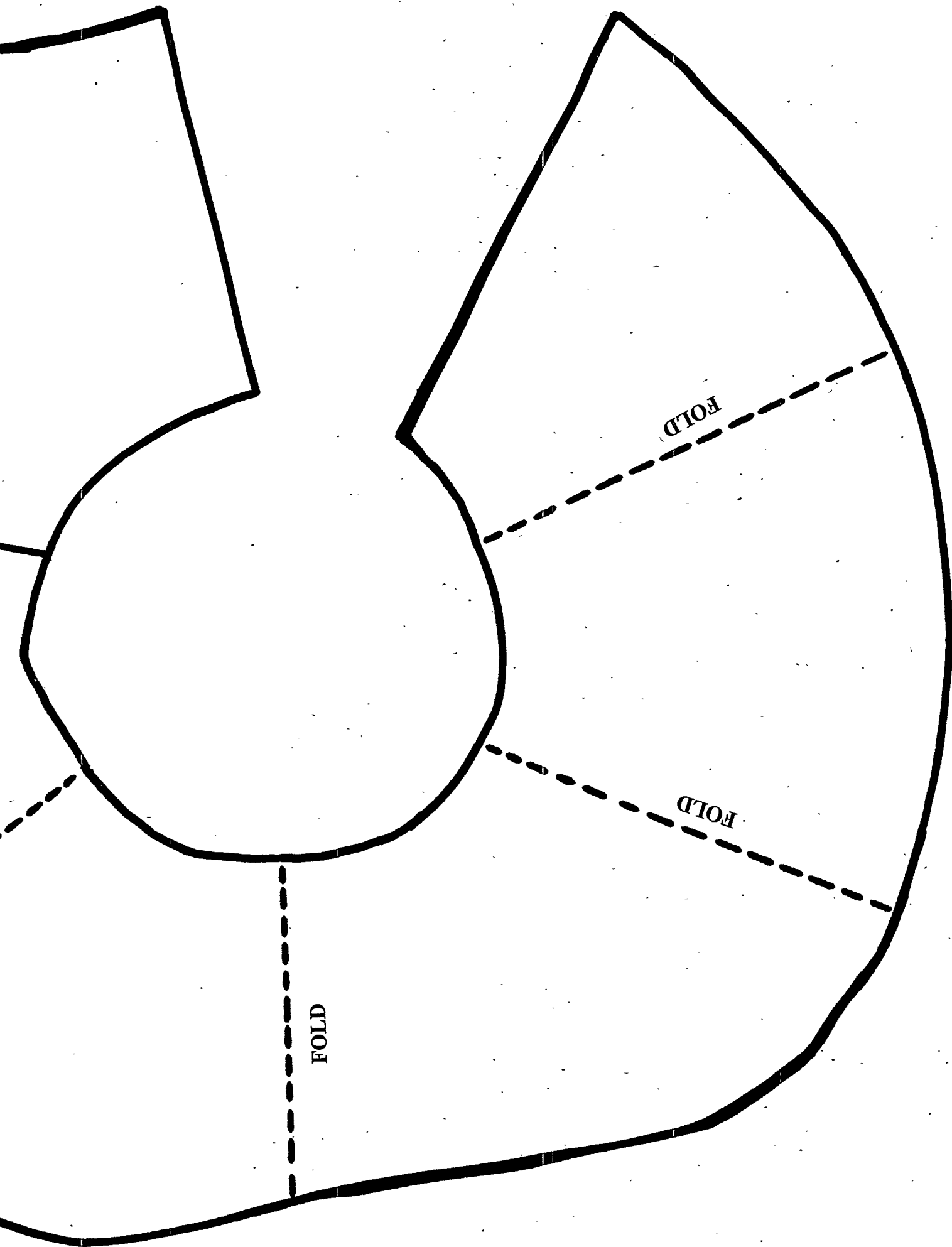
Tribal members build an 18-inch wide wooden bridge out from the rocks next to the falls. A fisherman ties one end of a rope to his waist, the other end to a tree and walks to the end of the plank. He stands all day, sometimes

all night, sweeping the water with a net at the end of a 25-foot pole. He stays until he has enough fish for his family and his tribe. This year, he may stay until the end of May and the end of fishing season. Even the Willamette River run is low this year. Only 50,000 chinook return to the falls.


And what happened to the little coho from the Clackamas River? While chinook may spend three years in the ocean, coho most often spend only one year. Two years ago, the coho came back as adults. Seventy-five of them made their way to the mouth of the Clackamas River below Willamette Falls. Fifty of them survived to return to their home streams, build redds and lay eggs. In fact, the eggs they laid hatched long ago. Another generation of wild coho has already left the Clackamas and is on its way to the sea.

VOLCANO PATTERN





S A L M O

		FREE  SPACE		

STORM DRAIN STENCILING

Activity: Students take responsibility for helping their stream environment by teaching others in their community about the hazards of inappropriate storm drain dumping. Using spray paint and stencils (a very popular activity) students stencil the words "DUMP NO WASTE, DRAINS TO STEAM" by as many city storm drains as time and energy allow.

Length of time: Flexible

Number of participants: Maximum 30, recommend breaking down into groups of 4 with one adult supervising each group.

Age Range: 2nd grade through high school.

Pre-field trip preparation:

1. Lead a group discussion of the impacts of erosion from landscaping and construction; the dumping of toxic waste, i.e. motor oil, anti-freeze, paint, detergents, etc. in to the local storm drain; and the negative impact from the over usage of fertilizers and pesticides.
2. Contact Environmental Services (503) 823-7740 If residing in the city of Portland to reserve paint, stencils, vests, cones, and other necessary supplies. If residing elsewhere, call your local water bureau or environmental service to arrange for supplies. Most cities do have a stenciling program in place.

Post-field trip preparation: Report the number of drains stenciled and their location to your local water bureau or environmental services.

WHY STORM DRAIN STENCIL?

Every year people pour hazardous chemicals, pesticides, paints, antifreeze and used motor oil down storm drains. Most of them don't realize that those drains dump their waste materials directly into our streams and ground water. While some of the drains go to waste treatment plants, those facilities are not equipped to handle these hazardous wastes.

The dumping of hazardous wastes into the storm drains is damaging our water quality. It can affect fish and wildlife. For example, only one pint of motor oil can cause a slick the size of two football fields on calm water.

Storm drain stenciling is one way to remind people that storm drains are for rain water only. The Stenciling Project will not only involve citizen groups and students but will also serve to educate neighborhood residents by providing them with important informational materials. It will provide a visual reminder for up to a year that pollution prevention is important.

THE STREAMWALK GAME

Activity: Primarily geared as an outdoor stream evaluation activity, but can be adapted for the indoor classroom in case of rain or lack of transportation.

Length of time: 1 hour

Number of participants: Maximum 30, recommend adult supervision on a 1:5 ratio.

Age Range: 1st through 5th grade

Field trip preparation: Recommend checking site prior to trip for: safe access, i.e. no steep embankments; enough room for group to stand and record data comfortably; and an interesting stream area to study. An area with an example of a run, pool and riffle area on the stream is ideal for elaboration on fish habitat.

ABOUT THE GAME

The Streamwalk Game fosters a child's natural curiosity about the living world. Children seem to intuitively know the health of a stream. They know pollution is not good and they know pollution is not right, but they don't have the reasoning or the tools to explain their knowledge. Using the Streamwalk Game, youngsters can go to a stream to determine whether the stream is healthy or unhealthy and to understand more of the components that go into keeping a stream healthy. The game enables them to quantify something they may already know intuitively.

The United States Environmental Protection Agency developed a program called Streamwalk to give citizens, ranging from 6th grade to adult, the ability to monitor and assess streams. The Streamwalk Game follows a similar yet much simpler format which allows younger children to gain exposure to scientific procedures for evaluating a stream, including the data gathering process.

Currently the Streamwalk Game is only available to students within the city of Portland who arrange a field trip in conjunction with Environmental Services. Students who complete the program also receive a Streamwalk detective pencil and button as a special memento of their experience. Call the City of Portland Bureau of Environmental Services at (503) 823-7740. This program resource is provided free to groups from schools or community education locations within the city of Portland.

Instruction for Streamwalk Game

1. There are 12 cards in each folder. If you are in an urban area, remove Card 12 (cows in stream) from the folder. If you are in a rural area, remove Card 7 (pipes dumping in stream) from the folder. There must be an uneven number of cards for the best results in the clue card section.
2. Read the Murky Water Mystery story aloud. It is a short story about Brown Beaver and the animals in the stream neighborhood who are upset about the increasing pollution around their homes. They need a private detective. that's where the players come in.
3. Either with a group leader or breaking down into smaller student groups, have a volunteer reporter from each group fill out an investigation report. All of the group should come to consensus on determining the data collected about the surrounding stream neighborhood.
4. Explain to the group/s the usage of the clue cards. Each card has a blue side (healthy) and a brown side (unhealthy). Read each card and look at your stream. Which side does your stream best match? If it is the blue side, place in the blue side of the folder. If your stream matches the brown side, place it in the brown side of the folder. Then count the number of blue cards chosen and compare it to the stream rating guide and determine if your stream needs help, could go either way, or is looking good.
5. Finally, search the Super Sleuth page to discover all the ways that students can be water quality stewards and make an ongoing commitment to help their stream neighborhood.
6. Pass out reward buttons and pencil for those who complete the program.

Optional activities: After doing a visual analysis of your stream, have students do a pH and temperature test of the stream to determine some of the invisible water quality conditions that exist in you adopted stream.

Using The Streamwalk Game Indoors

If you don't have a stream appropriate to visit, you can make one. have your group make a list of things that might be found along a stream. On large piece of butcher block paper draw two winding lines paralleling each other the entire length. This represents a stream. Using a variety of materials, have the children create a stream. Creating the stream can be a one-class activity or many-class activity. Once the stream is created, follow the for The Streamwalk Game.

*The Streamwalk Game was developed by the City of Portland Environmental Services with grant assistance for the U.S. Environmental Protection Agency.

Day 7

OUTLINE

TIME

ACTIVITIES

MATERIALS

(Based on class of 40)

7:45 a.m.

Leave Camp Site
(**Very important** to leave on time to view
Mount St. Helens video at 9:05 am.)

Student maps

8:50

Mount St. Helens Interpretive Center
Castle Rock-Exit 49 (I-5) ~5 miles east

Student workbooks
40 adhesive name tags
40 No. 2 pencils

9:05

Mount St. Helens video (22 min.)
(Weather permitting, Mount St. Helens
can be seen 30 miles east across Silver Lake.)

10:00

Leave Mount St. Helens Interpretive Center

10:30

Arrive at Toutle Salmon Hatchery
Collection of ash/Hatchery salmon process

Devastation to Hatchery by 1980 eruption

40 film canisters
2-1 gallon size plastic
bags
40 adhesive labels

11:30

Leave Toutle Salmon Hatchery

12:45

Lunch at Merwin Dam and Picnic Area
Woodland Exit 21 (I-5)

1:30

Leave Merwin Dam and Picnic Area
(State route 503 towards Cougar (go through Cougar)
Service road 90 then Road 83.)

2:15

Arrive at Ape Cave

Short Presentation by Forest Service Personnel
(Students will need warm clothing and
shoes for the hike.)

15 lanterns (RESERVED
at Ape Cave)
15 flashlights
candles/matches

3:45

Leave Ape Cave

5:00 p.m.

Arrive back at Camp Site

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DAY 7

TEACHER NOTES

MOUNT ST. HELENS/APE CAVE FIELD TRIP

EMERGENCIES

Mount St. Helens Interpretive Center - (206) 274-2103

Toutle Salmon Hatchery - (206) 274-7757

Forest Service - (206) 750-3900

Estimation Game: Students estimate how high Mount St. Helens blasted ash into the atmosphere on May 18, 1980 (or use a comparable estimation game for students).

Bus Activities: Students may complete games and/or activities in their student workbook during the bus ride.

OBJECTIVE(s): After completing the activities on this field trip, students will be able to:

- ◆ apply what they have learned in the classroom to their local and regional communities.

MATERIALS:

35 film canisters

2-1 gallon size plastic bags

35 No. 2 pencils

35 adhesive name tags

15 lanterns (RESERVED at Ape Cave)

15 flashlights

candles/matches

BACKGROUND INFORMATION:

MOUNT ST. HELENS

History

Mount St. Helens is one of the youngest composite volcanoes in the Cascade Range. It's smooth symmetrical shape is only slightly eroded by glacial ice and it's low timberline elevation are indications of recent volcanic activity. Even though the geologic history of Mount St. Helens goes back over 37,000 years, eruptions during the past 2,500 years have been mostly responsible for the mountain we see today. The volcano has produced basalt and andesite lava flows, as well as dacite domes and ash. About 1,900 year ago, fluid streams of pahoehoe (ropy) basalt flowed down the southern flank of the mountain and cascaded into the canyon of the Lewis River. Ape Cave and other lava tubes formed within the flow south of the volcano. In fact, most of the visible part of the cone was formed during the last 500 years.

It has only been since 1800 that eyewitness accounts of eruptions have been recorded. Early explorers recorded Indian accounts of eruptions before the coming of white men. Accounts of even earlier eruptions were handed down in Indian legends. Local Indians told explorers of a large eruption about 1800, when pumice accumulated to a depth of several inches many miles away from the volcano. The first authenticated eye-witness account of an eruption was made by Dr. Meredith Gairdner from Fort Vancouver in 1835.

May 18, 1980

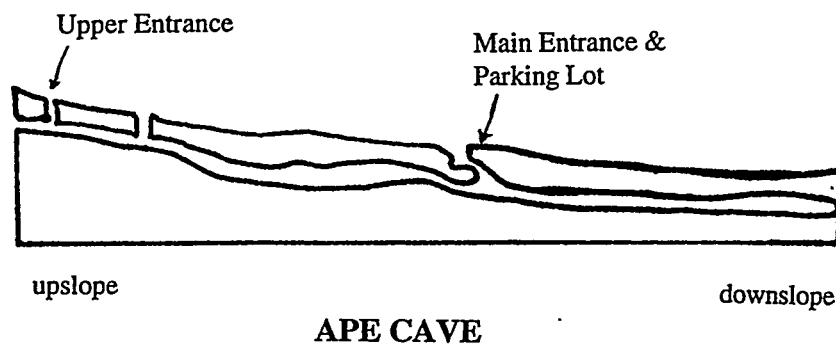
Silent for 123 years, Mount St. Helens awakened in the spring of 1980. By early Spring, the crater grew to 1,000 feet in diameter, and two giant crack systems broke across the entire summit area of the mountain. As thousands of earthquakes shook Mount St. Helens between April 1 and May 17, a giant magma "bulge" grew on its north flank. At 8:32 a.m., on May 18, 1980, within 15 to 20 seconds of a magnitude 5.1 earthquake, the entire north flank of the mountain slid away in a giant landslide. Explosions ripped through the sliding avalanche of debris, forming a laterally-directed blast of rocks, ash, gas and steam that swept as fast as 670 miles per hour down the North Fork of the Toutle River Valley. This lateral blast flattened four billion board feet of timber, enough to build 300,000 two-bedroom homes. In less than 10 minutes an enormous plume of pumice and ash thrust 13.6 miles into the stratosphere, and it continued for the next 9 hours. The prevailing winds carried 540 million tons of ash over 22,000 square miles across North America in three days, and circled the earth in 15 days. The ash clouds produced darkness during day light hours in many towns in Eastern Washington. As the hot blast (up to 300°C or 570 °F) spilled down all sides of the volcano, water from melting snow and ice mixed with loose rock debris to form mudflows. Mudflows poured down river valleys, ripping trees from their roots and engulfing roads, bridges and houses. On May 18, 1980, mudflows destroyed or damaged 27 bridges, 185 miles of road, approximately 200 homes and stranded 31 ships in upstream ports of the Columbia River. Thirty-six people are known dead and 21 are still missing.

The 1979 summit elevation of Mount St. Helens was 2,951 m (9,677 ft). It was reduced to 2,551 m (8,365 ft) and 2.5 km³ (0.6 mi³) of material was removed by the May 18 eruption.

APE CAVE

Ape Cave has a length of 3843 meters (12,810 feet) long and is the longest continuous lava tube discovered in the continental United States. While logging, Lawrence Johnson of Amboy, Washington discovered the cave in 1946. The cave was named for an outdoor group who called themselves the St. Helens Apes.

Ape Cave is divided into two portions, upslope and downslope, from the main entrance. The downslope portion of the cave extends for approximately 1200 meters (4,000 feet) before ending in a sand fill. The downslope portion is easily traveled, while the upslope portion is difficult. The upslope portion involving nearly 2100 meters (7,000 feet) of passage floored mostly by rock rubble caused by collapse of the passage walls and ceiling.



The eruption which produced the Ape Cave 1,900 years ago was of a less explosive nature than the May 18, 1980 event. Lava tubes such as Ape Cave, form in flows of ropy pahoehoe basalt when the top of the flow cools faster than the lava below. When the eruption ceases, lava drains from the tube leaving an open tunnel. Since lava is an excellent insulator, it is possible for the lava to flow through the tube for many miles with little loss of heat. This hot lava stream is able to erode downward, cutting into the rock below. This cutting activity caused the cave to have passages with a high, narrow cross-section. As the lava level dropped, hot gases caused melting of wall surfaces (much like a very hot oven) forming a dark shiny glaze. Where sections of wall lining have fallen away, it is possible to see hard reddish soil which was baked red by the heat of the overlying lava. Once the eruption ceased and lava drained from the tube, the cave was left as we see it today.

Lava stalactites were formed on the ceiling and stalagmites were formed on the floor where globules of dripping lava fell from stalactites. These lava formations are not common in the cave and where they do occur are small and very fragile. Lateral "flow marks" (minor ledges) along the walls, mark stages of lava decline in the tube. When the lava level dropped then stabilized for a period of time, a flow mark was produced along the wall, much like a ring is produced in the bathtub.

In the lower portion of the cave, a block of solidified lava (called the lava ball), was carried along in the lava stream and was wedged in a narrow portion of the passage. This lava ball is approximately twelve feet above the floor surface today.

At the end of the downslope portion of the cave, a sandy floor has formed. This sandy floor is made up of volcanic ash, pumice, and other debris which have been washed into the cave through the lower entrance. The majority of the debris was deposited following an eruptive episode geologists call the Early Kalama Period, 450 years ago. Flooding has carried fresh ash and sediment from the recent eruptions across the lava flow above Ape Cave.

The cave wind you feel is nearly always present and is sometimes as great as seven miles per hour. The wind is caused by differences in air temperature inside and outside the cave. During the winter, warm cave air rises like warm smoke in a chimney and pours out the upper entrance. This chimney effect reverses during the summer when cool cave air drains down-slope through the cave and pours out the lower main entrance.

PROCEDURE:

1. **Mount. St. Helens Interpretive Center** - Students should use their workbooks to complete the Mount St. Helens Scavenger Hunt. Information to complete this activity can be found throughout the Mt. St. Helens Interpretive Center and by watching the 22 minute video at the Interpretive Center.
2. **Toutle River Fish Hatchery** - Students will tour the salmon fish hatchery. A large part of the rearing ponds are still covered with Mount St. Helens ash from the May 18, 1980 eruption. Students will be able to collect a small amount of ash in film canisters. On Day 9, the students will view the ash under a microscope using polarized film.
3. **Merwin Dam and Picnic Area** - This lunch stop is short (45 min). Students should use this time to eat and use the facilities.
4. **Ape Cave** - Students will be divided into two groups, Camp A and Camp B. A short presentation about Ape Cave and Mount St. Helens will be given to each group as they enter the cave by Forest Service personnel. Then students (with their counselor) will hike for approximately 20 minutes into the downslope section of the cave and return to the lower entrance. This hike will take approximately 40 minutes (40 minutes equals 20 minutes downslope and 20 minutes upslope back to the entrance). Students will need warm clothes and shoes for this hike. Challenge the students to estimate the size of the cave. Lanterns should only be operated by the counselors/adults. Students may share the flashlights.

SCAVENGER HUNT-ANSWERS

(Mount St. Helens Interpretive Center)

Find the answers to the following questions as you view the museum.

Museum Entrance and the Mount St. Helens Film (22 min.)

1. In what national forest is Mount St. Helens located?
Gifford Pinchot
2. On what day did the first earthquake take place?
March 20, 1980.
3. On what day did the big eruption take place?
May 18, 1980.
4. Mount St. Helens was 9,677 feet high before the eruption and
8,365 feet high after the eruption.

Formation of the Earth

Birth of the Cascades: 5. What happened 200 million years ago (m.y.a.)?
First dinosaurs appeared.

Age of Man: 6. When did primitive man appear in Africa and India?
10 million B. C.

7. When did the first eruption of Mount St. Helens occur?
40,000 B. C.

Volcanic Events: 8. What happened 1200 years before the May 18, 1980 eruption
of Mount St. Helens?
Mt. Mazama erupted (Crater Lake)

VOLCANOES AND THE EARTH'S CRUST

A Volcano Erupts:

9. What is the hot molten rock under the surface of the earth called?
Magma
10. Name four kinds of volcanoes. a. Composite, b. Shield
c. Cinder Cone, d. _____

Man and the Mountain Part II

Native Americans:

11. Who is the keeper of the sacred fire?
Loo-wit
12. What three Indian groups lived around Mount St. Helens?
Cowlitz, Klickitat, and Upper Chinook.
13. Who was the husband of Mount St. Helens?
Mt. Hood
14. According to legend, what river could the Indians cross without getting their feet wet?
Columbia River
15. What fruit was important to the Native American diet?
Huckleberries (also blackberries, strawberries, elderberries and salal berries.)
16. What is the name for the fish trapping devices the Indians made out of wood slats and cedar rope?
Fish weirs
17. What were the two primary meat sources for Native Americans?
Salmon and venison

Explorers & Settlers

18. Who gave Mount St. Helens its name as we know it?
Captain George Vancouver
19. What year did the explorer get to the Northwest?
1792
20. From what country did he come?
England

Spirit Lake camps and lodges

21. What were bola stones used for?
Hunting

Mount St. Helens: During and After the Eruption

22. How much did the Oregon Journal cost in April 1980?
23. According to the Oregon Journal, on April 1, 1980, how much money did the United States Senate spend to improve salmon and steelhead fisheries in the Northwest?
24. Who was President on May 1, 1980?
President Jimmy Carter
25. The ash from Mount St. Helens caused what type of pollution?
Air pollution
26. How high were the temperatures around the mountain on May 18, 1980?
300 degrees Celsius

Magma Chamber

Tree Ring Dating Technique

27. What can trees tell us about volcanic eruptions?
When they occurred by observing their rings.
28. What type of tree is ideal for dating eruptions?
Douglas Fir

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MOUNT ST. HELENS WORD SEARCH



Cinders
Ape Cave
Lava Flow
Volcanic Ash
Crater
Mount St. Helens

Toutle River
Eruption
Lahar
Spirit Lake
Pahoehoe
Blast Zone

Lava Tube
Loo Wit
Volcano
Mount Adams
Devastation

MOUNT ST. HELENS WORD SCRAMBLE



Directions: Unscramble the words below.

1. RLAAH

1. _____

2. OLO TWI

2. _____

3. OVNOALC

3. _____

4. RCERTA

4. _____

5. NEORIUTP

5. _____

6. SRIEND

6. _____

7. EAP ECVA

7. _____

8. CVIONLAC HAS

8. _____

9. ALVA WFOL

9. _____

10. EPOAHHEO

10. _____

11. TSIPRI ELKA

11. _____

12. TMNOU SAMDA

12. _____

13. NDOEIVAASTT

13. _____

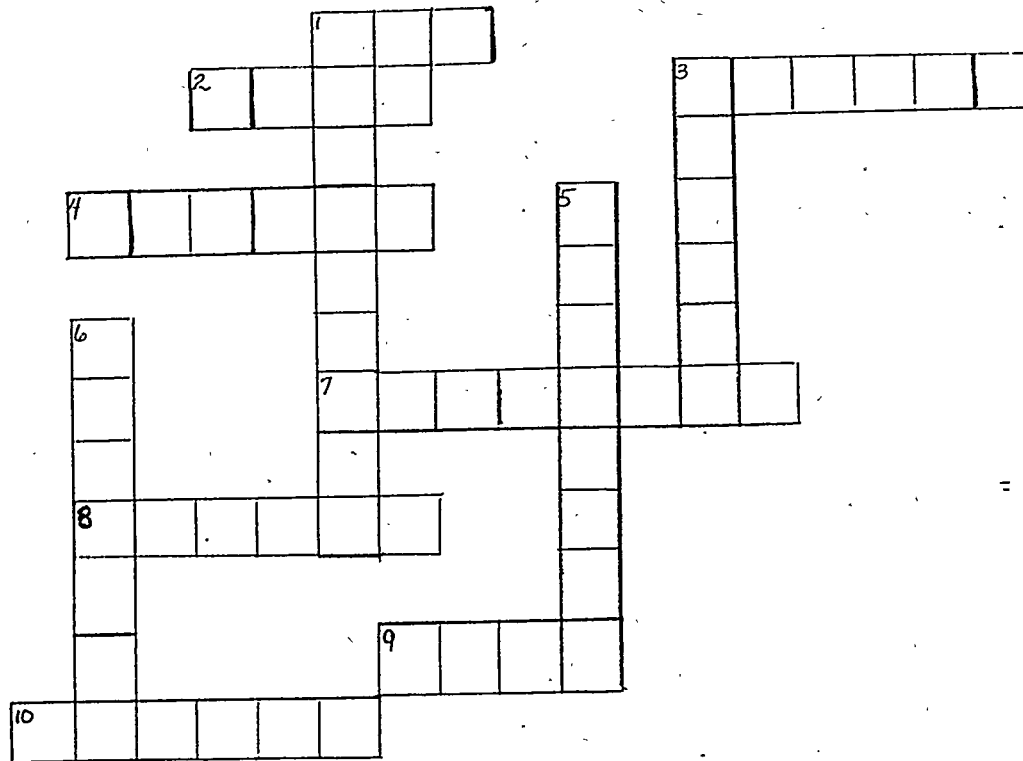
14. TBSLA EZNO

14. _____

15. ETLOTU RREIV

15. _____

MOUNT ST. HELENS CROSSWORD



ACROSS

1. Volcanic material that covered the area around Mt. St. Helens in May 18, 1980 eruption.
2. Magma that reaches the earth's surface.
3. The earth's crust is divided into many _____ (Juan de Fuca is one.)
4. The river that flows in the Toutle valley.
7. The mountain range that extends from California North into Oregon, Washington, and British Columbia.
8. The bowl-like hole in the top of a volcano.
9. The feature that built up in the crater of Mt. St. Helens prior to the May 18th eruption.
10. The native American name for Mount St. Helens.

DOWN

1. A large landslide that moves down a mountain.
3. A light weight rock that floats in water.
5. Ape Cave is an example of a _____.
6. A mountain that explodes is called a _____.

Day 8

OUTLINE

TIME

ACTIVITIES

MATERIALS

(Based on class of 40)

9:00 a.m.

Breakfast/Estimation Game

1 Bigmouth Minnow

9:15

Reflections
Journey of the *Oncorhynchus*:
A Story of the Pacific Northwest Salmon

Mural-add Section 8

9:30

(8-1) Fish Prints
(External Structure)

12 Bigmouth Minnows
100 sheets of newsprint
1 bottle of black tempera paint
Newspapers
1 pound of modeling clay
20-9 oz plastic cups
10 rolls of paper towels
1 box small straight pins
6 plastic tubs
1 bottle of dish washing detergent
20 medium paint brushes
2 bottles of lemon juice
1 box of baking soda
40 glue sticks
Assorted colors of construction
paper (12" x 18")

10:30

Break

(Rinse the paint off the fish.)

10:45

(8-2) Fish Dissection
(Internal Structure)

15 microscopes
microscope slides/coverslips
8 dissection pans
40 dissecting probes
8 scalpels
8 dissecting scissors
8 rolls of paper towel
12 Bigmouth Minnows
6 plastic tubs
2 bottles of lemon juice
1 box of baking soda

12:00

Lunch

1:00	Native American Guest Speaker (Regional Salmon Legends)	Native American Legends
1:45	(8-3) Mount. St. Helens Ash (Observations)	15 microscopes Polarizing Film squares microscope slides/coverslips Mount St. Helens ash 7 rolls of Clear tape 15-9 oz plastic cups 15 medicine droppers
2:15 p.m.	(8-4) Race to the Redd-game (Salmon Life Cycle/Perils)	10 game boards 10 bags of game pieces/markers 10 die
2:45 p.m.	Reflections	
3:00 p.m.	Camp ends for students	

DAY 8

TEACHER NOTES

Estimation Game: Estimate the length and width of a bigmouth minnow in centimeters. (The winners will be announced during the break.)

Story Time: Journey of the *Oncorhynchus*-Chapter Eight. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up either the Journey of the *Oncorhynchus* mural by adding **section eight** or the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section eight. The first student to find the hidden salmon will be awarded a prize.

ACTIVITY 8-1: FISH PRINTS

SCIENCE CONCEPTS/PROCESSES: System, Symmetry, Observe

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ identify the major external structures of a fish.
- ◆ explain how a fish is adapted to living in water.

MATERIALS:

20 fish (Bigmouth Minnows)	100 sheets of newsprint
1 bottle of tempera black paint	newspaper
1 pound of modeling clay	12 microscopes
1 box of small straight pins	8 rolls of paper towels
construction paper-assorted colors	35 glue sticks
1 bottle of dish washing detergent	18 medium 2cm paint brushes
6 plastic tubs	2 bottles of lemon juice
40 microscope glass slides/cover slips	

BACKGROUND INFORMATION:

FISH PRINTS

The art of fish printing called gyotaku (pronounced giyo-ta'-ku) has been used in Japan for more than a century. This technique was used to record catches of sport fish. Fish prints can be made with almost any fish, however, carp, bass, bluegill, rockfish or flounder will produce the best results.

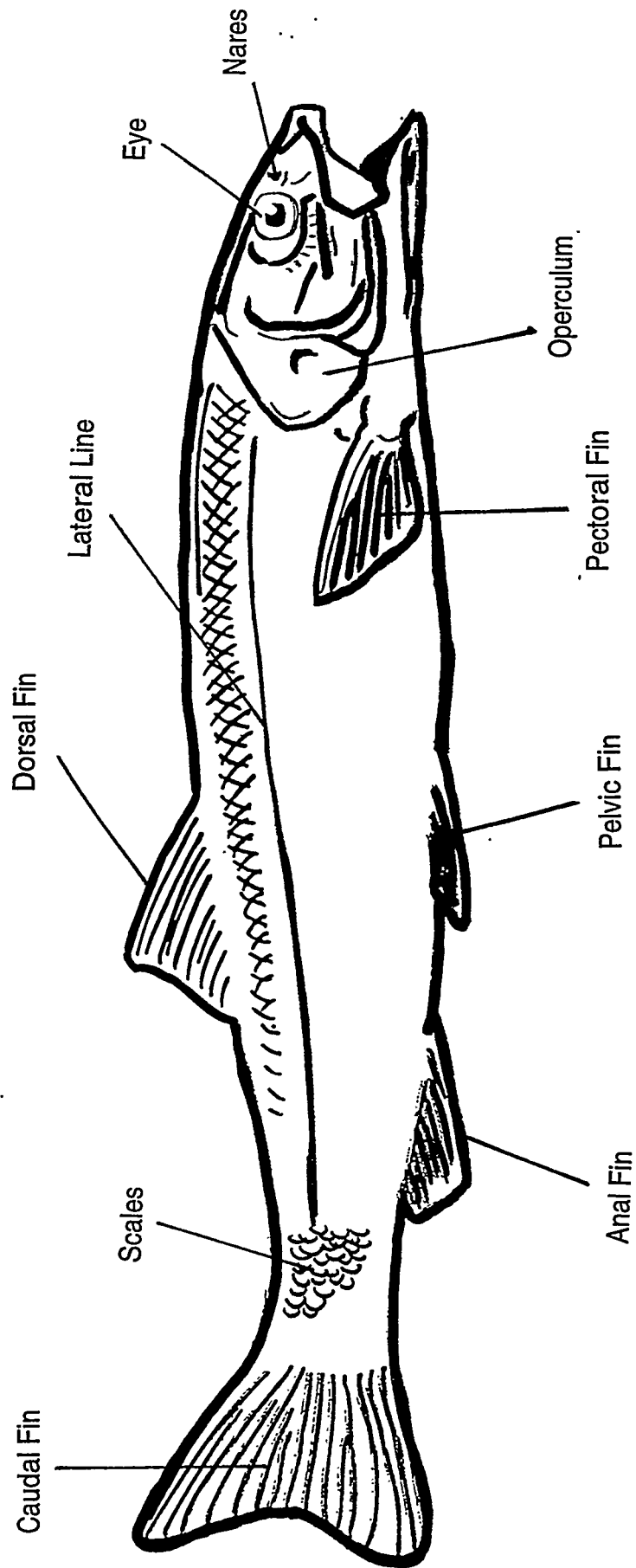
FISH

The first major group of vertebrates to evolve were fish. Fish are confined to living in water. They possess gills for respiration, fins and tails for swimming, and scales to protect their bodies. Fish also have a unique sensory system enabling them to detect changes in pressure and water currents.

Many external structures of fish make them well adapted to their life in water. The streamlined body; the fins used for locomotion, steering, stability and defense; the lateral line which serves as a pressure sensitive organ; the nares at the anterior end, and the structure and positioning of the teeth, adapt fish to their aquatic environment.

External Structures-Function(s):

1. **Nares** (or nostrils) - Water carried through the nares leads to the nasal cavity and the olfactory organs. Chemicals in the water stimulate certain nerve cells to send an electrical message to the brain. A fish's keenest sense is smell.
2. **Eyes** - Located on either side of the head. Most fish eyes can see both to the left and right at the same time. This is definitely an advantage for an animal that has no neck to turn the head from side to side. Most fish have poor vision, and can see objects no farther than 0.5 meters away.
3. **Operculum** - covers and protects the gills. It regulates the water flow through the gills.
4. **Lateral Line** - is sensitive to pressure waves in the water, senses the movement of other animals in the vicinity and the reflections of the waves produced by the fish's own movements.
5. **Scales**- used for protection. Fish are born with a certain number of scales. The scales enlarge throughout the life of the fish, however, new ones are never grown.
6. **Pectoral and Pelvic fins** - serves as oars and aid in steering and balance.
7. **Dorsal and anal fin** - serves as keels to keep the fish upright.
8. **Caudal fin** - serves as main propelling and steering fin.

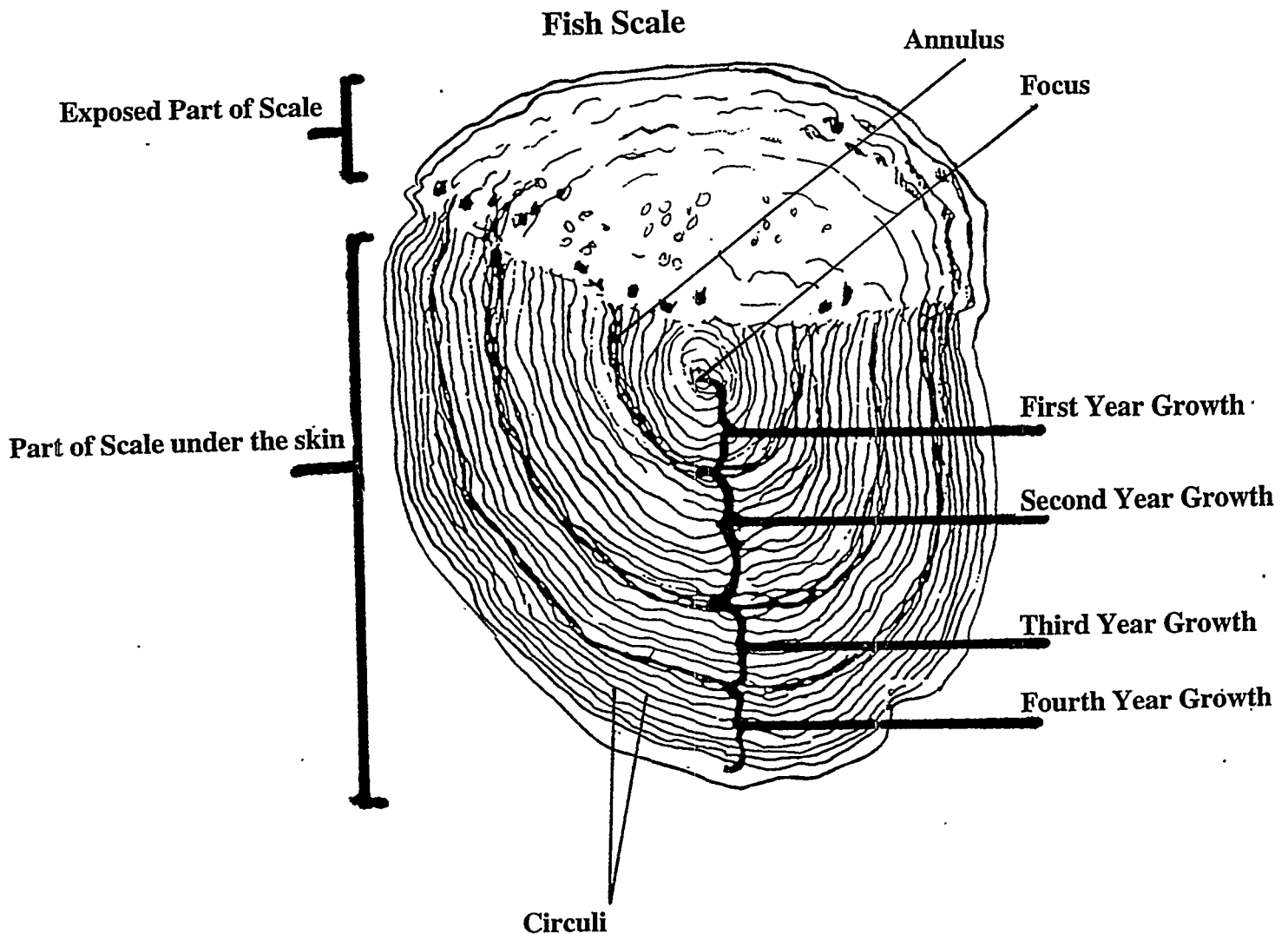


Bigmouth Minnow - External Structures

Fish Scales

Fish scales are just like the cross section of a tree trunk. The oval scales of a fish show annual growth rings. Annual rings can be used to learn the age of a tree or fish.

Most fish are born without scales, however, as the fish grows, scales form. The scales increase in size while the number of scales remains the same. Growth begins at the focus near the center of the scale. As the fish grows, fine ridges called circuli are laid down in a circular pattern around the focus. During the summer or other times when growing conditions are good, the fish grows quickly and the rings or circuli are far apart. In the winter when living conditions are not as good, the fish grows slowly so the rings or circuli are close together. One year's growth is revealed as a series of widely spaced spring and summer circuli followed by a series of closely spaced fall and winter circuli. The outer edge of a series of closely spaced circuli, called the annulus, represents the end of growth for that year. The age of the fish is determined by counting the number of annuli.



A Fishy Smell?

A practical acid-base reaction can be used to eliminate fishy odors. Fish oils contain dissolved bases called amines. Amines give fish that fishy odor. Lemon juice, a citrus fruit juice, is an acid. When an acid and a base react, either or both of them may be used up (neutralized). When combining lemon juice (acid) with the fish amines (base), the acid will neutralize the base and eliminate the odor.

PROCEDURE:

1. In this activity, students will use newsprint and black tempera paint to create their own fish print. The bigmouth minnow will be used to make the prints.
2. Before starting this activity, cover all the tables with newspapers. Be sure to have adequate amounts of paper towels for clean-up.
3. The outside of the fish will need to be cleaned with soap and water. Dry the fish well. The cleaner and dryer the fish, the better the print will turn out.
4. Students will place their fish on the covered tables. Using small amounts of modeling clay, spread the fins out over the clay and pin them in this position. **Allow the fish to dry further.**
5. Students need to brush on a **thin**, even layer of black tempera paint. Paint all of the fins. Instruct student to paint around the insertion of the pelvic fin, leaving a small space between the body and the fin. Do not paint the eye.
6. Carefully place a piece of newsprint over the painted fish. Use fingers to gently press the newsprint over the surface of the fish. Be careful not to move the newsprint as you are pressing the paper. If this occurs, a double impression may be the result.
7. Quickly remove the newsprint from the fish, lifting one end and peeling it off. Students may want to try this process two or three times to get the best print.
8. Students can use the paint brush to paint the eye on the finished print. Allow the print to dry completely.
9. As the fish prints are drying, instructors should use a bigmouth minnow to go over the external structures of the fish: eye, operculum, nares, scales, lateral line, fins (pectoral, dorsal, caudal, anal, pelvic). See diagram in background section. This would be an appropriate time to discuss bilateral symmetry. Bilateral symmetry is the arrangement of an organism's body parts so that one-half of the body is an apparent mirror image of the other half. Humans have bilateral symmetry. What type of symmetry does the bigmouth minnow have?
10. To find out the age of their bigmouth minnow, students should prepare a slide of a fish scale. The scale can be obtained from the bigmouth minnow. Using a scalpel, rub the fish firmly to remove the scales. A team of three students should prepare a slide of a scale by placing the scale between two glass slides. (Hints: Very old fish will have scales difficult to interpret as the scales will be thick and opaque. Freshwater fish scales tend to work better than marine specimens.) Instructors need to assist students in aging their fish.

11. When the fish prints are dry, students will use their fish print to review the external structures of a fish. Instructors should assist students in labeling the following external structures on their fish print: eye, operculum, nares, scales, lateral line, fins (pectoral, dorsal, caudal, anal, pelvic). See diagram in background section. When the labeling is complete, students may want to mount their fish print on colored construction paper.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. Identify the five types of fins and give their functions.
2. How are trees and fish alike?
3. What external structures move water pass the gills?

ACTIVITY 8-2: FISH DISSECTION

SCIENCE CONCEPTS/PROCESSES: System, Observe

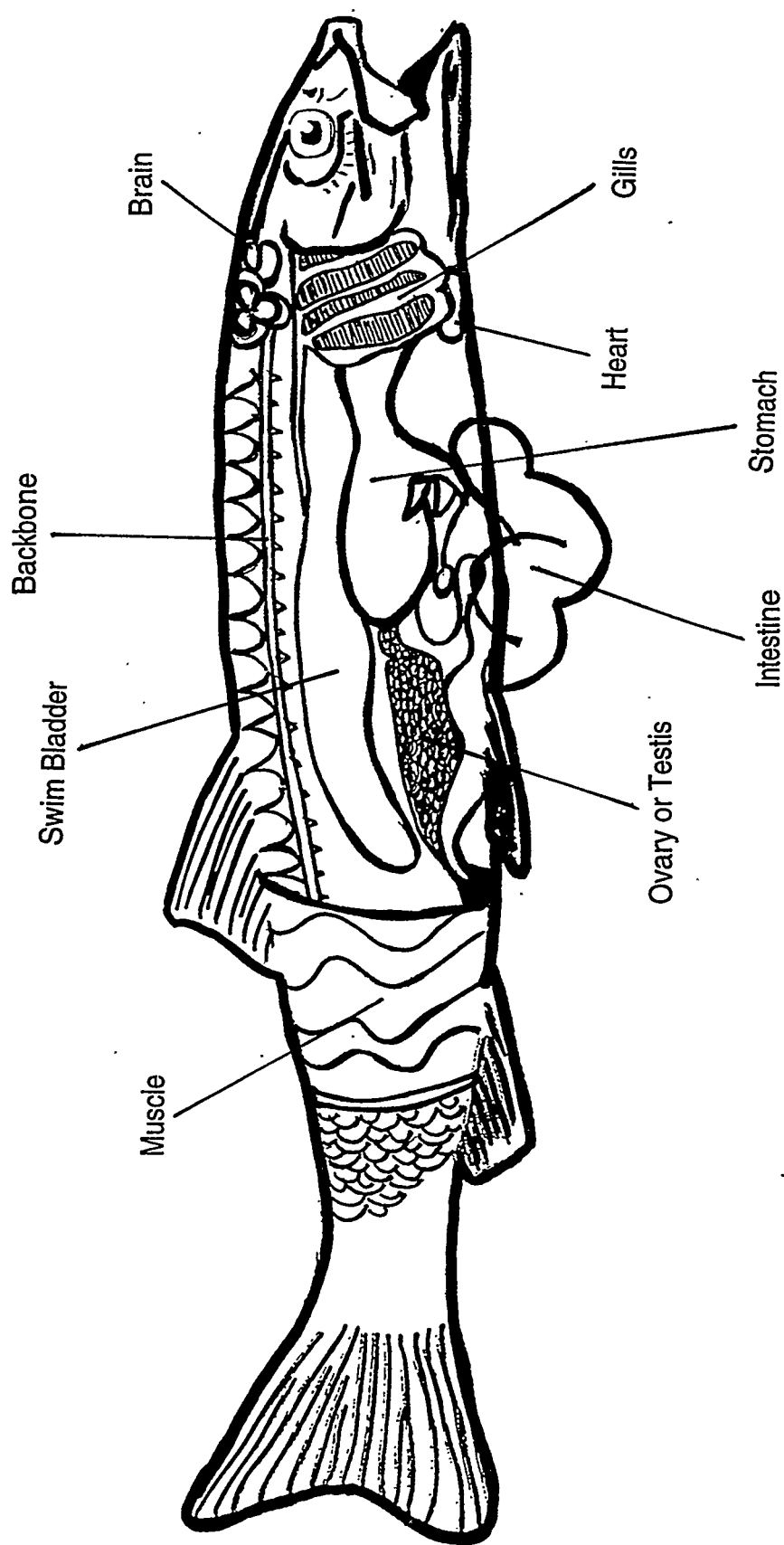
OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ identify the major internal organs of a fish.
- ◆ explain the function of the swim bladder.

MATERIALS:

18 large dissecting pans
18 scalpels
8 rolls of paper towels
6 plastic tubs
several newspaper

12 dissecting probes
18 dissecting scissors
18 Bigmouth Minnows
2 bottles of lemon juice



Bigmouth Minnow - Internal Structures

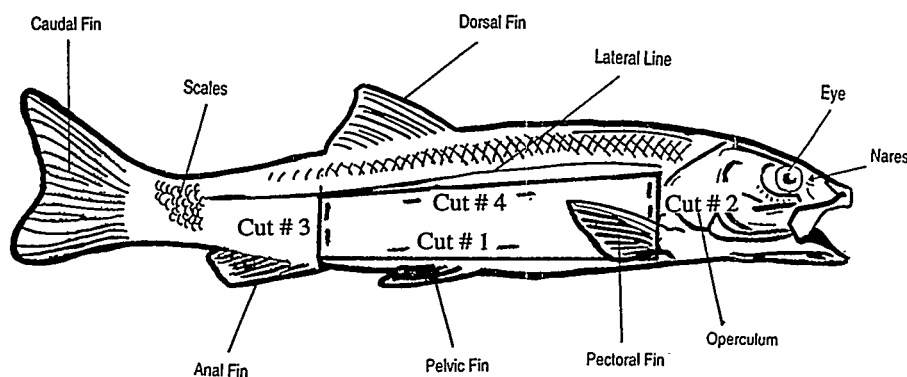
BACKGROUND INFORMATION:

Internal Structures-Function(s):

1. **Brain** - control center for the vertebrate body.
2. **Gills** - as the mouth and throat force water over the gills, dissolved oxygen from the water diffuses through the thin walls of the blood vessels in the gills.
3. **Heart** - two-chambered heart which pumps blood through a series of vessels to all parts of the body.
4. **Stomach** - where mechanical and chemical digestion take place.
5. **Backbone** - provides structure.
6. **Intestine** - connects the stomach with the anal opening and absorbs nutrients.
7. **Swim Bladder** - gas-filled organ that acts as a float.
8. **Muscle** - organ made of the tissue that can contract.
9. **Ovary or Testis** - reproductive organ. The ovary produces the eggs and the testis produces milt (contains sperm).
10. **Liver** - a large gland which acts in the formation of blood and metabolism of various body chemicals.
11. **Gallbladder** - a small pearshaped muscular organ in which bile secreted by the liver is stored.

PROCEDURE:

1. In this activity, students will observe the major internal structures of the fish. Instructors will demonstrate how to dissect a bony fish.
2. Insert the dissecting scissors at the base of the operculum (gill cover) at the very bottom of the fish. Cut along the base line to the anal opening (cut #1). **See diagram.**
3. Return to the original starting point at the operculum. Cut upward to the midline of the body (cut #2). Use your scissors to cut from the anal opening to the midline of the body (cut #3). This should create a flap of muscular tissue which can be removed by using a scalpel to cut the attached edge along the top edge of the body cavity (cut #4).



4. Instructors should locate the following internal organs: heart, gills, backbone, stomach, intestine, swim bladder, muscle, ovary or testis. Ovaries may be yellowish in color and contain many eggs. The testis are somewhat smaller than the ovary and creamy white. The air bladder lies along the top of the body cavity. It may have been broken in removing the body wall, and you will only be able to observe the space it occupied. The stomach of the Bigmouth Minnow may contain small fish (smolt) that they have eaten.
5. Students should label the internal structures on their Bigmouth Minnow diagram on Student Activity Sheet 8-2.
6. If time permits, the instructor can locate the brain.
7. Students/instructors should wash their hands in soapy water and rinse with lemon juice to eliminate the fishy odor after clean-up.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. Why is it important for a fish to have a swim bladder?
2. List five internal structures and their functions?

ACTIVITY 8-3: MOUNT ST. HELENS ASH

SCIENCE CONCEPTS/PROCESSES: Observe

SKILLS: Microscope Technique, Drawing

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ prepare a wet mount slide.
- ◆ understand the dangers of inhaling volcanic ash after a volcanic eruption.

MATERIALS:

12 microscopes
Mount St. Helens ash
12-8 oz plastic cups

slides/coverslips
polarizing film
12 medicine droppers

BACKGROUND INFORMATION:

MOUNT ST. HELENS ASH

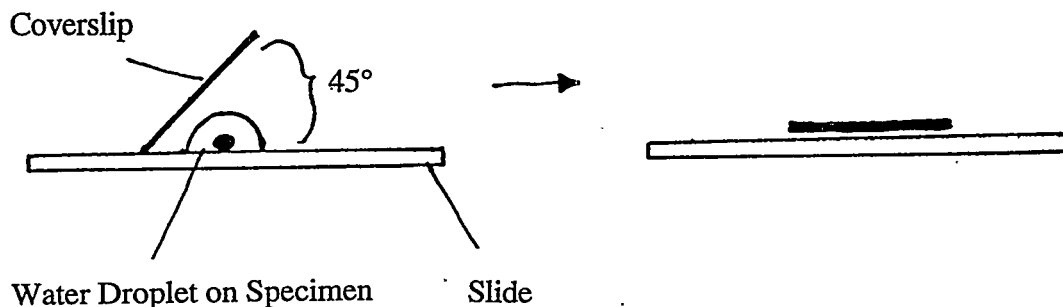
Volcanic ash is made up of fine-grained pyroclastic particles which are less than 2 millimeters in diameter. These fine particles of pulverized rock may be either solid or molten when blasted by an erupted volcano. By far the most common variety of ash is vitric ash which is composed of glassy particles. The temperature and force of the Mt. St. Helen's eruption produced this type of glassy ash particles.

A polarizing microscope allows you to see the different kinds of materials which make up the ash by allowing light in just one plane to pass through the eyepiece. Turning the polarizing filter changes the plane of light reaching your eye.

Mount St. Helens produced an ashfall which circled the globe. Volcanic ash that has fallen through the air from an eruption cloud forms well sorted and layered deposits (heavier/larger particles followed by lighter/smaller particles).

WET MOUNT SLIDE

To prepare a wet mount slide, place the specimen to be examined on a clean slide. If the material is dry, place it directly on the slide and add a drop of water. Then cover the specimen with a coverslip. To avoid trapping air under the coverslip, hold the coverslip at a 45° angle to the slide, and move the coverslip across the slide until it touches the water. Immediately lower the coverslip until it's parallel to the slide surface. Remove trapped air bubbles by gently tapping with a pencil.



PROCEDURE:

1. In this activity, students will prepare a wet mount slide of Mount St. Helens ash. By placing the slide between the polarizing film squares on the eyepiece and stage of a compound microscope, students will be able to see the particles of ash in a variety of colors.
2. Students should work in groups of three. Each student should make a wet mount slide of Mount St. Helens ash. Using low or medium power, students should first bring the ash particles into focus. Then by carefully turning the eyepiece, students should be able to observe the ash particles changing colors.
3. Students should draw what they see in the microscope on Student Activity Sheet 8-3.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. What is the ash made of?
2. What shapes were most of the ash particles in?
3. Why did the ash particles change colors as you turned the eyepiece?
4. What would happen to your lungs if you inhaled a lot of ash particles?

ACTIVITY 8-4: RACE TO THE REDD GAME

SKILLS: Counting, Reading, Discussion, Cooperation

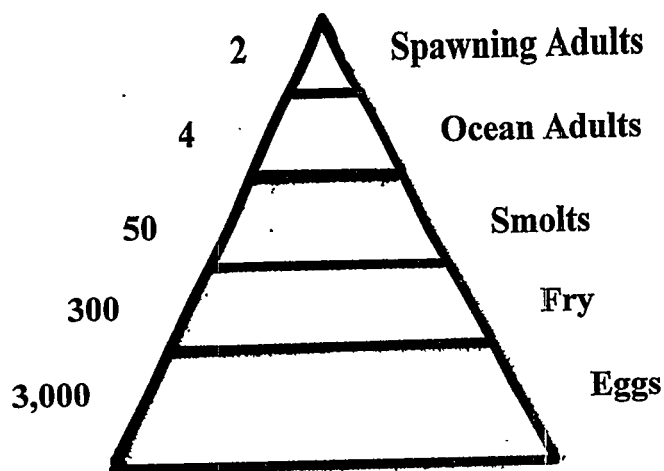
OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ review the many dangers salmon can face throughout their life cycle.

MATERIALS:
9 Race to the Redd game boards
9 bags of marker pieces/die

BACKGROUND INFORMATION:

Salmon - Survival Statistics



PROCEDURE:

1. Review salmon life cycle before beginning the activity..
2. In this activity, students will play the game Race to the Redd (From Washington State Department of Environmental Education Curriculum Guide "Clean Water, Streams, and Fish."). While playing this game, students will review the many dangers salmon can face throughout their life cycle.
3. Students should play the game in groups of four.

CONCLUSION:

Instructors should bring closure to this activity by making a class list of the possible causes of death for salmon at each stage of their life. Examples of natural causes are: landslides, floods, predators, etc. Examples of human caused problems are: pollution, dams, road building, etc. Instructors should also discuss the survival statistics. Did everyone make it to the redd?

Journey of the *Oncorhynchus*

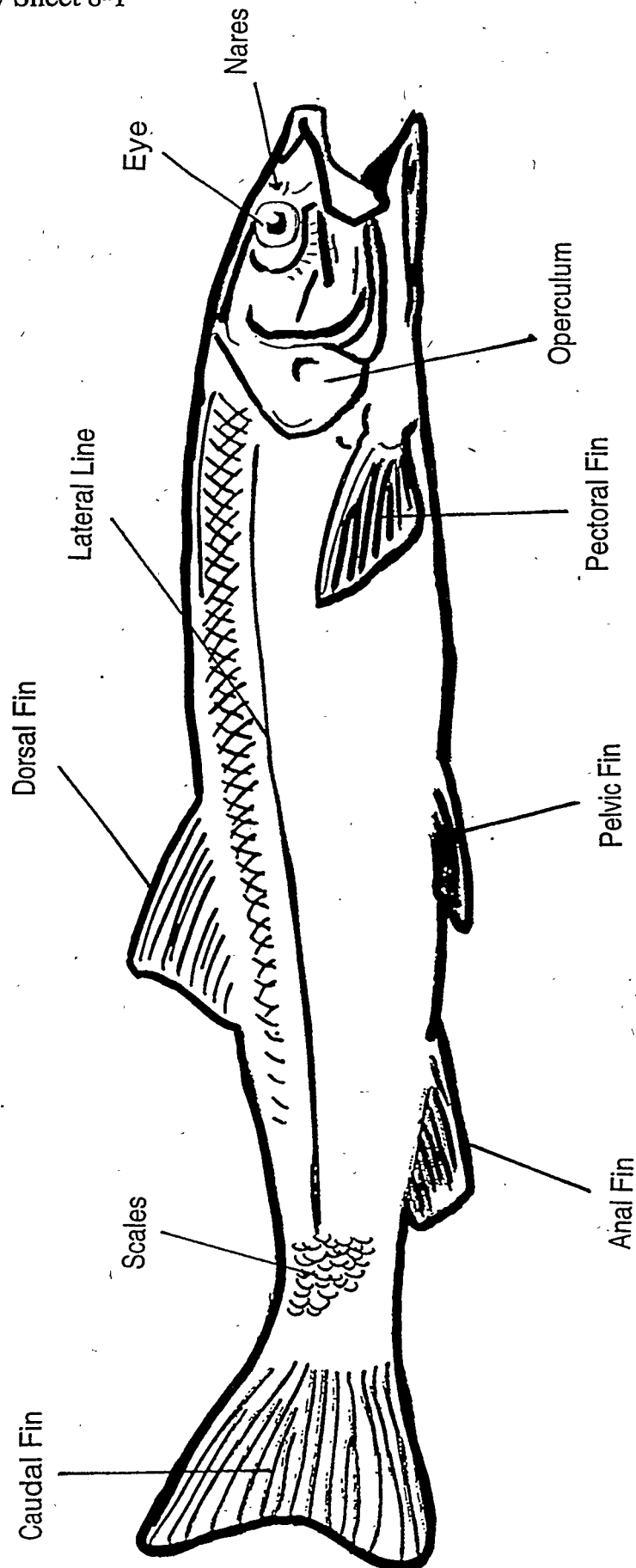
A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY EIGHT

The story of the Toutle River salmon is very different from the Willamette, Clackamas or Hood River stories. But the chinook that swam up the Toutle 14 years ago did not live to tell the tale. It happened on a nice day in May 1980. Scientists were keeping a close watch on the mountain they call St. Helens. The Indian Nations have long known this mountain. They called it Loo-Wit, the keeper of the fire. The mountain had been quiet for many years, but in early March it began to awaken. Lava began to push on the north side of the mountain. Earthquakes rumbled through the area. Small eruptions came from the mountain's peak. But what was about to happen would change the lives of the salmon and many other animals for a long time. On May 18, at 8:32 a.m., the mountain blew its top. Hot ash covered the Northwest from Washington to Montana. Hot mud flowed down the sides of the mountain. The blast blew down all the trees in its path. The hot mud washed the trees into the Toutle River. It boiled and buried everything in its path, including the river's brave salmon.

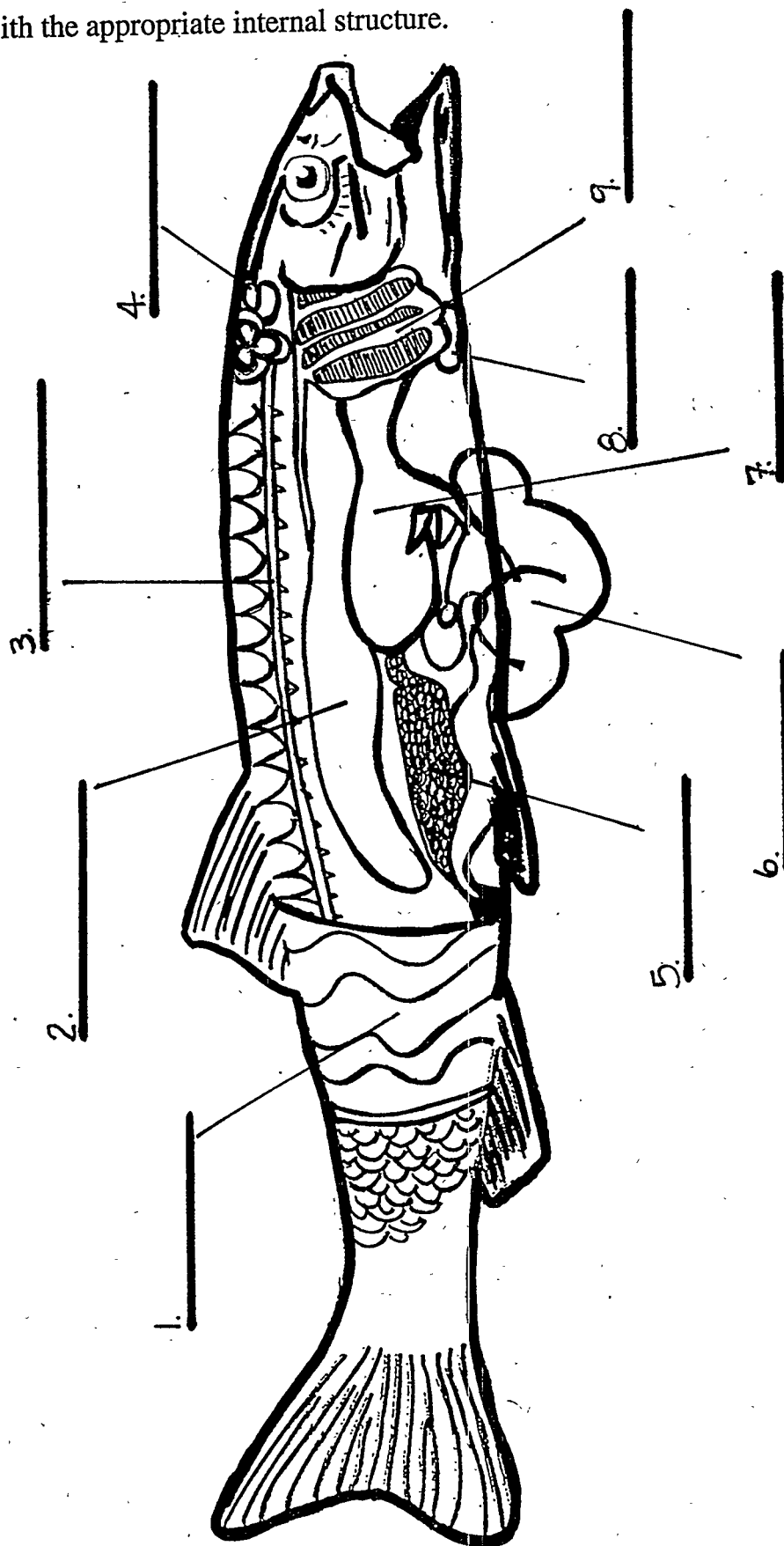
No one thought the salmon would ever return to the Toutle. But the salmon proved them wrong. Within two years, chinook found their way again to the river's mouth and began building their nests. Today the scars of the blast remain, but the Toutle's salmon have returned.



Bigmouth Minnow - External Structures



Fill in the blanks with the appropriate internal structure.

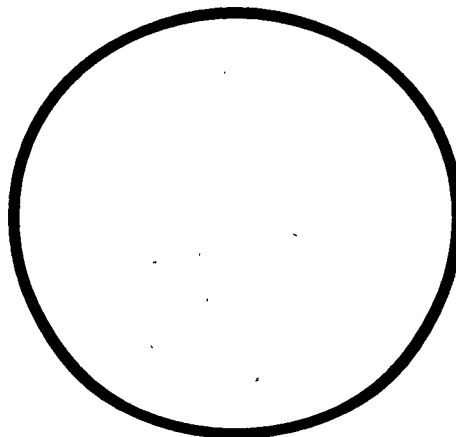


Bigmouth Minnow - Internal Structures

Student Activity Sheet 8-3

MOUNT ST. HELENS ASH

1. In groups of 3, obtain:
 - 1 cup of water
 - 1 medicine dropper
 - 3 slides
 - 3 coverslips
 - 1 microscope
 - Mount St. Helens ash
2. After your instructor demonstrates how to make a wet mount slide, each student in the group should prepare a wet mount slide of Mount St. Helens ash.
3. Focus on the ash particles using **low** or **medium** power.
4. Draw what you see in the microscope.



5. Describe the most common shape of the ash particles?
6. What do you think the ash is made of?
7. What would happen to your lungs if you inhaled a lot of ash particles?

Introduction to Legends of Native Indians Concerning the Columbia River and the Salmon

For centuries, Indian tribes from northeastern Washington to central Oregon have related traditions and stories of magical delight which teach us lessons of human understanding and empathy for the animals, nature, and the Earth. In many instances, there are several versions of the same basic story. Following are just a few of the many legends. Indian tribes relate a story of a rock bridge that at one time spanned the Columbia River. There are also stories of how salmon came to be in the Columbia River and how the Great Stone Bridge was destroyed, among others. In all instances, there is the underlying teaching which acts as a springboard to provoke curiosity, discovery, and respect of the animals and the environment.

An Indian Legend

Loo-Wit, the Fire-Keeper and the Making of Mt. St. Helens

Many, many years ago, when the Earth was young, the Great Spirit Creator made sure that everyone on Earth had all they needed to be happy. It was a time when all the trees, animals and birds were able to talk, just like the people.

There was plenty of food and plenty of land for all the people. But although everyone should have been happy, two brothers began to argue. Instead of working together, each wanted to control the land. As the Creator watched, it made him sad. Soon the brothers would make war.

So, one night as the brothers slept, the Great Spirit carried them away to a new country. As the sun began to rise, the Creator gently awakened the brothers. They were amazed at what they saw. There was a beautiful river (the Columbia) and tall mountains which reached into the clouds. It made their hearts warm and good. Lying next to each brother was a bow and a single arrow.

"You must each take the bow and arrow I have given you and follow my instructions," the Creator said. "Aim your bow high into the air. Shoot your arrow in opposite directions; the land for you and your people will be where your arrow falls. You will each be a great chief in the land I have given you, and you must live in peace. The river shall divide you."

The brothers obeyed. As the older brother pulled back the string of his bow and aimed his arrow, he arched it high over the river. His arrow landed to the south of the Willamette River. He gathered his people and traveled to this new land. He and his people would later be known as the Multnomahs.

As the younger brother took aim, his arrow went north of the great river. He and his people became the Klickitats.

Although the two peoples were separated by distance, there was a Great Stone Bridge which connected them and lay across the great river between them.

This Great Stone Bridge would remain there as a sign of peace between the Klickitats and the Multnomahs. "This bridge," said the Creator, "is a sign of peace. It will remain as long as your hearts are good. It will be here so you can visit each other. But if you ever again fight, the bridge will fall, and you will be separated from each other and forced to stay on your side of the river."

For many years and many seasons, the Klickitats and the Multnomahs remained at peace. But slowly the people began to look with greed at the other's land. "The land to the south

is better than ours," said the Klickitats. And the Multnomahs said, "The land to the north is more beautiful than what we have." Once again the two peoples began to quarrel.

When the Creator saw this, he was again sad. He wanted all people everywhere to live together in peace. It made his heart sad to see quarreling and fighting. He did not want to destroy the Great Bridge. So the Creator darkened the skies and took fire away from the people. Now fire was very important. It gave them warmth when the rain and the cold weather came. And they used the fire to cook with. But now there was no more fire. And the people suffered.

"Please give us back the fire," the people begged. "We will live in peace." The prayers of all the people touched the Creator. There was only one place on Earth where fire remained. And that was at the lodge of Loo-Wit. She was not greedy and had stayed out of all the quarreling, so fire had continued to burn in her lodge. But although her heart was good and beautiful, she was an old, old woman. The Creator said to Loo-Wit, "I have heard the prayers of the people. Will you share your fire with the people? In return, I will give you whatever you wish."

Loo-Wit thought for only a minute, and then replied, "I want to be young and beautiful."

"And so it shall be," said the Creator. "Take your fire to the Great Stone Bridge which is over the river. You must keep the fire burning, and let all people come to you to get fire for their lodges. You must remain at the Great Stone Bridge to remind the people that their hearts must stay good."

And Loo-Wit followed the instructions of the Creator. She took her place at the Great Stone Bridge. The prayers of the people were answered. When the people came to the Great Stone Bridge to get fire, they saw before them a beautiful young maiden - not an ugly, toothless, old woman. The peoples' hearts were once again good, and they were at peace. Loo-Wit radiated like the sunshine. And the people were in awe of her beauty.

One day the chief of the people from the north and the chief from the people of the south came to the Great Stone Bridge. And when they saw the beauty of Loo-Wit, they both loved her. And they began to quarrel over who would marry Loo-Wit. When the Great Spirit saw the two chiefs arguing, he became angry. He had had enough of this fighting. He changed the chiefs into two great snow mountains. The chief of the Klickitats in the north became Pa-toe (Mt. Adams). The chief from the peoples in the south, the Multnomahs, became Yi-East (Mt. Hood).

But the two great mountains still remembered their old quarrel and continued to keep alive their old rivalries. And on occasion, when the Great Spirit was called to another part of the World, the mountains would take up their quarrels. This time, as mountains, they would stomp the ground and shake the Earth. Sometimes they would throw great white-hot stones at each other, setting fire to forests and killing off the animals. The

people living around the Pa-toe (Mt. Adams) and Yi-East (Mt. Hood) would have to hide or flee out of the country to avoid being destroyed from the anger of the mountains.

During one of the wars between Pa-toe and Yi-East, as they were spewing rocks and liquid fire, Loo-Wit did her best to save the Great Stone Bridge from destruction. She stayed by her post, but she was badly burned and battered by the large hot rocks. And when the Great Stone Bridge broke apart and fell into the river below, she too fell.

Loo-Wit was heartbroken that her beauty had caused such pain and destruction. When the Great Spirit returned from his journey, it was too late to prevent the terrible crash of the Great Stone Bridge. He heard the moan of Loo-Wit where she had fallen. When he learned how brave she had been and how she had remained at her post, he said he would reward her for her trustworthiness. Loo-Wit no longer wanted to be a beautiful young woman. So the Great Spirit took pity on her and changed her into a beautiful young mountain, which we know today as Mt. St. Helens. Because of her faithfulness, Loo-Wit was allowed to keep the fire within herself which she had once shared on the Great Stone Bridge.

For many years she slept peacefully, withdrawn from the main mountain range. And we are told that we humans should treat the land with respect. If we don't, some day Loo-Wit will wake up and let us know how sad the Creator is with our behavior. So it was said, long before 1980 when Loo-Wit awoke and we had the Mt. St. Helen's eruption.

Adapted from Keepers of the Earth, Indian Legends of the Pacific Northwest, and Legends of the Klickitats

An Indian Legend

Koyoda and How He Brought Salmon to the Columbia River

Many years ago, before the Great Stone Bridge was destroyed, Koyoda, half-god and half-man, served the Creator by helping the people of the Earth. He gave the people mouths and taught them to eat. He also taught the people how to grow and prepare maize (corn) and other foods so they would have plenty to eat during the cold winter months. And he also gave the Law to the people so they would know how to be good and to live in peace with each other.

At a time when the two great snow mountains, Pa-toe (Mt. Adams) and Yi-East (Mt. Hood) were carrying out one of their terrible battles, they destroyed the great in-land sea. This happened when Loo-wit was still guarding the Great Stone Bridge. During this particular fierce quarrel between the mountains, the animals had been killed or fled in terror. The forests around the mountains were burned. The berries and the maize which would have served for the Indian's winter food supply was buried beneath the ash. Thoughts turned towards Koyoda, and the people sought him out. Since Koyoda had given the people mouths and taught them how to eat, surely, he would help them as they faced starvation. Messengers were sent to find Koyoda, but he had already heard of their hardship and was on his way to help.

Koyoda listened quietly as the leaders complained of their situation and blamed Koyoda for their situation. Why had he given them mouths to eat with? At first Koyoda was angry, for eating should be a blessing and they were cursing the person who had given the blessing. But it wasn't long before the leaders saw their error, and they asked Koyoda to forgive them for complaining and to help them. He told them, "Give me one of your best war-canoes and six of your best young men. There is no food here. The animals are gone and the maize and berries are buried under the ash. We must follow the river down to the old sea until your fish can be found. Then we will drive at least part of them back up the river."

The people quickly found the best of the remaining canoes and named six braves to join Koyoda on this journey down the great river Columbia. Taking a few small food supplies which was willingly shared by the villagers, Koyoda and the six braves started on their quest. This was the first time anyone had gone down this great river. No one had any idea where it would lead after they passed under the Great Stone Bridge. Would they be sucked down to the center of the Earth? What awaited them once they entered the great dark hole under the mountains?

Although each man was terrified, they determined to make the journey with Koyoda. At first the river flowed swiftly and smooth. There were no sharp turns or rocks to create dangerous swirls in the river. Nothing seemed to disturb their progress.

As they reached the great tunnel under the bridge, darkness came upon them and they were frightened. The darkness seemed to surround them as they rounded that first bend. The noise of the rushing water was deafening. Suddenly the canoe rammed head on into a stone wall or an island in the middle of their path. As the canoe jerked violently, cold water splashed over the sides of the canoe and everyone was thrown overboard. The swirling water rushed over them. Gulping for their every breath, all except one managed to pull themselves to safety. The canoe was also saved, but the paddles and what little supplies they had taken from the village were lost.

Before leaving on this journey, Koyoda had carefully wrapped his fire flint and some cedar bark in buckskin and tied it in his hair. Carefully removing it, he was able to use it to start a small fire. The men found driftwood all around them, and before long a good fire was burning. As they warmed themselves, the braves mourned for their lost companion.

They knew they could not remain on the banks of the river for long, for the people back home would soon be starving. After finding pieces of driftwood which could be used for make-shift paddles, they climbed into the canoe and started on their way. Koyoda noticed a hole in the hull which had been made when the canoe first hit the obstruction in the river. But the hole was high enough, so that even with everyone in the canoe, their combined weight did not push the hole below the water level and they could stay afloat.

Because of the darkness, the party of braves and Koyoda decided to leave their fire burning on the banks so the light from the fire could help to guide their way. Suddenly in the dim of the light they saw a moving figure and realized it was their lost companion. He was clinging to a piece of driftwood alongside a rock wall at the edge of the river. A shout of joy filled the air as the braves paddled to rescue their brother. But as they pulled him to safety, their canoe settled deeper into the water, so that the water poured through the hole in the hull. They had no supplies and nothing to bail out the in-rushing water. Their canoe soon began to sink. Suddenly and unexpectedly, Koyoda jumped into the river. As half-god and half-man, Koyoda could take different forms and he became a great beaver. As a beaver, he took the canoe in tow, and gently guided them down the river. Before long, they passed through the darkness and entered into bright sunlight and more quiet waters.

But as their eyes became accustomed to the light, they were shocked at what lay before them. Everywhere the land was devastated. It was worse than their own land. In addition to the destruction caused by the fire, ash and lava, the waters of the great in-land sea had hurled through the mountains and destroyed everything before it. In all directions, everything was flooded. Silence overcame the group as they looked in horror at the site before them. Koyoda, in the form of a beaver, was still guiding their direction, and after spotting a small island pushed them to shore. Thoughts of food soon broke the silent trance and as they reached shore the braves gathered wood as Koyoda changed back into a man and caught a few nice fish which had not been lost to the great destruction on this side of the bridge.

After regaining their strength from the hearty meal, they found a balsam tree and gathered some pitch to repair the hole in their canoe. Soon they were on their way and Koyoda felt certain they had found the lost fish. But he had no idea how to get them back through the mountain.

Just as dusk began overshadowing the day, the party sighted another small island. A small stream of smoke was rising upwards to the clouds, and they were certain they would find another camp. But it was too late to investigate that night, so they wrapped themselves in their blankets and lay down in the bottom of the canoe to sleep.

But while they slept, the waters continued to flow and pushed them past the channel of the Willamette. They continued to drift. Suddenly, as they awakened from their night's sleep, there was a deafening roar from the waters as they tumbled through the channel between the hills. Caught in the pull of the current, the braves could do nothing but try to keep their canoe upright. But it was to no avail. The canoe overturned and all were once again thrown into the swirling rumbling waters. This time, there was no island, for they were on the bar at the mouth of the great river and entering the ocean. Instantly, Koyoda changed himself into a beaver and gathered his companions. They rode on his back to the safety of a sandy beach. The beach extended as far as the eye could see. In one direction was the great river they had just traveled down in search of the lost fish. It carried the waters from their own sea. In the other direction, they saw a number of faint smoke columns spiraling to the clouds. Surely this meant a large village, and perhaps this village had plenty of food.

During their last overturn, the canoe was damaged beyond repair, so they decided to walk to the village. They had never before seen the roar of ocean waves as they rolled upon the beach. After a short time, they wondered if they had angered the God of this great water, because the waves began to roll in from the sea and seemingly drive them further towards the bank. Before long, they found themselves climbing the rocky cliffs to avoid being showered with the spray of salty waves. The young men cried out to Koyoda, and he succeeded in casting a spell on the waves, and they once again began to recede back into the ocean.

As they walked along the moist sand, they noticed dead fish all around them. These were the fish from their own homeland. They also found parts of canoes, pieces of wigwams and other relics from their own homes which had been carried away by the great river.

Upon reaching the village, they were ushered into the presence of the chief, who ended up being an acquaintance of Koyoda. Koyoda had once saved his life from an enormous bear. After embracing, the chieftain ordered a feast of salmon and venison. Koyoda and the chieftain talked late into the night, and Koyoda told him how they had journeyed down the river to find the lost fish.

At early dawn, Koyoda rose to greet the light of a new day. His friend led the party to the seashore and pointed toward the horizon. Everywhere there were dead fish. "There are your fish," said the chieftain. "See the seagulls? They are feasting upon their dead carcasses. Your fish were carried down to here by the great flood. They could not live in our salty water. I have an idea. Take some of our great white birds, the Klickitats, and with them, drive the salmon back up the new river over which you came. The salmon can live in fresh water, for that is where they are born."

Koyoda thought this was an excellent plan. The next morning, he called together his party to start the journey back to their village. He called the great white birds and the dogs of the sea and asked for their help. They were delighted with his offer and a new adventure. They gathered a great host of salmon and began to drive them into the river. Koyoda and his companions followed behind the seagulls and the sea dogs in a new canoe, given to him by the chieftain of the ocean village. All along the journey, you could hear the cry of the gulls as they called out, "Klick-tat, klick-tat."

As the party reached the country beyond the Great Stone Bridge, some of the gulls liked it so well, they begged Koyoda to let them stay there always. So Koyoda, with his enchanted power, changed them into Indians and they settled at the base of Pa-toe, whose name was then changed to Klick-tat, in honor of the gulls. This is why the Klickitat Indians claim to be brother to the gulls. Each year, the seagulls, brothers from the sea, follow the salmon to Klickitat country and visit their distant family members.

When Koyoda's party reached the village, the salmon had already found their way through the mountains. All the people were well-fed and were preparing salmon for the winter food supply. The Great Spirit instructed Koyoda and his friends the gulls and the sea-dogs, to drive the salmon up the river twice each year for six years. Afterwards, the salmon would learn the way themselves and return of their own accord.

And that is how the salmon were brought to the Columbia River. Thereafter, the people along the great river always had plenty of salmon to eat. The mountains were at peace, and Loo-wit guarded the Great Stone Bridge.

Adapted from Legends of the Klickitats

An Indian Legend

Salmon Boy

Many years ago there was a young Indian boy among the Haida people who had no respect for the salmon he ate. From the time he was very little, he was taught that after eating his fill, whatever was left over of the salmon, including all the remaining bones should be returned to the river. The salmon who swam upstream had offered their bodies for food. By returning the bones to the water, the circle of giving and receiving would continue. The salmon meant life to the people. The people showed respect for the salmon through prayer and reverence and by doing this act of obedience. Then the circle would not be broken.

But the boy didn't care. He would carelessly step on the bodies of the salmon that were caught by the stream, and after eating his fill, he wouldn't think twice about throwing the bones onto the ground and into the surrounding shrubs. Many times his parents and the villagers told him the spirits of the salmon were not pleased. He must not break the circle of taking from the river and giving back a gift in return. But the young boy did not listen, nor did he care. This made the spirits of the salmon very sad.

One day, when his mother had prepared a hearty meal of salmon, the boy shoved it away in disgust. He threw it on the ground, even though the meat was good. Then he went down to the river to play with the other village children. But as he stepped into the river, the current swept him off his feet and he felt the rapids pushing him into a deep hole. He could not swim, nor could he escape. He sank down to the bottom and drowned.

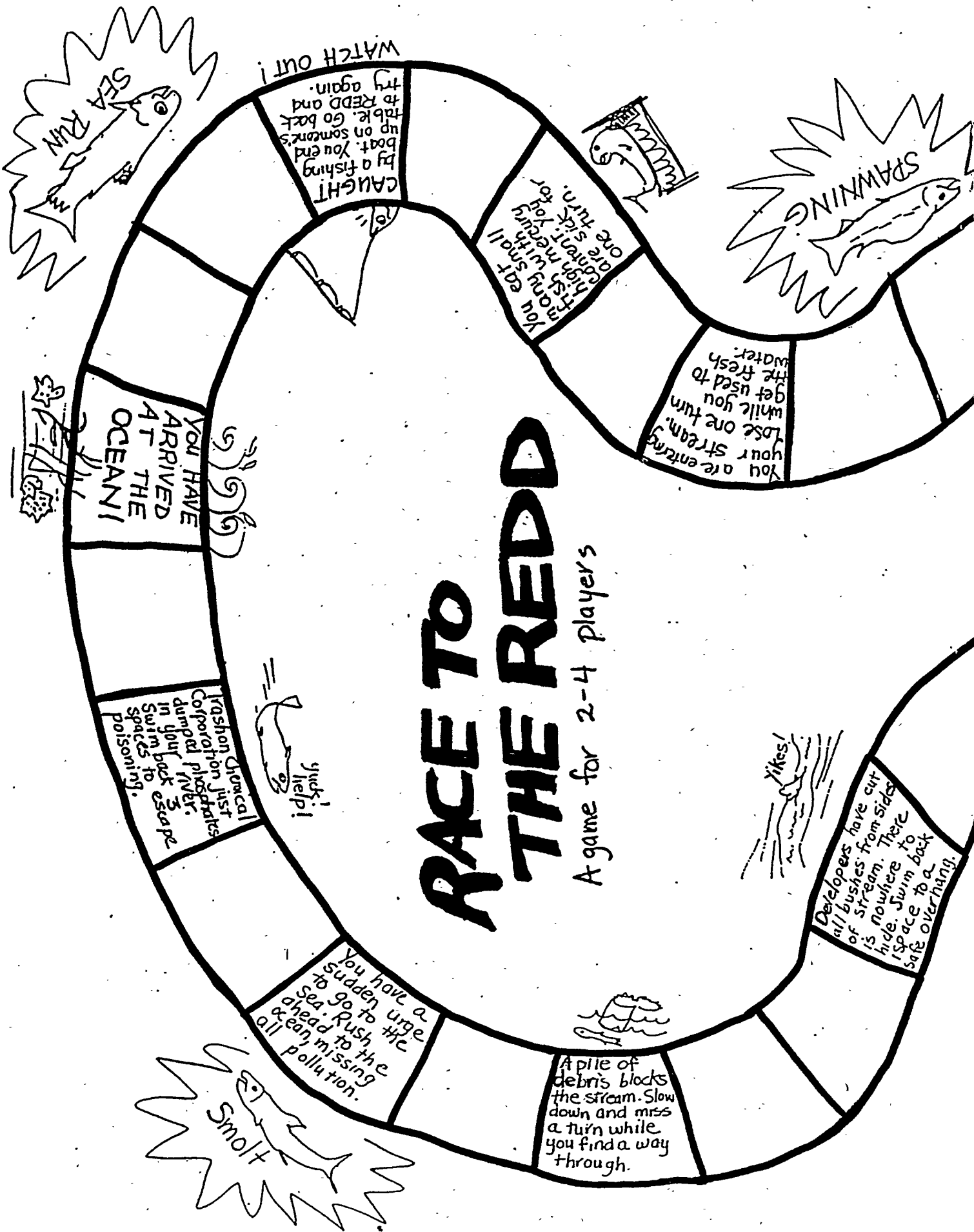
As he sank to the bottom, the spirits of the salmon, the Salmon People, moved to his side. They had left their bodies for the animals and the people to eat, and their spirits were returning to the ocean. They were not angry with the boy for how he had treated their bodies, but they moved to his side. They would take him to the ocean, so he could more fully understand who they were and how to care and respect them. The spirit of the child went with the Salmon People, for he now belonged to the salmon.

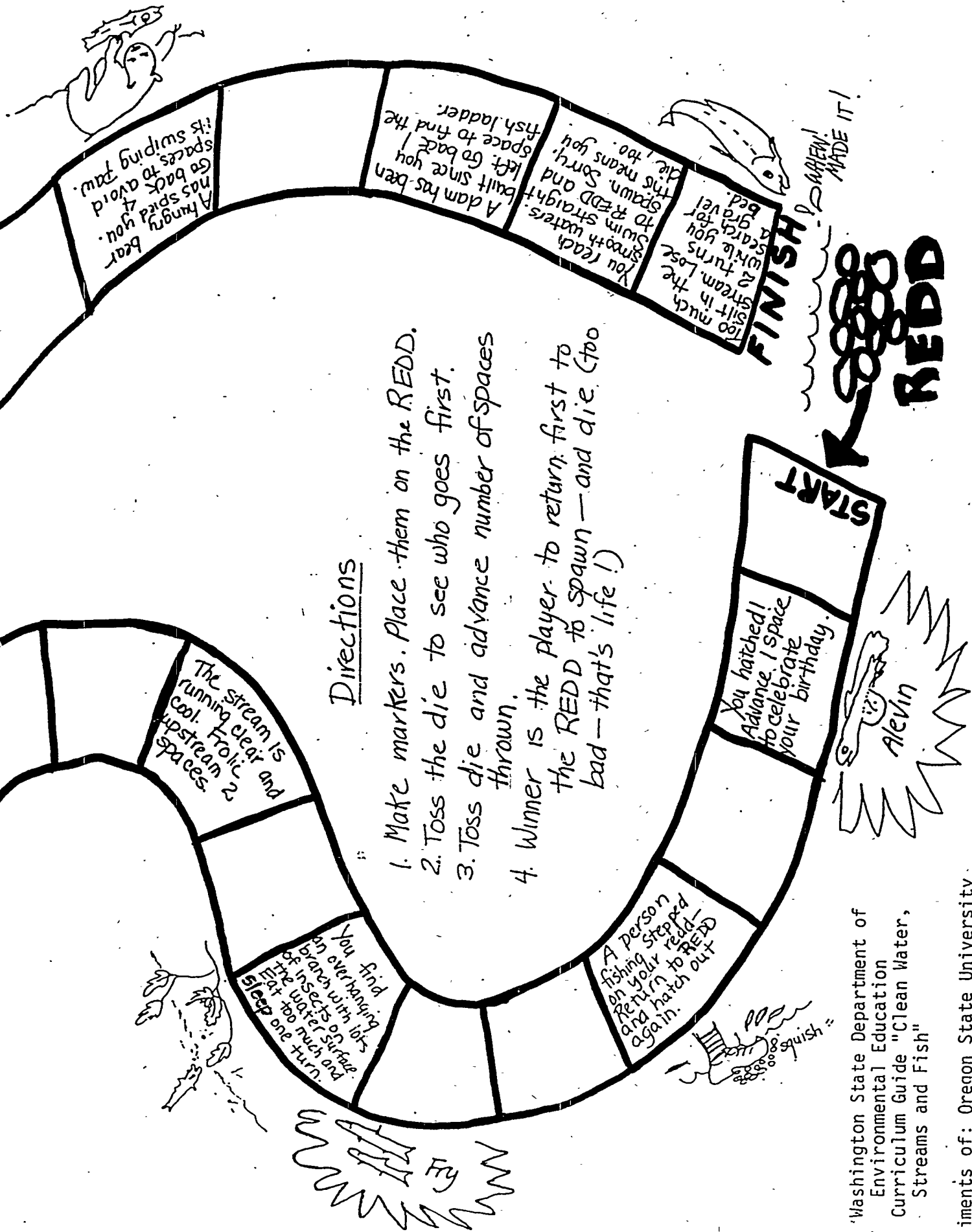
When the Salmon People reached their home in the ocean, they appeared like humans. Their village reminded the young Indian boy of his own village. There were children playing and laughing next to a stream which flowed behind the village.

The young boy began to learn many things from the Salmon People, and he was ready to listen. When he was hungry, the Salmon People told him to go to the stream and catch one of their children. You see, the children were actually salmon who were swimming in the stream. But he was also cautioned that once he had finished his meal, he must return the bones and everything he did not eat to the river again. The Salmon People told him, if he obeyed, then their child would come back to life again.

RACE TO THE REDD

A game for 2-4 players





Directions

1. Make markers. Place them on the REDD.
2. Toss the die to see who goes first.
3. Toss die and advance number of spaces thrown.
4. Winner is the player to return first to the REDD to spawn—and die (too bad—that's life!)

from: Washington State Department of
Environmental Education
Curriculum Guide "Clean Water,
Streams and Fish"

compliments of: Oregon State University
Extension Sea Grant Program

Day 9**OUTLINE****TIME****ACTIVITIES****MATERIALS**

(Based on class of 40)

9:00 a.m.

Breakfast/Estimation Game

9:15

Journey of the *Oncorhynchus*:
A Story of the Pacific Northwest Salmon

Mural-add Section 9

9:30

(9-1) Dancing Rice
(Static Electricity)1 medium bag of Puffed Rice
40 large balloons
1 roll of kite string
20-9 inch paper plates
1 container of iodized salt
1 large container of black pepper
(fine ground)
12 pieces of wool cloth

10:00

(9-2) Magnetic Fields
(Magnets)40 dowels (~20 cm in length)
115 ring magnets (~2.5 cm dia.)
20 bar magnets
4 boxes medium paper clips

10:30

Break

10:45

(9-3) Electricity & You
(Electricity)40 Pathway Sheets
40 miniature light bulbs
40 miniature sockets
36 m insulated wire (22 gauge)
sandpaper
wire cutters
2 rolls clear tape
40 house patterns
2.5 lb. modeling clay
80 notched craft sticks
80 craft sticks
40 "D" cell batteries
6 hole punches
200 medium rubber bands
1 box medium paper clips
2 rolls of electrical tape

12:00

Lunch

Autograph signing

1:00

Journey of the *Oncorhynchus*:
A Story of the Pacific Northwest Salmon

Mural-add Section 10

1:15	(9-4) Electrifying Fish Facts (Circuits)	1-200 sq. ft of aluminum foil 40 manila file folders (letter size) 40 green fish facts sheets 40 blue fish facts sheets 40 rolls of clear tape 40 scissors 40 "D" cell batteries 24 m insulated wire (22 gauge) wire cutters 40 miniature light bulbs* 40 miniature sockets* sand paper 8 single hole punches 40 glue sticks
2:30	Salmon Survey Awards Presentation	40 surveys Certificates
2:50	Hydromania Fair Set-up	
3:00	Hydromania Fair Stations:	Cookies/Juice
	1. Mount St. Helens Ash	Microscope polarizing film slide/cover slip Mount St. Helens ash
	2. Electrifying Fish Facts	student samples
	3. Salmon Life Cycle Hexaflexagons	50 Pacific Salmon Life Cycle Hexaflexagons
	4. SALMO Bingo	Prizes - pencils, balloons, etc. SALMO bingo cards/poker chips
	5. Bigmouth Minnow Dissection Microscope with Fish Scale	student sample Microscope slide/cover slip 1 dissection pan 4 dissection probes 1 Bigmouth minnow
	6. Race for the Redd	Game Boards Game Pieces/die
	7. Hydromania Curriculum Display	Mural Story Book Student Workbook Curriculum Copy
4:00 p.m.	Camp Ends for Students	

DAY 9

TEACHER NOTES

Estimation Game: Estimate the number of major dams on the Columbia River. There are 59 major dams on the Columbia River: 31 Federal, 23 Non-Federal, and 5 Canadian. (The winners will be announced during the break.)

Story Time: Journey of the *Oncorhynchus*: A Story of the Pacific Northwest Salmon- Chapter Nine. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up either the Journey of the *Oncorhynchus* mural by adding **section nine** or the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section nine. The first student to find the hidden salmon will be awarded a prize.

ACTIVITY 9-1: DANCING RICE

SCIENCE CONCEPTS/PROCESSES: Cause and Effect, Force, Observe, Define Operationally

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ understand static electricity in terms of positive and negative charges.
- ◆ give two examples of static electricity.

MATERIALS:

1 Bag of Puffed Rice

1 roll of kite string

40 medium paper plates

20 pieces of wool cloth

40 large balloons

1 container of ionized salt

1 large container of black pepper

BACKGROUND INFORMATION:

Why is there a shock when you walk over certain carpets? Why does your comb stick to your hair on a dry winter's day? Why does your socks stick together in the dryer? To understand the answer to these questions, you need to know a little about static electricity.

Static electricity takes its name from the Latin word *electrum*, which means amber. Amber is a hard yellow rock that is the fossil remains of tree sap. The Greek philosopher Thales (600 BC) discovered that when amber was rubbed with cloth, it attracted bits of straw or hair. Approximately 2,500 years later, with the discovery and understanding of atoms, scientists were able to explain what produced static electricity. It wasn't the yellow rock but electrons that were responsible for static electricity.

All matter is made up of tiny particles called atoms. Atoms are made up of protons, neutrons, and electrons. Protons and neutrons are located in the center of the atom in the nucleus. Electrons make up the outer part of the atom in a fast moving cloud. Protons have a positive charge, electrons have a negative charge, and neutrons are neutral or have no charge. Generally, an object has an equal numbers of electrons and protons so their charges cancel each other out.

To build an electrical charge, and objects must have electrons removed or added to it. Sometimes when certain objects are rubbed together, friction will rub electrons off one object onto another. The object that has gained electrons has an electric charge that is negative (gained electrons). The object that has lost electrons has an electric charge that is positive (loss electrons). Coulomb's law (pron: koo'lum's) states that charges that are the same repel, opposite charges attract.

Rubbing two objects together sometimes causes static electricity. (It is important to note that all static electricity experiments work best on dry days.) It is static because the electricity doesn't flow (static means standing still). An object that has lost electrons must try and pick some up to be balanced again. The shock you may get from static electricity happens when the object that had most electrons gains them back. The charge jumping from one object to another causes the shock. Sometimes you may even see a spark when this happens. When you rub the balloon on different objects around the room, you find that only certain materials are good at giving up electrons. In general, wool carpets along with your dog or cat etc., give up electrons easily. Cotton and most synthetic materials do not give electrons as easily. Things like rubber and amber actually work to take spare electrons in.

PROCEDURE:

1. In this activity, students will explore static electricity using a wool cloth, a balloon, and puffed rice.
2. Each student should obtain a balloon, a piece of string, a piece of wool cloth, a paper plate, and some puffed rice pieces.
3. After inflating the balloon, tie a piece of string onto the balloon. Students should rub the balloon with the wool cloth. This procedure will add electrons (negative charges) to their balloon. (Electrons may also be added by rubbing the balloon on your hair.)
4. Place the balloon near the pieces of puffed rice. The puffed rice will provide the opposite or positive charge. Since opposite charges are attracted to each other, the puffed rice will stick to the balloon.
5. Students should experiment and see what happens to the puffed rice pieces when they touch the balloon with their finger. What happens?

6. Static electricity can be used to separate different substances. Each group of two students should obtain two paper plates. One plate should contain a mixture of salt and pepper and the other is empty. Challenge the students to separate the pepper from the salt using static electricity. They may accomplish this challenge by holding a charged balloon above the mixture of salt and pepper.
7. Encourage students to experiment with static electricity using their balloons. What happens when two balloons with similar charges approach each other? Will the balloon stick to the wall? Can you make three balloons stick together?

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. What happens when two different charges approach each other?
2. What happens when two like charges approach each other?
3. Give everyday examples of static electricity.

ACTIVITY 9-2: MAGNETIC FIELDS

SCIENCE CONCEPTS/PROCESSES: Cause and Effect, Force, Observe, Define Operationally

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ describe magnetism and the behavior of magnetic poles.
- ◆ describe uses for magnets

MATERIALS:
40 dowels (~20 cm)
40 bar magnets
120 ring magnets (~2.5 cm dia.)
4 boxes of medium paper clips (100 per box)

BACKGROUND INFORMATION:

More than 2000 years ago, ancient Greeks living in a part of Turkey known as Magnesia, discovered a rock which could attract materials containing iron. Because the rock was found in Magnesia, the rock was called magnetite. The Greeks noticed an interesting thing about magnetite. If they allowed it to swing freely from a string, the same part of the rock would always face in the same direction, towards a certain northern star. This star was called the leading star or lodestar, so magnetite also became known as lodestone.

Magnetic forces, like electric forces, involve attraction and repulsion. The magnetic forces usually are strongest at the two ends or poles of a magnet. The simplest kind of magnet is a straight bar of iron. Bar magnets have a north and south pole. If magnets were allowed to swing freely from a string, each pole would point north and south, respectively. The rule for magnetic poles is: **like poles (charges) repel each other and unlike poles attract each another**. The region in which such magnetic forces can act is called a magnetic field.

PROCEDURE:

1. In this activity, students will experiment with magnets.
2. Each group of two students should obtain: 6 ring magnets, 2 dowels, 2 bar magnets, and approximately 20 paper clips.
3. Students should obtain two bar magnets of the same size and hold one in each hand. Holding the magnets with the two north poles facing each other. Slowly bring the magnets together. What do you feel in your hands? Students should record their answers/observations on Student Activity Sheet 9-2.
4. Now move the magnets apart. Hold them with the north pole of one facing the south pole of the other. Slowly bring the magnets together. What do you feel? What happens to the magnets? Record answers on Student Activity Sheet 9-2.
5. Students should explore the possibilities with the ring magnets and the dowels. Challenge the students to arrange magnets in a variety of ways and record their observations on Student Activity Sheet 9-2.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. Define magnetism.
2. Describe the properties of magnetic poles?
3. What happens when you bring like poles together? unlike poles?

ACTIVITY 9-3: ELECTRICITY AND YOU

SCIENCE CONCEPTS/PROCESSES: Fundamental Entities, Order, System, Formulate Models

OBJECTIVE(s): After completing the activity, students will be able to:

- describe the path that electricity takes from the hydroelectric dam to their home.

MATERIALS:

40 Pathway sheets	40 miniature light bulbs
40 miniature sockets	36 m <u>insulated wire</u> (22 gauge)
80 craft sticks	
wire cutters	2 rolls of clear tape
40 house patterns	2.5 lb. of modeling clay
40 notched craft sticks	40 "D" cell batteries
100 medium paper clips	2 rolls of electrical tape
200 twist ties	6 hole punches

BACKGROUND INFORMATION:

The word electricity comes from the Latin word *electrum*, which means amber. The word *electrum* comes from a Greek word that means *shining*. Electricity is the energy associated with electrons that have moved from one place to another. Electric energy is measured by the flow of electrons. The greater the number of electrons, the higher the electric current.

There is tremendous power in moving water. Since ancient times, people have used water power to turn mill wheels. By the late 1800's, most water mills had been replaced by steam engines. With the invention of the electric light bulb in 1879, water power became important once again as a means of generating electricity.

The mechanical energy (energy associated with motion) in falling or flowing water is used to generate usable electricity in a hydroelectric power plant. Hydroelectric means "using water to produce electricity." At a hydroelectric plant, dams hold back millions of tons of water. Some of the water is allowed to pass through pipes and is then channeled past turbines within the plant. The rushing water spins the blades of a turbine in an electric generator to produce electricity. The spinning turbine causes large electromagnets to turn. The spinning electromagnets generates electricity.

☒ For more information see brochure entitled "Hydro Power: How Electricity gets from the River to Your House" at the end of the Day 9 section.

PROCEDURE:

1. In this activity, students will build a transmission tower and circuit connecting the path that electricity travels from the hydroelectric dams to their homes (use the craft sticks connected with twist ties to simulate the transmission towers).
2. Each student will use insulated wire, a pathway pattern, a house pattern, a "D" cell battery, and miniature light bulb/socket to trace the electric pathway.
3. Students will start their electric lines at (1) the Hydroelectric Dam or the "D" cell battery. Students should use insulated wire to connect the dam to the (2) Transmission Tower which will carry electricity further down the line. From the Transmission Tower, electricity is carried to (3) the Substation where electricity is transferred to utility companies. The electricity travels from the substations to (4) their Home.
4. The Pathway sheet includes pictures of (1) a dam, (2) a transmission tower, (3) a substation (X's indicate where wires are to be taped), (4) your home (the "H" indicates where to place your house).
5. To construct the house, students should use the House patterns. A hole punch can be used to add windows to their home. This will allow students to see the light from the bulb.
6. Instructors should read through the brochure "Hydro Power: How Electricity gets from the River to Your House" with their students.

CONCLUSION:

Instructors should bring closure to this activity by asking the following questions:

1. How is the majority of electricity produced in the Northwest?
2. What do transmission towers do?
3. What happens at a substation?
4. How can you conserve electricity at home?
5. How does generating electricity affect salmon?

ACTIVITY 9-4: ELECTRIFYING FISH FACTS

SCIENCE CONCEPTS/PROCESSES: Interactions, Energy-Matter, Observe

OBJECTIVE(s): After completing the activity, students will be able to:

- ◆ build a circuit.
- ◆ review vocabulary introduced throughout the curriculum.

MATERIALS:

1-200 sq. ft. aluminum foil
40 green fish facts sheets
40 rolls of clear tape*
40 "D" cell batteries*
wire strippers*
40 miniature sockets*
12 single hole punches
40 rulers

40 manila file folders (letter size)
40 blue fish facts sheets
40 scissors
24 m insulated wire (22 gauge)
40 miniature light bulbs*
masking & electrical tape*
40 glue sticks
paper cutter

BACKGROUND INFORMATION:

Electric current can be defined as the flow of an electric charge from one place to another. In order for electric current to be used, energy must be able to move through a special arrangement of conductors called a circuit. All devices that use current, no matter how simple or complex, are constructed with circuits. While circuits are rarely shaped like a circle, they all provide a continuous, unbroken pathway for energy to flow. Most circuits are designed to be either series or parallel. In a series circuit, there is only a single pathway for energy to travel. If for some reason the pathway gets interrupted, the energy stops and the circuit goes dead. Parallel circuits provide for two or more alternative energy pathways. If one section of a parallel circuit gets broken, the rest of the section keeps functioning.

All circuits have at least three basic parts: Something to excite the electrons to get them moving, something to carry the energy, and something to use the energy. In our activity, a "D" cell battery will excite the electrons, aluminum foil strips will carry the energy, and a light bulb will use the energy.

PROCEDURE:

1. In this activity, students will create a quiz board using their knowledge of circuits. When completed, students will use their quiz boards to review facts about the Pacific Salmon.
2. Each student will need a file folder, a blue fish facts sheet, a green fish facts sheet, a "D" cell battery, aluminum foil, scissors, clear tape, insulated wire, and a miniature light bulb/socket.
3. Each student should glue the green fish facts sheet to the larger inside cover of the file folder. The blue fish facts sheet should be cut in pieces along the lines provided.
4. Place the file folder on the table with the fold facing you. On the front cover of the file folder, measure **2.5 centimeters** from the left-hand side of the file and draw a line from the top to the bottom. Students should arrange the numbered terms so that they are glued to the right of the line. Then use a hole punch to make a hole to the left of each term.
5. Measure **2.5 centimeters** from the right-hand side of the front cover and draw a line from the top to the bottom. The definitions of these terms should be arranged on this side of the cover and glued to the left of the line. The definitions should be mixed before arranging on the file folder. Students should use a hole punch to make a hole to the right of each definition.
6. Students should cut aluminum foil strips that are approximately 1 cm in width and a length of approximately 30 cm (teachers may want to do this step ahead of time). One strip is needed for each term. Ten strips are needed for each student.
7. On the back of the front cover, students should connect the correct term with its definition using the strips of aluminum foil. Be sure to cover each hole completely with aluminum foil. The holes should appear as aluminum spots on the front. **Make sure that the aluminum at each hole is not taped over.** Students should use the green fish facts sheet for assistance with vocabulary.
8. When the foil is in place, use electrical or masking tape to **completely** cover the foil strip. It is very important to cover all the aluminum foil with clear tape. If students have exposed foil, the circuit may be broken and the game will not work. The tape is acting as an insulating barrier between each strip of foil.
9. After all the terms are connected with foil, students can use insulated wire, a "D" cell battery, and miniature light bulb/socket to test their knowledge.
10. Students can test each other by switching games. If the answer is correct the light bulb will light up, if not, try again.

CONCLUSION:

Instructors should bring closure to this activity by reviewing the different vocabulary terms and information on the game boards.

Salmon Survey: This post-test is designed to evaluate the acquired knowledge of the students regarding the Pacific Northwest Salmon. Students should be given approximately **15 minutes** to complete the survey. Students can draw or write information on the survey sheet. It is important that each student complete the bottom portion which includes their name, camp and date. A pre-survey was administered on Day 1 of the camp. The comparison of the pre- and post- surveys will be an important tool in the evaluation process.

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MAGNETIC FIELDS

1. Obtain two bar magnets of the same size and hold one in each hand. Holding the magnets with the two north poles facing each other, slowly bring the magnets together.

What do you feel in your hands?

2. Now move the magnets apart. Hold them with the north pole of one facing the south pole of the other. Slowly bring the 2 magnets together.

What do you feel? What happens to the magnets?

3. Using the ring magnets and dowels, experiment putting on the magnets in different ways. Draw a picture of each different outcome.

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

DAY NINE

Hydroid has joined other water droplets to form a cloud over Mount Hood. Below, the final seven Hood River chinook are facing the last step last part of their journey home. The Toutle River chinook are building new homes in their damaged river. The Willamette River chinook are fighting the falls and fishermen. At the same time, the Hood River chinook are coming face to face with a big wall. The wall is all across the river. It is the front of Bonneville Dam.

The fish must get past the dam. They search for the fastest water. The water is flowing over a set of stairs built by the same people who built the dam in 1937. The fish use all their strength and jump through the water over each of the smooth, flat steps. It's hard work. Two of the fish don't make it. The other five swim past a window. A person on the other side of the window counts the fish as they pass. Once again the Hood River chinook are in the large lake of Bonneville Dam's reservoir. They rest for a moment. The water is slow. The fish are confused, but soon they move on up the river. They rest no more. They do not eat. Not far is the smell of home.

Three of the chinook make it to the mouth of Hood River. They are weak from their travels. Their skin is dark. The male's snout is curved into a hook. They are thinner than when they entered the Columbia. Yet the sides of two of the fish are bulging. These are females full of eggs. They are in a hurry to build their nests.

Still they wait two days for rain to raise the water level. The river changed in the four years they were gone. This winter, loggers cut a stand of trees from the side of the mountain. A farmer cleared forty acres of land to put in a new orchard. Others sent their cattle into the stream to drink. The cattle hooves trampled the stream bank and killed the plants, leaving a trail of mud. Spring rains washed a heavy load of dirt and fertilizer into the river.

The water must run higher to clean the river of this pollution. The clouds next to Hydroid help. They brush the top of Mount Hood and unleash fresh water down the mountain side, through the streams and to the waiting fish. The fish begin to move up the river.

Journey of the *Oncorhynchus*

A Story of the Pacific Northwest Salmon

Teacher's Guide to Storybook

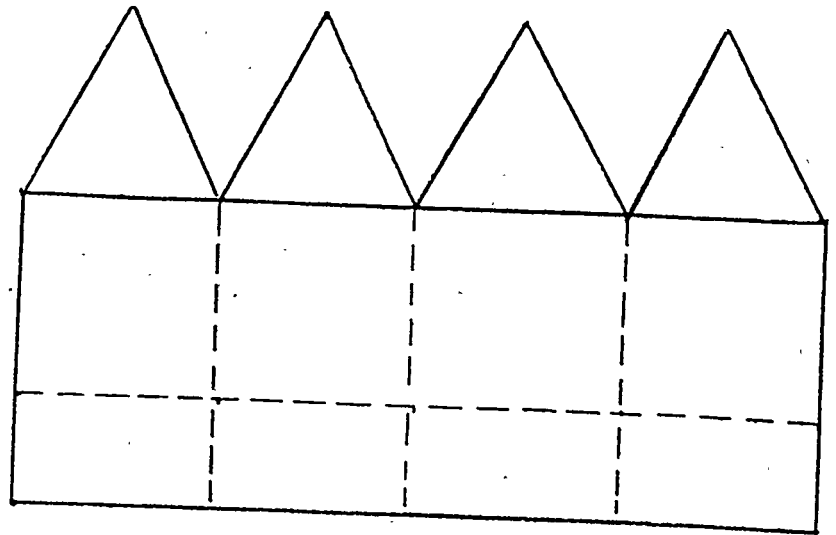
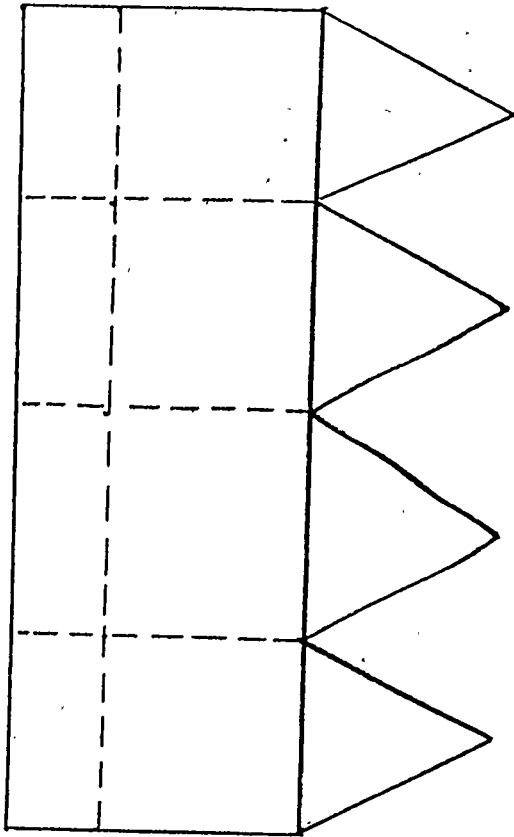
DAY TEN

One good thing happened while the fish were away. Workers built a small ladder to cover the waterfall they passed when they were just fingerlings. What was once a four-foot wall is now just four small steps. But even these are too much for one of the females. She dies at the base of the ladder. The other two move on. They have just one mile to go. There is not much time now. They must get home soon.

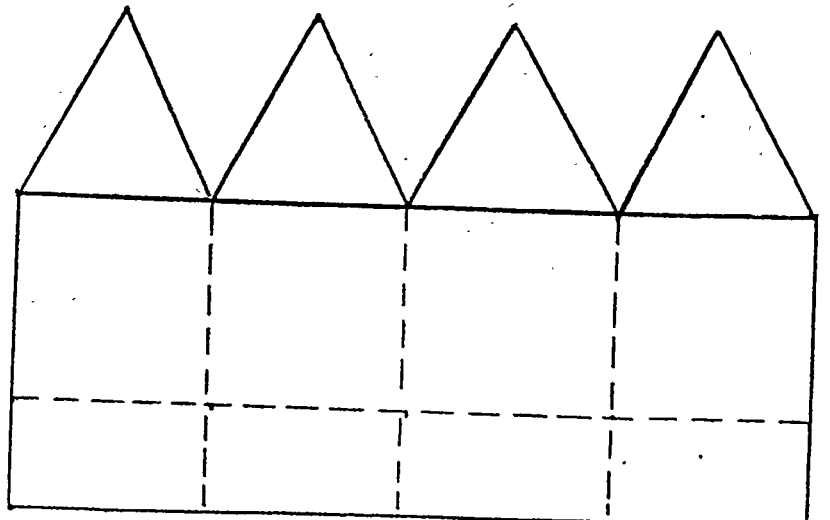
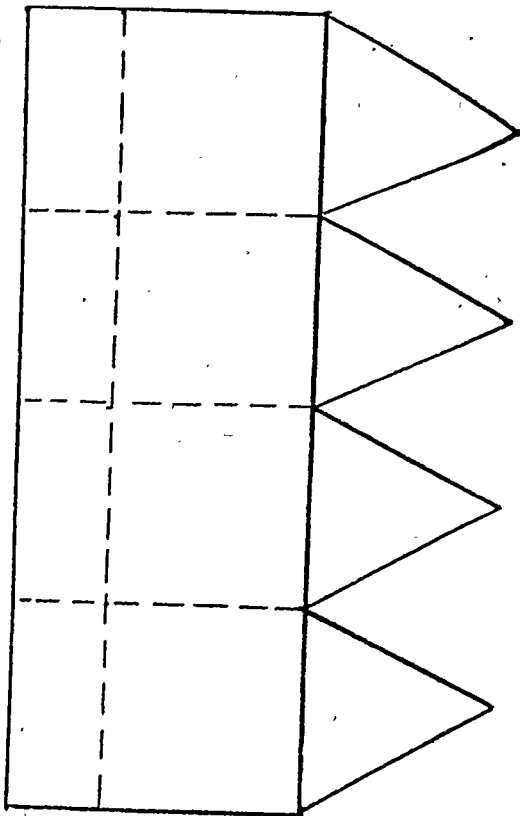
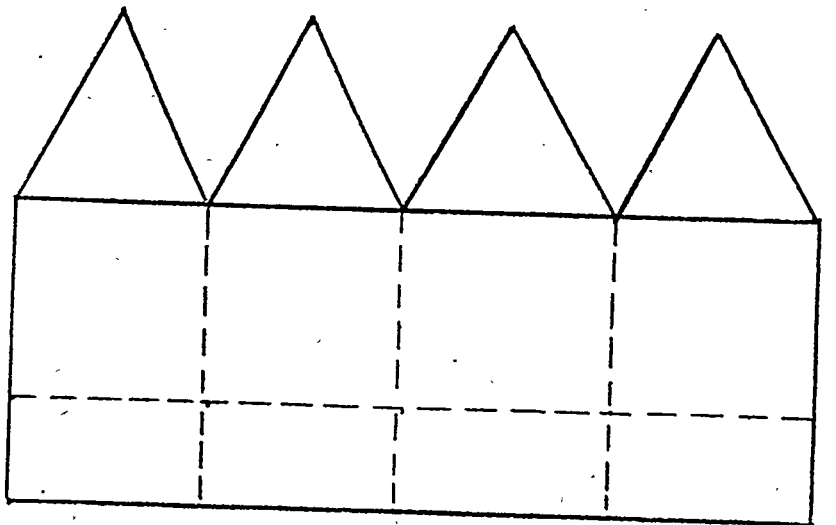
And there it is. A right turn and they are home at last. The stream of their birth. They were once little fish here. Now they are adult salmon, nearly four feet long. The female chooses a shallow spot in the shade of a clump of grass. The water runs fresh, but not too fast. She begins to build her nest. The male stands guard close by. For the next hour, she moves over her chosen spot, flipping her tail to move the gravel into place. After each pass, she inspects her work. She moves her body through the redd to test her work. Finally it feels just right. She settles in one last time. The male swims up close to her and presses her side with his body. She lays her eggs. About 5,000 small pink eggs float down from her body into the spaces between the rocks of her nest. At the same time, milt pours from the under side of the male. The milt spreads to cover the eggs and fertilize them. The female moves upstream of the nest. With one last effort, she flips up fine pieces of gravel to cover and protect her eggs.

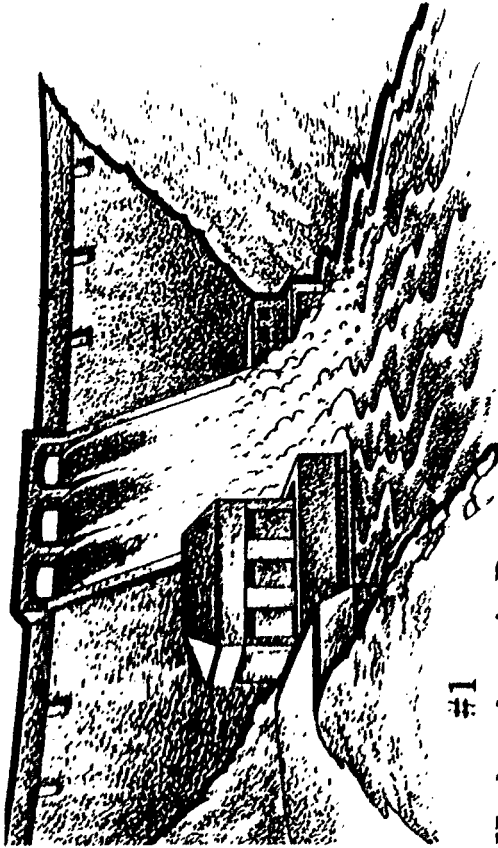
Their work done, the fish rest for awhile in the stream. In a few days, they die. Hydroid watches as their bodies drift down the stream to become food for the crows, raccoons and smaller creatures of the water. These small creatures are food for the Hood River chinook that hatch next year. By dying, the adults nourish their young. The droplet has been watching the fish so closely that it has not noticed that its cloud has moved closer to the mountain.

The cloud brushes against the tip of Mount Hood. A gentle rain falls on a small stream low on the mountain's northeast slope, 50 miles east of Portland, Oregon. Several drops hit the arching blades of grass shading a shallow pool at the edge of the stream.



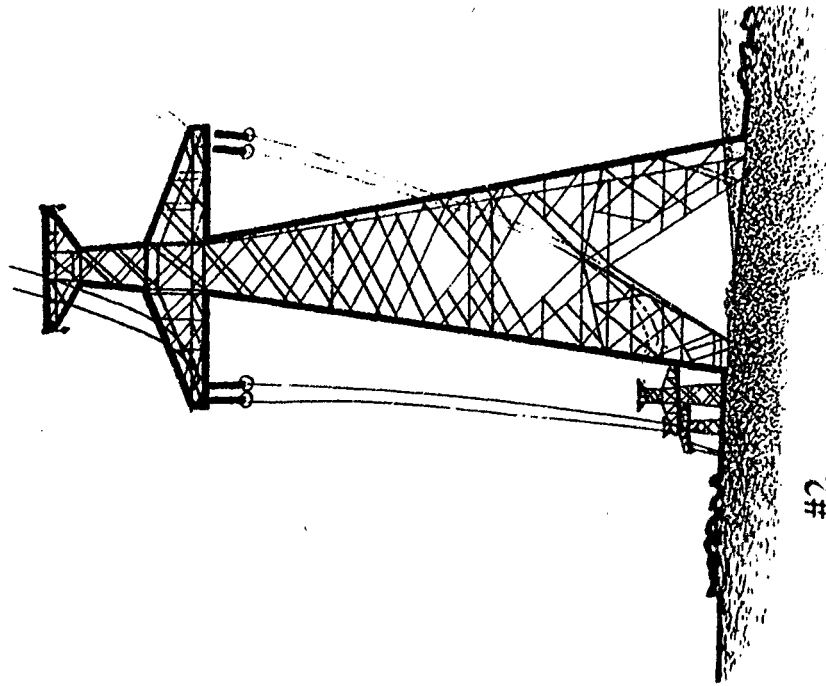
House Patterns





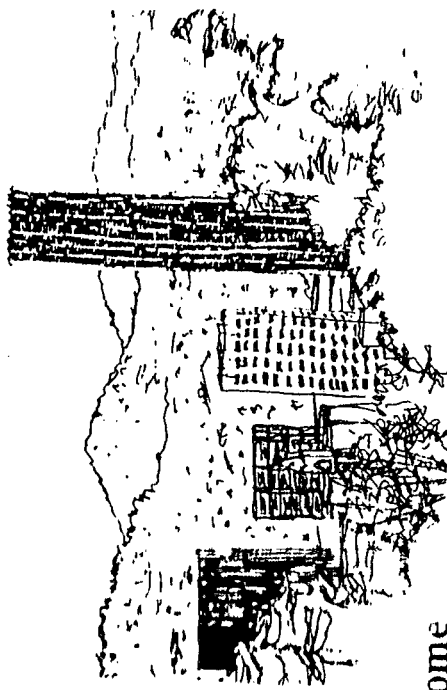
#1

Hydroelectric Dam



#2

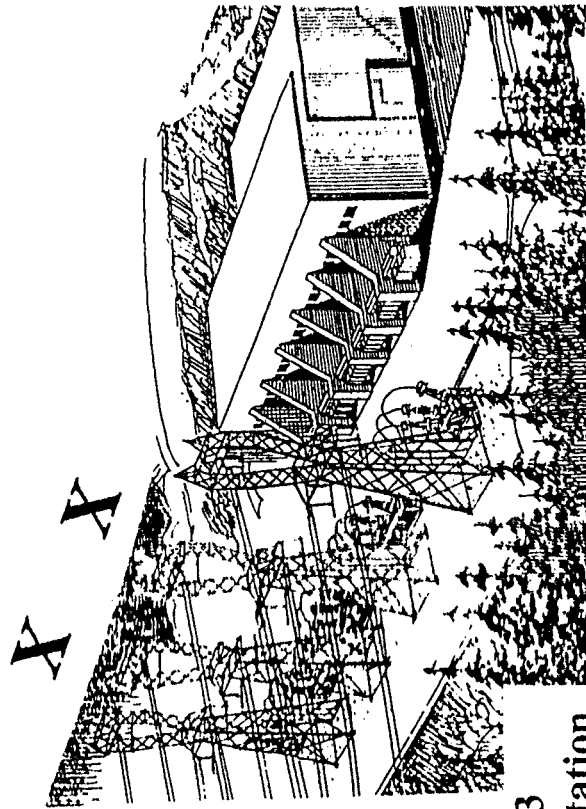
Transmission Tower



#4

Your Home

H









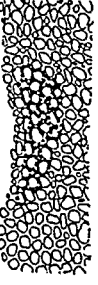


#3

Substation

ELECTRIFYING FISH FACTS

1. Chinook
2. Coho
3. Sockeye
4. Chum
5. Pink
6. Fry
7. Anadromous
8. Smolt
9. Alevin
10. Redd

Called King Salmon, are the longest lived and the largest of the Pacific Salmon.	
Called Silver Salmon, turn muddy red when they begin their spawning run.	
Called "Reds", turn red with green heads during spawning.	
Called Dog Salmon, develop a very hooked jaw with fierce teeth at spawning time.	
Called Humpies or Humpback, the smallest of the Pacific Salmon. The males develop a grotesque humpback during spawning.	
Young salmon that no longer have a yolk sac and have left the gravel bed.	
A fish that lives part of its life in freshwater and part in saltwater.	
A salmon that has spent over one year in the stream and is ready to go to the sea.	
The newly hatched salmon with its yolk sac still attached.	
The gravel bed in the stream where the salmon deposit their eggs.	

Draw (or write) everything you know about the Pacific Salmon.

(dam, life cycle, environment, saltwater, freshwater, food chain, predators, prey, body parts, and electricity are examples of things to write about)

Name _____

Camp _____

Date _____

Hydro Power:

How Electricity gets from the River to Your House

When you flip on a light switch in your home, electricity makes the light turn on. It makes the wires in the bulb glow bright enough to give off light. But, where does the electricity come from? How does it get to the switch? In the Northwest much of the electricity comes from the rivers that have hydroelectric dams on them.

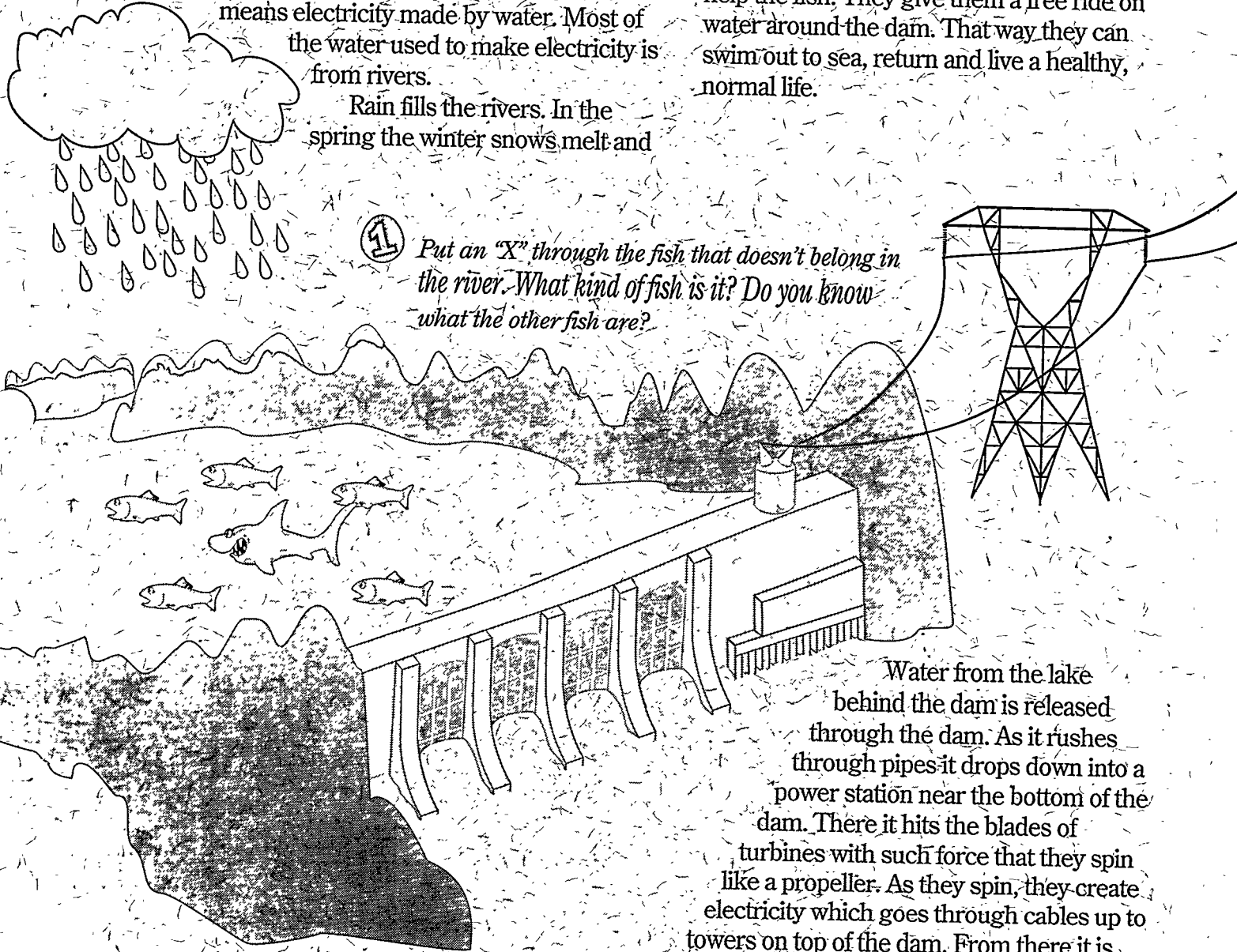
"Hydro" comes from the Greek word for water. Hydroelectric means electricity made by water. Most of the water used to make electricity is from rivers.

Rain fills the rivers. In the spring the winter snows melt and

make the rivers swell almost to bursting.

Hydro power comes from dams that are built on rivers. A dam holds back river water so a large reservoir forms. The dam also holds back fish who have to swim up and down the river in order to live, but people help the fish. They give them a free ride on water around the dam. That way they can swim out to sea, return and live a healthy, normal life.

① Put an "X" through the fish that doesn't belong in the river. What kind of fish is it? Do you know what the other fish are?



Water from the lake behind the dam is released through the dam. As it rushes through pipes it drops down into a power station near the bottom of the dam. There it hits the blades of turbines with such force that they spin like a propeller. As they spin, they create electricity which goes through cables up to towers on top of the dam. From there it is sent out on power lines for use.

② What animal makes a natural dam?
Can you draw one?

From the dam . . .

BPA does not own or run any hydroelectric dams. What it does is sell and deliver the power from dams in the Northwest. Last year the dams made more than 77 trillion watt hours of electricity! That's enough to keep a light bulb lit for 1 1/2 million years! It's the same amount of energy you'd get by burning over 5 billion gallons of oil. You could cover the entire city of Portland (102 square miles) three inches deep with that much oil.

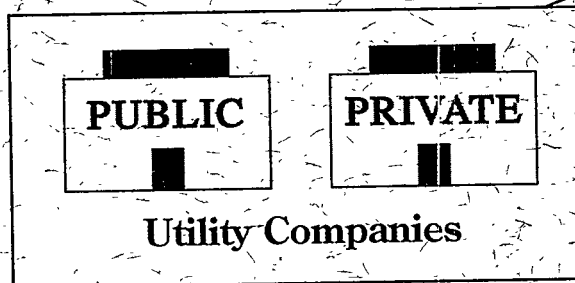
③ Can you name some hydroelectric dams?

From the dams BPA sends the electricity over power lines on huge towers. The lines cross four states: Oregon, Washington, Idaho and Montana.

④ Circle the tower that is different from the others.

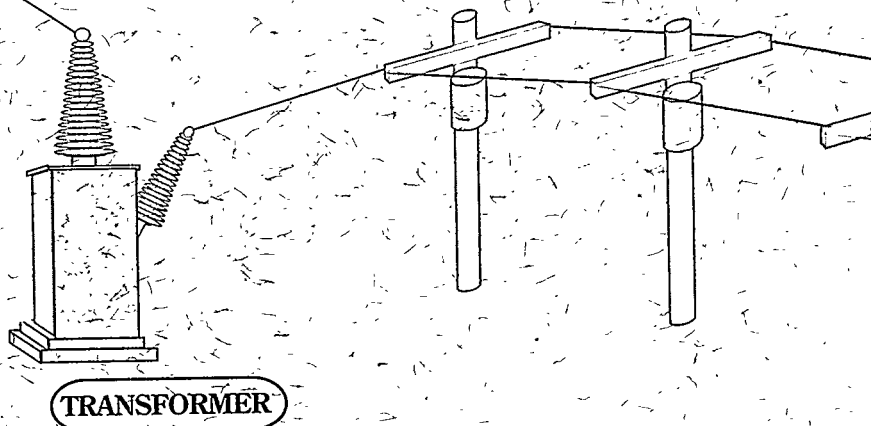
through BPA and utilities . . .

Most of BPA's electricity is sold and sent to utility companies. Then they provide it to their customers. BPA sells to two kinds of utility companies — public and private. The public ones are owned and run by the people they serve. Private utility owners invest their money in the company, but do not run it.



⑦ Can you name your electric utility company?

The power coming from the substation is too strong for the wires in homes and other buildings, so it stops at a transformer. The transformer changes it to a lower voltage.



to industry . . .

Some of the electricity goes straight to very large industries, such as aluminum plants. They are called "Direct Service Industries."

6 Can you name and draw some things that are made from aluminum?

BPA moves the electricity to a power station called a substation. There, utilities and industries take the electricity. They send the power from BPA substations over their own lines to businesses, farms, homes and other customers.

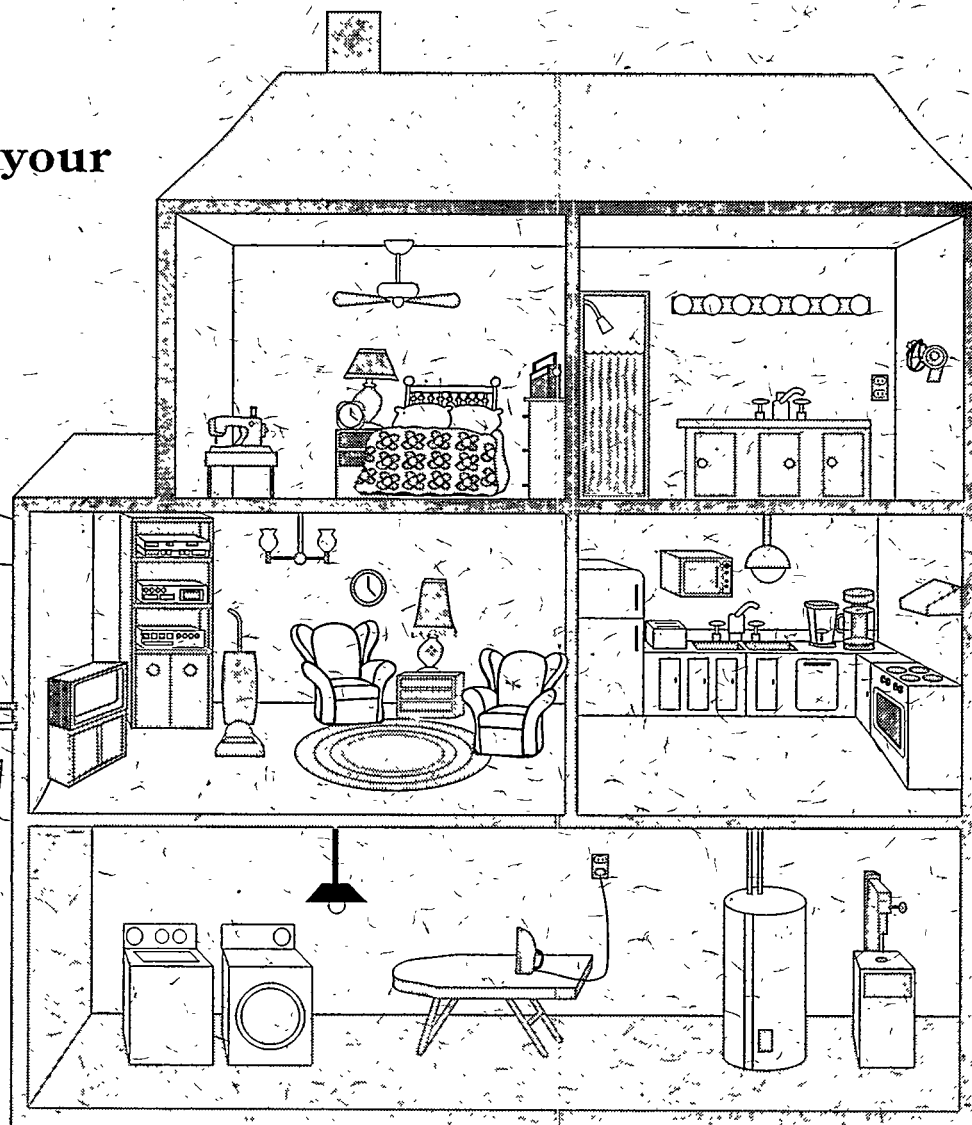
5 Name another kind of station, such as a radio station.

to businesses . . .

8 Name some businesses and tell how they would use electricity for something besides lights. (Example: An ice cream shop uses a freezer to keep ice cream from melting.)

9 Where do you see electricity when you are in the city?

... and to your home.



The electricity is sent through large wires or cables. Sometimes the wires are strung on wooden poles. Sometimes they are under the ground. When a wire or cable gets to your house, it is joined to smaller wires. These wires run between the floors, ceilings and walls of your house. They connect to electric outlets and switches.

Like the river it began with, the electricity flows through the lines and turns on whatever you wish with the flip of a switch.

10 Circle each item that uses electricity in this house. There are 31.

If you want to learn more about the Northwest's power system call BPA's Public Involvement Office at (503) 230-3478 in Portland, or toll free 1-800-622-4519 nationwide. For additional copies of this brochure call BPA's Document Request Line 1-800-622-4520 (recorded message).

Day 10**OUTLINE****TIME****ACTIVITIES****MATERIALS**

(Based on class of 40)

9:00 a.m.

Leave Camp Site

Breakfast
Student Workbooks
40 adhesive name tags
First Aid Kit

9:45

Arrive at Washington Park Zoo

10:00

Scavenger Hunt-Endangered Species
Tour of the Exhibits/Train ride

12:00

Lunch
Bird of Prey Demonstration

1:00

Scavenger Hunt-Endangered Species
Tour of the Exhibits/Train ride

1:45

End of Scavenger Hunt
(Meet at grassy area between the
Elephants and AfriCafe.)

Prizes

2:15

Leave the Zoo

3:00 p.m.

Arrive back at Camp Site

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DAY 10

TEACHER NOTES

WASHINGTON PARK ZOO FIELD TRIP

Estimation Game: Challenge students to estimate the number of threatened and endangered species in the state of Oregon. (Winners will be announced at the beginning of lunch.) The answer is 29. There are twelve threatened species and fifteen endangered species in the state of Oregon.

Bus Activities: Students can complete games and/or activities in their student workbook during the bus ride to the zoo.

OBJECTIVE(s): After completing the activities on this field trip, students will be able to:

- ◆ apply what they have learned in the classroom to their local and regional communities.

MATERIALS:

Prizes for Scavenger Hunt

35 No. 2 pencils

BACKGROUND INFORMATION:

Extinction is the final step in the evolutionary process. Thousands of species of animals and plants flourished and disappeared long before humans became recognizable. Dinosaurs, mammoths, and sager-toothed tigers all became extinct a long time ago. More recently, the dodo bird, the sea mink, and the passenger pigeon have become extinct. Extinction has been going on since life began on the Earth. But today, extinction is happening faster than ever before.

The terms threatened and endangered describe wildlife species in danger of extinction. There are more than 600 endangered or threatened species in the United States today. Endangered species are those plants and animals that are so rare they are in danger of becoming extinct. Threatened species are plants and animals whose numbers are very low or decreasing rapidly. Threatened species are not endangered yet, but are likely to become endangered in the future.

There are over 29 animal species listed as threatened or endangered in the state of Oregon. The northern spotted owl, western snowy plover, loggerhead sea turtle, sea otter and the wolverine are threatened. The gray wolf, green sea turtle, Brown pelican, Columbian white-tailed deer are endangered.

PROCEDURE:

1. Upon arriving at the zoo, each adult should pick up a map of the zoo. Use the map to locate the area your group will start.
2. Each group of student (A, B, etc.) will include one team from each of the two camps. Each group of students will experience all the exhibits at the zoo. The in which each group will go through the zoo exhibits is listed below.

<u>Group</u>	<u>Morning Stations</u>	<u>Afternoon Stations</u>
A	1, 2, 3,	4, 5
B	2, 3, 4,	5, 1
C	3, 4, 5,	1, 2
D	4, 5, 1,	2, 3
E	5, 1, 2,	3, 4

3. WASHINGTON PARK ZOO STATIONS

It is very important to following the order listed. The number represents where your group will start.

STATION 1: Start with **THE BIG CATS**. Answer questions 1-15.

STATION 2: Start with **BEARS**. Answer questions 16-30.

STATION 3: Start with **PRIMATES**. Answer questions 31-53.

STATION 4: Start with **AFRICA**. Answer questions 54-75.

STATION 5: Start with the **ZOO TRAIN**. The train will run to the Washington Park Station above the Rose Gardens.

4. When your groups have completed all of the stations return to the grassy area between the elephant exhibit and the AfriCafe. At approximately 2 pm, the final prizes will be awarded to the groups for the Zoo Scavenger Hunt. If time permits, students can sign autographs as the groups arrive.

STUDENT ACTIVITY SHEET 10-1

SCAVENGER HUNT (WASHINGTON PARK ZOO)

Find the answers to the following questions as you walk through the zoo.

BIG CATS

A. SIBERIAN TIGER

1. What kind of food (diet) do these cats eat? _____
2. What is the genus name of the Siberian Tiger? _____

B. LION

3. What is the scientific name (genus and species) of the lion? _____
4. Lions travel in groups called _____.
5. What type of habitat do these animals prefer? _____

C. COUGAR

6. What is the scientific name of this cat? _____

D. SNOW LEOPARD

7. Why is this animal endangered? _____
8. Why is the long tail of the snow leopard so fluffy? _____

E. JAGUAR

9. Where does the Jaguar live in the wild today? _____

**** Note!** Buy Brazil Nuts and save a jaguar. No one knows how to grow brazil nuts commercially. They all come from wild trees in the tropical rain forests of South America. By buying them, you are encouraging preservation of forests that are home to jaguars and other species.



Put a star next to the cat that is native to Oregon.

INSECT ZOO

10. Stop and check out the Walking Sticks. Where are these animals found in the wild?
11. Name one type of food that is eaten by the Australian Walking Stick.
12. Name two types of spiders.

PENGUINS

13. Where is the natural home of the Humboldt Penguins?
14. All penguins live in the _____ hemisphere.
15. Where do penguins lay their eggs?

BEARS

A. RED PANDA

16. Describe the habitat that the pandas live in?

B. POLAR BEAR

17. Why is the Polar Bear's nose black?
18. List three types of food that these animals eat.
19. What five countries are working together to save the Polar Bears?
20. What color is the Polar Bear's skin and why is it this color?
21. Describe the fur of the Polar Bear.

C. SUN BEAR

22. What is the normal habitat for this bear?
23. What adaptation does this animal have for finding its food?

BEARS - CONTINUED

D. KODIAK BEAR

24. The Kodiak Bear is the largest meat eating bear. How much can it weigh?

25. Where can you find this animal in the wild?

E. ASIATIC BLACK BEAR

26. This bear is an omnivore. What does that mean?

F. SPECTACLED BEAR

27. Why is this bear endangered?

28. This bear is also called _____.

** This bear is the only bear found on the South American continent.

G. AMERICAN BLACK BEAR

29. What type of habitat does it prefer to live in?

30. The American Black Bear can be found in what other colors?

PRIMATES

A. WHITE-CHEEKED GIBBON

31. The White-Cheeked Gibbon is native to _____.

32. Gibbons swing from tree to tree, this behavior is called _____.

B. SIAMANG

33. Siamangs are native to _____ and _____.

34. How do they communicate?

C. MANDRILL

35. What type of habitat do these primates prefer?

D. CHIMPANZEE

36. What is the scientific name of this monkey?

PRIMATES - CONTINUED

E. MARMOSETS/TAMARINS

37. These smallest true monkeys are found in _____ and _____

F. FRANCOIS' LEAF MONKEY

38. Why is this monkey highly endangered?

G. ORANGUTAN

39. Why is the Orangutan endangered?

H. HANUMAN LANGUR

40. In India, these monkeys are called _____

I. COLOBUS MONKEY

41. These monkeys are the most arboreal of the African monkeys. What does arboreal mean?

J. RINGED-TAILED LEMUR/RED RUFFED LEMUR

42. Both of these monkeys are native to the island of _____
which is located off the coast of _____

ELEPHANT MUSEUM

(Lilah Callen Holden Elephant Museum)

43. True or False. The American Mastodont has been found in the Portland area?

44. How does the Mastodont size compare to the present day elephant.

45. The large tusks present in the Mastodont skeleton are made of plastic. Why is this so?

ELEPHANTS

46. When was Packy born?
47. Why is the Asian elephant endangered?
48. Female elephants are pregnant for how many months before giving birth?
49. How many pounds of food does one elephant eat in a day? List the types of food elephants eat.

****Note -** There are only two kinds of elephants, African and Asian. They are easy to tell apart. The African is larger and has bigger ears. The trunk of the African has two lips, while the trunk of the Asian has one.

ALASKAN TUNDRA

A. MUSK OX

50. Another name for the Musk Ox is _____.

B. GRAY WOLF

51. How do adult wolves carry food back to their young?

C. GRIZZLY BEAR

52. How many years can a Grizzly Bear live?
53. A newborn Grizzly cub weighs only _____ pounds.

AFRICA

A. THE AVIARY--BIRD WALK

54. Be sure to visit the aviary, how many different birds can you see?
55. The African Jacana or lily trotter is one cool bird. Who carries the young birds around until they are ready to go out on their own?

B. BLACK RHINOCEROS

56. What type of habitat does the rhino live in? _____
57. Why is it endangered? _____

C. HIPPOPOTAMUS

58. What is the genus name of the Hippopotamus? _____
59. Why are their eyes, ears, and nostrils high on their head? _____
60. An adult male can weigh as much as _____ Kg or _____ pounds.

D. HARTMANN'S MOUNTAIN ZEBRA

61. Zebras travel in herds of _____ animals.
62. Zebras can go without water for _____ days.
63. Why are these animals highly endangered?

E. RETICULATED GIRAFFE

64. The Giraffe can run up to _____ miles per hour.
65. Why do they have such long necks?

F. IMPALA

66. These animals can jump _____ feet in length and _____ feet in height.

AFRICAN RAIN FOREST

A. MONGOOSE

67. These animals are _____ eaters.

68. While hunting, the mongoose communicates by _____.

B. FRUIT BATS

69. True or False. These animals are mammals.

70. List three types of fruit that these bats eat.

C. CAPE CLAWLESS OTTER

71. These otters use their broad teeth to eat _____ and _____.

D. AFRICAN ROCK PYTHON

72. How does a python capture its food?

E. WADING BIRDS OF THE AFRICAN RAIN FOREST

73. List three types of birds found here.

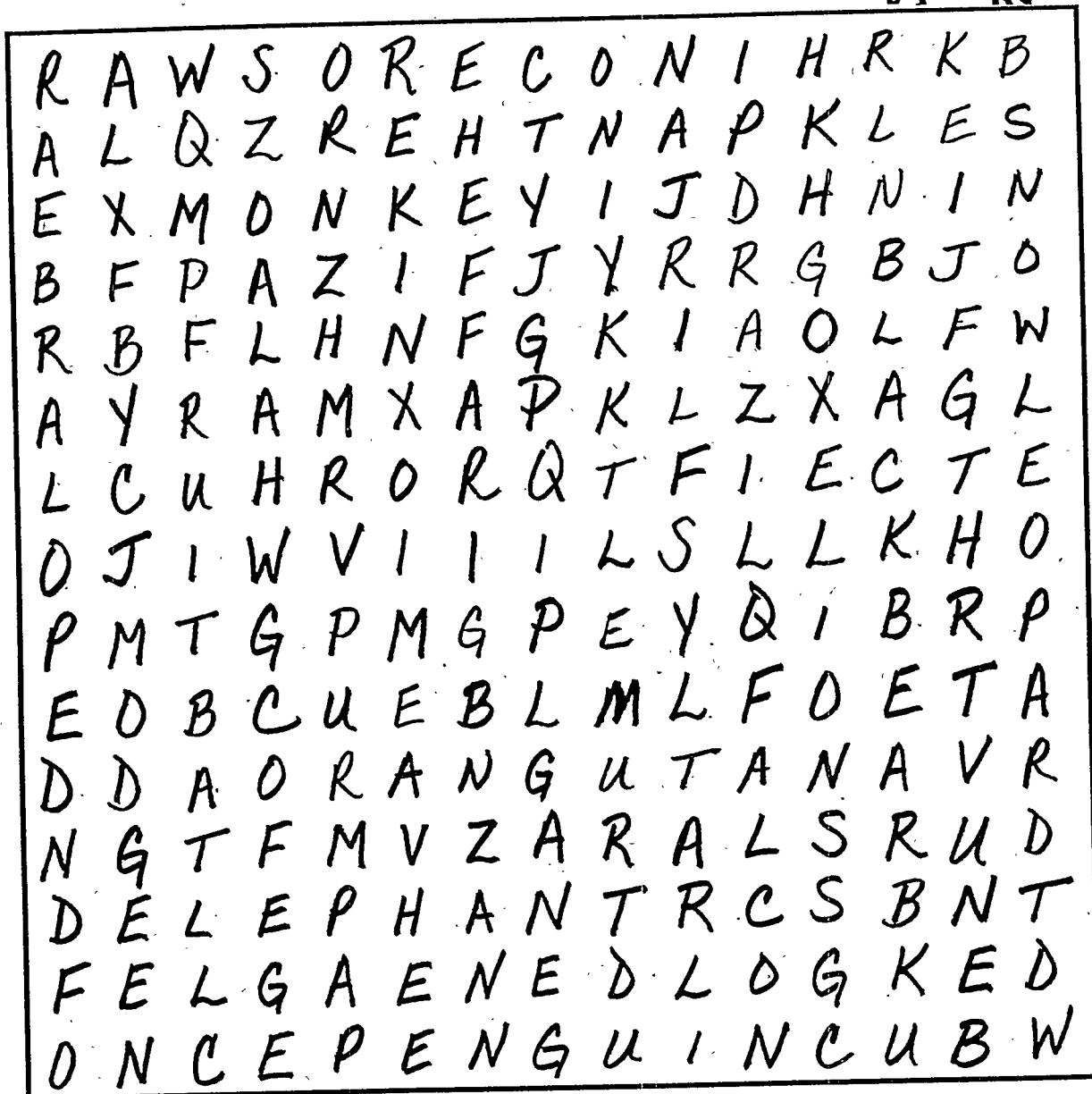
F. LUNGFISH

74. Why is this fish called a living fossil?

G. LEECH

75. What do these parasites live on?

ZOO ANIMAL WORD SEARCH



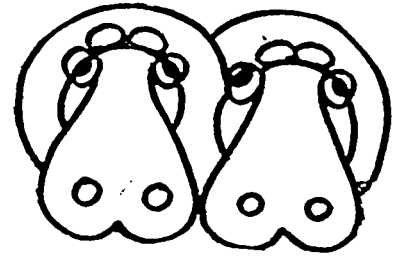
Orangutan
Polar Bear
Monkey
Fruit Bat
Lizard
Golden Eagle

Rhinoceros
Penguin
Lion
Snow Leopard
Lemur
Bengal Tiger

Black Bear
Panther
Elephant
Falcon



ZOO ANIMAL WORD SCRAMBLE



Directions: Unscramble the words below.

- | | |
|------------------|-----------|
| 1. NOARTAUNG | 1. _____ |
| 2. NFOACL | 2. _____ |
| 3. TENLEAHP | 3. _____ |
| 4. RLUEM | 4. _____ |
| 5. DLRIAZ | 5. _____ |
| 6. YMEOKN | 6. _____ |
| 7. NPIEUNG | 7. _____ |
| 8. RPEAHNT | 8. _____ |
| 9. SROHRIENCO | 9. _____ |
| 10. NLOI | 10. _____ |
| 11. RPAOL RBAE | 11. _____ |
| 12. KBCLA REAB | 12. _____ |
| 13. LBAEGN RTEIG | 13. _____ |
| 14. NGEODL EELAG | 14. _____ |
| 15. WSON DLREAPO | 15. _____ |

Answers to word scrambles and crosswords.

WORD SCRAMBLES

Oregon Coast: 1. seagull, 2. tides, 3. kites, 4. seal, 5. waves, 6. estuary, 7. driftwood, 8. ocean, 9. Columbia River, 10. sand castles, 11. smolt, 12. Peter Iredale, 13. sea shells, 14. Fort Stevens, 15. killer whale.

Salmon Life Cycle: 1. spawning, 2. chinook, 3. smolt, 4. alevin, 5. eyed egg, 6. yolk sac, 7. sockeye, 8. migration, 9. redd, 10. fry, 11. parr, 12. tributary, 13. anadromous, 14. pink, 15. coho.

Wildlife: 1. wildlife, 2. snag, 3. silt, 4. osprey, 5. predator, 6. chinook, 7. ecosystem, 8. huckleberry, 9. Douglas fir, 10. tracking, 11. kingfisher, 12. great blue heron, 13. temperature, 14. dissolved oxygen, 15. prey.

Zoo: 1. orangutan, 2. falcon, 3. elephant, 4. lemur, 5. lizard, 6. monkey, 7. penguin, 8. panther, 9. rhinoceros, 10. lion, 11. polar bear, 12. black bear, 13. Bengal tiger, 14. golden eagle, 15. snow leopard.

CROSSWORDS

Chemistry: Across 2. metrics, 6. indicator, 7. Celsius, 8. chemical, 9. temperature, 11. acid, 12. neutral. Down 1. balance, 3. thermometer, 4. dissolved oxygen, 5. graduated cylinder, 10. base.

Mount St. Helens: Across 1. ash, 2. lava, 3. plates, 4. Toutle, 7. Cascades, 8. crater, 9. dome, 10. Loowit. Down 1. mudslide, 3. pumice, 5. lava tube, 6. volcano.

Oregon Coast: Across 4. Fort Stevens, 6. trash, 8. wave, 10. estuary, 11. sea shells. Down 1. battery, 2. ocean, 3. Peter Iredale, 5. smolt, 7. tides, 9. seagulls.

Glossary

A

- acid** Any of a large class of substances whose aqueous solutions are capable of turning litmus paper red, of reacting with and dissolving certain metals to form salts, of reacting with bases or alkalis to form salts, or having a sour taste.
- aerobic** Living or occurring only in the presence of oxygen.
- alevin** A young salmon during the first two weeks after hatching, until the yolk sac has been absorbed.
- algae** Any of various chiefly aquatic plants, one-celled or multicellular plants without true stems, roots, and leaves but containing chlorophyll.
- amber** A hard, translucent, yellow, orange, or brownish-yellow fossil resin, used for making ornamental objects.
- amines** Any of a group of organic compounds of nitrogen that may be regarded as ammonia derivatives in which one or more hydrogen atoms has been replaced by a hydrocarbon radical.
- anadromous** Migrating up rivers from the sea to breed in fresh water, as salmon do.
- anaerobic** Capable of living in the absence of free oxygen.
- andesite** A fine-grained, gray volcanic rock, composed mainly of plagioclase and feldspar.
- annulus** A ringlike figure, part, structure, or marking.
- aquifer** A water-bearing rock, rock formation, or group of rock formations.
- atom** A unit of matter which is the smallest complete part of an element made up of a dense, central, positively charged nucleus surrounded by a system of electrons.
- autotroph** An organism like a plant which is capable of manufacturing it

B

- basalt** A hard, dense, dark, often, glassy volcanic rock composed composed chiefly of plagioclase, augite, and magnetite.
- base** Any of a large class of compounds, including hydroxides and oxides of metals, having a bitter taste, a slippery solution, the ability to turn litmus paper blue, and the ability to react with acids to form salts.

Glossary

Belted Kingfisher	Kingfishers are any of the birds of the family Alcedinidae, having crested heads; the Belted Kingfisher is the most common kingfisher in North America.
biosphere	The part of the earth and its atmosphere in which living things exist.
bony fish	Any fish that has a skeleton made of bones rather than cartilage.
C	
Caddisfly	Any of various four-winged insects of the order Trichoptera, found near lakes and streams.
caldera	A large crater formed by volcanic explosion or the collapse of a volcanic cone.
carnivore	A flesh-eating or predatory organism, as a bird of prey or an insectivorous plant.
chemical	A substance produced by or used in a chemical process.
circuit	A closed path followed or capable of being followed by an electric current.
circuli	Growth rings which surround the center or nucleus of a scale, typical of fish.
composite volcano	A volcano form which has resulted from a combination of quiet effusive lava flows alternating with explosive eruptions of ash and ejecta.
conclusion	The outcome or result of the steps in the scientific process.
conductor	A substance or medium that conducts electricity, heat, light, or sound.
Continental Drift	The concept that the continents can drift on the surface of the earth because of the suboceanic crust, much as ice can drift through water.
Coulomb's Law	The fundamental law of electrostatics stating that the force between two charge dparticles is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.
current	The amount of electric charge flowing past a specified point per unit of time.
D	
data	Information organized for analysis, can be used to form a scientific conclusion.
decomposer	An organism in an ecosystem that breaks down dead organic matter into its constituent parts.

Glossary

decomposition	The act or result of decomposing.
density	The mass per unity volume of a substance under specified or standard conditions of temperature and pressure.
dissolved oxygen	Oxygen that has formed a solution with teh surrounding medium, often as dissolve doxygen content in water.
E	
earthquake	A series of elastic waves in the earth's crust, caused by abrupt easing of strains built up along geologic faults and volcanic action, and resulting in movement in the earth's crust.
ecosystem	An ecological community with tis physcial environment, regarded as a unit.
eggs	One of the female reproductive cells of various animals, consisting usually of an embryo surrounded by a nutrient material with a protective covering.
electromagnetic	The field of force associated with electric charge in motion, with both electric and magnetic components and containing a specific amount of electromagnetic energy.
electron	A subatomic particle of ordinary matter having a very small mass and a negative electrical charge.
endangered species	A species which is in danger of extinction throughout all or a significant portion of its range.
energy	The capacity to do work.
English system	The system of measurement that is based on the inch, foot, pound unity of measure.
experiment	A test performed to demonstrate a known trugh, examine the validity of a hypothesis, or determine the effectiveness of something untried.
extinction	The condition of having been removed from existence.
F	
food chain	The transfer of food energy from the source in plants through a series of animals, with repeated eating and being eaten.
food web	An interlocking pattern of food chains.
fry	The young of fish.

Glossary

G

Gondwana Theoretical ancient continent including India, Australia, Antarctica, and parts of southern Africa, and South America supposed to have fragmented and drifted apart over 200 million years ago.

gyotaku The Japanese art of fish printing.

H

herbivore An animal that feeds on plants.

heterotroph An organism that derives its nourishment from organic substances, as do some plants and animals.

hydroelectric Generating electricity by conversion of the energy of running water.

hypothesis An explanation accounting for a set of facts that can be tested by further experimentation.

I

insulator An insulating material, especially a nonconductor of heat or electricity.

ion An atom, group of atoms, or molecule that has acquired or is considered to have acquired a net electric charge by gaining electrons in or losing

K

kilogram The basic unit of mass in the metric system, equal to 2.2046 pounds.

Kokanee Freshwater land-locked variety of salmon.

L

Laurasia Hypothetical continent in the northern hemisphere which supposedly broke up about 290 million years ago and formed the present northern continents.

liter A metric unit of volume equal to approximately 1.056 quarts

lithosphere The solid portion of the earth, as contrasted with the hydrosphere and atmosphere. More particularly, the earth's crust.

litmus paper An unsized white paper colored with litmus and used as an acid-base indicator.

lodestone A magnetized piece of the mineral magnetite used by ancient mariners for navigation.

Glossary

logarithmic scale A scale in which the distances that numbers are at from a reference point are proportional to their logarithms.

Lorax A make believe creature that tries to help the environment.

M

magma Molten matter beneath the earth's crust, from which igneous rock is formed by cooling.

magnetite A dark mineral that is an important ore of iron and can be magnetized.

mass The physical volume of bulk of a piece of matter.

matter Any material that takes up space and has mass.

meniscus The curved upper surface of a nonturbulent liquid in a container that is concave if the liquid wets the container walls and convex if it does not.

metabolism The complex of chemical and physical processes involved in the maintenance of life.

metamorphosis A change in the structure and habits of an organism during normal growth, usually in the postembryonic stage.

meter The basic unit of length in the metric system that equals 39.37 inches.

metric system A decimal system of weights and measures based on the meter as the unit of length and the kilogram as the unit of mass.

milliliters A unit of volume equal to one thousandth of a liter.

Miocene That portion of geologic time from 25 to 5 million years before the present time, marked by the presence of primitive apes, whales, and grazing animals.

N

neutral Relating to a compound or substance that is neither acidic or basic.

neutron An electrically neutral subatomic particle normally bound to an atomic nucleus.

non-point source pollution A non-specific source of pollution.

nucleus The positively charged central region of an atom, made up of protons and neutrons and containing almost all of the mass of an atom.

O

oceanic crust The crust of the earth that lies beneath the oceans which is generally much thinner than the continental crust.

Glossary

ocher	A mineral that is used as a pigment to intensify color; it occurs in brown, yellow, and red hues.
olfactory	Of or relating to the sense of smell.
Oncorynchus	The that Pacific salmon, steelhead, and trout belong to.
operculum	A fold of tissue that covers the gill slits in most species of fish.
organic	Relating to or derived from a living organism.
P	
pahoehoe	A Hawaiian term for basaltic lava flows that have a ropy appearance.
Pangaea	Theoretical great continent in the Northern Hemisphere which fragmented to produce the present continents.
Panthalassa	Theoretical sea surrounding surrounding Pangaea before its fragmentation.
parallel circuit	An electric circuit in which the elements, branches, or components are connected between two points, with one of the two ends of each component connected to each point.
parr	The fingerling stage of young fish.
pH paper	A specially treated paper that can indicate the pH of a liquid from 1-12 by changing colors.
photosynthesis	The process by which chlorophyll-containing cells in green plants convert incident light to chemical energy and synthesize organic compounds from inorganic compounds.
Plate Tectonics	A branch of geology concerned with seismic activity and continental movement, based on the theory that the earth's surface is composed of a small number of large semirigid sections that float across the mantle, with seismic activity and volcanism occurring primarily at the junction of these sections.
Pleistocene	The earlier of the two epochs comprised in the quaternary period of the geological time scale, from 2.5 million years to 10,000 years before present.
point source pollution	An identified source of pollution.
producer	An autotrophic organism in an ecosystem which synthesizes complex organic substances from simple inorganic materials, as by photosynthesis or chemosynthesis.

Glossary

proton A stable positively charged subatomic particle in the baryon family with a mass of 1,836 times that of an electron.

pumice A porous lightweight volcanic rock used commonly used as an abrasive.

Q

quahog A hard-shelled edible clam.

R

redd The gravelly nest a female salmon digs and deposits her eggs in.

Richter scale A logarithmic scale ranging from 1 to 10, for expressing the magnitude or total energy of an earthquake.

S

Salmonidae A family of soft-rayed fishes in the suborder Salmonoidei including the trouts, salmons, whitefishes, and graylings.

seismic Pertaining to, characteristic of, or produced by earthquakes or earth vibration, as seismic disturbances.

series circuit A circuit in which all parts are connected end to end to provide a single path for current.

sinew Common name for a tendon.

smolt The stage in a salmon's development when they migrate from freshwater to the sea.

solubility The ability of a substance to form a solution with another substance.

stalactites A deposit that projects down from the roof of a cavern due to the dripping of mineral rich water.

stalagmites A deposit that projects upward from the floor of a cavern as a result of the dripping of mineral rich water.

subduction zone The zone where one crustal block descends beneath another, such as the descent of the Pacific plate beneath the Andean plate along the Andean Trench.

synthesize To make by combining separate elements.

T

Tethys A Greek mythological Titaness and sea goddess who was both sister and wife of Oceanus.

Glossary

thermometer An instrument for temperature measurement, especially one having a graduated glass tube with a bulb containing a liquid that expands and rises in the tube as the temperature rises.

threatened species A species that is likely to become endangered.

V

vent The opening of a volcano on the earth's surface.

vitelline vein Any of the embryonic veins in vertebrates uniting the yolk sac and the sinus venosus.

vitric ash Ash composed principally of volcanic glass fragments.

volume The capacity of a three dimensional object or region of space.

vortex Fluid flow involving rotation about an axis such as a whirlpool.

W

wampum Small cylindrical beads made from polished shells, once used by North American Indians as currency or jewelry.

watershed The region draining into a river, river system, or body of water.

Z

zooplankton Floating, often microscopic aquatic animals.