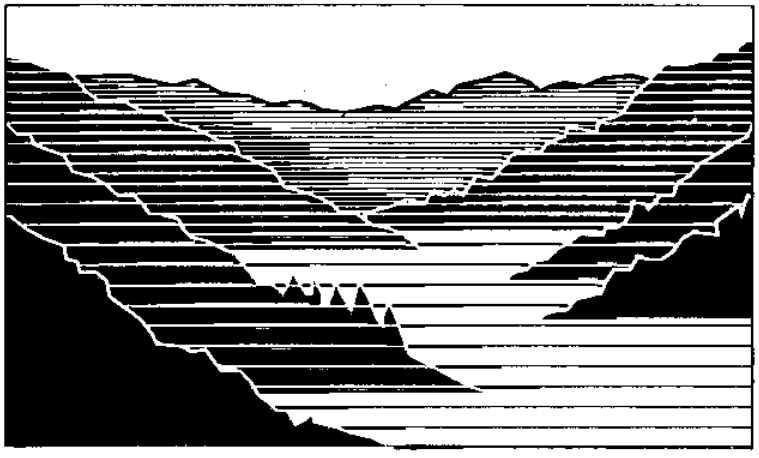

THE COLUMBIA RIVER

ITS FUTURE AND YOU

GRADES 9-12

OREGON STATE UNIVERSITY
EXTENSION SERVICE
OREGON SEA GRANT PROGRAM
EM 8475 • JANUARY 1993

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The project is funded by Oregon Sea Grant and Washington Sea Grant, under the direction of Vicki Osis, OSU marine education specialist, and Mike Spranger, assistant director for marine advisory services, Washington Sea Grant.

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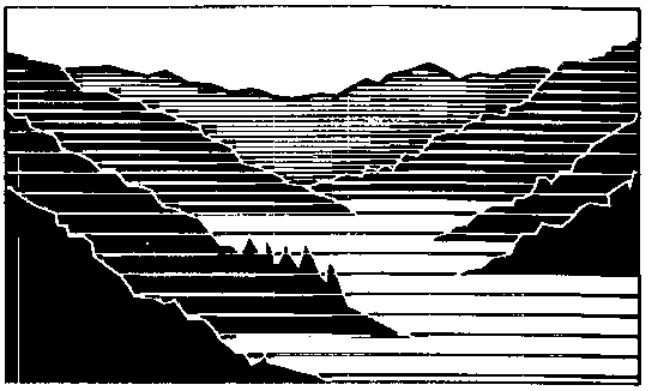


THE COLUMBIA RIVER

ITS FUTURE AND YOU

GRADES 9-12

VICKI OSIS, MARINE EDUCATION SPECIALIST,
OREGON STATE UNIVERSITY
and
MIKE SPRANGER
ASSISTANT DIRECTOR FOR MARINE ADVISORY
SERVICES, WASHINGTON SEA GRANT

CONTENTS

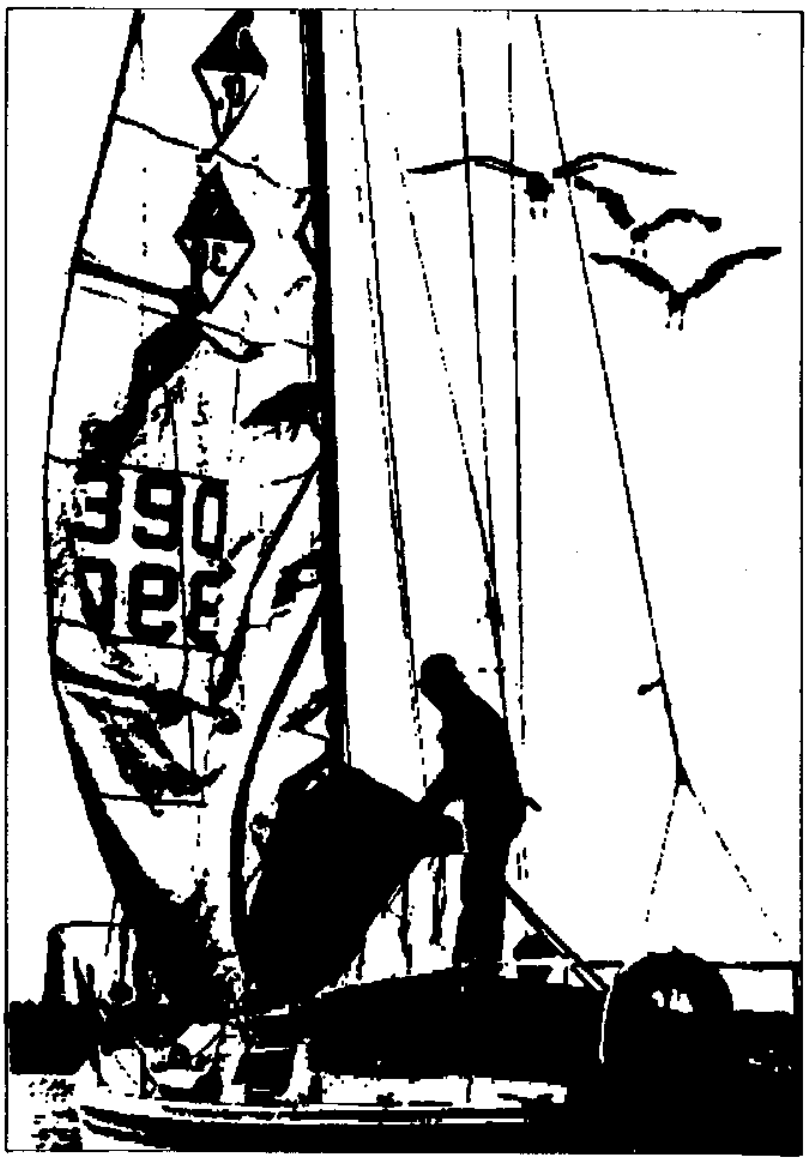
INTRODUCTION *TO TEACHERS*

This study of the Columbia River is designed as a multidisciplinary study that combines the skills, competencies, and concepts of many different disciplines. It can be used readily by the social studies teacher and the science teacher, both of whom will find material from their areas. They will also find work for students in the basic skills that we all are increasingly expected to teach and reinforce.

Students completing this curriculum will be well on their way to meeting the fundamental goal of education: *to learn to be participants in their culture and not simply spectators of it*. They will also be guided by two secondary goals of education: (1) to learn skills and competencies with which to demystify their culture and (2) to gain knowledge and self-confidence in order to negotiate their environment. The curriculum involves reading in content, writing, math, decision making, problem solving, and invention.

When students have finished this work, the following objectives will have been met:

1. Students will understand the complex political and economic decisions to be made regarding future use of the Columbia and its tributaries.
2. Students will understand the impact of the Columbia River on their lives and on the lives of past and future residents.
3. Students will gain a historical perspective of the Columbia River and will understand specific aspects of its use: power generation, navigation, fisheries, agriculture, and recreation.
4. Students will apply the basic skills of reading, writing, computing, verbal communication, analytical thinking, and creative problem solving to the study of science and social studies.
5. Students will understand better the impact of their environment on their daily lives, their political system, their economic activities, and the history of the people of the region.



This study of the river addresses as well the three stages of learning: acquiring information, making some personal sense out of the information, and acting on the information. Each section of the study is developed to deliver all three stages to your students: they will read and take in information; they will be asked to analyze and discuss that information; and they will be asked to solve problems, develop potential political and economic positions on issues, invent legends and theories, and take personal stands on delicate and complex concerns.

Especially in the third stage, the teacher needs to provide guidance and be patient. The discussions are often intended to be open-ended with no particular "right" answer. Indeed, eliciting a variety of answers is often more desirable than expecting one, predetermined answer. That is the heart of problem solving and decision making. For example, in the introduction and the conclusion of the curriculum, your students are asked to simulate the positions of various citizen groups on a complicated issue. You will need to keep them from straying too far from "reality" and at the same time allow their creative thinking and speculation to roam. Your students need such flexibility in order to get involved. We all do! Similarly, in the section on agriculture and irrigation, they are asked to consider the positions of a variety of taxpayers on a controversial issue. You must help them remember that all those people have complex reactions to economic concerns. They are special-interest individuals as well as people with personal convictions. This section will help prepare the students for the complicated emotions that come to the surface when the specific interests of taxpayers are at stake.

A word of caution is needed: students will often be asked to invent. In some cases they are asked to draw a map. Don't let their fear of the creative process prevent them from doing that. They will learn from the process of invention; you are not asking them to develop great products. Also caution them, when they are asked to invent a legend, that they are inventing their legend, not an Indian legend. To call their creations "Indian legends" would be presumptuous. Remember the message from Judy Annus, a highly respected Northwest educator, when she was informed that a particular class was "making African masks." Her cool reply: "Do they do Renaissance paintings too?"

Although this material is developed as a nine-week minicourse or unit, the teacher is left with the crucial decision of whether to cut it into a shorter study or expand it into a longer, perhaps semester, class. If you intend to expand it, the section on "Suggestions for Advanced Study" is designed to give you ideas. It is assumed that the teacher can add to those suggestions as well as to the activities in each section. The suggested length of each section is intended only as a guide. The teacher, as mentioned, will likely think of more activities as well as alternatives. Decisions on testing, homework, review plans, and tempo are also left to the teacher. If you limit your study to fewer than nine weeks, you will need to consider some material from each section in order to retain balance in the study.

The materials in this study are designed so that as students proceed, they become *involved*. Warn your principal and brace yourself!

Topics and Suggested Length of Developed Materials

Introduction	*4 days*
History	*10 days*
Power	*4 days*
Navigation	*4 days*
Agriculture and irrigation	*2-3 days*
Fisheries	*4-5 days*
Recreation	*4-5 days*
Summary and conclusions	*6 days*

Suggestions for Further Study

Rationale

The activities suggested below were designed for the following situations:

1. A class wishes to interrupt the curriculum and study one issue or section in greater depth.
2. A student individually or with a small group wishes to branch off and do a more in-depth study.
3. A student completes her or his work quickly and needs more homework or in-class activities.
4. A student finds regular schoolwork difficult and needs alternative assignments.
5. A teacher wishes to continue this study beyond the suggested time, perhaps to extend it into a semester elective course.

Suggestions

1. Read the publication *The Columbia River Salmon: A Resource in Danger*, by Michael S. Spranger. Either write a short paper on a topic of your choice or do further reading on the salmon fishery and write a longer paper.

2. Try to locate the articles about Woody Guthrie that appeared in the Oregonian on August 13, 1983 and September 1, 1983. Arrange to have Guthrie's songs, especially "Roll On Columbia," performed in class.

3. Read *Across the Wide Missouri*, by Bernard DeVoto, or other books on Rocky Mountain fur-trapping activities in the 1830s. Study the history of fur trapping in the Rockies, the beginning of exploration of what was to become Washington, Idaho, and Oregon, and the origins of the Oregon Trail. Focus your study on how those developments were influenced by the Columbia-Snake system.

4. Read *The Columbia River Watch Primer: The River Within Us*, a short book of poetry, essays, and brief articles on rivers large and small. This can be done as a reading project alone or as material for written projects. The booklet is published by the Institute of the Rockies, Box 9383, Missoula, Montana 59807. It costs $1.00.

5. Develop a series of questions regarding the political trade-offs in the use of Columbia River water and the question of state, regional, and national control over use and development. Interview your local politicians—state legislator, county commissioners, city council members, and so on—and compare their responses.

6. People are debating how the Columbia River Gorge should be managed. Interview members of Friends of the Gorge, the Gorge Defense League, and other interest groups concerned about the gorge. Determine their positions and strategies. Define their positions, reactions, and statements and try to determine the differences among them.

7. Write an annotated bibliography of resources (books, articles, speakers, tours, and so on) in your area. Your teacher can hand this out to next year's class.

8. Research the history of stern-wheelers on the Columbia, taking special note of reasons for their popularity and reasons for their decline.

9. Create a bulletin board or a chart that illustrates the products that arrive in the Northwest from other countries by way of the Columbia.

10. Create a display map that shows the Indian tribes that lived on the Columbia River. Demonstrate where these tribes are concentrated today.

11. Make a collection of Indian legends that contain references to the Columbia or Snake rivers.

12. Develop a fishing guide of fish that live in the Columbia and Snake rivers.

13. Create a map of the rivers that includes all the bridges that cross it. Research and write a short history of each bridge.

14. What wildlife populations depend upon the Columbia and Snake for their livelihood? Write a booklet describing the impact of the rivers on their lives.

15. Compile a guide of the different environmental groups interested in preserving the rivers, their tributaries, and the Columbia estuary.

16. Research the explorers of the Columbia River and create a tape or write a paper about their explorations.

17. Imagine that the river does not exist. List all the things we would need to meet our daily requirements (trains, trucks, and so on) if this were true.

18. Plan a river trip from Astoria to Lewiston by small boat or canoe. Plan to get all your food and water from the river. Describe the clothing and tools you would need to take with you. Include information about the locks you would need to pass through on your journey. Explain how you would go about getting through the locks.

19. Create a historical graph showing the growth of towns and cities alongthe Columbia from the 1840s to the present.

20. Research the history of ferry boats on the river. Who did they serve? Where were they? How much travel did they make possible?

21. Compile a career guide for high school seniors interested in working on the river (as fishermen, bridge tenders, river pilots, and so on). Get your information from a variety of sources, including interviews.

22. Create a booklet for young children in which you illustrate and explain how a dam and locks work.

23. Create a crossword puzzle of the Columbia and Snake in which you focus on one of the following topics:
    shipping and navigation
    agriculture and irrigation
    towns and cities along the rivers
    plant and animal life on the rivers
    Indian groups who lived along the rivers

24. Research women, who are often overlooked but who have had an impact on the use of the rivers. Include both historical and contemporary figures. Create a chart or bulletin board showing their contributions. A good source is the Women's Shipping Club in Portland.

25. Research a current issue regarding use of the Columbia-Snake system, and write a letter to an appropriate elected official outlining your views.

26. Read *The Journals of Lewis and Clark*. Compare what Lewis and Clark said about the Columbia with what you have read during this study and what you already know.

27. Compile a list of all the sporting events that take place because of the Columbia, such as the Cross Channel Swim at Hood River. What are the origins of the event? What is its purpose? What arrangements are made to hold back water from the dams and traffic from the locks?

28. Find out if any new dams are being proposed. Where? What changes will they bring?

29. Research ghost towns on the Columbia River system. When did they thrive? What industries did they serve? When and why did they fade out?

30. Research railroad lines that have served the Columbia region. How have they changed since 1900? Did the river make any differences in the changes?

31. Compile a cook book of fish (other than salmon and steelhead) that come from the Columbia and Snake.

32. Undertake an oral history similar to the Foxfire project. Interview elderly people who live along the Columbia and write up their answers to your questions.

33. What plants are native to the Columbia region? Read about them, collect all that you can, and develop your findings into a presentation.

34. Paint, sketch, draw, or use some visual medium to portray wildlife or plants in the Columbia region.

35. Sit, listen, smell, watch, and observe the waters of the Columbia or some other river. Write what you sensed.

36. Collect data on weather patterns in the Columbia regions where you live. Record temperatures, precipitation, wind, and so on.

Teaching Resources

Teachers are encouraged to send for the following materials for background information and use in class. Most of the items proved useful in preparing this curriculum.

Brochures/Newsletters

Are We Prepared For the Next Drought? Managing Low Water Year Emergencies. Charles F. Broches, Michael S. Spranger, and Bill Williams. 1983. Conference proceedings. Available from Washington Sea Grant, 3716 Brooklyn Avenue NE, Seattle, WA 98105-6716. $9.00.

Discusses the impact and implications that a serious low-water year (drought) would have on the Columbia River system and the Pacific Northwest. Papers are from major users and water managers of the Columbia River system.

The Dalles Lock and Dam, John Day Lock and Dam, and *Bonneville Lock and Dam.* Obtain from Portland District U.S. Army Corps of Engineers, 319 SW Pine, Portland, OR 97204. No cost.

Pamphlets that describe the operation, management, and multiple purposes of Bonneville, The Dalles, and John Day dams.

Columbia River Salmon. Michael S. Spranger and Randall S. Anderson. 1988. Available from Washington Sea Grant, 3716 Brooklyn Avenue NE, Seattle, WA 98105-6716. $3.00.

Traces the Columbia river salmon from its historic beginnings to the present efforts to restore and protect salmon runs.

Columbia River Sturgeon. Randall S. Anderson. 1988. Available from Washington Sea Grant, 3716 Brooklyn Avenue NE, Seattle, WA 98105-6716. $3.00.

Discusses the biology and life history of Columbia River sturgeon and present concerns about overharvesting and efforts to manage and rejuvenate this fishery.

Politics and Economics of Columbia River Water. Charles F. Broches and Michael S. Spranger. 1985. Available from Washington Sea Grant, 3716 Brooklyn Avenue NE, Seattle, WA 98105-6716. $10.00.

At one time the Columbia was considered an unlimited resource, but the river may no longer be capable of meeting all the demands being placed on it.

The Role of the Columbia/Snake Navigation System in Intermodel Ocean Transportation. James R. Jones. 1980. ORESU-T-80-001. Available from Sea Grant Communications, Oregon State University, Administrative Services A402, Corvallis, OR 97331-2134. No cost.

Backgrounder. Newsletter available from the Bonneville Power Administration, P.O. Box 12999, Portland, Oregon 97212.

Selected titles from this series:
"The World's Biggest Fish Story: The Columbia River's Salmon," "Downstream Fish Migration: Improving the Odds of Survival," "Columbia River Treaty Revisited."

Books

Magnificent Gateway. John Allen. 1979. Available from Timber Press, 9999 SW Wilshire, Portland, OR 97075. $8.50.

Describes the geology of the Columbia River and Columbia River Gorge. It also contains a mileage road log excellent for self-instructed field trips on the geology of the gorge.

Cataclysms on the Columbia. 1987. John Allen, Marjorie Burns, and Sam Sargent. Available from Timber Press, 9999 SW Wilshire, Portland, OR 97075. $19.95.

Tells the story of the cataclysmic floods that created the Columbia Gorge and of the geologist who first postulated them.

The Making of Oregon: A Study in Historical Geography. Samuel N. Dicken and Emily F. Dicken. 1979. Available from the Oregon Historical Society, 1230 SW Park, Portland, OR 97205. Cost $10.95.

Discusses the natural history of Oregon.

Barbie. Roger T. Tetlow and Graham J. Barbie. 1990. Binfort and Mort Publishing. 1202 NW 17th Ave., Portland, Oregon 97209. $25.00.

Explores the cannery industry of the Columbia River.

Reach of Tide, Ring of History. Sam McKinney. 1987. Oregon Historical Society Press, 1230 SW Park Avenue, Portland, Oregon 97205. $19.95.

Offers a look at the history of the Columbia River.

Voyages of the Columbia to the Northwest Coast, 1787-1790 and 1790-1793. Frederick W. Howay. 1990, 2nd ed. Oregon Historical Society Press. 1230 S.W. Park Avenue. Portland, Oregon 97205. $40.00.

By one of the foremost maritime historians of the Pacific coast. Contains the logs from four different captains of the Columbia.

Audiovisual Materials

The Columbia River Gorge: A Natural History. 1985. Available from Northwest Film Center, 1219 SW Park Ave., Portland, OR 97205. 16-mm film: rental $35, purchase $325; video: rental (check with Northwest Film Center), purchase $225.

Student-produced 16-mm film that uses claymation to depict the formation of the gorge by floods.

Estuary: Columbia's Link with the Sea. 1982. Available from Sea Grant Communications, Oregon State University, Administrative Services Building 402, Corvallis, OR 97331-2134. 16-mm film: rental $20, purchase $200; VHS video: rental $20, purchase $50.

Twenty-eight-minute 16-mm film points out the importance of the Columbia River estuary. It also discusses the multiple uses of the Columbia and how they affect the estuary and its users.

Here Comes the Steamer. Obtain from the Oregon Historical Society, 1230 SW Park, Portland, OR 97205. Rental $5.

Slide program showing the importance and historical role of steamboats on the Columbia and Willamette rivers.

Journey of the Kings. Obtain from Northwest Power Planning Council, 851 SW Sixth Avenue, Suite 1100, Portland, OR 97204. No cost.

A 16-mm film that discusses the plight of the Columbia River salmon and the remarkable regional program designed to protect them. This beautiful movie soars over some of the most stunning landscapes in the world as it follows the salmon from their upriver spawning grounds, through the mighty dams, to the sea, and back again. Twenty-eight minutes long.

Work is our Joy: The Story of the Columbia River Gillnetter. 1989. Available from Extension Sea Grant, OSU Seafoods Laboratory, 250 36th St. Astoria, OR 97103. Purchase: $25.00 plus $3.00 shipping.

A video looking at the heyday of the gill net salmon fisheries on the Columbia River through interviews with fishermen.

Other Resources

Contact a local port for a possible field trip, outside speaker, or written materials. For example, the Port of Portland offers the following:

- Tours of the port (adapted for grade 3 and above)

  Requires groups of 15 or more. Your school must provide transportation—a single vehicle for the whole group—during the tour itself.

- Van Program (grades 4 and 5)

  A 38-foot trailer is used to teach students about the port and Oregon's role in international trade.

Prior to your participation in either the port tour or the van program, representatives of the Port of Portland will be happy to make a background presentation to your class.

- Speaker's Bureau (high school-adult)

  A presentation of current issues facing the port.

Contact a dam near you and arrange a tour. Students can watch a fish ladder in operation, see the turbines, learn about the spillway, and get some history on the development of the dam.

INTRODUCTION

Introductory Activities

Before you begin this study of the Columbia River system—its history, its uses, and its effect on the lives of people for 12,000 years—do the following:

A. Write to any town on the Columbia River system. Send your letter either to the Chamber of Commerce or, if the town is especially small, to the local newspaper. Ask these questions:

- How did the town get its name? If the town has an Indian name, what does it mean in English?
- What effect does the Columbia River have on the town's development, economy, employment, and unusual activities, such as a yearly festival?
- Is the town growing or declining in population, and what role does the river play in its growth or decline?
- What recreational opportunities are available in or near the town? (You will need this for a later assignment.)

Ask your source to send you whatever other information may be available on the town. Send a self-addressed, stamped envelope along with your letter and indicate that you need the material for a class assignment and would like to have it as quickly as possible.

Make certain that your letter has correct spelling, good punctuation and grammar, and complete sentences.

B. Draw in the Columbia on the blank map (page 11). Place the following items on the map: Astoria, Portland, Vancouver, the Willamette River, The Dalles, the Snake River, Grand Coulee Dam, Pasco, the Washington-Canadian border, Lewiston, Longview, Bonneville Dam, and the states of Idaho, Oregon, and Washington.

If this is difficult, don't be embarrassed. You will know the river by the time your study is finished.

C. Look at the map at the end of this section. Find what subdivision you live in. What is the name of the subdivision? Compare the map you just drew with this one.

D. Complete the Hidden Word Puzzle. After doing it, discuss in class each word, making certain all the words are understood.

E. Start the following discussion: The entire class should pick one of these tributaries of the Columbia River system:
the Clearwater River
the Boise River
the Deschutes River
the Lewis River
the Spokane River

Answer the following questions by using a map, atlas, or other resource:

1. What major towns and cities are situated on the river?
2. What state and county are they in?
3. What dams and industry are near?
4. Is the area used much for agriculture?
5. Is the area a popular recreation and sportfishing site?
6. What other significant areas are located on the river: hatcheries? wildlife refuges?

Now discuss in class or small groups the following:

1. Assume that some county commissioners want to develop the land around the mouth of the river for a public park with boat ramp, fishing access, swimming, picnicking, and hiking trails. They plan to use 1,280 acres (two square miles) for this purpose.

Which of the following groups would likely support the idea? Why?

- Small retail businesses in nearby towns
- Industry nearby and on the tributary
- Conservationists
- Farmers whose land is on the tributary, near the site
- Local sheriff
- Bankers in nearby towns
- Citizens of the towns who enjoy outdoor recreation
- Fishermen
- Indians
- Local Chamber of Commerce
- Local public utility commission
- Federal and state agencies

2. Why do you think the groups you left out would not support the plan?

3. Which people who usually are on the same side of an issue would probably take opposing stands on this issue? Why? What arguments do you think the opponents would use against the plan?

4. How would you vote if you were on the Board of County Commissioners? Why? Compare your vote with that of other members of the class and discuss these questions.

5. How might this situation change if there were plans to develop a 1,000-megawatt, coal-fired, electricity-generating power plant on this site rather than a public park? What differences would there be in opposition to the plan? Why?

Keep track of your ideas in this activity. In discussing this issue and in making your decisions, you are going with your hunches, your biases and opinions, and the knowledge you already have. When you complete this study, you will have more information than you now have with which to make a rational, well-informed decision. The point is, the Columbia River, like any other river or any mountain or meadow, is only so large. It is not getting larger. If additional use is planned, some other use must be reduced.

If you have only enough chairs in your classroom for each student to use one, and you desire two, someone will have to give up his or hers. The student won't like that, and will try to convince your teacher that your desires are not only unnecessary, but harmful. You will need to convince your teacher that, not only is your request legitimate, but in all likelihood the entire class will benefit from your having two chairs.

So it is with politics. The Columbia River is definitely a political arena. With the construction of dams, some people gain and some lose. Industrial pollution benefits some and hurts others. The diversion of water for agricultural purposes (irrigation) helps some interests and diminishes the water supply for other uses (power generation, for example). It is a series of trade-offs. There simply may not be enough water for all of us to do everything we want with it.

After you read the above, think through your group's responses to the questions and issues you have addressed. At the conclusion of the study of the Columbia, you will work on the same questions and issues.

F. Take the following pretest:

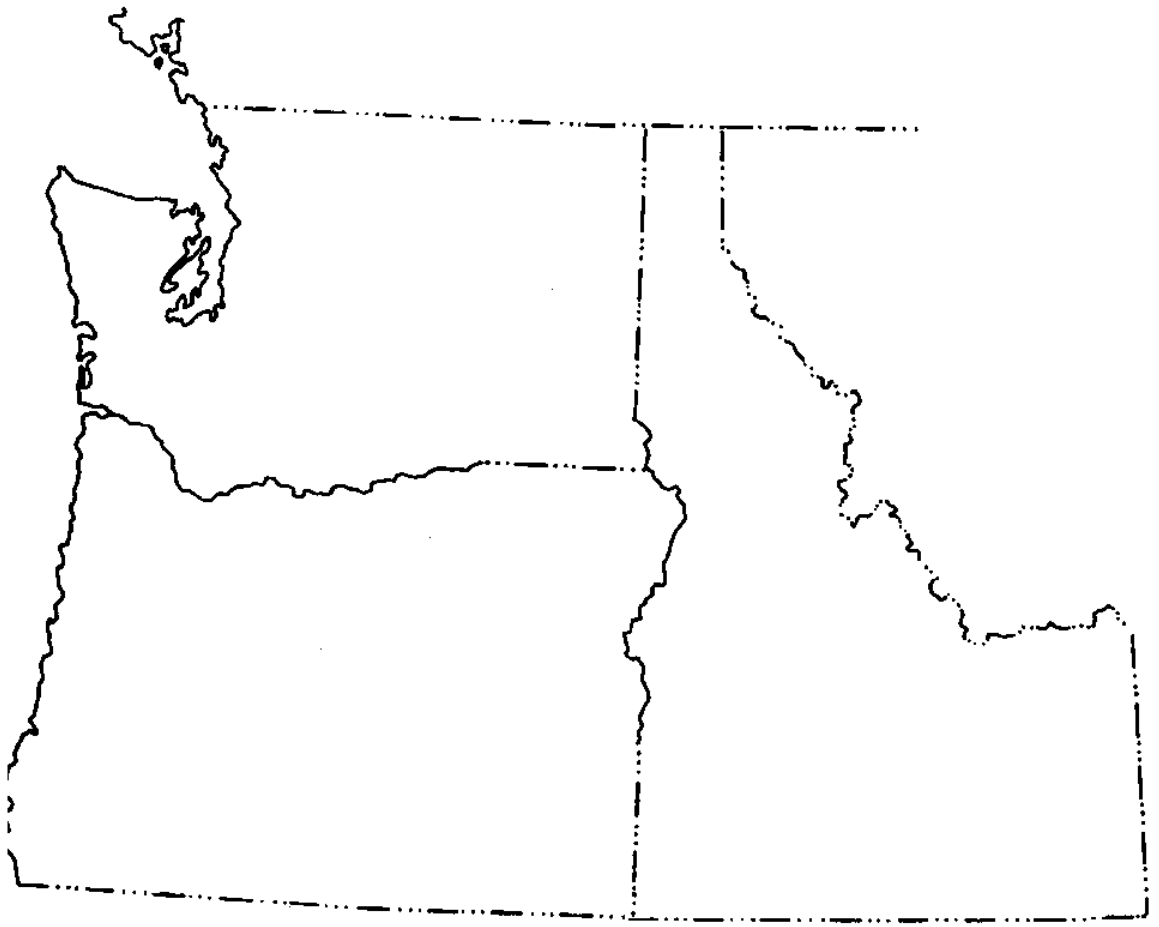
1. In what direction does the Columbia River flow?
2. Where is the source of the Columbia?
3. How large is the Columbia River system in length? in square miles?
4. What is the name of the city at the mouth of the Columbia?
5. What is the largest tributary of the Columbia?
6. Approximately how long have people lived along the Columbia?
7. What is the first dam upstream from the mouth of the Columbia?
8. Which of the following is not a major use of the Columbia: (a) fishing, (b) agriculture, (c) navigation, (d) recreation, (e) power generation, (f) scenic, wild river?
9. Which of the following is a major city on the Columbia: (a) Spokane, (b) Portland, (c) Seattle, (d) Boise?
10. Why is there political controversy over use of the river?

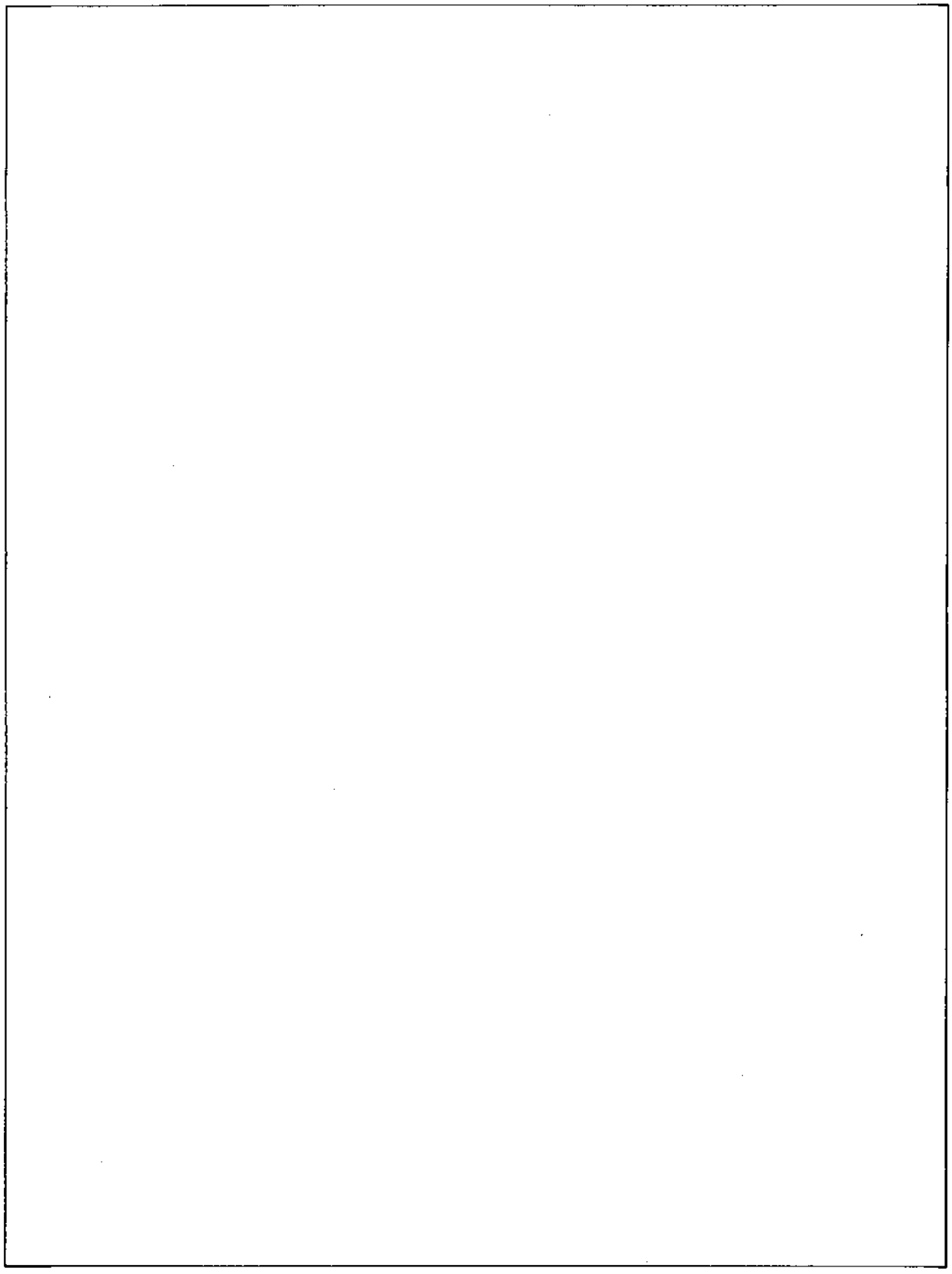
Correct your own test from the answers on the next page. It will not be graded. At the end of this study, you will take it again and then compare your results. It is not expected that you will get many correct answers now.

Answers to Pretest

1. north, west, south, west, north, west
2. Columbia Lake in British Columbia, Canada
3. The Columbia River flows more than 1,200 miles before it enters the Pacific Ocean. The river and its tributaries drain nearly 260,000 square miles—an area comparable to that of France. The Columbia is the largest North American river flowing into the Pacific Ocean. Its flow is ten times that of the Colorado River. In the United States, it is second only to the Mississippi River in average annual runoff.
4. Astoria, Oregon, which is named after John Jacob Astor, a famous explorer and trader
5. Snake River
6. 12,000 years
7. Bonneville Dam, named after the early explorer, Captain Benjamin Bonneville
8. scenic wild river
9. Portland, Oregon
10. All the water in the river is now being used. Every decision involving a present or future use now requires a trade-off. This means making a decision to give up the benefits of one thing to gain benefits from another. These decisions become political because all groups want to maintain or increase their use of the water.

Map for Activity B, page 8





Activity: Hidden Word Puzzle

See if you can find these words in the puzzle. You can play many different ways. For example, let one person find all the fish-related words, while another finds the birds, and so on. You might want to use different colored highlighters for each category. Good luck, and have fun.

BLUEBACK
DOVE
WASHINGTON
TURBINE
CHINOOK
KILLDEER
OREGON
KILOWATT
COHO
DUCK
TRAIL
SPILLWAY
COUNTER
MALLARD
BONNEVILLE
GENERATOR
ELECTRICITY
FINGERLING
OSPREY
RIVER
GANTRY
FISH LADDER
CANADA GOOSE
CORPS OF ENGINEERS
POWER
GORGE
GULL
LAMPREY
BARGE
LOG RAFT
RAINBOW
ISLAND
LOCKS
SALMON
EAGLE
COLUMBIA
HYDRO
SHAD
DAM
TUGBOAT
SOCKEYE
LEWIS AND CLARK
TAILRACE
SPAWN
STEELHEAD
BRADFORD
NAVIGATION
STURGEON
WATER
CRANE
TROUT
CASCADES
SWING BRIDGE
WHEAT

K I L O W A T T O Z Q C O L U M B I A V D C M
D F G R H S J M T P A X F L R L C W B R A A J
R S P I L L W A Y N H U E S M Z C V A S I P W
B D O V E E E I A S O C K E Y E T L C W Y X A
L L G E H H O D N R L C F I S H L A D D E R S
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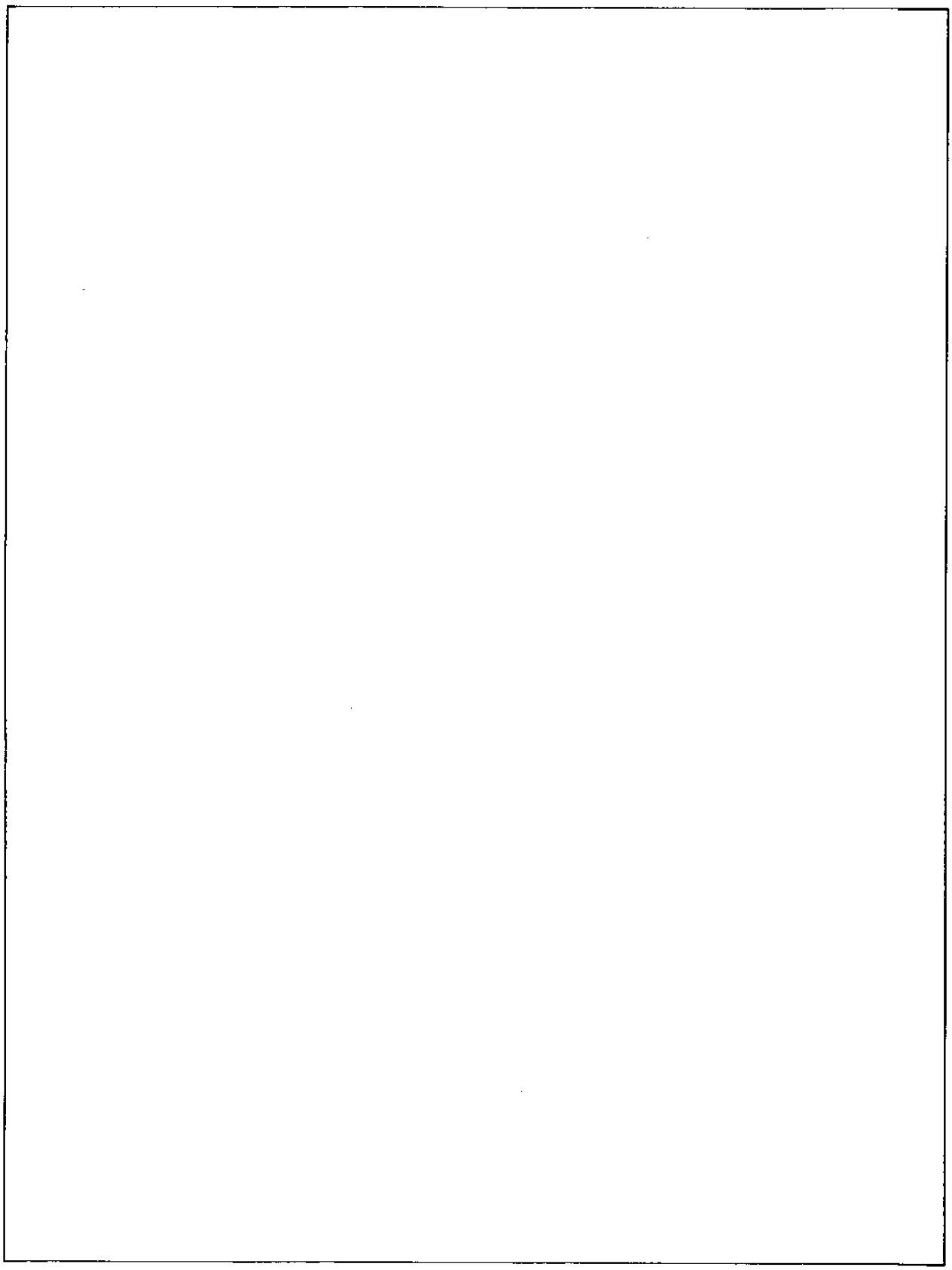


HISTORY

HISTORY: *A READING*

The Columbia River originates in the high country of eastern British Columbia, Canada. The Snake River, the Columbia's main tributary, has its origins in the high country of Yellowstone National Park in Wyoming. In fact, the two river systems that dominated the shaping of our nation's western history, the Columbia and the Missouri, have origins very close to each other—less than the distance from Seattle to Portland. The Columbia-Snake drains the western slope of the Rockies and enters the Pacific Ocean between the states of Washington and Oregon at Astoria, Oregon. The Missouri River originates north of the Snake, in the Rocky Mountains. It drains the eastern slope of the Rockies, entering the Mississippi River near St. Louis, Missouri. These rivers were important transportation routes for the early explorers, such as Lewis and Clark, and the early settlers who gradually claimed this land for the United States.

About 6 to 7 million years ago the Columbia changed course, taking its present route: it ran from its source northward in British Columbia, made a 180° turn, flowed southward into eastern Washington, received the waters of the Snake near present Pasco, Washington, turned westward to Portland, and then north to Longview and west again to the sea. This change was the result of floods, landslides, and volcanic eruptions that would make the eruption of Mt. St. Helens look like a low-budget Fourth of July celebration. The first evidence we have of these eruptions occurred 40 million years ago.

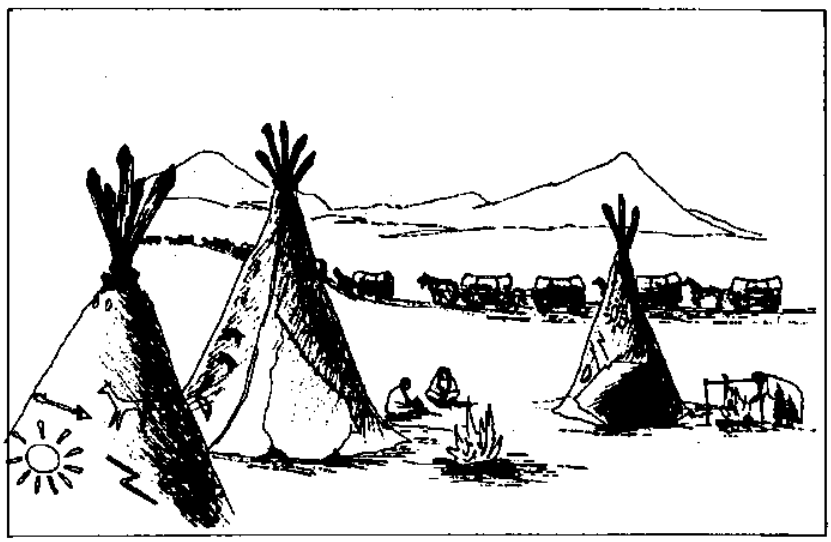
The Columbia-Snake river system forms one of the great rivers of the world, draining an area of over 262,000 square miles. This area includes most of Idaho, about two-thirds of Oregon and Washington, the western third of Montana, small portions of Wyoming, Nevada, and Utah, and part of British Columbia. This land equals an area the size of France!

The annual surface water runoff at the mouth of the river averages 256 million acre feet, which equals a continuous flow of 350,000 cubic feet a second entering the Pacific Ocean.* This volume ranks the Columbia fourth among North America's great rivers. Only the Mississippi, the St. Lawrence, and the Mackenzie are larger. In comparison with other great rivers, the Columbia exceeds twice over the volume of the Nile. Its flow is also more than ten times that of the Colorado. In the United States, only the Mississippi River has more water than the Columbia.

The Columbia flows over 1,200 miles from its Canadian origin until it enters the Pacific Ocean. Twenty percent of the water of the Columbia is provided by the Snake and its tributaries. This complex system, the Columbia-Snake, has been a center of economic activity since the first people occupied these lands.

**In terms somewhat more relevant to everyday life, one acre foot equals 1,000 liters, or 264 gallons. Thus, the average surface water runoff at the mouth equals 67,584,000,000 gallons. This is about 1.16 times the total annual water consumption of approximately 90 percent of the residents of King County (including Seattle, Washington).*

The First Inhabitants



From the dawn of early civilization, people have lived along the banks of the Columbia. Some anthropologists claim that people have lived in this area for over 12,000 years. The first dated evidence of a settlement, the oldest continuously occupied permanent village known to us in the Columbia area, was found near the present site of The Dalles, Oregon. This village, known to the Indians as Wy-am, dates back over 10,000 years.

Rich native cultures that engaged in fishing, trading, and art developed and flourished along the Columbia's banks. Among these people were the Chinook Nation, which claimed as its territory land from Wy-am to the Pacific Ocean, and the Sahaptin Nation, which lived east of Wy-am. On the Snake River, the Shoshone, Bannock, Nez Perce, and Paiutes claimed the land.

These people all shared in the bountiful salmon of the Columbia. They would meet annually at Wy-am near the ancient fishing grounds of Celilo Falls, where the natives of the interior would trade dried salmon, hides, and baskets for the shells and woven bark of the coastal tribes. This culture flourished for thousands of years until the early 19th century when "invaders from the east" completely disrupted it.

The Explorers and Settlers

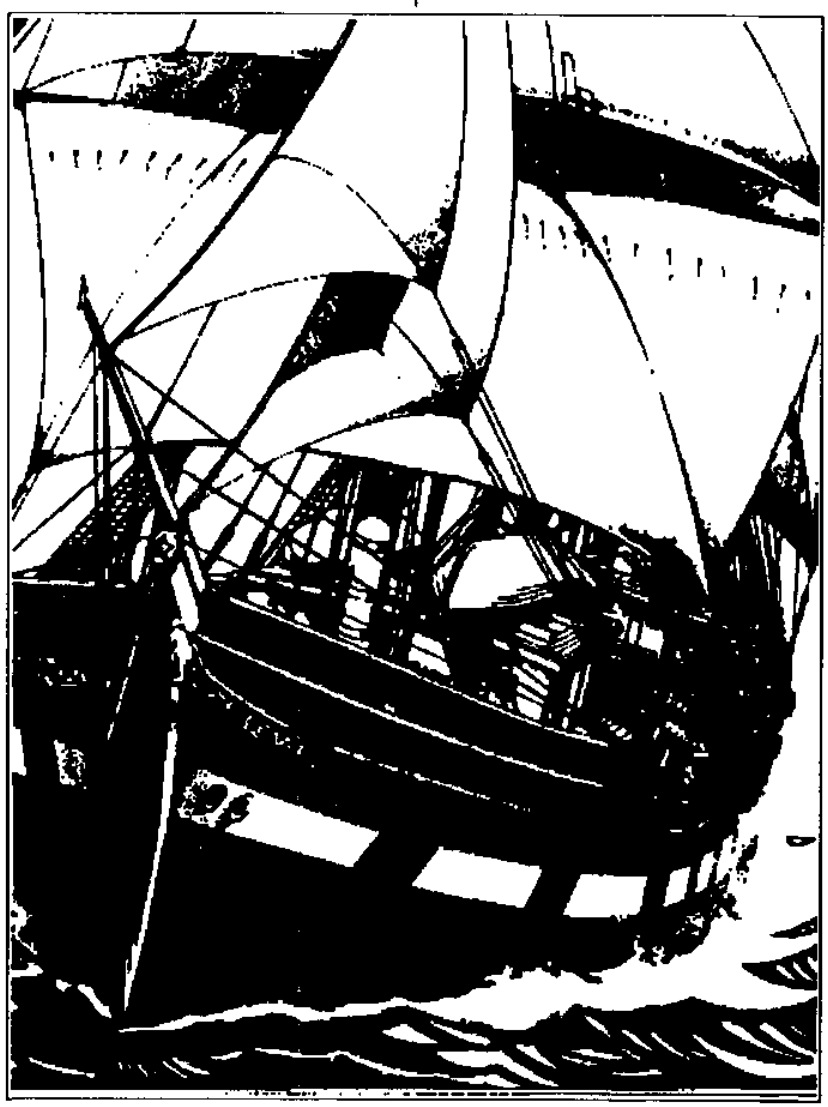
The Columbia River was the last major river "discovered" and developed in the United States. Since the 16th century, Europeans had traveled along the Pacific coast hoping to find the "Mysterious River of the West" which would connect their countries with the riches of the Orient. Despite this extensive search, the Columbia River was not discovered by explorers until 1792 when an American from Boston, Captain Robert Gray, entered the mouth of the Columbia.

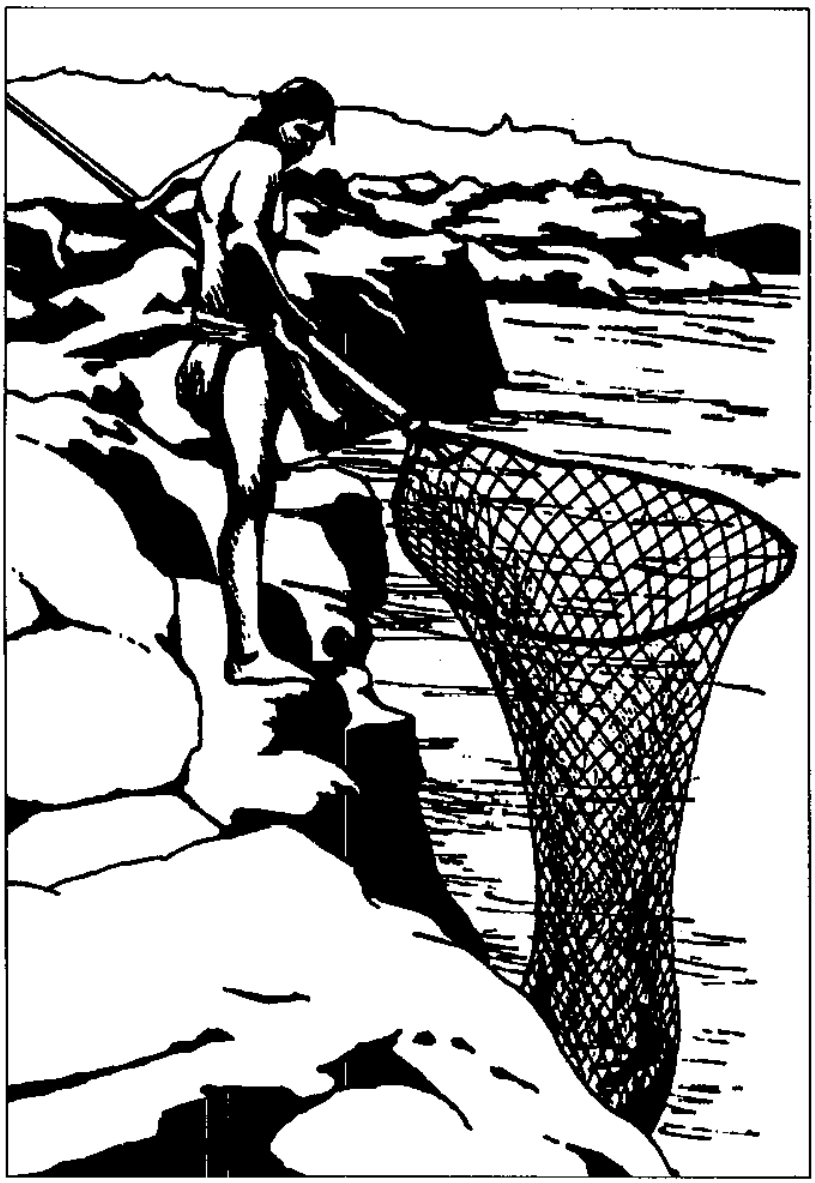
Although the river did not lead to the riches of the Orient, the land was rich in natural resources. When word of this rich area spread, the invasion began.

In 1805, captains Lewis and Clark, on a mission from President Thomas Jefferson, entered the Columbia-Snake region in their efforts to explore and map the great land of the west. After them, other explorers established a settlement in 1811 in Astoria, and isolated fur trappers began making their way along the upper Snake. Fort Vancouver was established by England's Hudson Bay Company in 1825. After that, things moved fast.

The mountain men ran a thriving fur trade all along the Snake tributaries. Jedediah Smith and his men took a hot, dry route from the Rockies to California and then up into Oregon. After a disastrous experience with Indians in southern Oregon, he made his way to Fort Vancouver by going down the Willamette.

In the 1830s, missionaries Jason and Daniel Lee and Marcus Whitman established Christianity as the new religion of the Indians in the Willamette Valley and also near the present cities of The Dalles, Oregon, and Walla Walla, Washington. The missionaries brought many features of white culture to the area, the most important of which was the practice of agriculture. They also publicized the riches of the area to the people of the East. It was only a short time later—in the 1840s—when wagon trains bringing settlers over the 2,000 miles of the extremely hazardous Oregon Trail entered the Columbia region by way of the Snake. More settlers followed, bringing with them the customs and values of European Americans.





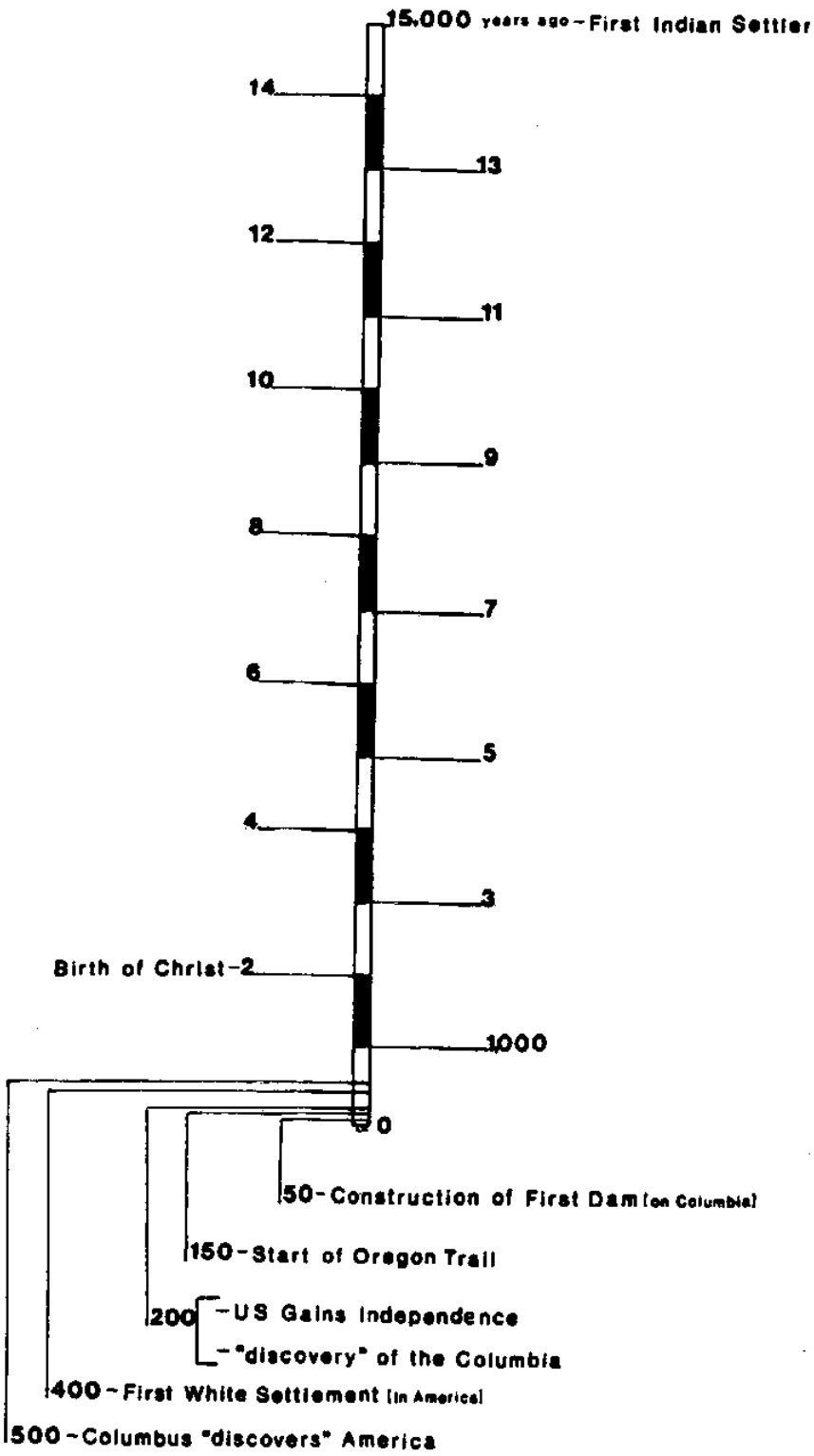
These invaders began to claim the land for themselves, altering the lifestyles that had existed for thousands of years. They brought disease, which eventually killed most of the earlier people, and plows, which tore up the land.

In 1848, 12 years before the Civil War broke out, the United States established the Oregon Territory, the first territory the nation claimed west of the Rocky Mountains, its western boundary at that time. The Oregon Territory was huge, comprising what are now the states of Oregon, Washington, and Idaho, and parts of Montana and Wyoming.

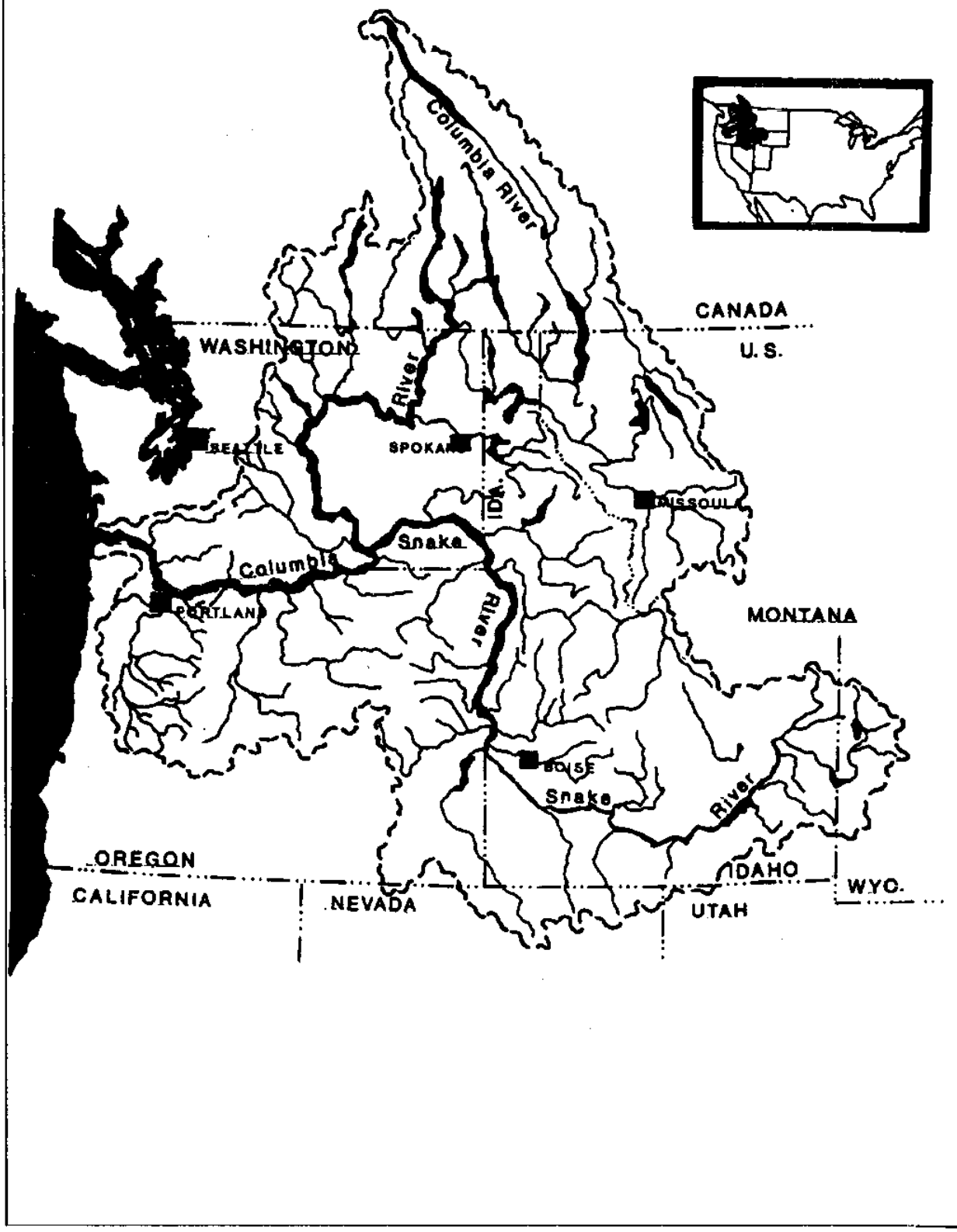
The United States claimed this land to establish "law and order" over an area where for 12,000 years the original inhabitants had done things their own way. Afraid of the diseases brought by these newcomers and disgusted with land claims and plows, some of the natives fought back. Because they retaliated against the taking of their land, they were rounded up onto reservations by the military Territorial Government. To the east the nation was stretching and flexing. Some nations with claims, like England and France, left the area. Other nations—like the Chinook and the Sahaptin—were defeated because they had no other place to go.

Within a short time, some 50 years, the Columbia River—at least, the Columbia south of the Canadian border—had become a United States "resource."

Human Use of the Columbia



The Columbia/Snake River Drainage System



Lesson Activities

I. Words and Concepts

Write and discuss definitions to the following:

1. tributary
2. origin
3. source
4. volcanic eruption
5. evidence
6. economic activity
7. inhabitant
8. emigrant
9. continuously occupied village
10. retaliate
11. isolated
12. thriving
13. disastrous
14. settler
15. hazardous
16. missionary

II. Class Activities

On a map, find the Pacific Northwest, then complete the following activities:

1. Identify the sources of the Columbia and Snake rivers.
2. Identify the following tributaries:
   - Snake-Clearwater
   - Salmon
   - Payette
   - Boise
   - Columbia-Spokane
   - Umatilla
   - John Day
   - Willamette
   - Lewis
   - Cowlitz
3. Identify the following sites in the Columbia River basin:
   - Walla Walla, Washington
   - Pasco, Washington
   - The Dalles, Oregon
   - Portland, Oregon
   - Vancouver, Washington
   - Astoria, Oregon
   - Lewiston, Idaho
   - Salem, Oregon
   - Idaho Falls, Idaho
   - Twin Falls, Idaho
4. Outline the Oregon Territory.

III. Class Discussion or Written Assignments

1. What are some of the reasons we have relatively little information on Indian life on the Columbia, even though it goes back 12,000 years? Discuss the lifestyle and living conditions of Indians in the Columbia region.
2. On the map, look at the territories occupied by the various Indian tribes. How were these tribes similar? What differences were there among these tribes?
3. The Columbia pumps over 128,000 gallons of water into the Pacific Ocean every minute. Is that water wasted as a human resource?
4. Do you agree with calling the early white settlers of the Columbia region "invaders"? Explain.
5. Why was the plow seen by the Indians as such a threat to their way of life?
6. Develop a plan for the 1840-1860 period for Indians and settlers to coexist on the Columbia and its region without war. Think of reasons your plan was not used.
7. Why did President Thomas Jefferson want the area west of the Rockies explored? He had just bought the Louisiana Purchase Territory from France, but it extended to the Rocky Mountains.
8. Imagine that you are a member of the Lewis and Clark expedition, the first white people to enter this wild, unexplored territory. Discuss the adversities, dangers, and hardships you endured during your three-year exploration of the West.
9. Imagine the first meeting between the white settlers and the Indians. What do you think they discussed? What differences were there in their cultures? What was similar in their cultures? Discuss why the attitudes they had for one another changed over time.

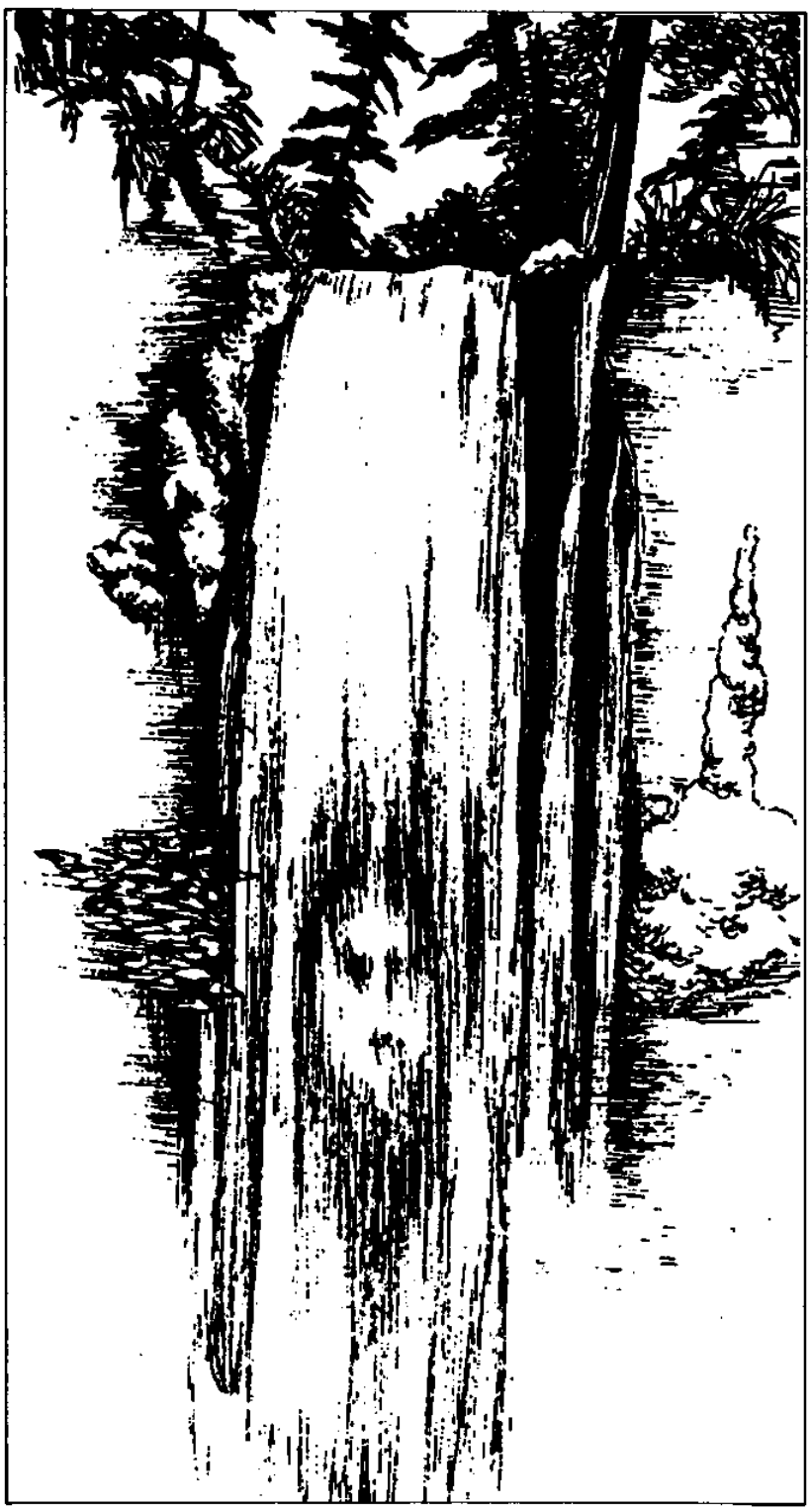
CHANGES IN THE RIVER: *A READING*

Near the end of the Ice Age—between 12,000 and 19,000 years ago—a huge ice dam in the region of what is now northern Idaho and western Montana created an enormous lake (known as Lake Missoula). Waters backed up over 250 miles, forming a lake about half the size of the present Lake Michigan. After many years these waters eroded the ice dam. Suddenly a great force of water rushed over the dam and into eastern Washington. It flooded most of southeastern Washington and helped carve out the Columbia Gorge that separates Washington and Oregon between The Dalles and the Sandy River just east of Portland. These were no minor floods. The water flowing through this area during the floods has been estimated to be ten times the combined flow of all the rivers of the world.

This raging series of floods had elevations ranging from 1,000 feet above sea level to 600 feet near Portland, and 400 feet down the Willamette Valley, covering land as far south as what is now Eugene, Oregon. Geologists estimate that during a period of 5,000 years, the floods occurred over 40 times, at intervals of from 175 to 200 years.

The effect of these floods on the land was spectacular. It is nowhere clearer than in the Columbia Gorge where famous waterfalls, such as Multnomah Falls, demonstrate how rivers were left hanging by the force of the rushing water. In fact, some refer to these falls as "hanging rivers," rather than waterfalls.

It has been estimated that one flood came through the gorge at a rate of 1.66 cubic miles of water an hour for two to three weeks. Can you imagine the impact of 1.66 cubic miles an hour?



When the floods receded, the Columbia was left for many centuries a wild river flowing freely and rapidly to the sea. About 700 years ago (the time of Gengis Khan), a landslide near what is now Bonneville Dam caused that section of the gorge to narrow, forming dangerous rapids called the "great cascades." They became a considerable threat to river transportation and travel. In the 19th century, many pioneers who had survived the difficult Oregon Trail lost their lives trying to float their covered wagons on barges through the rapids. After months on the trail some of these pioneers, within 50 miles of the Willamette Valley, didn't make it because the river was too wild.

In the early part of the 20th century it was decided to tame the river for flood control, navigation, irrigation, and generation of electric power. Modern civilization came to the Columbia. Navigation canals were built around the great cascades (1896) and Celilo Falls (1915). In the 1930s during the Great Depression, the construction of dams began. Construction has continued into the present. Bonneville Dam was built, providing jobs to many who were unemployed during the Depression. Then came Grand Coulee Dam in eastern Washington. Now there are major dams all along the Columbia and the Snake. This Columbia-Snake system, no longer a wild river, is often described as a series of lakes.

The dams accomplished many things: they provided jobs, increased irrigation of agricultural land, generated electrical power, controlled flood waters, and made it possible, with the use of navigation locks, for grain and timber to be shipped from Lewiston, Idaho (465 miles from the Pacific Ocean), to nations across the Pacific. In fact, Lewiston now connects huge agricultural areas east of the Rockies with markets across the Pacific.

However, in taming the Columbia, people have destroyed wildlife habitat, reduced or eliminated salmon runs, and submerged scenic and historical areas. You need to decide what you think of this aspect of water management. Remember the discussion you had on trade-offs? Trade-offs have already been made, and the final chapter on the history of the Columbia might be that it no longer can provide enough water to meet all our needs. When Bonneville Dam was first built, some critics said it would provide more electricity then we could ever use. That has proven to be a mistaken assumption. We all need to think about these questions: Have we overdone it? Are we using water too fast? Have we developed too many uses for this water? Will the Columbia become an exhausted resource?

Lesson Activities

I. Words and Concepts

Define the following:

1. elevation
2. enormous
3. estimate
4. demonstrate
5. cubic mile
6. navigation
7. irrigation
8. Great Depression
9. habitat
10. inundated
11. trade-offs

II. Class Activities

1. On a map, recreate the great flood. Locate regions on the map where the ice dams were located. Trace the flood waters down the Columbia. What cities that now exist would have been under water?

2. Compare the two maps on the next pages: The Four Columbia-Snake Zones and the Major Hydroelectric Dams on the Lower Columbia and Snake. In which of the following zones are the dams located?
   a. upper Columbia
   b. mid-Columbia and lower Snake
   c. mid- and upper Snake
   d. lower Columbia

3. Discuss the great floods. Compare this great geological occurrence with present-day earthquakes and floods.

4. Sam Barlow, after traveling the Oregon Trail, decided to construct a "road" around the southern slope of Mt. Hood so that emigrants could get to the Willamette Valley without risking the great cascades. His work was exhausting and dangerous, and the resulting road was terrible. However, many families decided to take the road instead of the water route. Barlow charged them a toll to use his road. Read more about Barlow Road. Compare his route with that of the river.

   Imagine yourself a pioneer facing the great cascade rapids after many months on the Oregon Trail. Would you have made a raft and attempted the run down the river, or would you have looked for a trail around Mt. Hood?

5. A legend is a special type of story. Legends were used by the Indians to explain their natural surroundings or environment. The word *legend* comes from the Latin *legendus*, which means to be read. But the Indians did not write out their legends. Instead, they passed them on to others in several interesting ways. They told their legends as stories around the fire, sang them, and acted them out in dances. They also painted their legends as petroglyphs, or rock carvings.

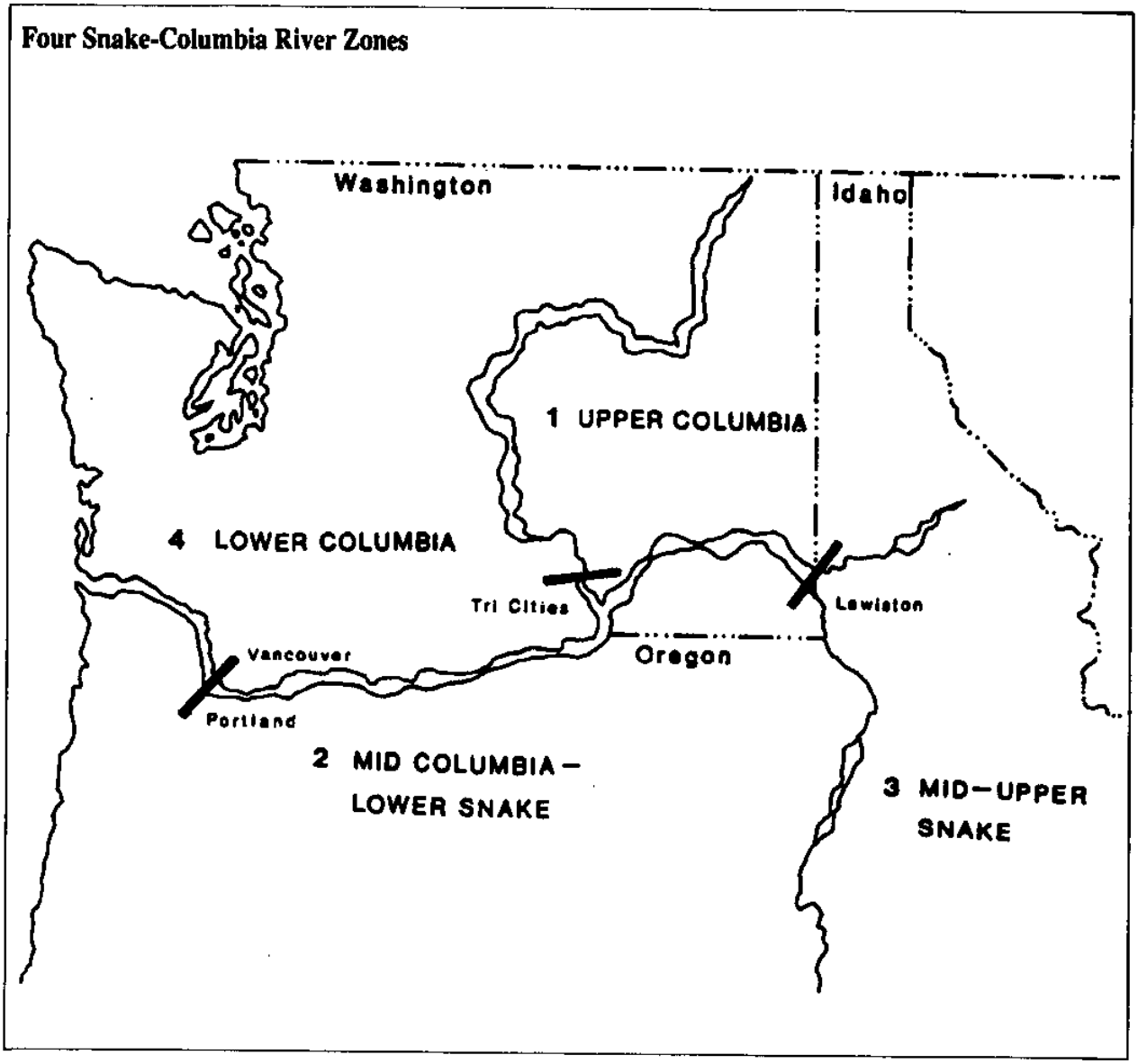
   Read "Coyote Takes Water from the Frog People." Decide whether you agree with Coyote or with the Frog people. Give reasons for your choice. Would this legend apply to today's dams on the Columbia? Why or why not?

6. Read the Indian legend "Guardians of the Columbia."
   a. Find on a map each of the three mountains: Mt. Hood, Mt. St. Helens, and Mt. Adams. Which one is on the south side of the Columbia? In what state is each mountain located?
   b. Working either alone or in groups, invent a legend to explain how one of the following sets of cities was created and named: (1) Lewiston and Clarkston; (2) Pasco, Kennewick, and Richland; (3) Hood River and White Salmon; (4) Portland and Vancouver; (5) Longview, Kelso, and Rainier.

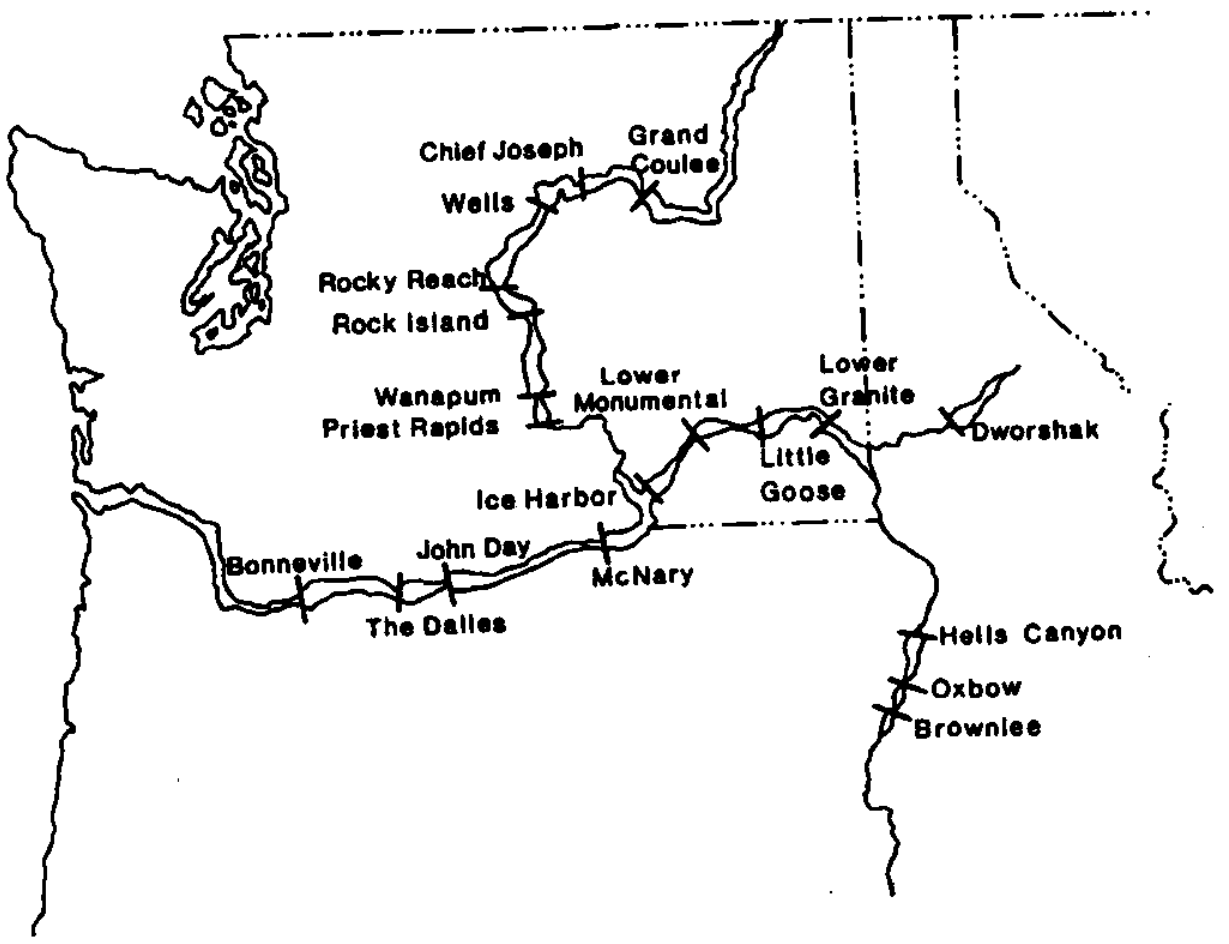
7. Invent a legend to explain one of the following:
   a. the great floods
   b. the Columbia River gorge and the high mountains guarding it
   c. the landslides 700 years ago that created the "great cascades"
   d. the sea receiving the waters of the great floods
   e. the "hanging rivers" of the Columbia Gorge

   Write up your legend and present it either in writing or orally. In inventing your legend, use any of the preceding material you have studied that will be helpful.

Four Snake-Columbia River Zones



Major Hydroelectric Dams on the Lower Columbia and Snake River



Coyote Takes Water From the Frog People

Coyote was out hunting when he found a dead deer. One of the deer's rib bones looked just like a big dentalia shell. Coyote picked it up and took it with him to see the Frog People. The Frog People had all the water. When anyone wanted any water to drink, to cook with, or to wash with, he or she had to get it from the Frog People.

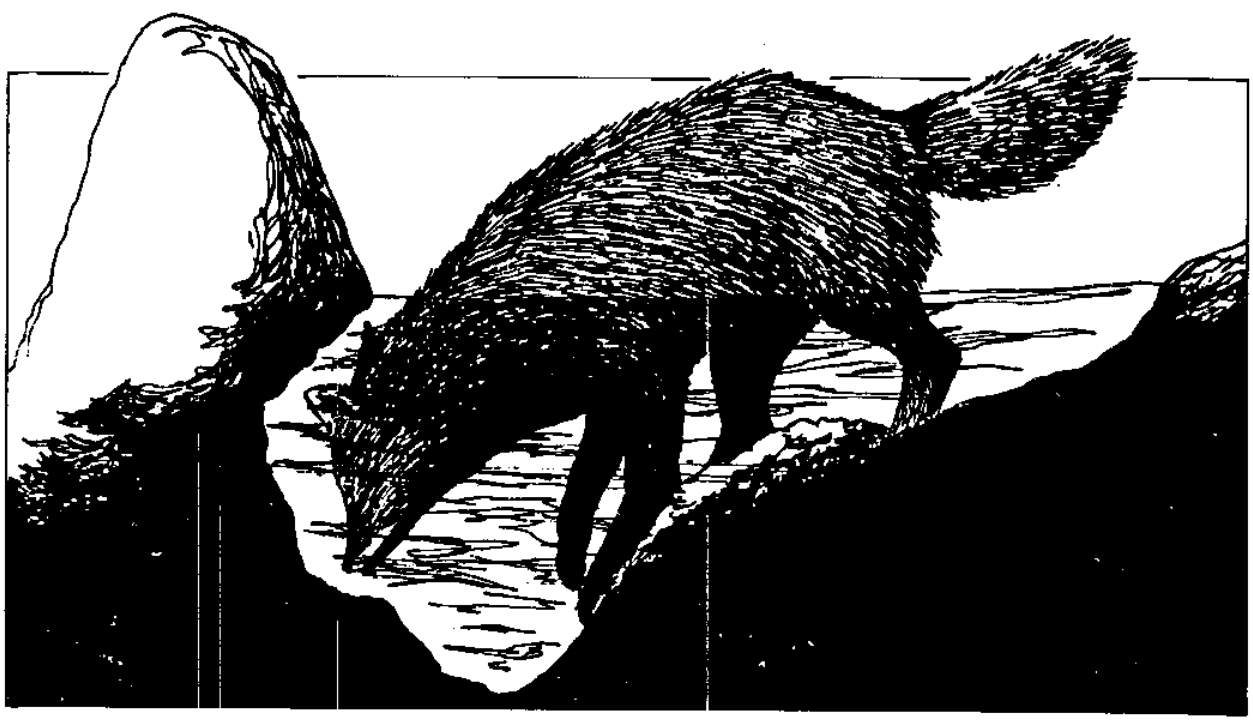
Coyote said, "Hey, Frog People, I have a big dentalia shell. I want a big drink of water, and I want to drink it for a long time." "Give us that shell," said the Frog People, "and you can drink all you want." Coyote gave them the shell and began drinking. The water that Coyote drank was behind a large dam.

Coyote began drinking. He drank for a long time. Finally, one of the Frog People said, "Hey, Coyote, you sure are drinking a lot of water there. What are you doing that for?" Coyote brought his head up out of the water. "I'm thirsty."

After a while one of the Frog People said, "Coyote, you sure are drinking a lot of water. Maybe you had better give us another shell." "Just let me finish this drink," said Coyote, putting his head back under the water. The Frog People wondered how Coyote could drink so much water. They thought Coyote might be trying to trick them.

All the time he had his head underwater, Coyote was digging out under the dam. When he was finished, he stood up and said, "That was a good drink—just what I needed." Then the dam collapsed and the water went out into the valley and made the creeks and rivers and waterfalls. The Frog People were very angry. "You have taken all the water, Coyote!" they cried. Coyote said, "It is not right that one group of people has all the water. Now it is where everyone can have it."

Now, anyone can go down to the river and swim or get water to drink or to cook with.



Guardians of the Columbia

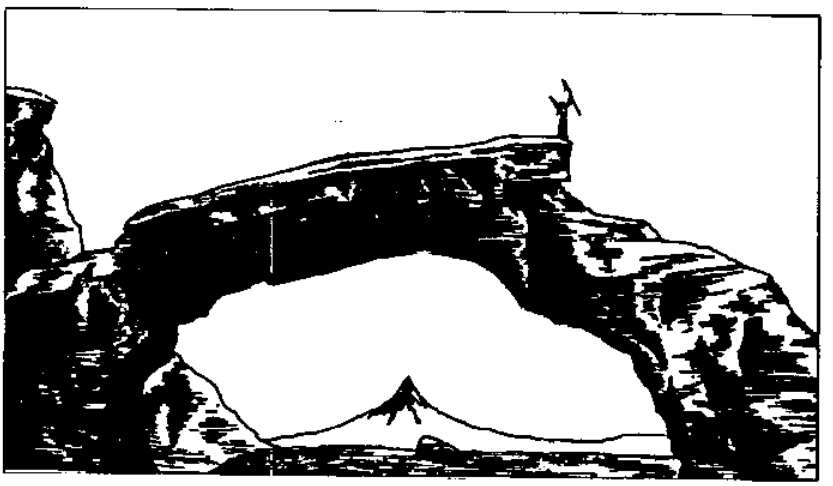
There are many legends about the Bridge of the Gods. This land bridge was claimed to span the Columbia River near present-day Cascade Locks, Oregon. Various Indian tribes living in the Gorge had their own version. This version comes from the Klickitat Indians.

The old men of the tribes say it was Tyhee Saghalie, chief of all the gods, who put the Guardians of the Columbia there, and they say it was an act of harsh justice by a tired old man whose sons took up arms against each other.

They say Tyhee Saghalie and his two hot-tempered sons came down the river from the far north in search of a land suitable for the Tyhee of all gods, and after a long, arduous trip that was difficult even for a god, they found the land beside the river where the rocks were like stepping stones, which the white men named The Dalles.

They had never seen a land so beautiful, and Tyhee Saghalie made it his own. But his two sons quarreled over the possession of that land, and Tyhee Saghalie settled the dispute by shooting two arrows from his powerful bow—one to the west and one to the north. One son, Klickitat, followed the arrow to the north and made it his land and became the grandfather of a tribe named for himself. The other son, Wy-east, followed the arrow to the west and became the grandfather of the Multnomahs, who lived beside the river called Willamette.

Then Tyhee Saghalie raised the mountains on both sides of the river for a boundary between the sons' land, but he did not raise any high enough to have a cap of snow, perhaps remembering the cold of the far north. Then he built the most beautiful structure man had ever seen—Tahmahnawis, the Bridge of the Gods—so that his sons and their children might pass across the river in safety and his family might not always be divided.



Then Tyhee Saghalie did a good thing that led to the destruction of his family. On the river lived a witchwoman, Loowit, who was the ugliest of the ugly crones. But being a woman, Loowit had a way to make herself needed and wanted: she had charge of the only fire in the world.

She saw how miserable the tribes on both sides of the river were during the long, wet winters with no fire to keep them warm or to cook their fish and venison. It hurt Loowit's heart to see the women always cold and wet and to see the little children sick and dying.

So one day she made a gift of the fire to Tyhee Saghalie. His gratitude was without limit, and he offered Loowit anything she wanted.

She asked at once for youth and beauty, and so Tyhee Saghalie made her the most beautiful maiden in the world. All the young men fell in love with her, but she paid them no attention.

Then she met Tyhee's sons, Klickitat and Wy-east. She could not decide which of them she liked better. The two young men became jealous of each other, and their tribes quarreled among themselves over which of their chiefs should have Loowit's hand. Soon war broke out between the brothers' people.

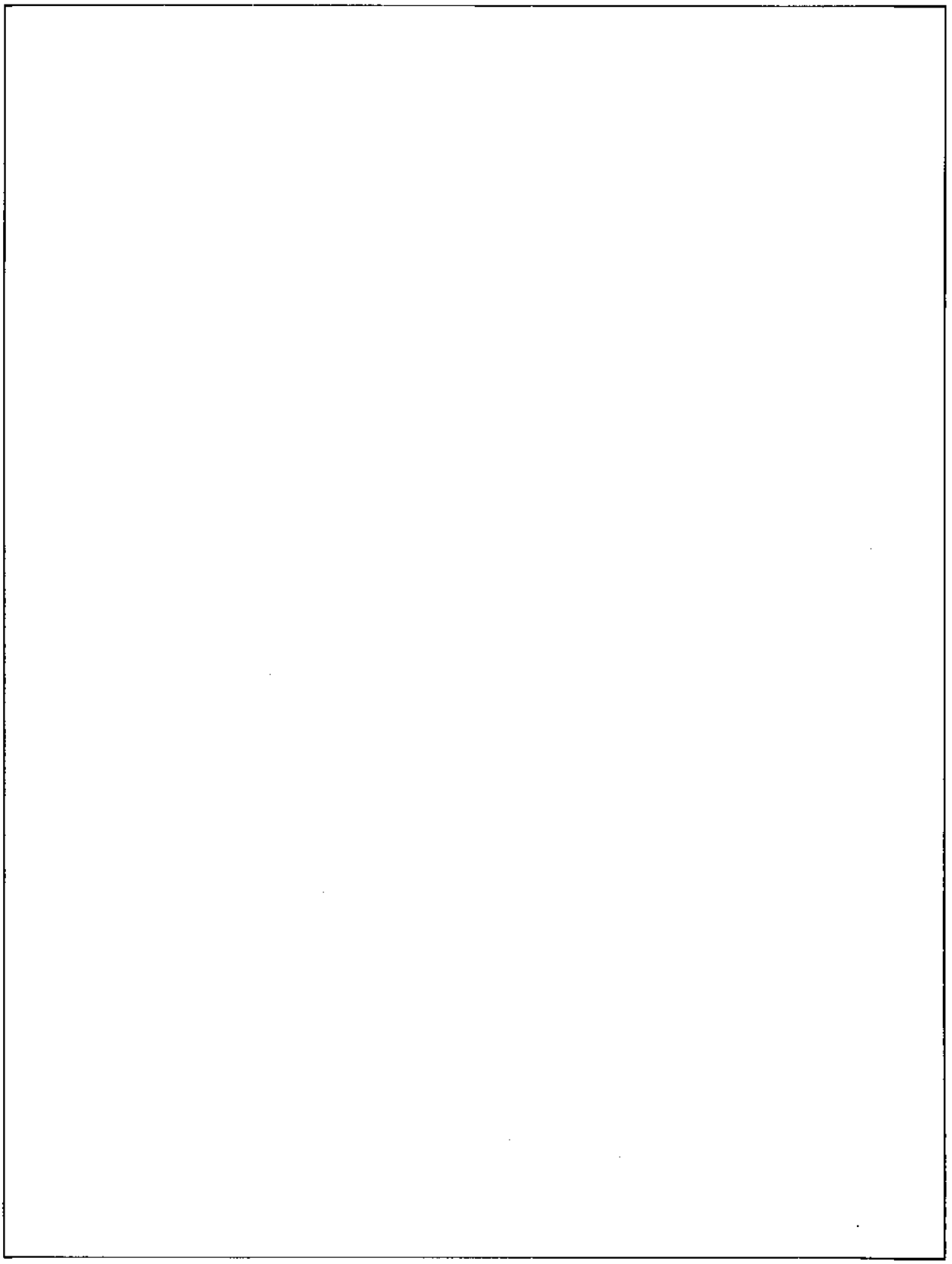
Tyhee Saghalie was sad and angry. He knew that to end the fighting he must destroy the cause. First he destroyed the Bridge of the Gods. Then he put Loowit, Wy-east, and Klickitat to death.

But he felt responsible for the tragedy, and he loved all three he had put to death. Because they were beautiful in life, he wanted them to be admired forever.

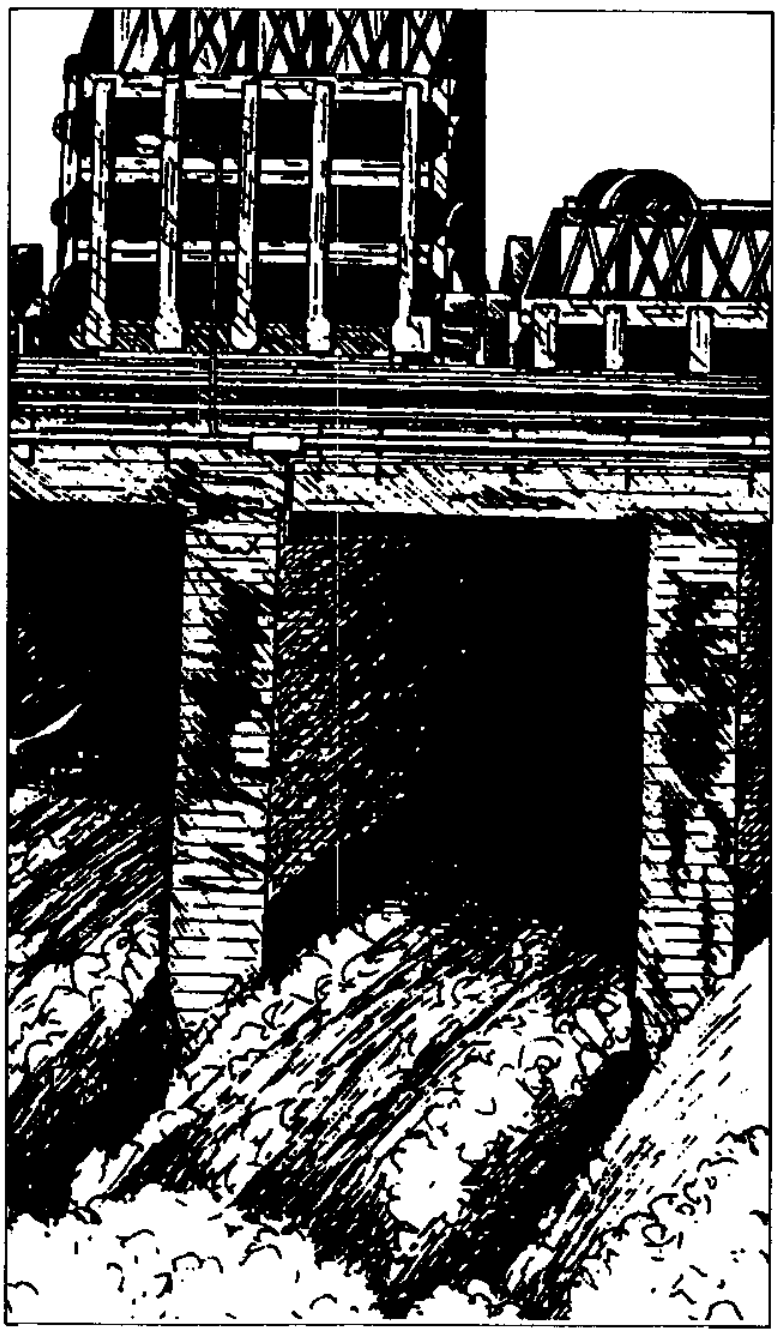
He made Wy-east into Mt. Hood, Klickitat into Mt. Adams, and Loowit into Mt. St. Helens.

And the rocks from the Bridge of the Gods that fell into the river created the great Cascades.

From Archie Satterfield's Moods of the Columbia *(Seattle: Superior Press, 1968).*



ENERGY



POWER: *A READING*

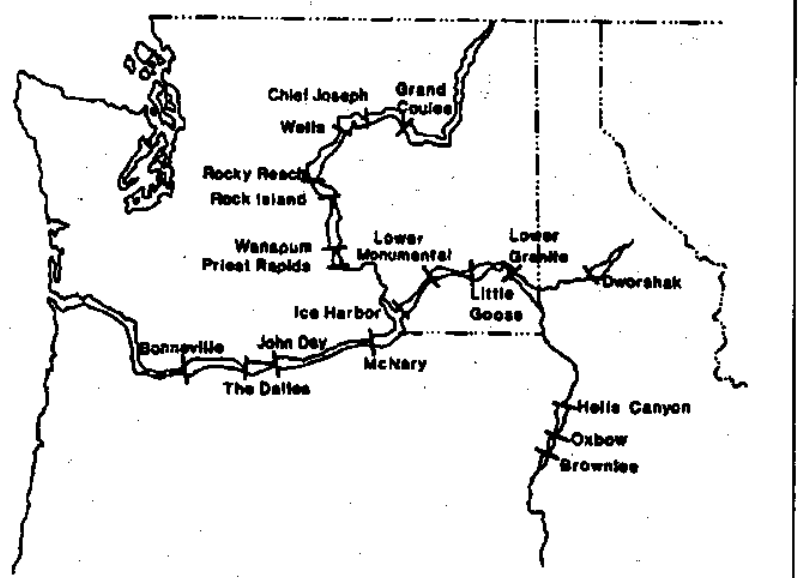
The Columbia River and its tributaries are impounded more than 190 times by dams constructed for electrical power, recreation, flood control, and transportation. The Columbia system has 38 major hydroelectric projects. It not only supplies the Pacific Northwest with 75 percent of its energy needs, but it also accounts for more than half of the hydroelectric-generating capacity of the whole United States.

Every time you flick on your stereo or TV, a power generator somewhere in the Pacific Northwest goes to work for you. Water flowing through huge generators inside a Columbia River dam produces electrical power that allows you to enjoy your stereo or TV. On the other hand, every time you listen or watch, there may be less water available for fish, navigation, irrigation, or recreation. Again, there are more uses for water than there is water. Every gallon of water used for fish passage around the dams, for locks that allow tugboats, barges, and recreation boats to get by the dams, and for diverting water from the river so that crops can grow loses some of its potential to generate electrical energy. Thus, if you want more electrical power, you may have to give up something else.

Most of us want the river, the fish, our swimming holes, good food, scenic beauty, and our stereos and TVs. Today, some of us have it all. That won't last.

The Dalles Dam, spanning the Columbia River between Washington and Oregon near The Dalles, Oregon, is one of the largest dams on the river. It generates electrical power, has a navigation lock, and also contains fish passage facilities. In addition, the dam created a high lake behind it. Boaters love the lake, but the wildlife populations that

Major Hydroelectric Dams on Lower Columbia and Snake Rivers



formerly lived on the shores of the river died or were displaced because they lost their homes. Many Indians also lost their homes and the site of their sacred fishing grounds (Celilo Falls).

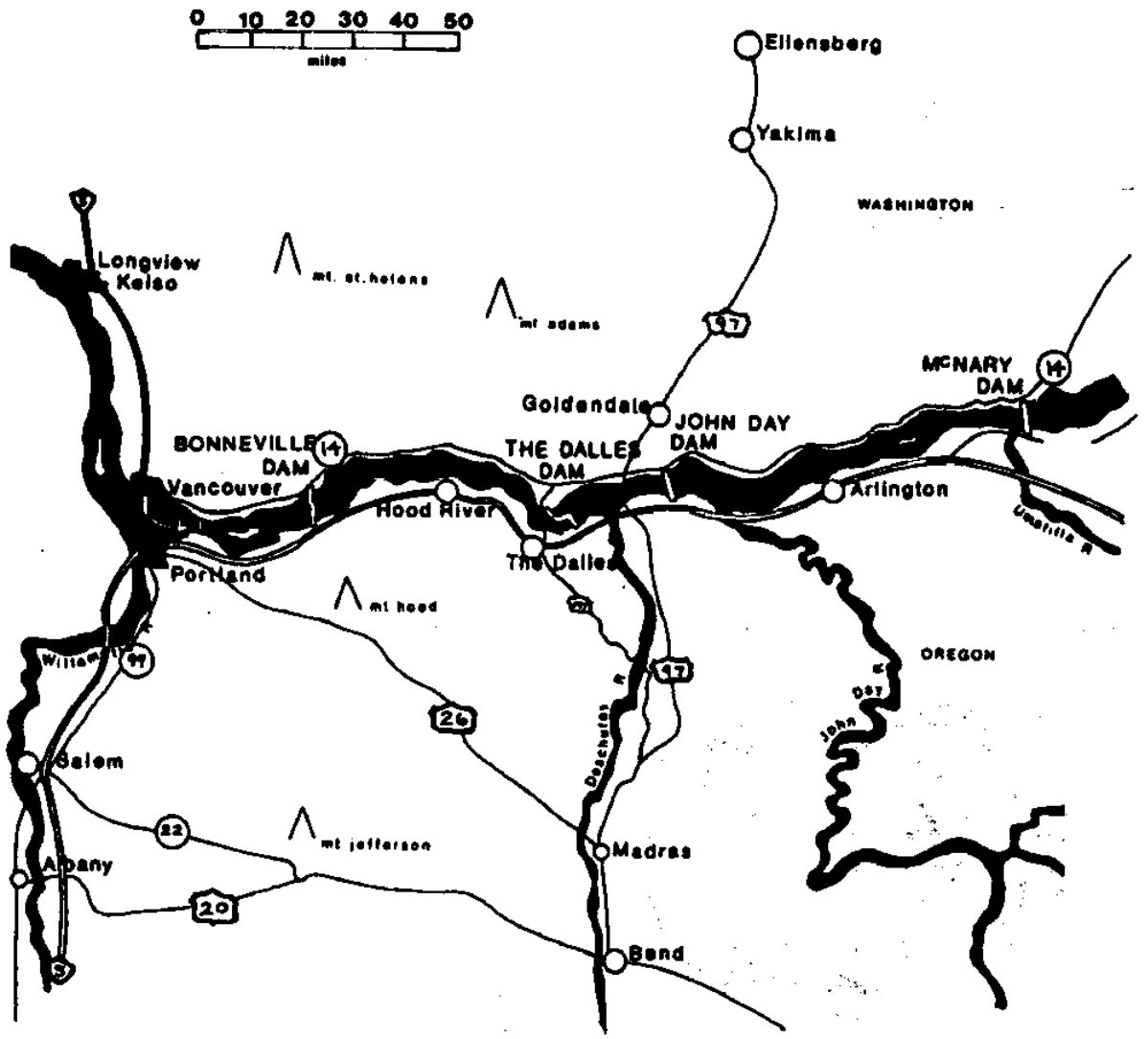
Built in 1957, The Dalles Dam can generate enough electrical energy to meet the energy needs of two cities the size of Seattle. It is only one of many large dams, but we could be running short of power.

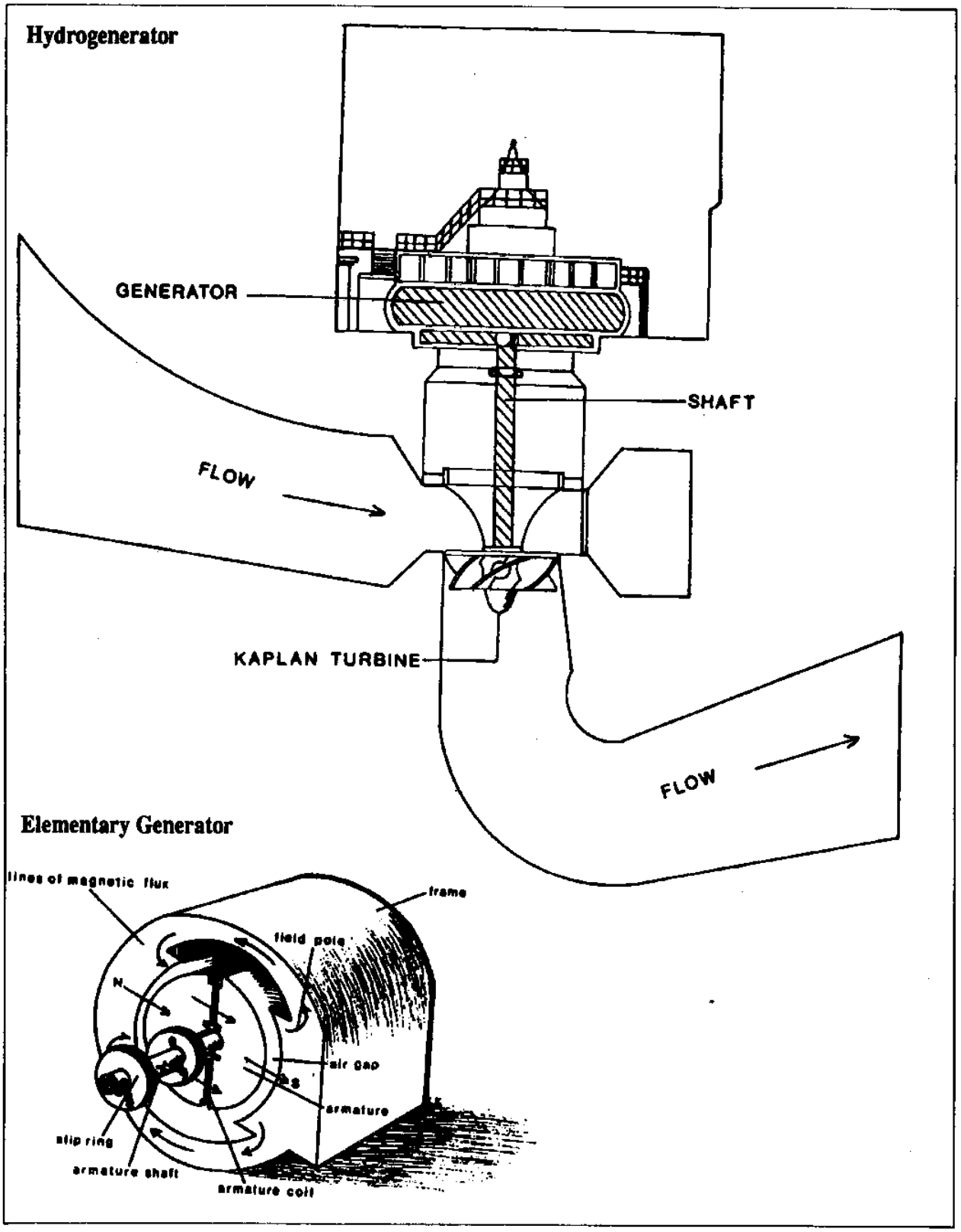
As you drive on the highways along the Columbia, you may see large wheels connected by pipes. These irrigation systems pump many gallons of water onto fields that produce crops for both human and animal consumption. Think about this the next time you eat a hamburger. If these irrigation pipes were not there, most of those fields would be dry and brown and, of course, would produce very little. In fact, 90 percent of all the water diverted from the Columbia goes to crop irrigation. Farmers like the dams and get into serious arguments with commercial fishermen over them. One problem is that in spite of the fish passage facilities, many young migratory fish (like salmon) do not make it downstream to the sea. Likewise, many adult fish do not make it past the dams to enter the stream of their birth to spawn and produce more young fish.

Dams interfere with fish in other ways too. Fish are destroyed after being sucked through a dam's machinery. They also become disoriented by the reservoirs created

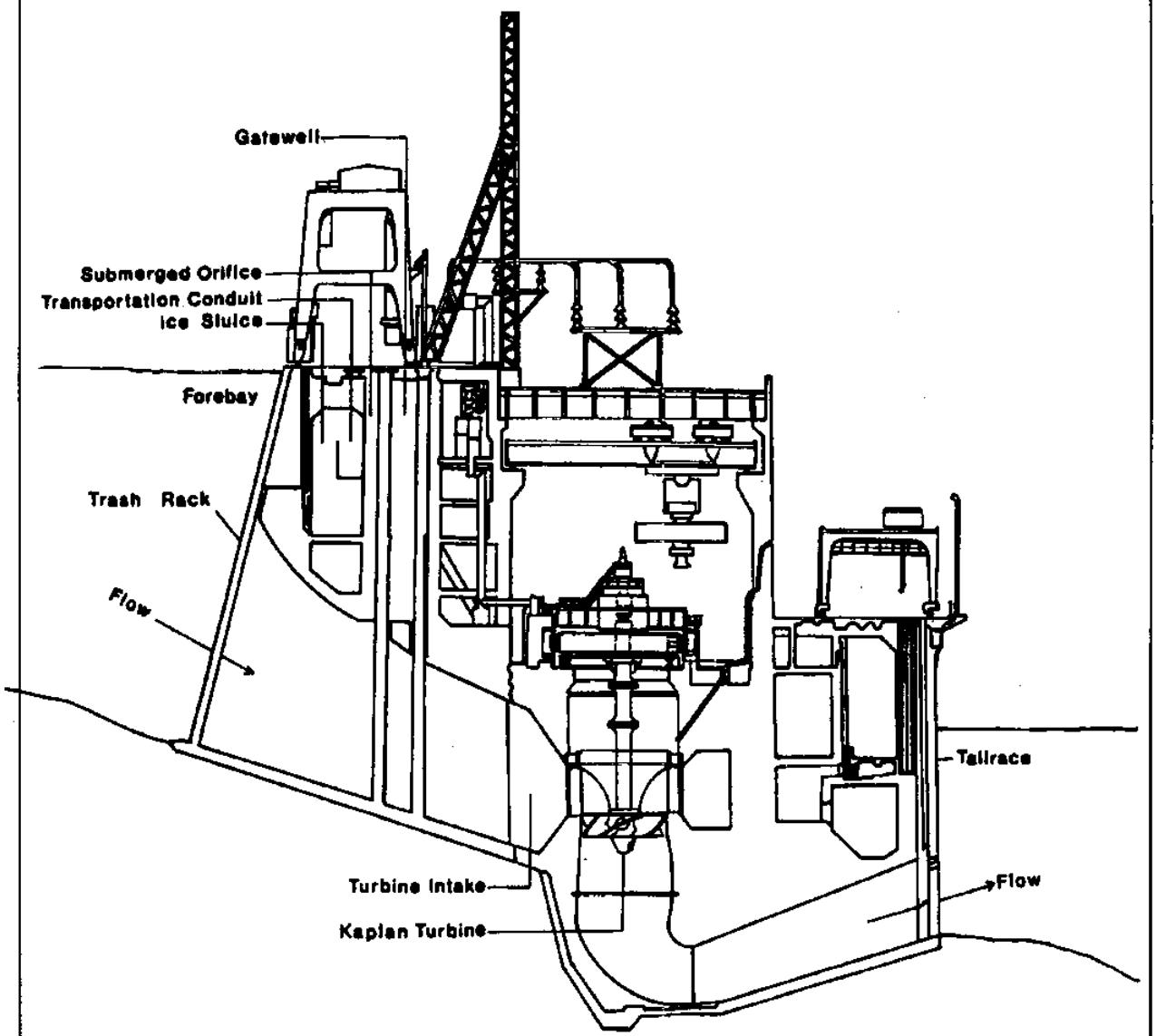
by the dams. Today, the Columbia is no longer a fast-flowing river. When an environment is changed, the life it once supported changes. Fewer fish now live in the river. Of those that do, it is estimated that 5 to 15 percent of the young fish may be killed at each dam. The odds are slim that a young fish from a mountain stream entering either the Snake or the upper Columbia will ever make it to sea, reach adulthood, and make it back to spawn. We may have our grain and power, but the opportunity of having fish with them is decreasing.

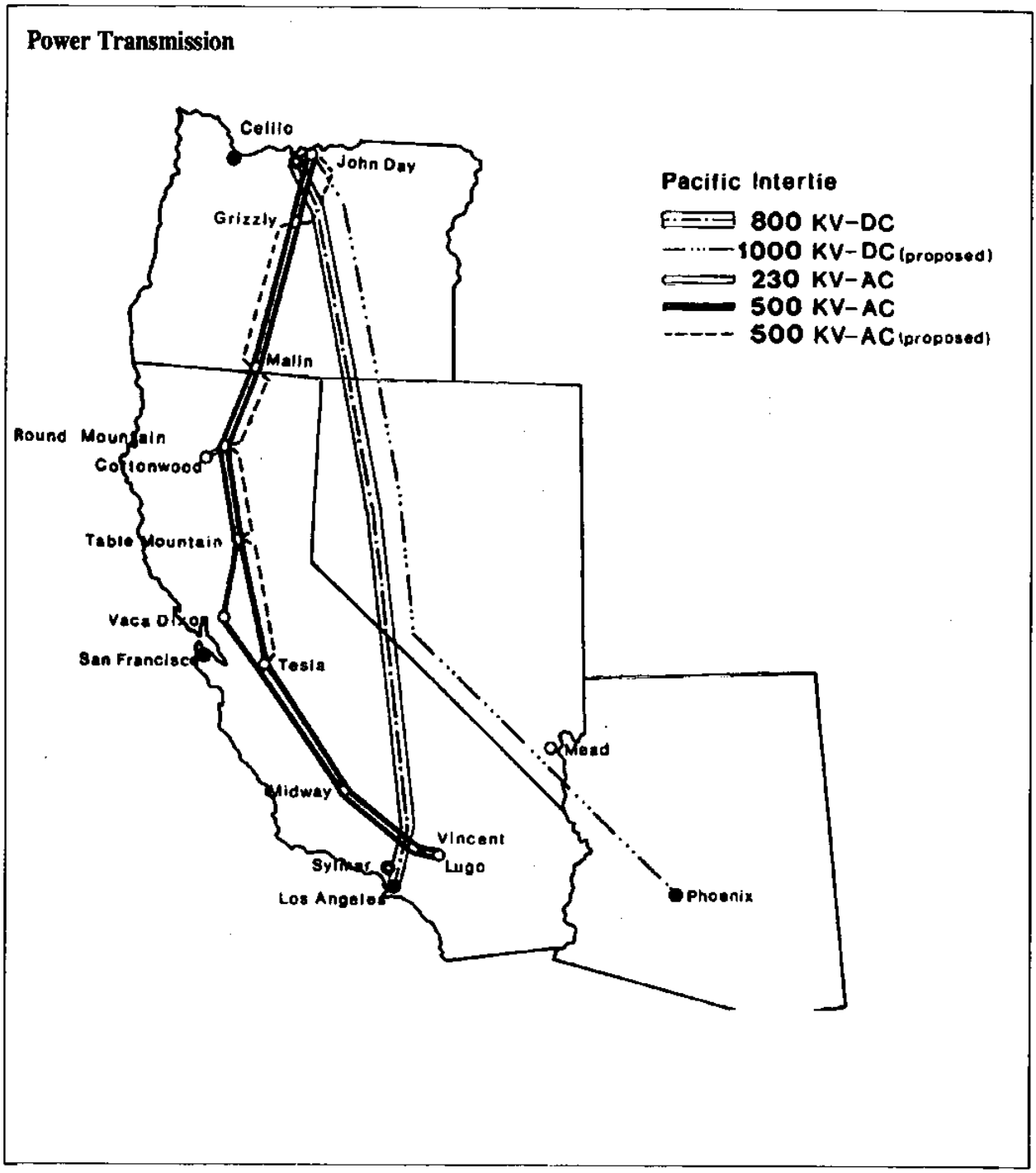
Dams on the Oregon-Washington Border




Hydrogenerator
GENERATOR
SHAFT
FLOW
KAPLAN TURBINE
FLOW
Elementary Generator
lines of magnetic flux
frame
field pole
N
air gap
S
armature
slip ring
armature shaft
armature coil

Cutaway View of a Dam




Power Transmission
Celilo
John Day
Grizzly
Malin
Round Mountain
Cottonwood
Table Mountain
Vaca Dixon
San Francisco
Tesla
Midway
Vincent
Lugo
Sylmar
Los Angeles
Mead
Phoenix
Pacific Intertie
800 KV-DC
1000 KV-DC (proposed)
230 KV-AC
500 KV-AC
500 KV-AC (proposed)

Lesson Activities

I. Words and Concepts

Define the following:

1. impounded
2. hydroelectric generating capacity
3. diversion
4. turbine
5. kilowatt
6. peaking power

II. Class Activities

Complete the word assignment, "How Is Water Turned into Electricity?" on page 38. For help, study the diagram of a dam first.

Each of you should fill in the words you know. After all of you have completed the task, compare copies and help each other fill in missing words. Then read the assignment again, making sure the words fit and make sense.

Discuss the reading, especially taking care with the questions at the end. For example, if a student leaves a 100-watt bulb on in a bedroom for 24 hours, how long would it take to consume a kilowatt?

Homework: you could ask your parents for the answers to the last four questions of the word assignment and compare answers in class.

III. Class Discussion or Written Assignment

1. Discuss in class the following questions:
   a. What are some of the ways in which electrical energy is used?
   b. Which of them are most important to members of the class?
   c. Which could we do without and not suffer major changes in our way of life?

2. Take sides on which of the following uses of electrical power is most important. Prepare a careful argument for your side's use being most important. Compare your arguments and see if the class agrees afterward that one or two uses are indeed most important.

   The sides:
   - Television and radio
   - City streetlights and lights for buildings at night
   - Telephones and computers
   - Home consumption: dishwasher, refrigerator, laundry, and so on, excluding TV, radio, and the telephone
   - Operating the electrical needs of businesses and industries

   Keep in mind that emergency services such as hospital use are not included. Your argument and class discussion should focus only on the five uses listed above. How can you conserve your use of electricity so we will have enough energy to meet future needs?

3. Study the energy grid map. Learn the vast area supplied by Columbia River water power.

4. If possible, visit one of the dams in your area. Most of these dams are operated by the U.S. Army Corps of Engineers or the Bureau of Reclamation. These agencies conduct interesting and informative tours and supply handouts.

How Is Water Power Turned into Electricity?

Before finishing this assignment, make sure you understand the basic mechanics of how a hydroelectric dam operates.

Description of Activity

To discover how water is turned into electricity, fill in the blanks in the essay. For every blank, there is only one word or phrase (listed after the essay).

Essay

Many dams on the Columbia River were built by the _____. The dam has two separate parts: a _____, which produces electricity, and a _____, which does not produce electricity, but does help to regulate the water level.

_____is the type of electricity produced at this dam. _____ means water. The water on the upstream, or _____, side is blocked by the dam and is higher than the water on the downstream, or _____, side of the dam. When water flows down through the dam, it causes giant propellers, called _____ , to spin. These are attached to machines which spin and produce electricity, measured as _____. The rotating part of these machines, known as _____, is a huge electromagnet. The stationary part, known as a _____, is made up of coils of copper wire. When the coils of copper wire are passed by the magnetic field, tiny particles known as_____ move. This movement is known as an electric current.

Next, the electricity flows through a _____, which transforms the electricity into higher voltage electricity. High-voltage electricity travels more efficiently through _____ lines than does low-voltage electricity. When the electricity leaves the dam through the lines, it becomes the property of the _____, a different federal agency which sells the electricity to your power company. When the high-voltage electricity gets to your neighborhood, it is transformed again into low-voltage electricity so you can use it in your home.

To give you an idea of how much electricity you use compared to how much is produced at a dam, here is something you can do. If you turned on ten 100-watt light bulbs in your home but used no other electricity, you would be using 1,000 watts, or one _____. Bonneville Dam can generate about one million one hundred thousand (1,100,000) of these, or one billion one hundred million watts (1,100,000,000)! That may seem like a lot of power but that does not mean you should waste any of it. Every time you use 1,000 watts for one hour you use 1 kilowatt/hour of electricity. The power company charges you a certain amount of money for each kilowatt/hour that you use. How much does your power company charge? How much did you use last month? How much did it cost? How could you use less and save some money?

Use These Words to Help You Fill in the Blank Spaces

electrons
rotor
transformer
tailrace
kilowatt
generators
hydro
powerhouse
spillway
stator
forebay
hydroelectricity
transmission
Corps of Engineers
turbine
Bonneville Power Administration

Definitions and Answers for "How Is Water Power Turned into Electricity?"

Corps of Engineers
Governmental agency responsible for maintaining and operating federal dams within the Columbia River system

Powerhouse
Building and machinery for the production of electricity

Spillway
Channel or structure which regulates reservoir overflow (water levels)

Hydroelectricity
Type of electricity produced by dams

Hydro
Latin for water

Forebay
Upstream side of dam

Tailrace
Downstream side of dam

Turbines
Machinery, consisting of blades arrayed around the circumference of a cylinder, which convert the kinetic energy of a moving fluid (water) into mechanical energy

Generator
A machine which converts mechanical energy into electrical energy

Rotor
Rotating part of an electrical or mechanical device

Stator
The stationary part of a motor, dynamo, or turbine about which a rotor turns

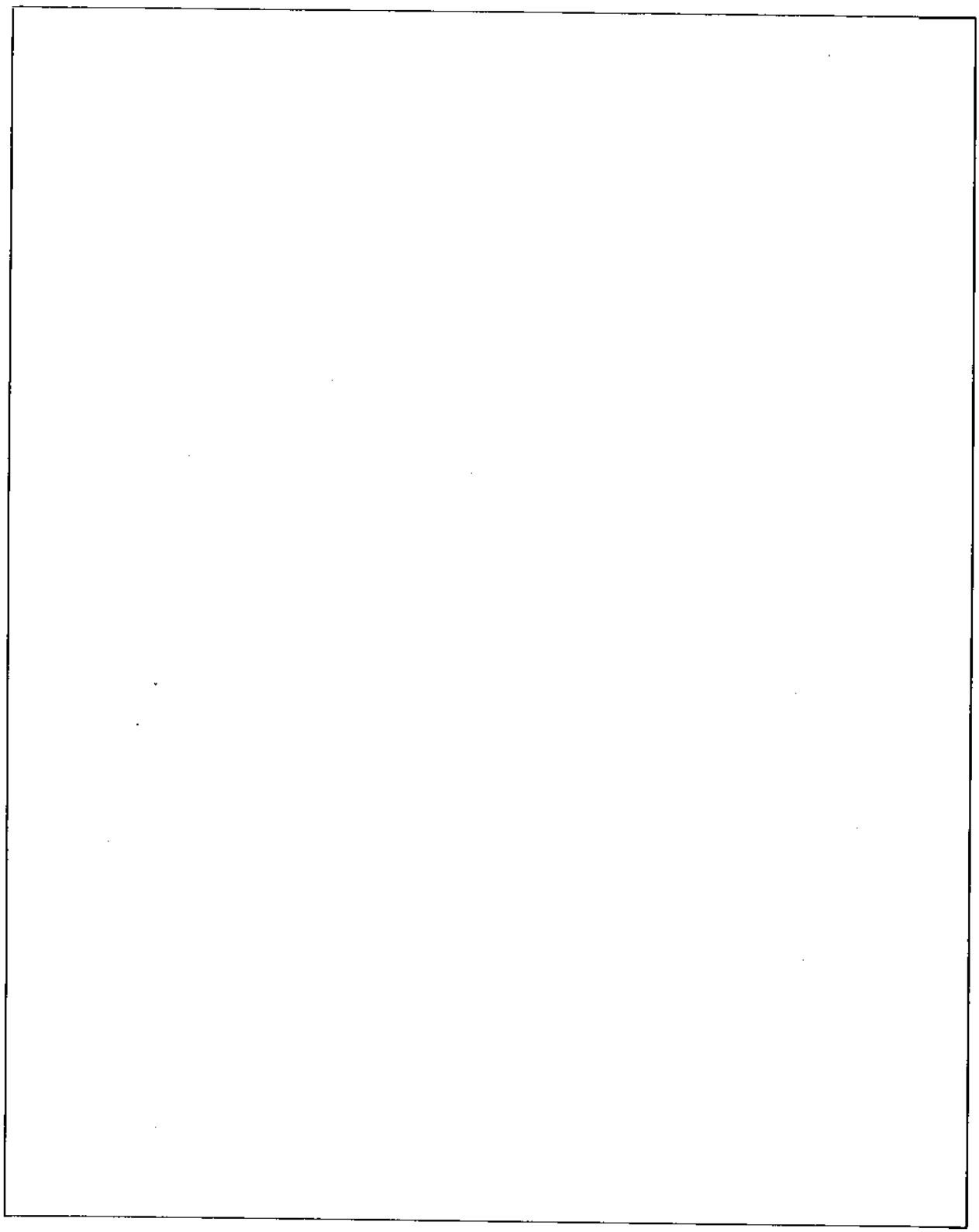
Electrons
Subatomic particles of matter which make up electricity

Transformer
Device which is used to transfer electric energy and which is capable of changing its voltage, current, or phase

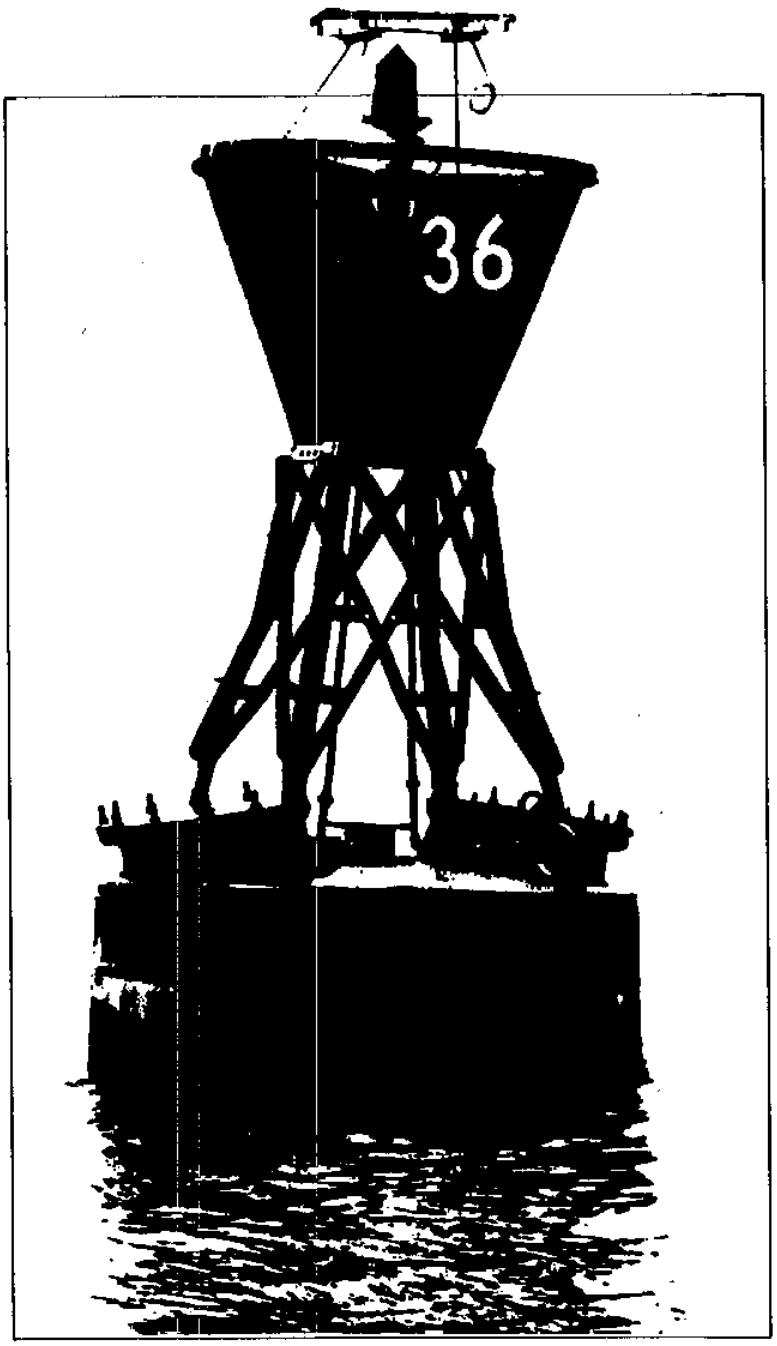
Transmission
Process of sending modulated electrical waves

Bonneville Power Administration
Federal agency responsible for marketing and selling electricity generated from federal dams within the Columbia River system

Kilowatt
One thousand watts. A watt is a universally recognized unit of energy.



NAVIGATION

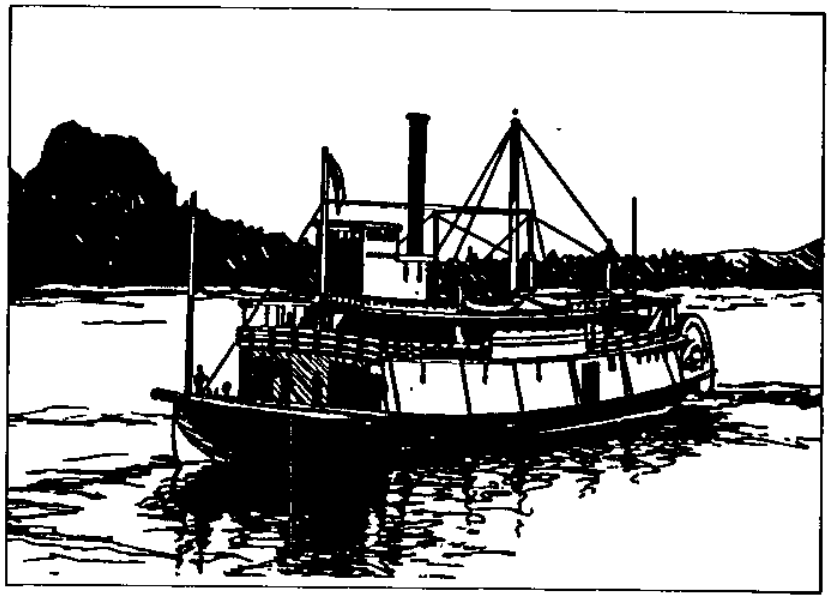


NAVIGATION: *A READING*

Commercial navigation on the Columbia dates back to the 19th century when stern-wheelers challenged the untamed rapids to move goods and people along its watercourse. Today, a modern inland water transportation system consisting of eight locks allows commercial vessels to travel as far east as Lewiston, Idaho, some 465 miles from the Pacific. This corridor, averaging a minimum of 14 feet in depth, is one of the deepest navigation systems in the United States. Barges with a capacity of more than 3,000 tons can be accommodated on the river, compared to a 1,500-ton capacity on the Mississippi system.

Take a look at a world map. With your finger trace a line from the mouth of the Columbia at Astoria north along the west coast of Canada, then along the Alaskan coast and west across the Aleutian Islands. Then turn south to Japan, Korea, Taiwan, China, The Philippines, Indonesia, New Zealand, and Australia. This "Pacific Rim" is the main market for products grown and manufactured along the Columbia-Snake system. Lewiston, Idaho, is only a barge trip away from Portland and then an ocean vessel trip away from the countries of the Pacific Rim. As you read before, grain and other products loaded on barges at Lewiston and Pasco come not only from eastern Washington, eastern Oregon, and Idaho, but from the Midwestern United States as well.

We are all familiar with imported cars, TV sets, and radios from Japan. Many of these goods come upriver to major ports along the Columbia, such as Astoria, Longview, Vancouver, and Portland. Downriver the products include varieties of grain and timber. They are transported in shallow-draft barges to the deep-draft ports and then are loaded on ocean-going



vessels for markets around the world, especially Pacific Rim markets. Without Columbia and Snake river navigation, many businesses and industries that distribute imported goods to us and sell exported products would locate somewhere else. Jobs would go with them, and many of us could no longer live near the Columbia.

Jobs associated with navigation can be found all along the Columbia. For example, workers load grain on barges in the ports of Lewiston, Umatilla, and Pasco. At ports such as Portland, Vancouver, Kalama, or Longview, dock workers move it onto ocean ships. For imports, the process is reversed. Workers may unload cars and other finished goods at Portland and Vancouver and send them to cities around the United States.

Astoria, the first port of entry on the river, was established in 1811 by John Jacob Astor. Lewis and Clark spent the rainy winter of 1805-6 near here at Fort Clatsop. Astoria has long been a center of fishing and canning although today its principal export is timber. Located only 10 miles from the ocean, Astoria is 540 nautical miles from San Francisco, 260 nautical miles from Seattle, and 100 miles from Portland. It's a handy place for a port. It's also close to the vast timber industry of the Coast Range in northwest Oregon and southwest Washington.

The Port of Longview, Washington, 66 miles from the Pacific Ocean, is the third largest port in Washington. It is a center of barge and railroad traffic and only three miles from Interstate 5, the main highway from Vancouver, British Columbia, to San Diego, California. This port, too, is in a good location, near small farms in southwestern Washington and large stands of timber. The Port of Longview has the largest water-based crane (nicknamed "The Columbia Giant") on the West Coast and has space for seven ships to dock.

Vancouver, Washington, across the river from Portland, is a larger city than either Astoria or Longview and, like Portland, is the end of the line for deep-water ocean ships and the beginning of barge traffic on the

Columbia. Therefore, many products—like grain—and materials are changed here from one type of vessel to another. Like Longview, the port can accommodate many ships. Vancouver is located near Interstate 5, which gives it highway access to most of the West Coast.

Portland, 110 miles from the ocean, is the largest port on the Columbia and the third largest on the West Coast. It is by far the largest city of all the Columbia River ports, with extensive commercial, banking, business, and industrial activity. It, too, is on Interstate 5. It is a major railroad center and leads the entire West Coast in grain exports and auto imports. Many shipments to states in the Midwest and East begin in Portland. Ships enter and leave Portland daily carrying flags from many Pacific Rim nations. Like Seattle and San Francisco, Portland is a gateway to the Far East.

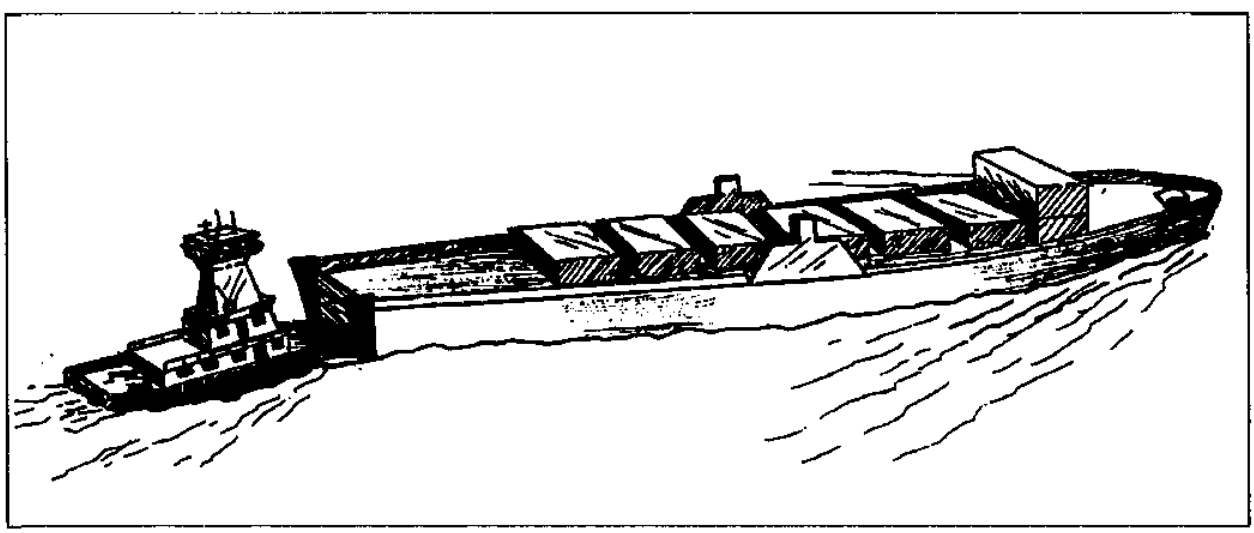
Portland is also the terminus for the movement of farm products up the Willamette. As such, it receives products not only from the east and west, but also from the south—the fertile Willamette Valley. From pioneer days, farmers have shipped their produce from the Willamette Valley to Portland for export.

This discussion has dealt primarily with the major ports on the lower Columbia. Small ports such as Kalama and St. Helens have not been mentioned but are equally important to the areas they serve by providing jobs and economic stimulus to these river communities.

As we have already indicated, ports upstream of Portland and Vancouver are shallow-draft ports. Because of the construction of the eight dams on the Columbia and Snake, barges can now travel to Lewiston, Idaho. There are many small ports in this stretch of the Columbia River system. These include the ports of Cascade Locks, Hood River, The Dalles, Arlington, Morrow, and Umatilla in Oregon and the ports of Stevenson County, Klickitat County, Pasco, Benton, Kennewick, Clarkston, and Whitman County in Washington. These ports are involved in a variety of water-borne activities, ranging from transferring grain shipments to providing recreational opportunities. Each port serves an important economic role in its area.

There are some problems with this transportation network. One constraint to continued growth of navigation is the Bonneville Locks. Constructed in the 1930s, they constitute a bottleneck on the system, with barge traffic often backed up and delayed. A new, enlarged lock is under construction. When completed, it will make all locks on the Columbia uniform in size (86 feet by 675 feet). Proponents claim that the new lock will make the Northwest a major exporter of agricultural products.

Another problem is the potential for conflict between navigation and other river uses. In low-flow periods, water required to operate locks reduces power generation. On the other hand, use of the dams for peak load generation and resulting water fluctuations can endanger navigation. Here, too, trade-offs must be made.



Lesson Activities

I. Words and Concepts

Make certain you understand the following phrases and words:

1. Pacific Rim
2. market
3. vessel
4. import
5. export
6. river mouth
7. principal
8. nautical mile
9. commodity
10. extensive
11. gateway
12. terminus
13. dredging
14. deep-draft port
15. shallow-draft port

Find any other words or phrases in the text which you do not understand. Make sure you know what they mean before you proceed.

Read *Navigation and Commerce on the Mid-Columbia/Lower Snake River System* by William A. McNamee and Lewis E. Queirolo (see "Teaching Resources"). You will learn about the ports and navigation upriver from Portland.

II. Class Activities

1. The ports of Lewiston, Pasco, Portland, and Longview are all at a confluence of two rivers. What is a confluence? What are the rivers in the case of each port?

2. Draw a map of the Columbia-Snake river system. On the map locate the ports mentioned in the readings in this chapter: Astoria, Longview, Vancouver, Portland, The Dalles, Morrow County, Umatilla, Pasco, Whitman County, Clarkston, and Lewiston.

3. On the same map locate each of the eight dams on the Columbia-Snake river navigation system.

III. Class Discussion or Written Assignments

1. Discuss the different types of vessels which use the Columbia River navigation system. What are their similarities? What are their differences? What types of products do they carry? Which type would you like to pilot? Why?

2. Find in the Portland newspaper (or possibly another) the daily log of ships departing and arriving. Continue this for a week and keep count of the number of ships going each way. Also list their country of origin.

3. Locate a port near you. Find out what types of activities it is involved in. Call or write the port authorities for information. How important is this port to your community?

4. You have been appointed port director of one of the Columbia River ports mentioned in this section. Create an advertisement for radio, TV, a newspaper, or a magazine that illustrates why your port is the best port in the area for farmers, lumber people, or importers to use. To make your advertisement more convincing, use outside research as well as information from this section. After you have finished your advertisement, show it to your class and compare efforts.

5. Construction of a new lock will relieve the bottleneck on the Columbia River navigation system. However, some groups and organizations may be opposed to this huge construction project. Why do you think some environmental groups and the railroads would object to the new locks? What groups would favor the locks?

FOREIGN COMMERCE CHART
(Summary of foreign imports to and exports from Portland via water)

Commodity	Export (short tons)	Import (short tons)
Alcoholic Beverages	3,497	1,528
Alfalfa Pellets	145	
Aluminum	28	
Aluminum, Mfgs.	55,474	
Apples, Fresh (654,500 bxs)	16,363	
Appliances	817	
Auto Parts	6,265	
Autos	14,297	
Autos, Vans & Parts		355,942
Bambooware		111
Barley (21,489,183 bu)	515,740	
Basketware/ Wovenware		168
Batteries & Parts	1,655	
Beans, Dried	1,568	
Beef, Chilled & Frozen	2,384	
Bentonite Clay	195,045	
Buckwheat	379	
Building Materials	18,989	1,268
Buildings, Precut/ Prefab	2,497	
Bulbs & Flower Seed	20	
Bullets & Explosives	14	
Burlap & Bags		1,611
Carbon Products		1,257
Cathodes, Copper	28	
Cement		225,001
Chemicals	28,516	6,840
Cherries, Fresh	829	
Coal Tar Pitch		34,795
Coconut, Dessicated		308
Coconut Oil		27,154
Coffee		740
Copper Products	137	
Corn (15,068,630 bu)	421,922	
Corn, Canned	16,107	
Corn, Frozen	7,739	
Cotton	227	
Drugs, Dental/ Med. Supplies	345	
Dry Goods & Clothing		29,206
Earthen/Stone/ Porcelainware		453
Electric Mfg.		1,030
Electrical Goods	287	
Electronic Equipment		3,257
Fertilizers	25	154
Fiberboard	25,023	

Commodity	Export (short tons)	Import (short tons)
Fish, Canned & Frozen		57
Fish, NOS	2,258	
Flour	92	
Food Byproducts	4,340	
Foodstuffs	18,275	
Foodstuffs, NOS		5,450
Footwear		5,857
Fruits, Fresh	523	
Fruits & Juices, Canned	6,036	
Fruits & Juices, Frozen	3,324	
Furniture		1,675
Gasoline		196,080
Glass Products		832
Hardware & Tools	107	2110
Hay, Alfalfa Cubes	56,941	
Hay, Baled	120,282	
Hides	59,933	
Hops & Extracts	34	
Ink	20	
Lab & Tech. Equip.	64	
Lentils	8,546	
Lignin Pitch	3,990	
Logs & Lumber	543,800	598
Machinery & Parts		13,919
Machinery & Parts, Agriculture	819	
Machinery & Parts, Lift Truck	1,179	
Machinery & Parts, Lumber	406	
Machinery & Parts, Mining	405	
Machinery & Parts, NOS	7,921	
Malt	11,402	
Marble, Granite & Stone		223
Meat, NOS	33	
Merchandise, NOS	11,427	
Metal - Misc. Iron & Steel Prod.		184,958
Metal, NOS	132	
Metal Scrap	228,551	
Methanol		40,910
Misc./Household Goods	582	
Miscellaneous		13,444
Molds, Pottery	871	
Motorcycle Parts & Access.		105
Mushrooms		84

Commodity	Export (short tons)	Import (short tons)
Nursery Supplies	1,734	
Nuts	387	
Oil, Pmint, Spmint, & Essence	15	
Oil, Tall	8	
Onions	11,301	
Oranges, Canned		120
Ore	34	
Ore - Alumina		593,468
Ore - Limestone		494,633
Ore - Manganese		9,083
Ore, NOS		6
Paints & Resins	1,912	
Palm Oil		28,478
Paper & Mfg.		613
Paper & Newsprint	5,860	
Paper Products	579	
Paperboard/ Linerboard	210,785	
Particle/Chipboard	60,585	
Pears, Fresh (17,162 bxs)	429	
Peas, Dried	18,157	
Petroleum Products	621	82,665
Pineapple		998
Pipe, NOS		23,257
Plastic Scrap	3,703	
Plywood & Veneer	29,643	489
Popcorn	952	
Pork, Frozen	519	
Potatoes, Dehydrated	6,249	
Potatoes, Frozen	55,236	
Poultry, Frozen	395	
Poultry, Pet & Stock Feed	15,889	
Recreational Equip.	2,289	678
Rubber, Crude	5	
Rubber, Crude/Synthetic		9
Rubber Mfg.		377
Salmon, Canned & Frozen	1,382	
Salt, Crude		289,487
Sandblasting Grit	1,223	
Seed		427
Seed, Bentgrass	29	
Seed, Clover	17	
Seed, NOS	3,449	
Seed, Ryegrass	540	
Seed Grass, NOS	4,309	
Shellfish, Canned & Frozen	19	
Soap & Cleansers	3,829	
Soda Ash	1,416,433	
Sorghum (1,011,735 bu)	28,329	
Soybeans (1,125,616 bu)	33,768	
Steel Bars	290	
Steel Coils	104	
Steel Plate	5,103	
Tallow	551	
Tires & Tubes		8,162
Toys		1,242
Tuna, Canned		1,105
Vegetables, Canned	885	
Vegetables, Fresh	82	
Vegetables, Frozen	2,513	
Wastepaper	77,699	
Wheat (202,485,721 bu)	6,074,572	
Whey Powder	1,727	
Wire		968
Wood Burls & Logs	1,059	
Wood Mfg.	751	555
Wood Pulp	79,121	
Woodchips	683,311	
Wool		2
Yarn, NOS		50

Leading Foreign Commerce Nations

Exports	Short Tons
Japan	3,485,277
Republic of Korea	1,478,030
Egypt	1,058,867
Republic of China (Taiwan)	636,829
India	608,829
Philippines	560,040
Indonesia	410,616
Malaya	258,286
People's Republic of China	131,302
Belgium	63,421

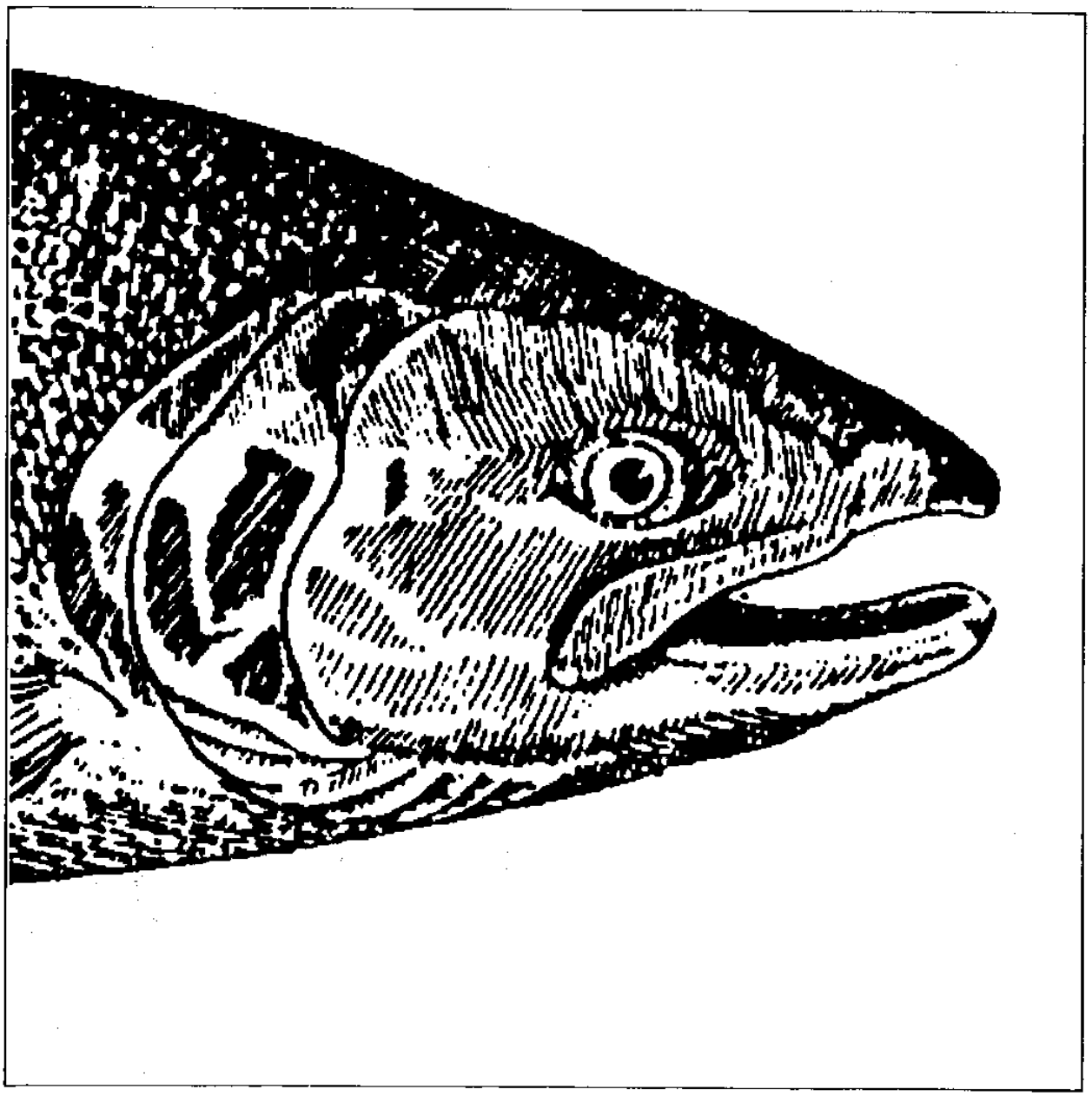
Imports	Short Tons
Japan	536,224
Australia	419,731
Canada	244,423
People's Republic of China	88,427
West Germany	62,321
Philippines	37,164
Malaya	34,864
Belgium	22,064
United Kingdom	13,705
Venezuela	6,724

Principal Foreign Exports Handled by Columbia River Ports 1989-1990

Thirteen Leading Commodities (Short Tons)

Wheat	11,569,427
Corn	6,968,267
Logs	3,155,651
Soda ash	1,464,768
Woodchips	898,804
Barley	715,265
Lumber	513,361
Sorghum	498,374
Coke	332,416

FISHERIES



ENDANGERED SALMON: *A READING*

Many kinds of fish live in the Columbia River system. The largest freshwater fish in the United States, the white sturgeon, is found in the Columbia and Snake rivers. Other fish in these waters include American shad, eulachon, Pacific lamprey, northern squawfish, bass, chiselmouth, peamouth, walleye pike, mountain whitefish, yellow perch, and many kinds of sculpins, sticklebacks, daces, shiners and suckers. However, salmon are the fish most closely associated with the Columbia and Snake rivers. Chinook, coho, sockeye, and chum salmon are kinds of salmon found there.

Salmon are the most valuable fish caught in the Columbia system. Commercial fishermen catch salmon and sell them. Recreational or sport fishermen catch them for fun or food. Indian fishermen also catch salmon for special ceremonies and for food.

Salmon are unusual fish in that they are anadromous: that is, they lay their eggs in fresh water, the young hatch, and then the young migrate to the ocean where they grow. Eventually they return to their original spawning area in fresh water to lay their eggs. After they spawn, most salmon die.

Once the Columbia-Snake river system was the most productive salmon and steelhead area in the world. One hundred years ago more than 11 million adult salmon returned to the system to spawn each year. Today, there are about 2.5 million spawners.

There are fewer adult fish today for several reasons. First, commercial fishermen overfished the rivers. Second, poor land practices in mining, forestry, and agriculture destroyed many spawning areas. Finally, beginning in the 1930s, the construction of hydroelectric dams put barriers in the way of the fish as they moved up and down the river. Many fish died because of the dams.

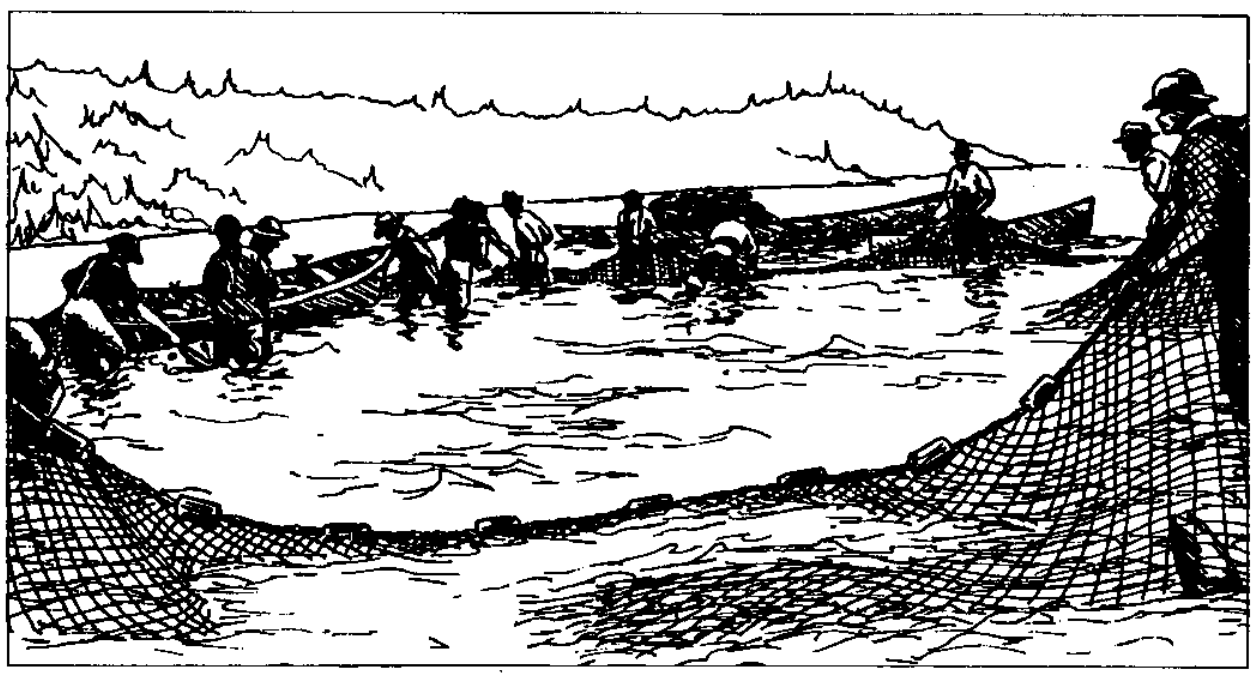
Dams slow the flow of the river, which slows the movement of fish out to sea. If the young fish take too long to reach the ocean, they die. The turbines at each dam also kill about 15 young fish out of every 100.

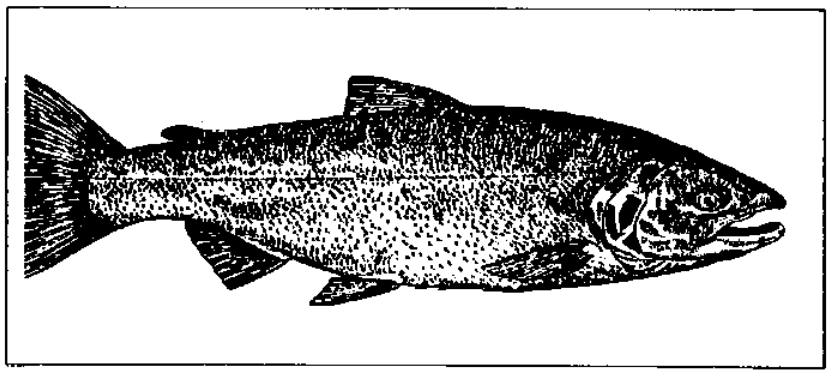
Adult salmon swimming upriver to spawn also are slowed by dams and by the fish ladders at some dams. Some fish do not reach their spawning grounds in time to spawn, while others do not reach them at all.

One hundred years ago, the fish spent their entire lives in the wild. Raised in a local stream, they found their way back to that stream to spawn. Clearly, these "wild" fish were well-adapted to that natural place.

Today, nearly all the fish produced in the Columbia system are raised in hatcheries. Society has turned to hatcheries because much of the wild environment the fish used to inhabit has become altered, and often spoiled, in the last hundred years.

Hatcheries have successfully produced salmon, but they have not been able to offset the losses caused by overfishing and by the damage to





the fish's environment. And hatcheries have not helped the "wild" fish. Many of the runs of wild-spawned salmon that returned to local streams have vanished. Some biologists believe that perhaps 200 wild runs are extinct.

Today, the decline of the salmon has reach a crisis.

In 1990 some groups concerned about the fish asked the federal government to give special protection to five vanishing runs of salmon. They asked for them to be protected under one of our country's strongest environmental laws, the Endangered Species Act.

In mid-1991, the National Marine Fisheries Service (the government agency responsible for deciding about the salmon) ruled that four of the five runs deserve protection. All four are upriver runs: the Snake River sockeye, the Snake River spring and summer chinook, and the Snake River fall chinook. The Fisheries Service proposed to give the sockeye "endangered" status and the chinook the slightly less serious "threatened" status.

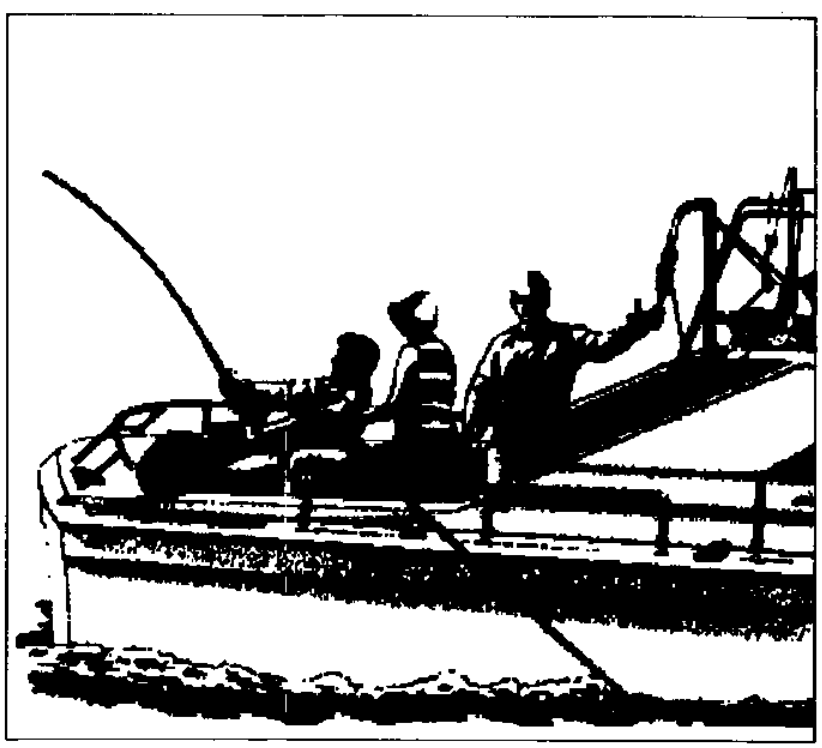
These rulings will not be final until 1992, but by issuing its first opinions in 1991 the Fisheries Service indicated that these runs were definitely in bad shape.

Protection for salmon under the Endangered Species Act will bring changes to the Columbia and Snake rivers. Under the law, the federal agency must not only protect the threatened or endangered salmon but also make a plan to increase their numbers and prevent them from going extinct. Such protection and restoration will mean that the other users of river water will have to modify their activities so as not to harm the fish. These users include the utility companies who use the water to generate electricity, the farmers who withdraw water to irrigate crops, and the shippers who depend on a certain amount of water in the river to float barges which carry grain and other items.

The costs of making adjustments are hard to predict. Some regions, businesses and people will lose money. But on the whole, economists predict that the overall cost for the Northwest will be minor.

The salmon crisis raises important questions not only now but for the future. Salmon have been residents of the Northwest for millions of years. In only about 100 years we have brought some of them to extinction and threatened the existence of others.

How many salmon do we want? How far into the future do we want to have them? Finally, what sort of an environment do we want for the Northwest?



Those Unique Salmon

by Malcolm Zirges, Marine Region

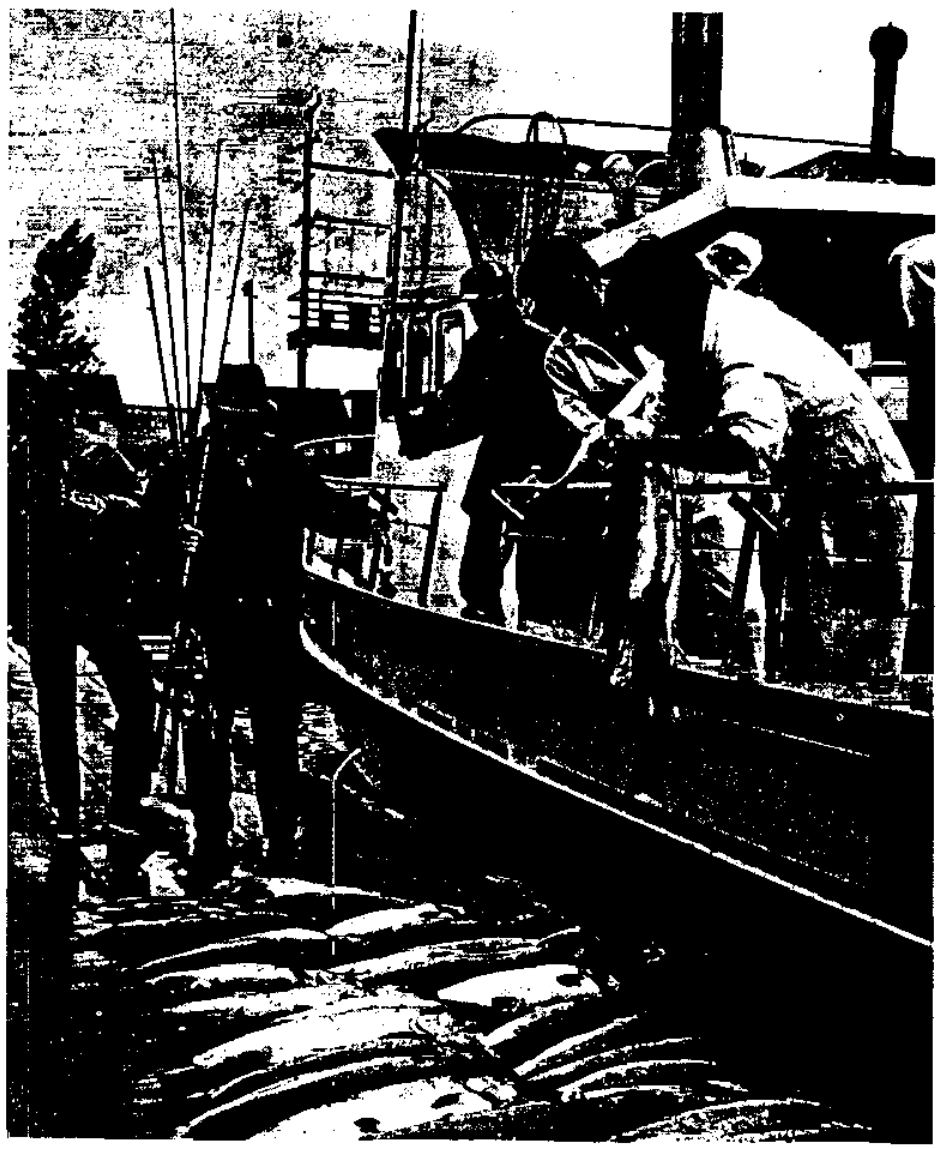
The Pacific Ocean is home to six species of salmon, each different in appearance, migration routes, life history and growth pattern. Most Oregonians only know about five of these, since one is found only in the western Pacific. Let's look at these six species and learn how they differ and why they may have evolved into separate species, how this affects their abilities to adapt and survive in the face of changing environments.

Chinook and coho salmon are found all around the Pacific rim from California to Japan. Chum and sockeye are found mainly from Washington state north and westward to Asia, pink salmon mainly from British Columbia north and west to Asia, and the cherry salmon only around the Sea of Japan.

There is a fish in the Atlantic Ocean called the Atlantic salmon, but it is actually a trout, very similar to our steelhead. Salmon and trout are closely related, however, salmon are thought to have evolved from a trout ancestor.

Steelhead and the Atlantic salmon share an important adaptation of salmon which most other trout generally do not — they are anadromous. Anadromous means the adaptation for spawning in fresh water, but primarily rearing and maturing in the ocean.

Only two salmon species, chinook and coho, are numerous in Oregon waters, supporting extensive sport and commercial fishing. Chum and sockeye salmon also enter Oregon streams. Chums are still produced in some north coast streams and are caught occasionally by ocean fishermen. Sockeye still run into the Columbia River, and contribute a few fish to gillnet catches. Oregon does not have resident populations of the pink salmon. Pinks are often caught off the coast of Oregon, particularly by commercial trollers, but they are all from streams to the north of Oregon, primarily the Fraser River of British Columbia.



Salmon constitute one of Oregon's most important natural resources. Six species of salmon exist in the Pacific Ocean; five of them are found in Oregon waters.

Why The Differences?

Subtle, but nevertheless unique, characteristics of different streams, and even different areas within specific streams, probably led to evolution of the different species. For example, it is not hard to imagine that a large, fast flow-

Some salmon are genetically geared to run only a short way to their spawning grounds. Others must travel more than 1,000 miles on the energy supplied by stored fats and oils. All Pacific salmon die after spawning.

ing river would favor larger, stronger fish, or that a small, shallow stream would be more suitable for a small fish. So the environment may have molded the different species. It is also obvious if you compare species, that they have unique shapes, coloration, behaviour patterns, and other characteristics, so the fish can tell a member of its own kind.

These physical differences can be fascinating in themselves. Consider the beautiful variegated coloration of a spawning chum salmon, the outrageous red body and green head of a spawning sockeye, the magnificent body size and spotting of a big chinook, or the fierce teeth on the kype, or hooked jaw, that forms on most male salmon near spawning time. But we should get on and explore the ways the different salmon species use different parts of the environment.

We must use many generalizations since salmon, like people, do not all act the same. Salmon are adaptable. There are many cases where one species of salmon has seemingly moved into another's niche because of nontypical water temperatures or some other factor. That adaptability is important for survival. Now let's look at some general characteristics.

Run Timing

Timing is an important element in the use of parts of the environment by the various salmon species. Timing of the spawning run is particularly significant.

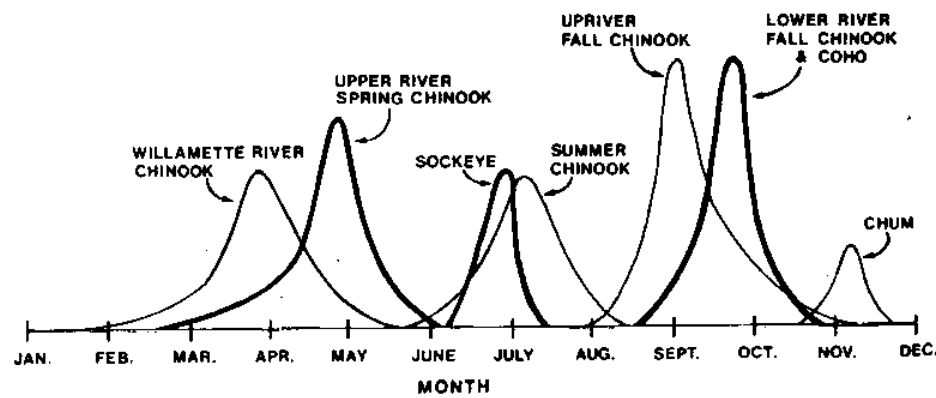
The accompanying chart shows the different times that the several salmon species and races of chinook enter and pass through the lower Columbia River on their way to spawning areas. Each stock of fish has developed a run timing which places the fish on desirable spawning areas at a time when water flow and temperature will be optimum for spawning and, in turn, egg incubation and fry emergence and rearing.

This timing also reflects the distance the particular stock must swim to reach its spawning grounds. Salmon originally spawned from near tidewater up to 1,200 miles in Canada. Since salmon cease feeding when they begin their spawning migration, it is obvious that fish going longer distances need more energy reserves to make the trip. This is done by accumulating more fatty tissue, and the upriver stocks, such as the spring and summer races of chinook, are famous for their high oil content. Short running fish need less reserves and are typically low in oil content. This is particularly true of chum salmon.

Spawning Area Location

Pink salmon typically move the shortest distance into fresh water, often spawning in tidal areas usually within several miles of the ocean. Chum salmon also generally make relatively short spawning runs of only a few miles, although it is not uncommon for them to go 100 miles or more in large river systems. These species prefer relatively untouched small streams that flow directly into estuaries or the ocean.

Chinook salmon generally use the greatest range of river areas for spawning. Chinook may

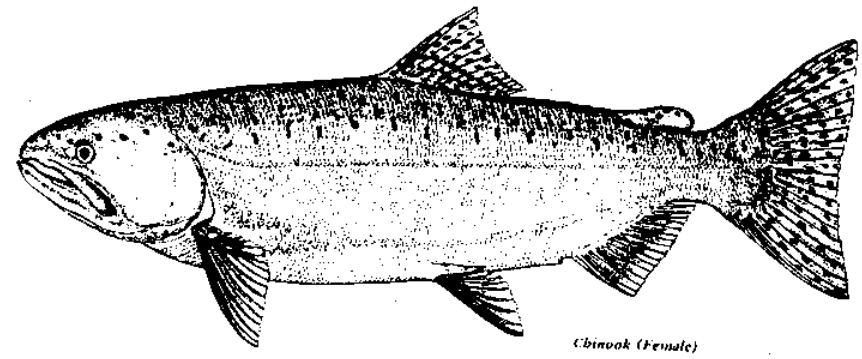


Time of run passage through the lower Columbia River for different salmon species and races.

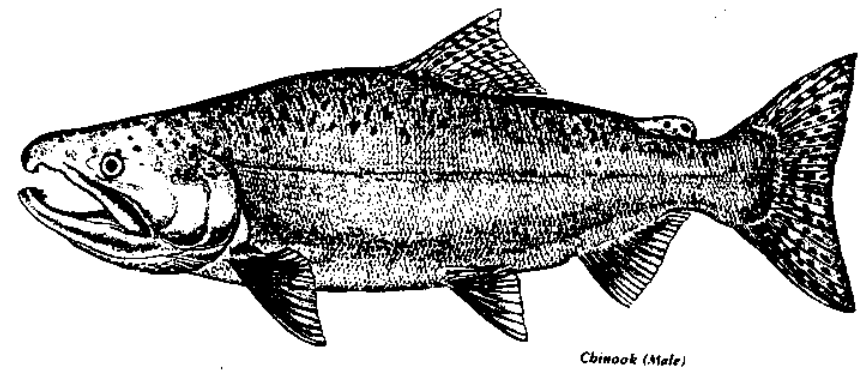
spawn from low in the mainstem of large rivers to smaller tributary streams high in a river system. This flexibility has been particularly important to chinook in large river systems that have been dammed for hydroelectric or other uses.

Coho and cherry salmon spawn in the very upper reaches of river systems, often in streams that dry up in the summer months. These streams are in areas most heavily damaged by road building, logging and other developments. These activities sometimes obliterate spawning areas for these species, and also affect water quality needed by the hatching fry.

Finally, sockeye salmon have adapted to spawn in streams that are usually above lakes or lake systems. In some areas, the Columbia River system in particular, these lake systems are no longer accessible to fish.



Chinook (Female)



Chinook (Male)

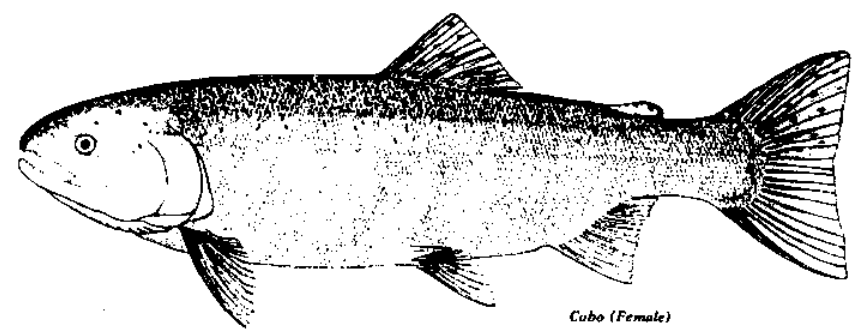
Illustrations by Ron Pittard
Reprinted by permission from *How to Catch and Identify the Gamefish of Oregon*, by E.A. Lusch, Frank Amato Publications, 1978.

Early Rearing

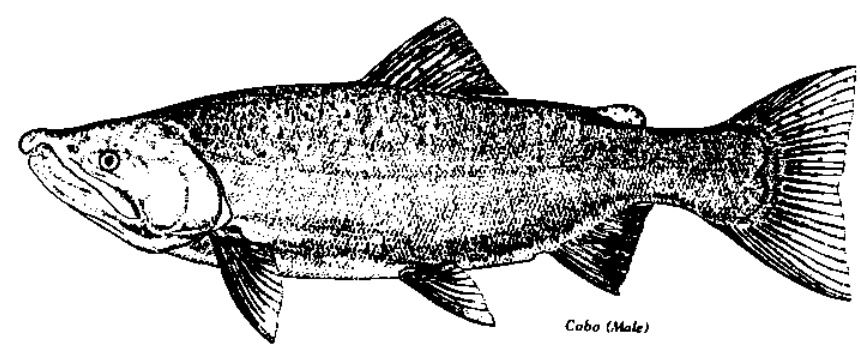
Spawning areas can, and often do, overlap between species of salmon because the needs of the eggs are related primarily to proper flow of water which provides oxygen. Temperature is probably one selection difference between species. For example, sockeye typically seek out and spawn at temperatures ten degrees cooler than chum salmon using the same river system.

Rearing space is very important for the young after they hatch. Suitable rearing areas with the necessary elements, such as food supply, space, cover and other considerations, are limited in most fresh-water environments. Man has had a serious impact on rearing space affecting particularly those species that rear the longest in fresh water.

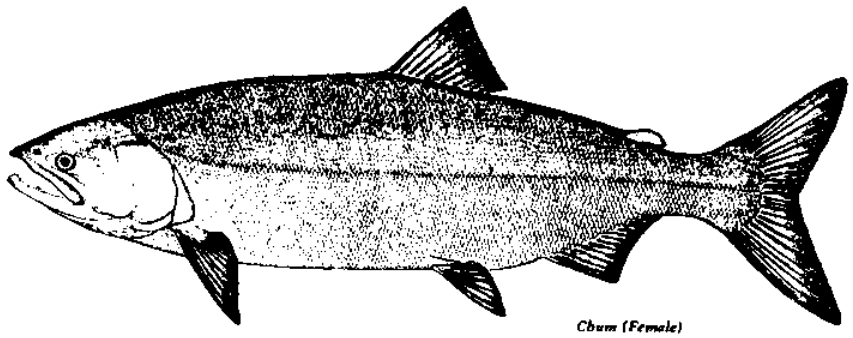
Chum and pink salmon probably have adopted the most extreme "adaptation" to rearing in the fresh-water environment. They typically do not rear there at all, but leave for the ocean almost upon hatching. Some chum salmon, usually those spawned in larger rivers, do rear in fresh water for short periods, but seldom longer



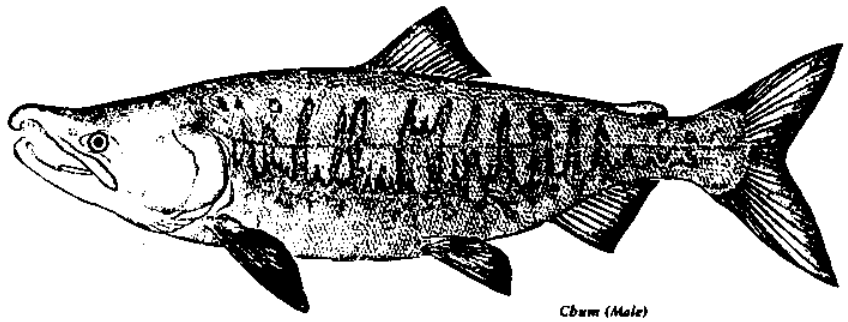
Coho (Female)



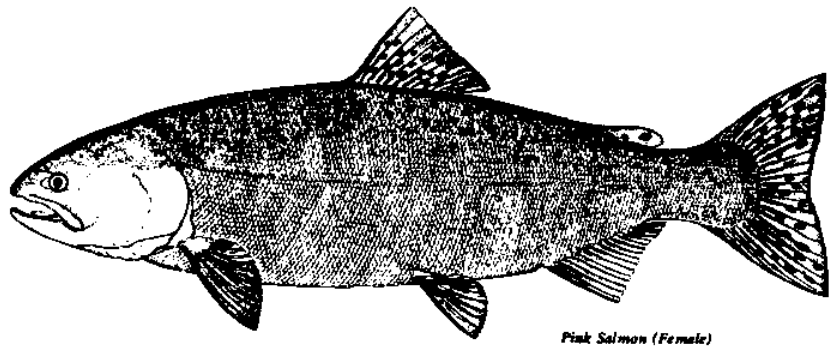
Coho (Male)



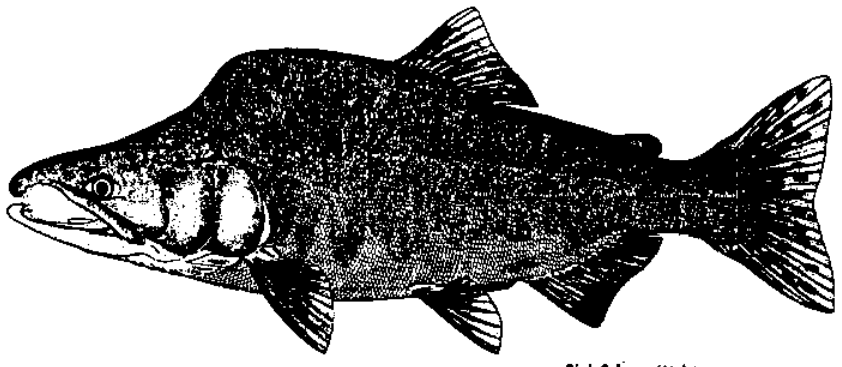
Chum (Female)



Chum (Male)



Pink Salmon (Female)



Pink Salmon (Male)

than two weeks. Oregon chum salmon typically move to sea almost immediately without feeding in fresh water.

Chinook salmon live mostly in large river systems and generally use the greatest portion of those rivers for early rearing. Chinook fry rear from the upriver areas where they hatch out on down into the estuary, typically dropping downstream as they grow and develop. They commonly reside in the river less than three months, except for spring-run fish which stay over a winter in fresh water. Chinook often hold and rear in river estuaries before moving to the ocean. This is very typical in Oregon coastal chinook stocks.

Coho and cherry salmon also drop downstream as they develop, but generally stay in the upper portions of rivers. These species rear over a winter in fresh water, even two or three winters in colder streams in Canada and Alaska. Since streams do not produce a lot of food, particularly in winter, competition is intense in these species. They have developed elaborate territorial behaviour to spread the young fish out — stronger fry get a share of available food and cover while excess fish are forced downstream. Coho fry are even known to run off other species as well where distributions overlap.

Young sockeye salmon remain in fresh water the longest of all salmon species. After hatching and leaving the gravel, sockeye fry move into a nearby lake where they rear for one to three years. They feed on plankton and congregate in schools without the territorial behaviour of coho.

Ocean Distribution

The ocean provides a vast feeding area for salmon, and young salmon spread over much of the north Pacific to grow and mature. The Gulf of Alaska, in particular, is a rich pasture for salmon and all North American species are found there. The different species are not just all mixed up over this area, rather each searches out certain preferred water temperatures and depths. The ocean that seems so

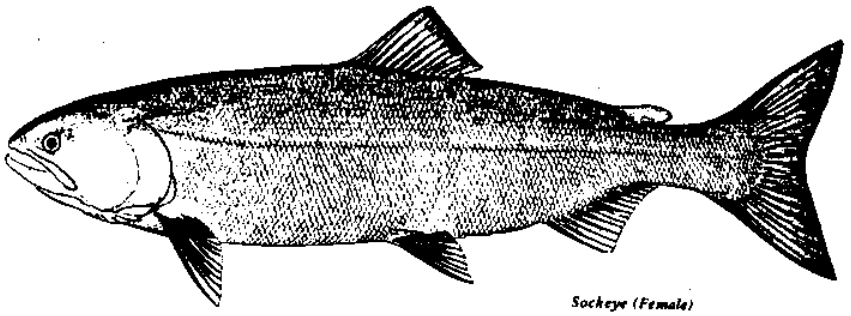
uniform to many people is made up of unique water masses of different temperature, salinity and certainly food organism content.

Pink and chum salmon fry, for example, are very small when they first enter the ocean, so they remain near shore for several weeks, their first summer feeding on plankton and small crustaceans before moving offshore. Later, they are thought to use mostly mid- and upper-water levels, still feeding primarily on small prey items such as shrimp. Chum salmon begin feeding on some fishes as they mature.

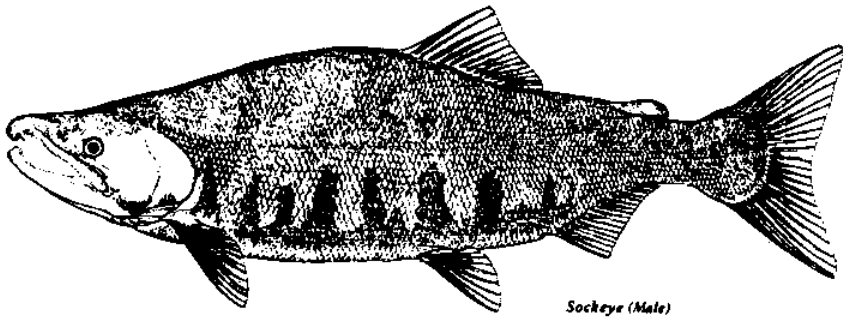
Chinook salmon smolts begin their migration as soon as they enter the ocean, and most chinook, particularly fall-run fish, move northward from their home stream. Their trip can be impressive indeed. For example, one Columbia River chinook was captured and tagged off Adak Island at the tip of the Aleutian Chain, Alaska, and returned to spawn the next year. Chinook like deep water, both in streams and in the ocean, and this species is generally associated with the bottom, or at least deeper water layers in the ocean. Chinook grow rapidly into fish-eaters.

Coho salmon are surface-oriented fish. They move offshore fairly rapidly after leaving fresh water, and are apparently adapted to do this since they are already in their second year of life and are larger than chinook smolts and much larger than chum or pink fry. Oregon stocks have been found both north and south of their home streams. They generally do not move as far as chinook, although their complete migration path is not yet fully known. This species feeds on intermediate-sized prey, including shrimps, squid, crab larvae and small fishes. As much as any salmon, coho feed on what is available.

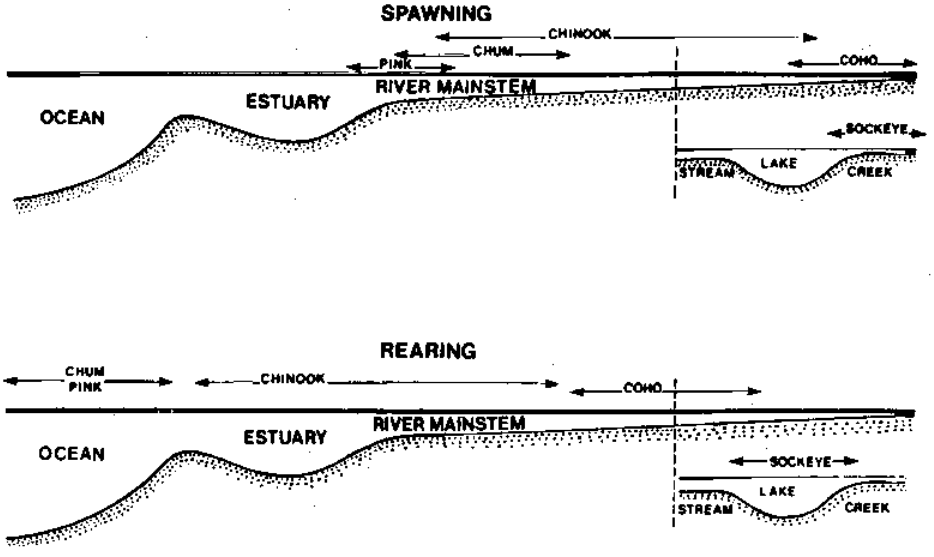
The sockeye is a plankton feeder throughout its life cycle, moving out into the north Pacific in large feeding schools that range to and fro through the swarms of krill and other small ocean animals. This species also seems to orient toward upper water layers, al-



Sockeye (Female)



Sockeye (Male)



General freshwater areas used by different salmon species for spawning and early rearing.

though is not as surface-oriented as the coho. The Japanese fish sockeye extensively with surface gillnets on the other side of the Pacific.

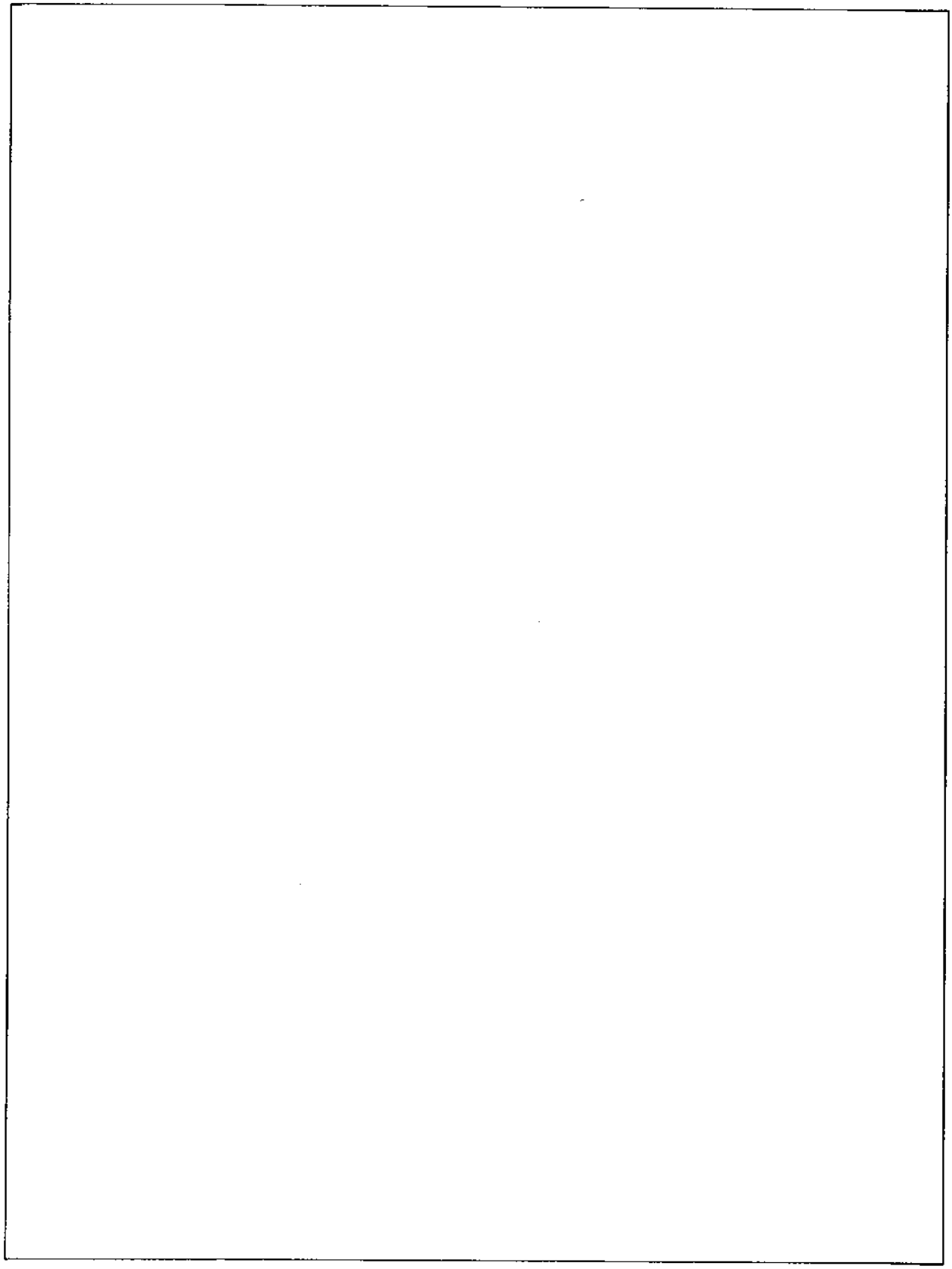
Maturation

Age of maturation is even variable within some species. Chinook mature as late as age four or five and rarely at six. Chinook jacks, or precocial males, however, mature at age two. This characteristic is shared to a lesser degree by sockeye, chum, coho, and cherry salmon. Coho, for example, typically spend two years in the ocean, although some coho males also mature early as jacks. Pink salmon are the exception, invariably maturing as two-year-olds.

Aside from the obvious importance of greater or lesser exposure to ocean fishing fleets and other predators, age of maturity has great adaptive significance when environmental changes occur. In pink salmon, for example, if the eggs from one year's spawners are somehow destroyed in a specific stream, there will be no adults to return to that stream two years later, or two years after that, etc. etc. Only by eventual straying of spawners from some other stream will that stream be restocked. If the destroyed stock was unique in some way, its special characteristics will have been lost.

A variable rate of maturation acts to cushion such disasters. If one year's eggs are somehow destroyed, the fish hatched from eggs deposited one, two, three or four years previous will mature the next year and return to the stream to spawn. This overlap is thought to have important genetic consequences, and species with less age of maturation variation, such as coho, probably are less resilient to change.

If this has seemed like a giant jigsaw puzzle, it is. Salmon are fascinating in their complexity, and have been a fertile field of study for fisheries biologists and other naturalists for many years and will continue to be for years to come.□



Lesson Activities

I. Words and Concepts

Define and clarify the following:

1. anadromous
2. spawning grounds
3. smolts
4. predator
5. migration
6. fish passage facilities
7. commercial fishing

As a class, collect any other words and phrases that need to be defined and clarified before a clear understanding can be gained. There are probably many of them in the readings. Discuss them carefully.

II. Class Activities

1. Name some of the different species of fish that live in the Columbia-Snake river system. Which ones are you most likely to eat? Which ones are predators?

2. In what ways are fish and wildlife habitat in the Columbia River basin being destroyed? What measures can be taken to reduce these losses?

3. Assume you have just caught a ten-pound salmon in Idaho's Salmon River. List the hazards the fish faced in its life.

III. Class Discussion or Written Assignments

1. Discuss or write on the following:

   Efforts are now underway to improve and protect the spawning migrations of salmon and steelhead. However, restoration of the anadromous fish does not come without costs, particularly in increased electricity bills. What are abundant, restored salmon populations worth? What process do you propose for coming up with an answer to this question?

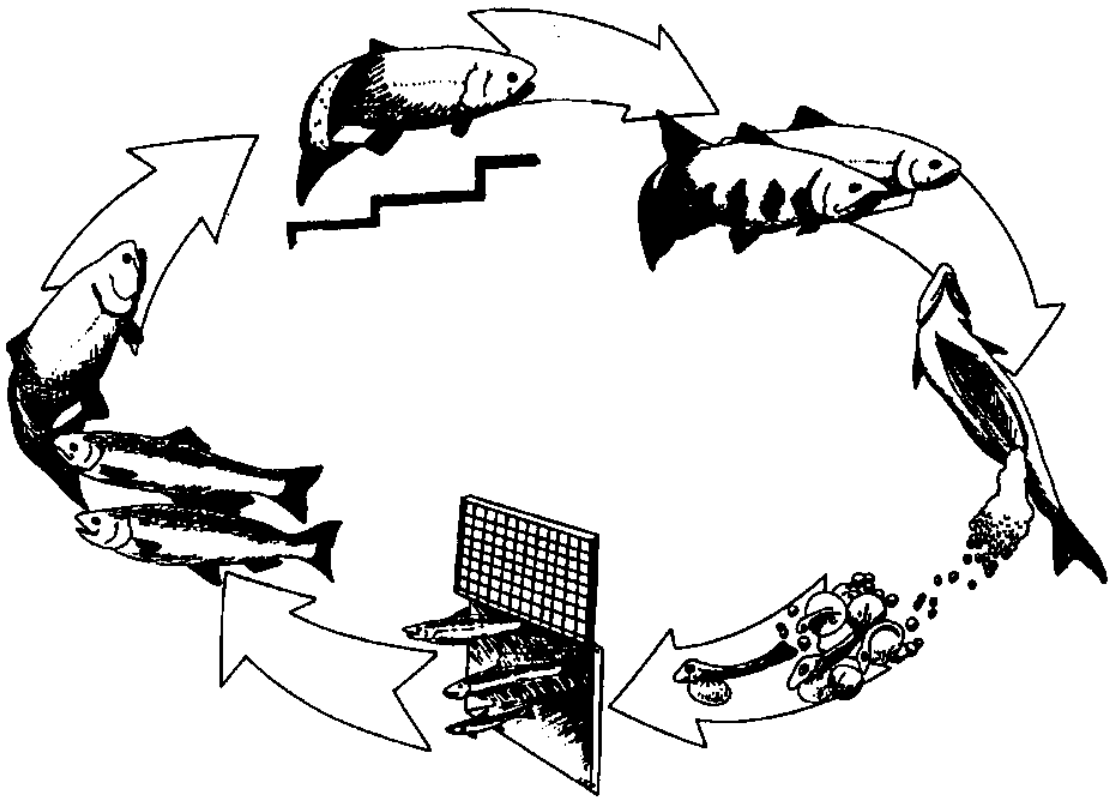
2. Invent and write up one of the following:

   - A legend explaining why a salmon returns to the stream in which it was born in order to spawn.
   - A legend explaining why there are so many different species of fish in the rivers.
   - A legend explaining the decline of salmon in the Columbia River system.

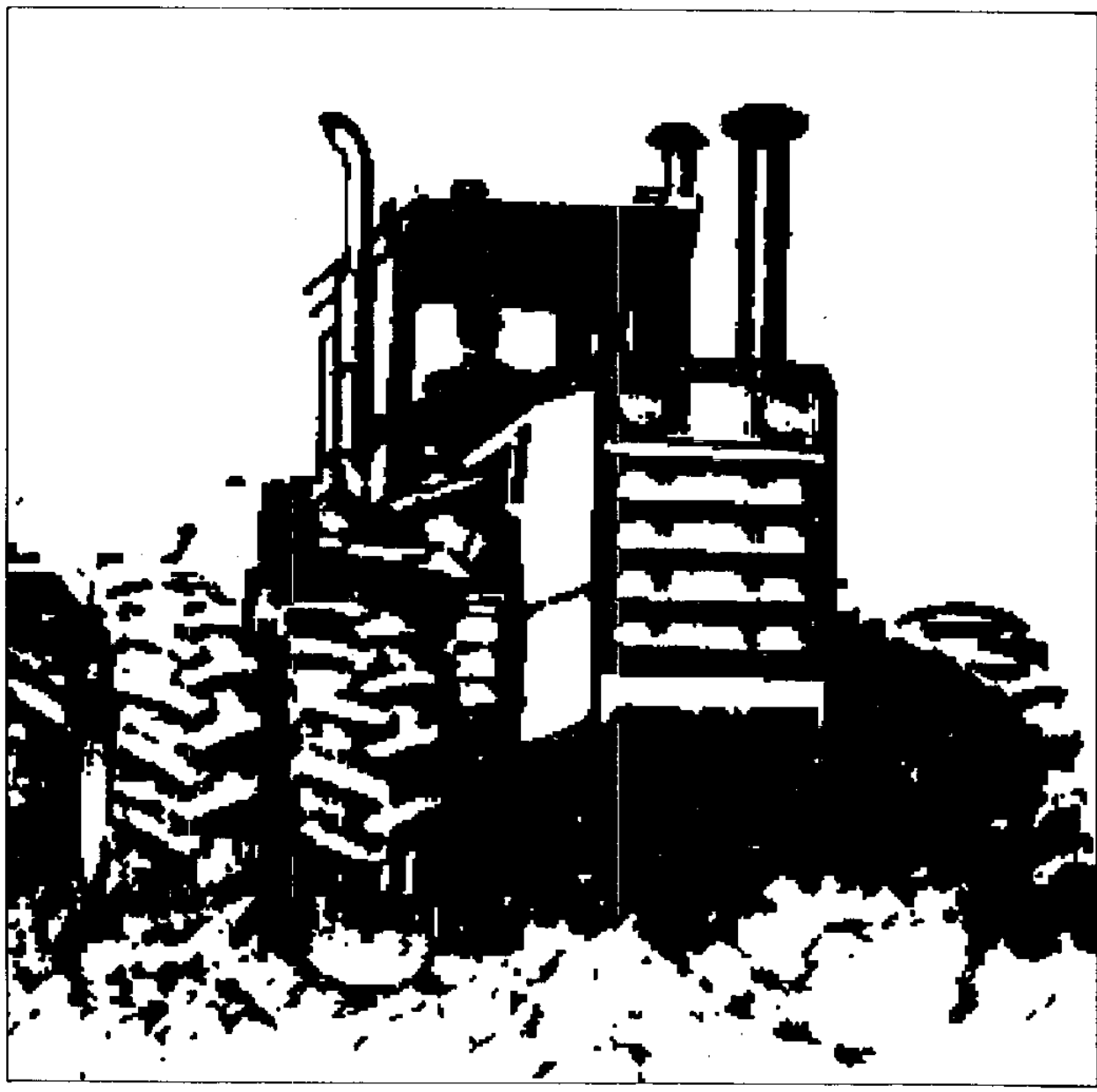
   After you have invented and written your selection, present it to the entire class.

3. Discuss the various fishing methods that have been used to harvest salmon. Which one would you use? Why? What other methods might be used to harvest salmon?

Hatchery Propagation of Salmon



AGRICULTURE



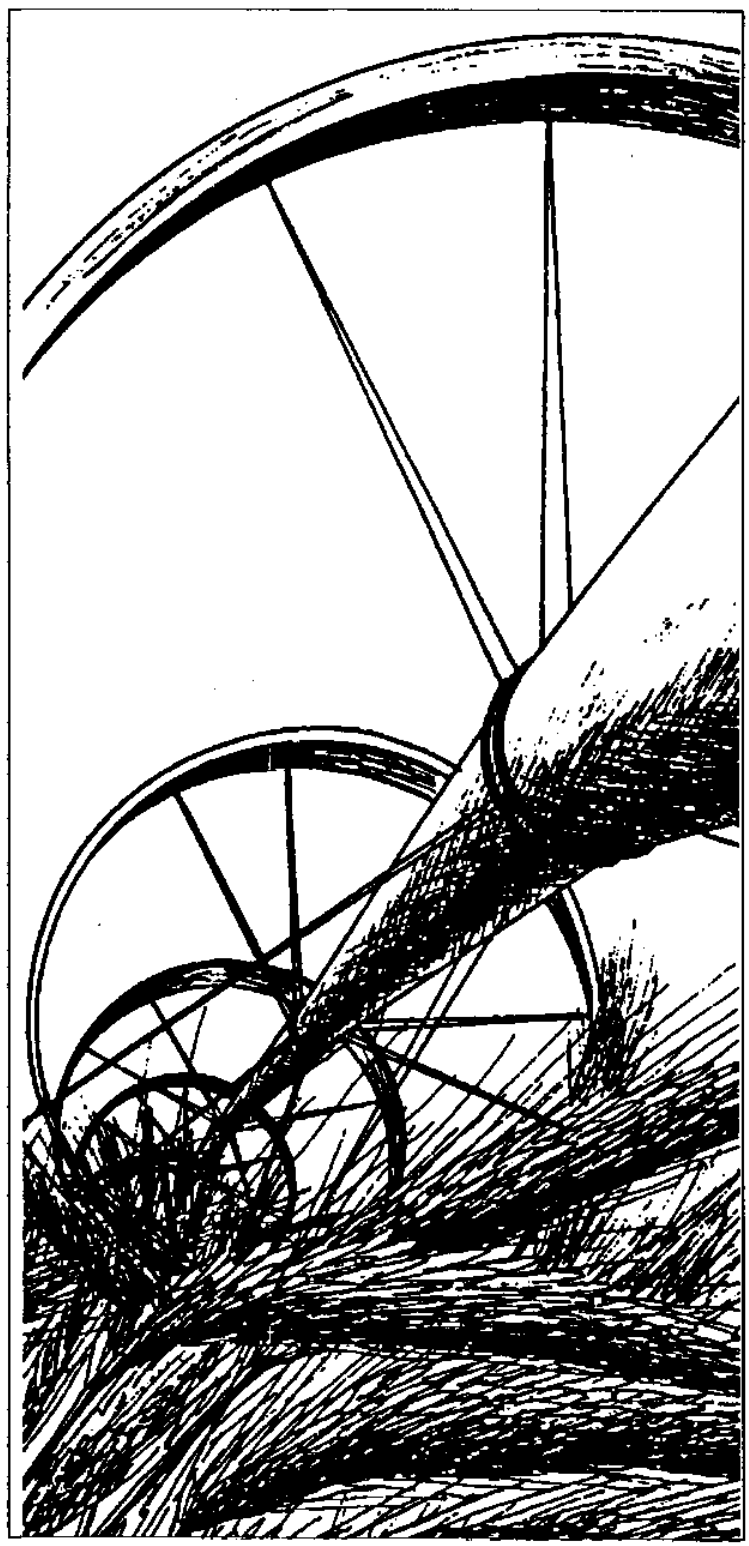
AGRICULTURE: *A READING*

The development of large-scale irrigation in the Columbia River basin coincided with the building of hydroelectric facilities. Early on, inexpensive electricity and unused flows of spring runoff each year suggested the potential for development of vast acreages of irrigable land. Today, irrigation accounts for more than 90 percent of the total water diversion and consumption in the Columbia River drainage area. Some of this water, of course, re-enters the river after use. The total land at present under irrigation is between 7 and 8 million acres. Within the next 20 years, another 2 to 4 million acres could be added, although many feel that fewer than 1 million acres will be developed.

By the time the Columbia and the Snake rivers join in southeastern Washington, they have nourished livestock, potatoes, peas, alfalfa, beans, hops, and barley, and extensive fruit crops such as watermelons, apples, pears, and cherries. Both large and small farms along the lower Columbia use its waters for irrigation.

As you already know, 90 percent of all the water that is diverted from the Columbia goes to crop irrigation, and little of that water returns to the river system. Most of it evaporates in the sun or transpires by the leaves of the irrigated plants. As you have been reading all along, if we want to produce these crops, we may have to learn to use the river less for other purposes: fishing, power generation, navigation, and recreation.

In the 1830s when the first missions were established between the Clearwater and the confluence of the Columbia and the Snake, water was diverted to irrigate gardens that fed the missionary settlers. When agriculture became a major activity on the Columbia, farmers in the region had to ship their food to the



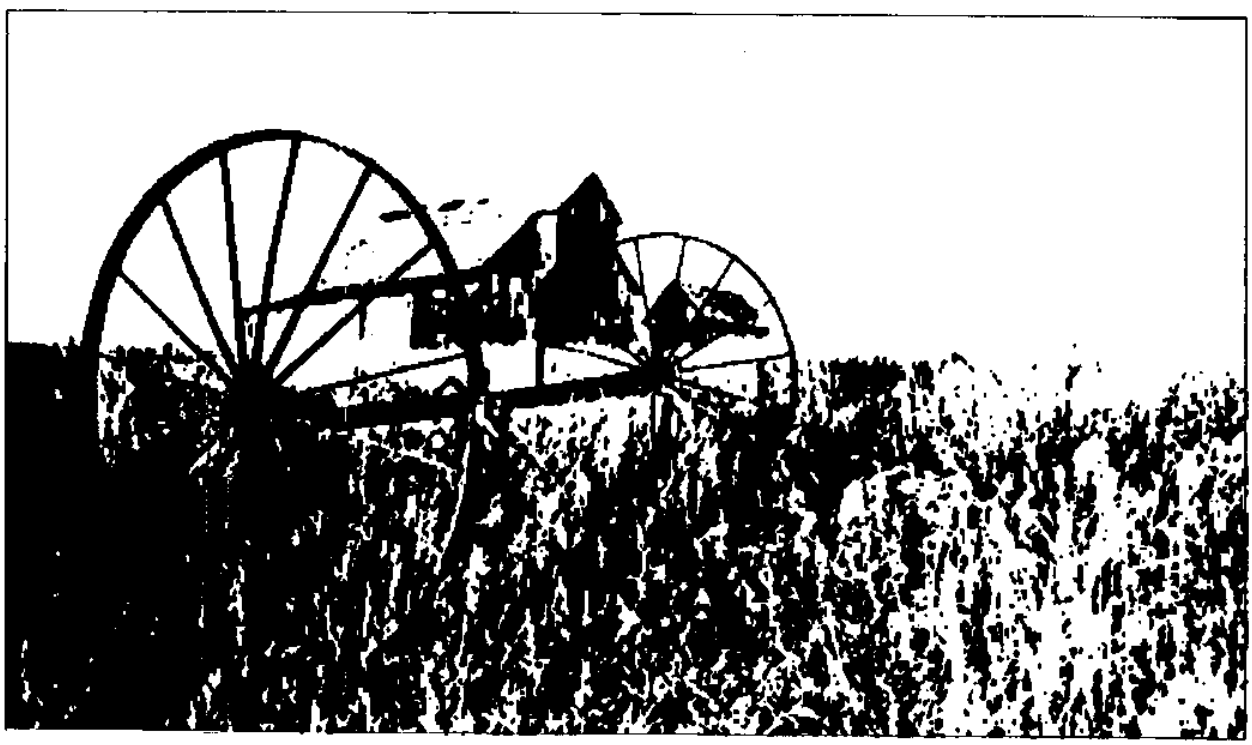
East Coast where the population was. They shipped down the river through the dangerous rapids, out to sea at Astoria, south to the tip of South America, around Cape Horn, and north in the Atlantic until eastern ports were reached. This was a long trip. Northwest farmers were far from their markets. Now they are the closest U.S. producers to the nations of the Pacific Rim, the quickly growing market for U.S. agricultural products.

Northwest soils, enriched by volcanic action over thousands of years and lying near one of the largest river systems in the nation, are extremely productive.

It is not a matter, however, of simply turning on the sprinklers. Lifting and distributing irrigation water consumes a great deal of energy. In the case of high-lift irrigation projects, the amount of energy required to lift the water from the river to the farmer's land may be as great, or in some cases greater, than the energy generated by using the water for consumer needs. Heat, lights, TV, stereos, neon advertising, or agricultural production? That would be a tough choice.

Few people question using the river's water for irrigating land now in production. However, some of the proposed developments in the Columbia River basin have come under criticism. Much of the proposed development will require large inputs of water, energy, and fertilizer. The expense in both water and dollars will be great. As proposed, the cost of these new developments will be paid largely with public funds. It is apparent that food production is considered vital to the Pacific Northwest as an important export commodity.

Center-pivot sprinkler systems and modern pumping methods have been developed to more efficiently bring water to crops, increasing crop yields while lowering water use. However, even with modern technology, the demand for both surface and ground water for increased irrigation will need to be balanced against other competing uses for the finite waters of the Columbia River system. Trade-offs will need to be made. Everything comes at a cost.



Lesson Activities

I. Words and Concepts

What do the following words mean?

1. diverted
2. evaporate
3. Pacific Rim nations
4. volcanic action
5. high-lift irrigation
6. confluence

II. Problems

1. Why do you think the early farmers shipped their crops to East Coast markets by way of the Columbia, around Cape Horn, and up the Atlantic coast, rather than over the Rockies, down the Missouri River, and then to East Coast cities and towns? The latter way is much closer. Figure out the exact distance for each route.

2. Look on a map and learn the vastness of the region irrigated by the Columbia and Snake waters. How many square miles are there in 8 million acres? What percentage of this is the Columbia River basin (260,000 square miles)?

3. Where on the map would high-lift irrigation be a necessity?

III. Class Activities

1. Below is a list of some of the crops grown on irrigated farm lands. Discuss the impacts that might occur if irrigation were stopped. Consider what might happen to
   a. the economy of the region
   b. the balance of trade of the United States with the Pacific Rim countries
   c. the retail cost of these products: wheat, apples, potatoes, beans, cherries, onions, alfalfa

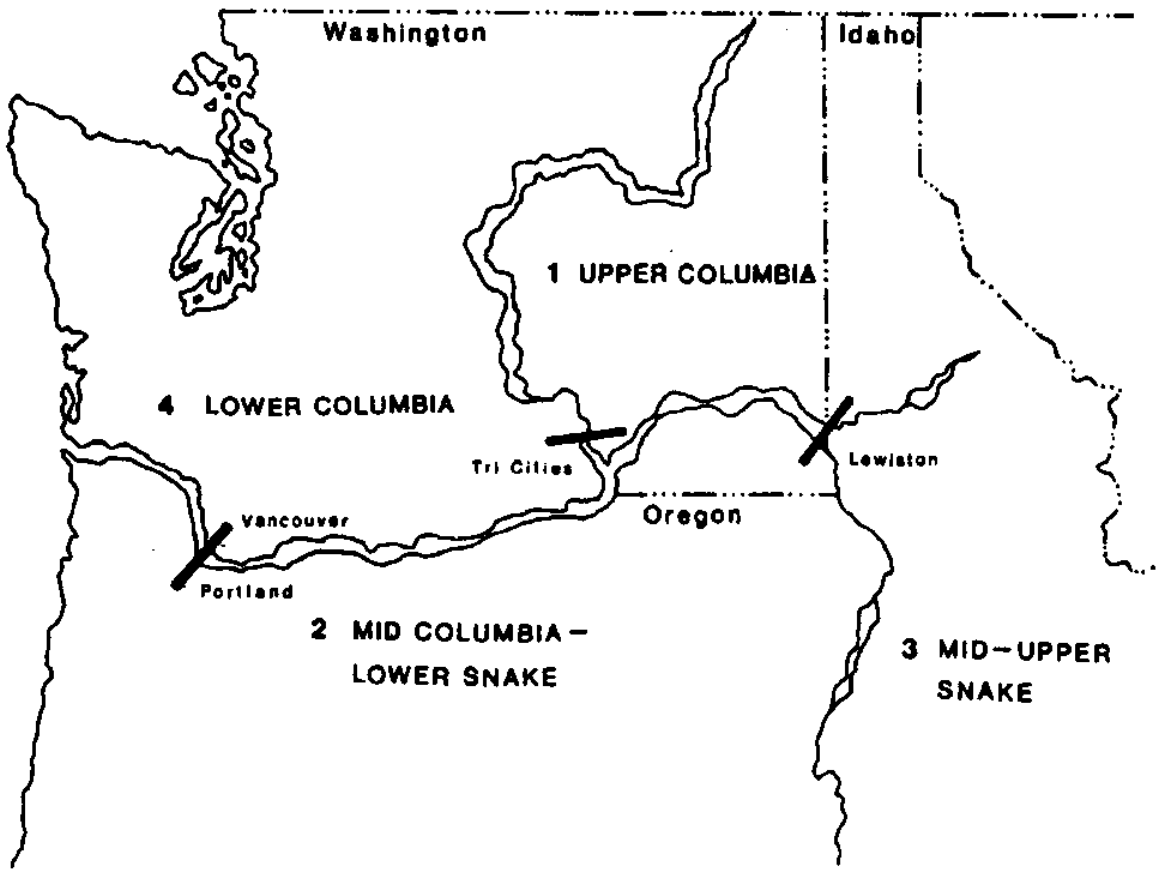
2. Think of the various ways these crops are used in the United States. Are they used in the same manner in Pacific Rim countries?

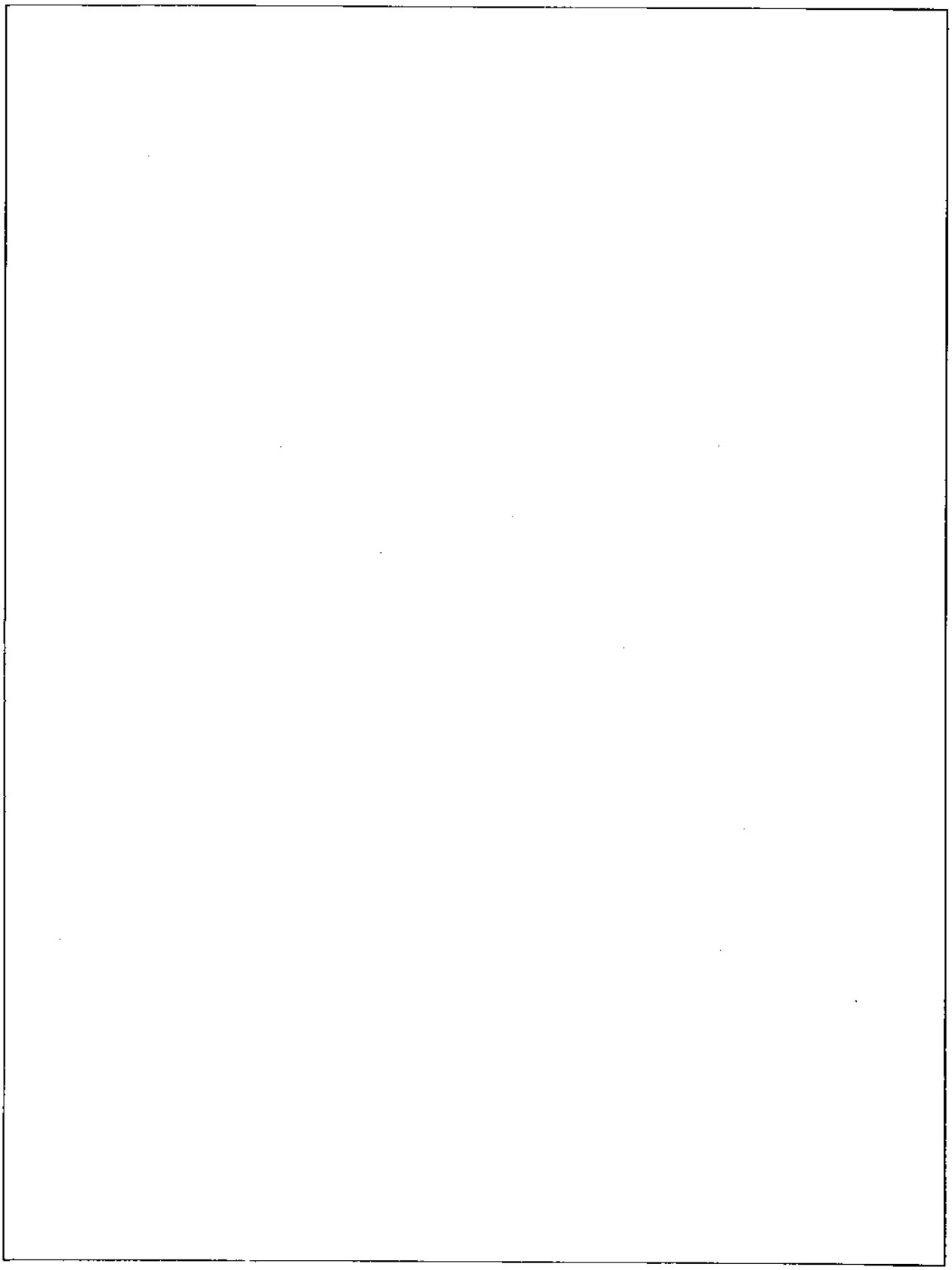
3. How do you think the following taxpayers would view picking up most of the cost of the proposed new irrigation projects?
   a. an alfalfa grower near Moses Lake, Washington
   b. an employee of the Port of Portland
   c. a crop worker in the Yakima Valley
   d. a banker in Walla Walla, Washington
   e. a commercial fisherman in Astoria
   f. a cattle or sheep rancher in eastern Montana
   g. a farmer in Missouri
   h. a commercial advertiser in New York City
   i. an owner of an ocean shipping company who lives in Florida
   j. an owner of a recreational boat moorage on the lower Columbia
   k. a logger in Idaho

Think of as many variables and conflicts as you can. For example, one person can have many interests, some of them conflicting. Taxpayers are also consumers, electrical rate payers, and sometimes recreational users. They are also, of course, income earners.

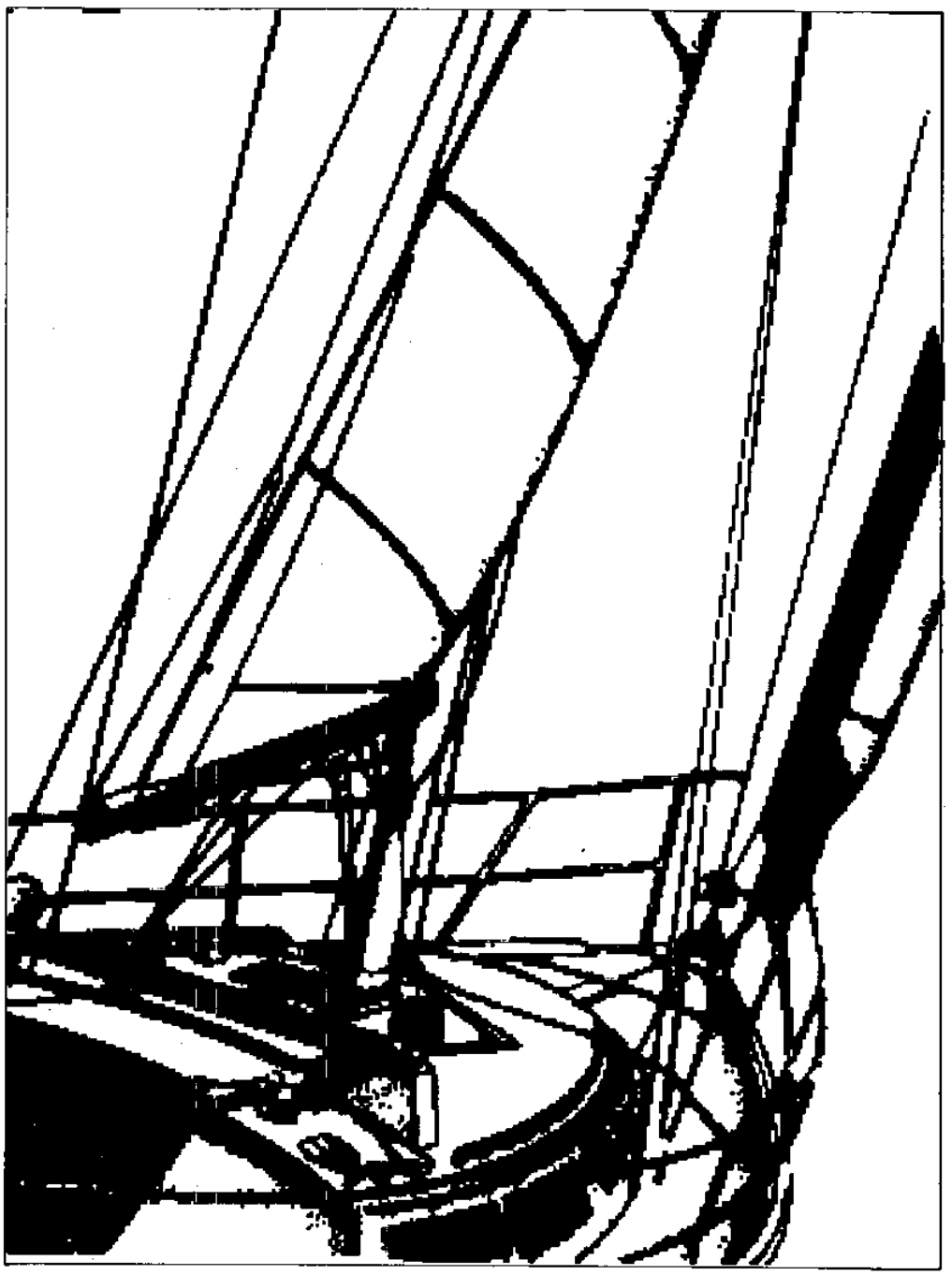
You need to see the immediate, perhaps predictable, response of a person's economic interests and the complicated responses of that person's life separate from his or her source of income.

Four Snake-Columbia River Zones





RECREATION



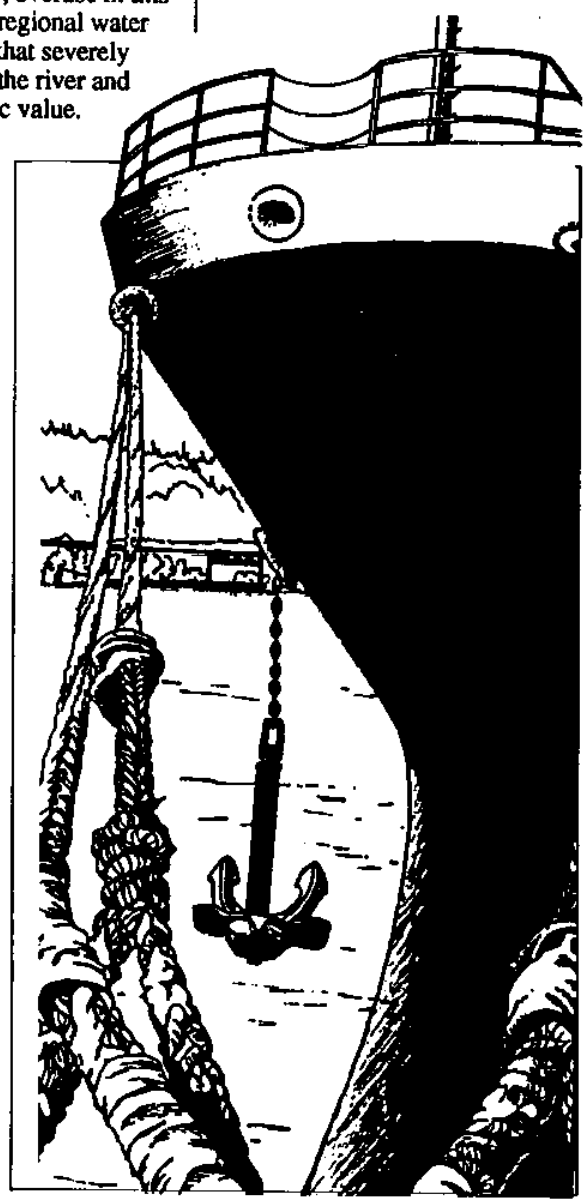
RECREATIONAL, MUNICIPAL, AND INDUSTRIAL USES OF THE RIVER: *A READING*

Water-related recreation, such as fishing, power boating, sailing, swimming, and waterskiing on the Columbia, is a Northwest tradition and contributes much to the economy of the region. It has been projected that recreation on the Columbia-Snake system will increase substantially over the next 25 years. However, attraction to this area will depend on continued access to a clean, safe, natural environment. Poor land management practices and rapid reservoir fluctuations, combined with increased irrigation drawdowns and associated water quality problems, could create a dangerous and unattractive recreational setting which would substantially alter the use of the Columbia River for recreational purposes.

Municipal and industrial demands on the river are many. The river is used for drinking water, as a coolant for industry, and as a place to dispose of our wastes. In the past, major problems centered around maintaining high water quality, mainly for drinking water and municipal waste treatment. Recently, however, there have been discussions of potential water withdrawals that could have an impact on water quantity as well. For example, cooling towers for thermal power plants to be located near the river could consume considerable amounts of water. In addition, there have been discussions about major out-of-basin water diversions that would provide water for domestic, agricultural, and industrial use in other states.

Although neither glamorous nor well known, use of the river to dispose of municipal, industrial, and agricultural wastes is nevertheless important. However, overuse in this area could result in regional water pollution problems that severely affect other uses of the river and certainly its aesthetic value.

Here, too, a trade-off is necessary. We need to find a balance to these important uses of the river.



Lesson Activities

I. Words and Concepts

1. reservoir fluctuation
2. irrigation drawdown
3. waste assimilation
4. water quality
5. pristine

II. Class Activities

1. By now you should have a reply from the town you wrote to some weeks ago. With the information sent you, do the following:
   a. If you haven't done it yet, read their answers to your questions.
   b. In class, compare answers from the different towns.

2. Now do the following activity. (If you have not received an answer yet, pair off with another student who has.)

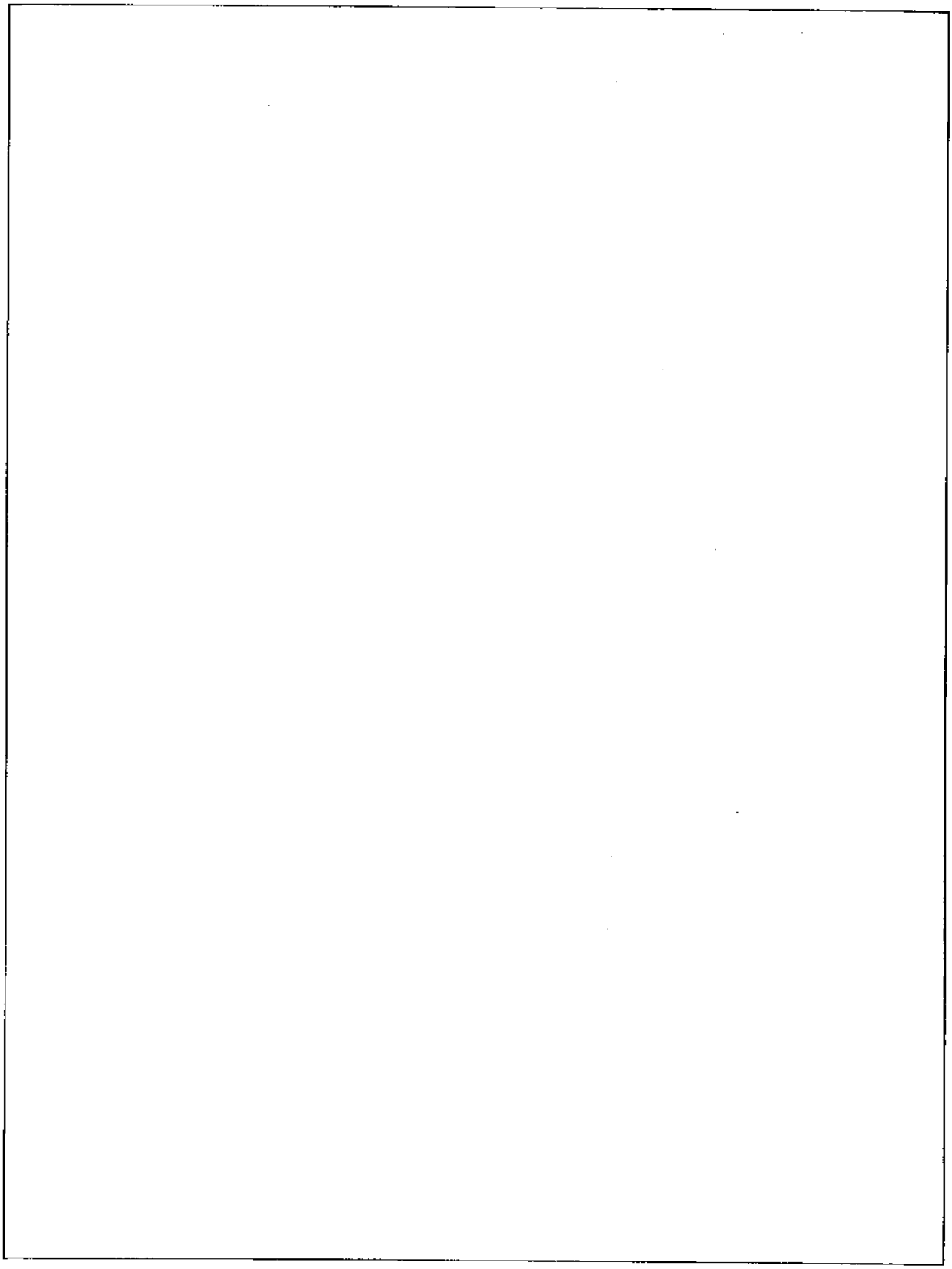
   You have won a contest sponsored by a recreational outfitter. Your award is $1,000. You plan to use the money for your vacation next summer, and you want to visit the town you wrote. You will travel in a car that gets 21 miles per gallon and uses a quart of oil every 700 miles. How much will it cost you to travel round-trip to your designated town? How much of the $1,000 will you have left? What types of things and activities will you spend the remaining money on?

3. In class, compare the different recreational sites and activities on the Columbia-Snake system.

III. Class Discussion or Written Assignment

1. Is it possible to use the river for recreational, municipal, and industrial purposes without any conflict occurring? What precautions or actions would be needed, especially if we are dealing with a small community (with limited funds) that needs to use the river for each of these purposes?

2. Should we return the Columbia River to the pristine state in which it existed before the arrival of white people? Should we preserve stretches of the Columbia for its beauty? Present arguments, both pro and con.



SUMMARY

SUMMARY: *A READING*

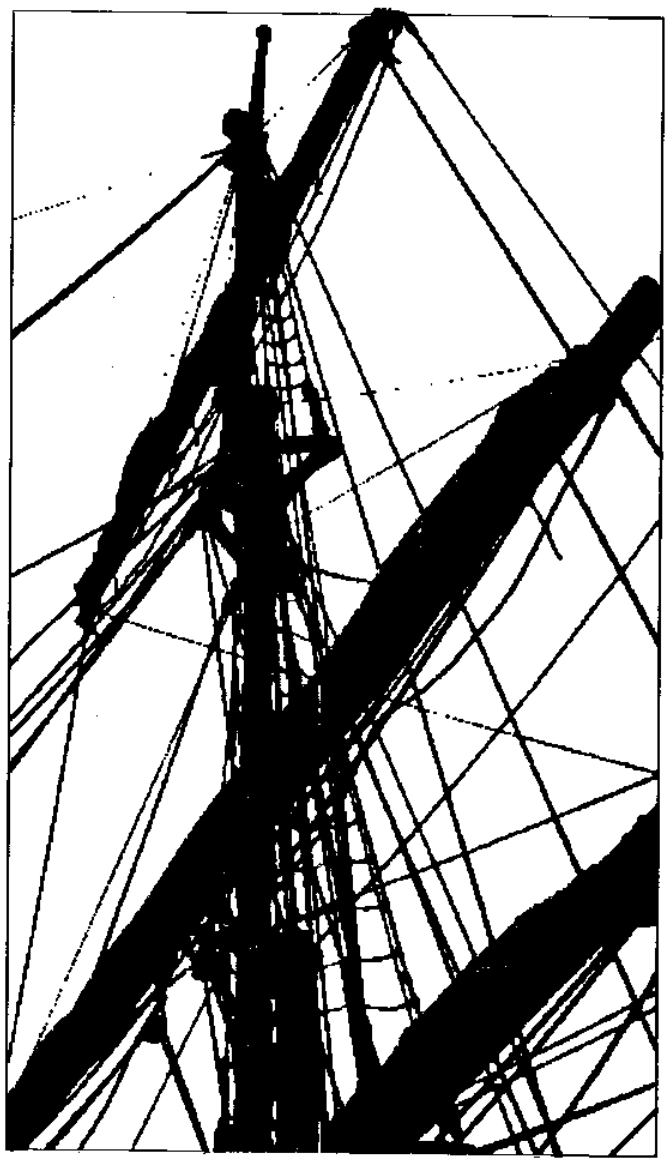
In our study, we have learned that the Columbia River is very important in our daily lives. We could say that it is the lifeblood of the Pacific Northwest: we constantly rely on it—for energy, for food, for lumber and other products, for recreation.

We have discovered that some of these uses compete with others for the water of the Columbia. We now may have to make trade-offs in the way this water is used, since there may not be enough water to meet all our needs. Because of the size of the river system and the number of people involved in managing it, determining the balance of these trade-offs is not easy.

The Columbia Basin includes parts of seven states plus the Canadian province of British Columbia. Some tributaries of the system cross the international border three times before entering the Pacific Ocean. Management authority for power generation, flood control, commerce, and other use is fragmented among local, state, regional, federal, and international agencies. Dozens of specific interest groups, as well as local, regional, and national committees, are also involved in some aspect of Columbia Basin policy. Because of the complexity and variety of the institutions and interests involved, what has evolved over time is a piecemeal, fragmented approach toward the problems and management of the waters of the Columbia River basin.

It is urgent that something be done. The Columbia River is no longer resilient and inexhaustible. It has clearly begun to show its vulnerability to overuse and to inadequate, uncoordinated, and inconsistent management. The river has been extensively developed for some uses without regard to their effects on other activities, on people, and on the environment.

Over the next few years, the citizens of the Pacific Northwest will be faced with vital regional choices about how, where, and under what conditions our water resources should be used. In this decision-making process, we all have a role to play. By becoming aware of and understanding the issues and conflicts, we will have an opportunity to voice our concerns so that rational decisions regarding the Columbia River will be made. By getting involved ourselves, we can help to ensure that the waters of the Columbia system are allocated in the future to allow a compatible mix of resource use for the benefit and enjoyment of all. The choice is up to us!



Class Activities

1. Discuss the following questions:

   a. Is the future of the river in question as a resource for our present use?
   b. What can be done, if anything, to make the river an inexhaustible resource?
   c. In what ways can *you* get involved in the decision making over allocation of the Columbia's waters? Now? When you are of voting age? Consider all possible ways, and then pick some ways best suited for you.

2. Consider the role of government on the rivers. Many different government groups cooperate in (and sometimes quarrel over) the management of the rivers. Following are some examples of these government groups. Find out some of their activities and responsibilities.

   a. Federal
      1. U.S. Army Corps of Engineers
      2. Bonneville Power Administration
      3. U.S. Bureau of Reclamation
      4. U.S. Fish and Wildlife Service
      5. U.S. Coast Guard
      6. U.S. Environmental Protection Agency

   b. Regional
      1. Pacific Northwest Regional Power Council (states of Washington, Oregon, Idaho, Montana)
      2. Pacific Fisheries Management Council
      3. Columbia River Inter-Tribal Fish Commission

   c. State (actual title will vary by state)
      1. Department of Fish and Wildlife
      2. Department of Natural Resources
      3. Department of Environmental Quality
      4. Department of Water Resources

   d. Local Governmental Agencies
      1. County with river-related responsibility
      2. Port of a city—established by the State legislature
      3. City

   Discussion: Study the above agencies at different levels of government. Which do you consider necessary? Are some more important than others? With increasing use of the river and the need for political trade-offs, would you favor more involvement of regional and federal regulation? Why? Why not?

   Carefully consider each of the following situations:

   a. If the City of Vancouver decides to limit its protection efforts on the waterfront because of budget restrictions, should Clark County be required to increase its police protection? Should the Port of Vancouver pick up the slack? Who should decide?

   b. A group of farmers wants to develop one million acres for irrigation. Large quantities of water will be drawn from the river. This will be of concern to fishermen, fish and wildlife personnel, the Bonneville Power Administration, and other farmers. Who owns the water? What government groups listed above should be involved? How should the decision be resolved?

3. Write an essay on how the Columbia River affects your life. After you turn in the essay, compare ideas in small groups. In your discussion, be sure to include industrial and municipal uses of the river, as well as your personal use.

   Compile as long a list as the class can of all the ways the river affects people in the Northwest.

4. Return to the questions and discussion on land use that you had during the introduction to this study of the Columbia. Answer the same questions as a class or in small groups. Try to remember how you answered before, and decide if your answers now are more knowledgeable and thoughtful.

   Pick one of these locations:
   the Clearwater River
   the Boise River
   the Deschutes River
   the Lewis River
   the Willamette River

Answer the following questions by using a map, an atlas, or other resources, but first try to answer them from your knowledge.

a. What major towns or cities are situated on the water?
b. What state and county are they in?
c. What dams and industry are near?
d. Is the area used much for agriculture?
e. Is the area a popular recreational and sportfishing site?
f. What other significant areas are located on the river? Hatcheries? Refuges?

Discuss the following:

a. Assume some county commissioners wish to develop the land around the mouth of the river for a public park with boat ramp, fishing access, swimming, picnicking, and hiking trails. They plan to use 1,280 acres (two square miles) for this purpose. Which of the following groups would be likely to support the idea? Why?
   1. Small retail businesses in the towns
   2. Industry nearby and located on the tributary
   3. Conservationists
   4. Farmers whose land is on the tributary
   5. Local sheriff
   6. Bankers in nearby towns
   7. Citizens of the towns who enjoy outdoor recreation
   8. Fishermen
   9. Indians
   10. Local Chamber of Commerce
   11. Local PUD commissions
   12. Federal and state agencies

b. Why do you think the groups you left out would not support the idea?

c. Which groups who usually are on the same side of an issue would oppose each other? Why? What arguments do you think the opponents would use against the plan?

d. How would you vote if you were on the Board of County Commissioners? Why? Take a class vote and compare your decisions and reasons. Also try to compare your vote with the one you took earlier.

e. How might this situation change if there were plans to develop a 1,000-megawatt, coal-fired, electricity-generating plant on this site, rather than a public park? What differences would there be in opposition to this plan? Why?

5. Take the post-test—the same one you took weeks ago—and compare your results then with now. After you correct the test, discuss answers with the class.
   a. What directions does the Columbia flow?
   b. What is the source of the Columbia?
   c. How large is the Columbia River system: (1) length? (2) square miles?
   d. What is the name of the city at the mouth of the Columbia?
   e. What is the largest tributary of the Columbia?
   f. Approximately how long have people lived along the Columbia?
   g. What is the first dam upstream from the mouth of the Columbia?
   h. Which of the following is not a major use of the Columbia: (1) fishing, (2) agriculture, (3) navigation, (4) scenic wild river, (5) power generation?
   i. Which of the following is a major city on the Columbia: (1) Spokane, (2) Portland, (3) Seattle, (4) Boise?
   j. Why is there political controversy over the use of the river?

Answers to Post-Test

a. It starts in a lake, flows north, turns west, turns south and enters Washington, continues south until the Snake enters near Pasco, turns west to Portland, flows north to Rainier and Longview, and flows west again until it enters the Pacific Ocean.
b. Lake Columbia in British Columbia, Canada.
c. The Columbia River flows more than 1,200 miles before it enters the Pacific Ocean. The river and its tributaries drain nearly 260,000 square miles—an area comparable to that of France. The Columbia is the largest North American river flowing into the Pacific Ocean. Its flow is ten times that of the Colorado River. In the United States, it is second only to the mighty Mississippi River in average annual runoff.
d. Astoria, Oregon
e. The Snake, which comes from northwestern Wyoming.
f. Natives have lived along the river for 12,000 years.
g. Bonneville Dam is east of Portland about 40 miles. It is nearly 100 miles upstream from the ocean.
h. The Columbia is no longer a wild river. The dams have made it a series of lakes.
i. Portland, Oregon, is on the river. The other cities are affected by the river, but Spokane is east of the river, Seattle is north on Puget Sound, and Boise is on the Snake in southern Idaho.
j. All the water in the river is now being used. Every decision involving a present or future use now requires a trade-off. A trade-off means giving up the benefits of one thing to gain benefits from another. Such a decision becomes political because all groups want to maintain or increase their use of the water.