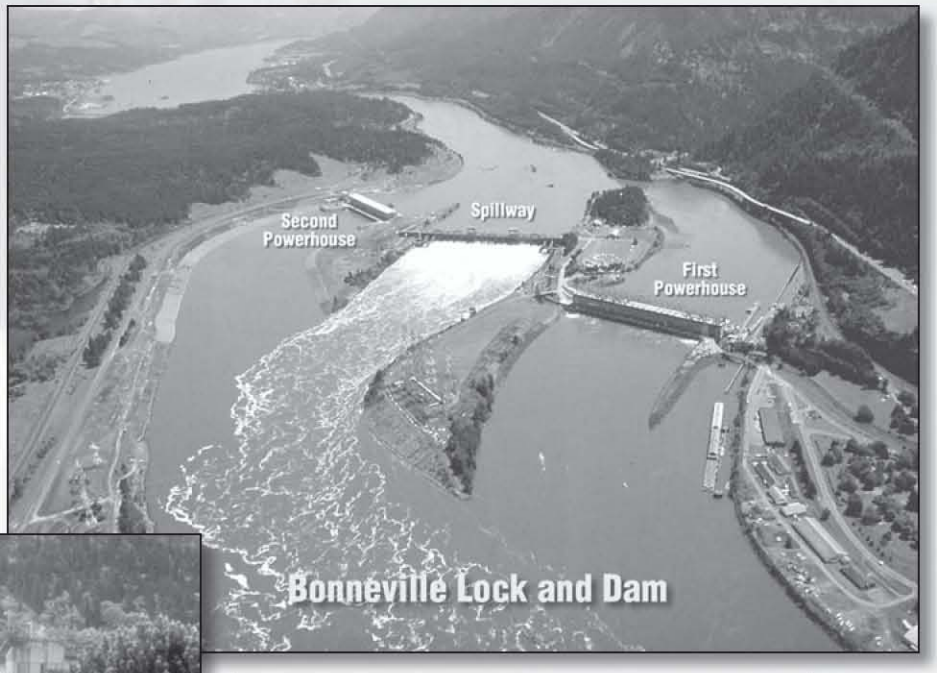
US Army Corps of Engineers®
Portland District

Teacher's Guide to Bonneville Dam



Teacher's Guide To Bonneville Dam

Packet #2

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Goals of The Teacher's Guide to Bonneville Dam

The goals of the Teacher's Guide to Bonneville Dam are:

To aid project personnel in accomplishing management objectives such as increasing public understanding of management issues including controversial issues, reducing vandalism, reducing the number of drownings, or other management problems in order to offset dwindling manpower resources.

To enhance general understanding of the role of the U.S. Army Corps of Engineers in development and administration of water resource projects.

To enhance general understanding of the purpose and operation of the project, its man-made, natural and cultural features.

To develop general appreciation for proper use of project resources in an effort to reduce overall project operation and maintenance costs.

Objectives of The Teacher's Guide to Bonneville Dam

1. To build an understanding of the Corps of Engineers and its missions, specifically navigation, hydropower, resource management, and recreation.
2. To explain the mechanics of, and to explore the need for: power production, fish passage facilities, navigation locks, resource management, and recreation in this region.
3 To increase participants' understanding of the cultural and natural history of Bonneville Dam and its environs through education and interpretation.
4. To explore the individuals' relationship and responsibility to the production and use of energy and other resources.
5. To increase participants' understanding of their interrelationships with the Corps of Engineers and to encourage their future interest in the agency.
6 To reduce monetary and environmental losses by instilling in participants an ethic of stewardship and safety at U.S. Army Corps of Engineers areas.
7. To enrich participants experiences at Corps areas by making them aware of recreational facilities and opportunities at Bonneville Dam and the surrounding region.
8. To provide an educational experience for participants which is relevant to their lives and which supplements the curricula of regional educational institutions.

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Introduction

Introduction To The Teacher's Guide

This is a collection of information and suggested learning activities for teachers and students. It is intended to enrich the experience of their visit to Bonneville Dam and increase their understanding of the Corps of Engineers.

How This Guide Is Organized

This packet is the second in a series of two packets. It is designed for grades 5, 6, 7 and 8. The first packet is targeted at grades 1, 2, 3 and 4.

To serve as a supplement to school curricula, the TEACHER'S GUIDE has been divided according to subject. Topics covered include: The Corps of Engineers, Hydropower, Navigation and the Navigation Lock, Natural Resources Management (including anadromous fish), and Recreation.

Each subject area provides factual information on that topic and at least two suggested activities to be implemented before, during, and after your visit. With this information, you will be able to design a tour to meet your individual needs.

Although many of the included activities are designed for specific locations and segments of your visit to Bonneville Dam, with slight modifications they can also be used in a classroom setting. Additionally, this TEACHER'S GUIDE can be used as an information resource.

Planning A Visit To Bonneville Dam

In planning your visit to Bonneville Lock & Dam Project, there are several decisions you must make. You must determine: if you want assistance from the Visitor Center staff; what subjects are of most interest; and what facilities at the project you will visit.

Visiting Bonneville Dam on your own for the first time can be somewhat overwhelming! There is much to be seen and shown to your students. For that reason, trained Corps of Engineers staff members are available to take you on special group tours. Once you have an idea of how to get around the Project, then you can create and lead your class tours.

If you plan to utilize the staff to lead your tour, we recommend that you contact the visitor center at least one month in advance to make a reservation for your group. If you plan to visit during the spring, which is one of the busiest school group seasons, you should call several months ahead to reserve the specific day you have in mind.

The reservation number is (541) 374-8820

When you call, please have the following information ready:

1. _____ The date of your visit to Bonneville Dam. (have several possible dates to avoid a second call if there is a scheduling conflict.)
2. _____ Which visitor facilities you would like to visit. (see pages 2 and 4 in this guide for a listing)
3. _____ How much time you will have to spend at the dam and how long your tour should last.
4. _____ The name of your school or organization.
5. _____ The name of the person in charge of the group and their phone number.
6. _____ The number of people in your group, their age or grade level, and how many supervising adults will accompany them.
7. _____ Which subject you'd like to emphasize during your visit. This includes details of any specific activities you would like or special assistance you will require.

Facilities At Bonneville Dam

Once you have determined the date of your visit and whether or not you will personally lead the tour, it is important for you to consider which area of the project you would like to visit. This will depend mostly on the subjects you wish to emphasize during your visit. Although visitor center staff can assist you with this decision, this brief listing of facilities at Bonneville Dam and what subjects are most suited to each area may help.

Facilities Accessible From 1-84 Exit 40 (Oregon) The Bradford Island Visitor Center.

This five-story visitor center contains exhibits about the natural and cultural history of the region; a multi-image theater where several films and slide shows are available; fish ladders; underwater fish ladder viewing; a small picnic area; snack machines and restrooms. A series of ramps, walkways, and elevators make this site accessible to people with disabilities.

Navigation Lock.

View the lock from the south side of the lock. Signs will direct you to the appropriate parking area. From this vantage point, you can watch a tug and barge going through the lock. Although there is no guarantee when a boat may go through, there are lockages every day. There is access for people with disabilities.

First Powerhouse.

Reached from the Bradford Island Visitor Center, the First Powerhouse Viewing Gallery provides a view of the generators. Informative exhibits are also found in this visitor area. If you are specifi-

cally interested in the production of electricity, you should consider visiting the Second Powerhouse on the Washington shore, where visitor areas have been created to allow you to safely walk on top of a running generator. A series of ramps, walkways, and elevators make this site accessible to wheelchairs.

Spillway.

Although automobiles and pedestrians are not permitted on the spillway, it may be viewed from the Bradford Island Visitor Center.

Bonneville Fish Hatchery.

Operated by the Oregon Department of Fish and Wildlife, the hatchery highlights include the Hatchery Operations Building where salmon are processed; rearing ponds for young salmon; and ponds where live sturgeon and trout may be viewed and fed. For hatchery tours call 541-374-8393

Picnic Facilities And Restrooms.

Both may be found at the Bradford Island Visitor Center and the Bonneville Fish Hatchery.

Sternwheeler Cruises.

During summer months, the Sternwheeler, operated by the Port of Cascade Locks may be boarded at the dock near the Bradford Island Visitor Center parking lot. For schedules and reservations contact the Port of Cascade Locks, Oregon at 541-374-8619

Public Telephone.

Telephones are located at the Bradford Island Visitor Center and the Bonneville Fish Hatchery.

Facilities Accessible From Highway 14 (Washington)
Second Powerhouse Interpretive Complex.

Facilities include:

The Visitor Orientation Building contains a visitor information desk, exhibits about the project, restrooms and snack area. The second powerhouse is reached from this building. This entire complex is accessible to wheelchairs.

The Second Powerhouse provides a setting for students to learn about and experience how hydropower is generated. Highlights include a display gallery and access to the actual generators. A self-guiding loop route to public areas is marked throughout the powerhouse.

The Fish Viewing Building provides an opportunity to see into the fish ladders used by adult salmon in their upstream migration. Exhibits about fish and the history of Columbia River salmon fishing provide students with information about the life cycle of the migrating salmon.

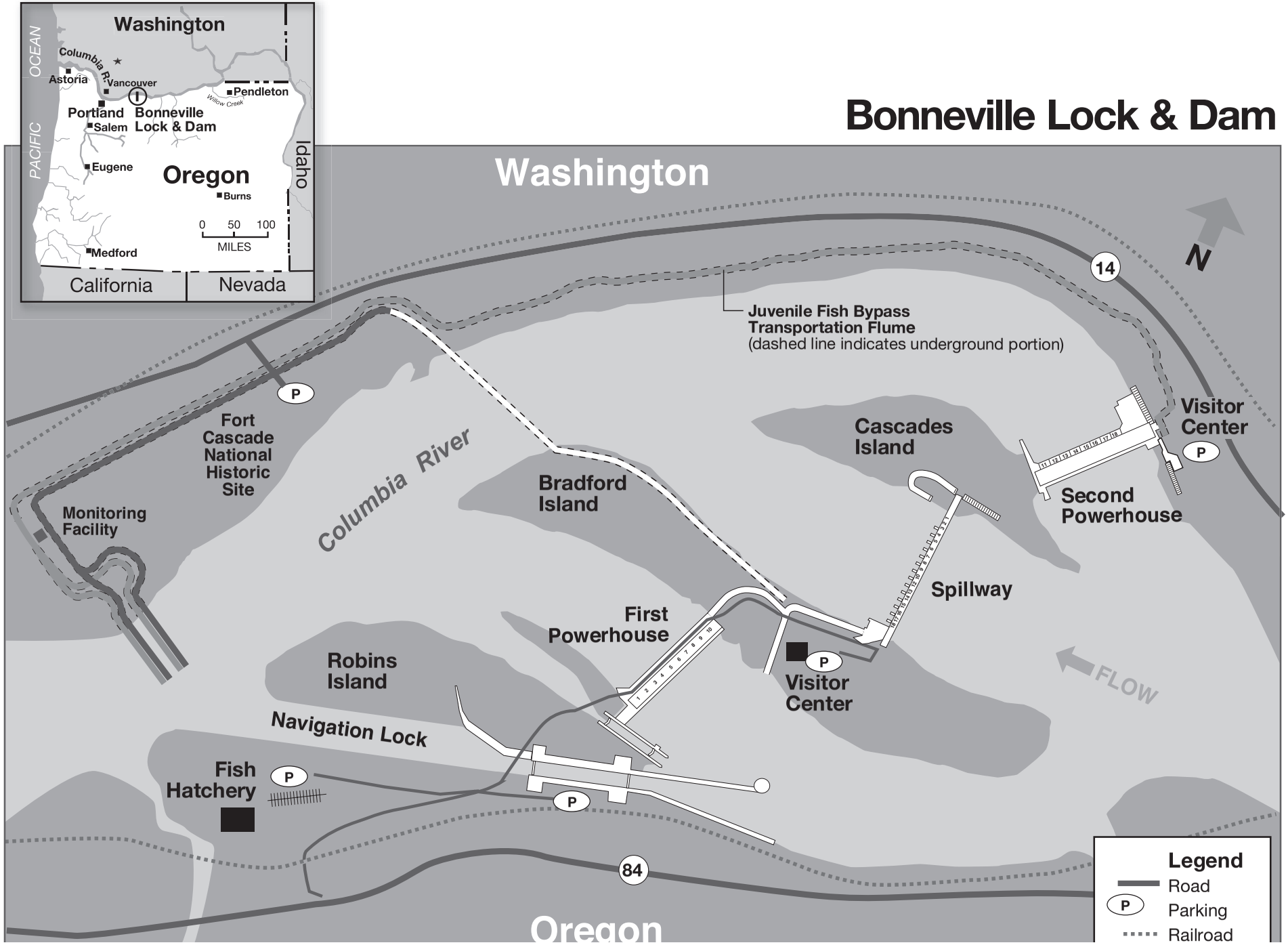
Picnic Facilities And Restrooms.

Please ask at the information desk about picnic areas currently open. Restrooms are located inside the Visitor Orientation Building, the Powerhouse, and the Fish Viewing Building.

Fort Cascades historic Trail

Hike a mile-long self guided trail to explore the history of this area

Bonneville Lock & Dam



Teachers Checklist

The following checklist may help to organize your trip to Bonneville Dam.

1.. Have you contacted the visitor center staff to make a reservation? (see "Planning a Visit," page 1)
2. Have you reviewed all of the pre-trip activities with your group?
3. Have you decided which on-site activities you will use at the dam? Will you conduct these or have you arranged for assistance from the visitor center staff?
4. Have you looked at the map and the list of facilities and planned your route and schedule?
5. Have you arranged for at least one adult for every 10 children?
6. Have you read the sections about "What to do on the way to Bonneville Dam"? (Ibis information is found in the "During Your Visit" section of each subject.)
7. Have you checked current security restriction?

We Need Your Comments And Suggestions

YOU ARE THE EXPERTS..... As you read the following, please keep in mind that your feedback on our product is important. Consider if the information is too complex; the activities understandable; the directions clear; etc.. Comments are welcome! Please complete and return the following comment sheet.

Comments and Suggestions About Teacher's Guide #2

Return Address

_____

_____

_____

ATTACH
FIRST
CLASS
POSTAGE
HERE

US Army Corps Of Engineers, Portland District
Bonneville Lock And Dam Project
Attn: Visitor Center
Cascade Locks OR 97014

DETACH HERE

TAPE HERE

General Adaptable Activities

Below is a list of general activities which can be adapted to fit almost any subject area. You can use these activities in addition to the two site-specific activities provided within each subject area.

Watch An Audio-visual Program.

The Bradford Island Visitor Center has a large selection of films and slide shows which relate to the many responsibilities of the Corps of Engineers at Bonneville Lock and Dam. Programs range from 5 to 25 minutes in length. Although our film library may vary from year to year, we normally have programs covering a variety of topics, including: the Pacific Salmon, the building of Bonneville Lock and Dam, the Lewis and Clark journey, etc. "The Lorax" (a Doctor Suess presentation) can be a fun way for the children to learn about conservation. If you are interested in seeing a movie during your visit, it is best to make arrangements with the Visitor Center Staff so they can help you select the most appropriate show for the subject you will emphasize and the age of the group.

Make A Collage.

This activity is excellent before or after your visit. If used before your visit, have your students bring in pictures related to the subject; have an art project and discussion while cutting out objects in the classroom; or have your students draw pictures themselves to be put together in a class collage. Students can also create individual collages representing their personal ideas about the topic. If used after your visit, have your students create a collage from the brochures that they collect during their visit. Visitor center staff can give a packet of brochures to each student if this is arranged prior to your visit.

Create Your Own Mobiles.

Like the collage activity, making class or group mobiles can be done before or after your visit. Again, materials necessary for the activity may be cut from magazines, drawn by the students, or collected during their visit to the dam. If your class has access to a camera, photographs can hang from the mobile to recap some of the memorable moments of the visit.

Create A Sight And Sound Experience.

This post-trip activity will stimulate your students' senses and reinforce what they saw at the dam by having them associate the sights and sound of their tour of Bonneville Dam.

To create this activity, you will need a camera and a portable tape recorder. Photograph and record a variety of sights and sound during your tour of the Dam. If a camera is not available this activity can be set up using pictures you cut out from magazines or our web site and have

mounted on cardboard. Either way, have fun dazzling your student's senses and imaginations. See below for ideas.

What To Include In Your Show:

Use slides and sounds of people, birds and animals, boats, water, generators, construction equipment, or anything else relevant to your theme or subject area. For example, you might use slides and sounds that include:

- Types of recreational activities enjoyed by people at Bonneville Dam. (anglers, water-ski boats, sails moving in wind, etc.)
- A Corps ranger helping an injured person. (sounds of the truck, siren, walking ranger with jingling keys, or ranger helping find out how the person is feeling, etc.)
- A ranger giving someone information. (sounds of the visitor center, telephones ringing, etc.)
- A ranger going through the daily routine of managing the natural resources of the area. (caring for the Canada geese or the plants, etc.)
- Someone on a boat telling a friend why they should put on a life jacket.
- Someone picking up litter. (sound could be garbage blowing in the wind...i.e. a tin can, etc.)
- The sounds of the generators spinning and the water rushing by.
- Water moving over the fish ladders (include people making comments about the fish they are seeing)
- An angler catching a fish. (use sounds of fish thrashing around)

Once you have put together your show, gather the group in a place where slides may be shown. Explain that they are about to hear a sound from their visit and that you would like them to raise their hands once they have identified the sound. After you have discussed what the students think the sound is, show the slide of the object.

Hints For Your Film/Sound Debut:

It is a good idea to leave the screen blank while playing the sounds. Those who are trying to guess the origin of the sound will not be distracted or confused by the image of the last sound producer.

Variations:

To make the exercise a thinking and sound-making exercise for your students, you might also think about having them make the sounds they think of for the pictures that you show.

“News Clipping” Show And Tell.

Have older students keep track of the current events around the Columbia Gorge by having them cut newspaper clippings about topics associated with area.

Have A Spelling Bee.

Before your visit, you can help familiarize your students with important vocabulary words by having a “Spelling Bee.” You can easily use those words underlined in each of the subject areas IMPORTANT CONCEPTS section. We have found that students who are familiar with these words seem to better understand what they are experiencing during their visit.

About the Corps

The U.S. Army Corps Of Engineers An Introduction

The purpose of this subject area is to introduce your students to the U.S. Army Corps of Engineers and their role as a water management agency.

The first section of activities is included to introduce your students to the roles of the Corps. Activities that take advantage of the visitor facilities at Bonneville Dam are next, and finally, activities for after your visit have been included to reinforce the concepts learned about the Corps.

History Quickie

President Jefferson, recognizing the need for information about the area west of the Mississippi, dispatched his private secretary, Captain Meriwether Lewis, along with Captain William Clark, on their now-famous expedition.

It was the U.S. Army Corps of Engineers which received the overall assignment for surveying and exploring the West. The officers in charge of the operations were educated at West Point, which was founded by the Corps and was the only engineering school in the country at the time. They were commissioned as topographical engineers. Their mission was to obtain the scientific data necessary for opening the frontier to settlement. They became scientist-explorers, skilled in both the natural sciences and in the practical techniques of surveying and mapping.

Important Concepts

The activities in this section will help the student understand the following concepts. Important vocabulary words are in bold print.

The **Army Corps of Engineers** built and operates Bonneville Lock and Dam. An **engineer** is someone who uses mathematical and scientific principles in the design, construction and operation of structures, equipment and systems.

The Corps is a part of the U.S. **government.** The leader of this and other parts of the U.S. government is the President of the United States.

Some people who work for the Corps are in the Army; some are not. Most of the people who work for the Corps are civilians. Bonneville Dam is operated by civilian employees of the Corps.

The Army Corps of Engineers was founded in 1775 when Colonel Richard Gridley was appointed by George Washington as Chief Engineer of the Continental Army during the Revolutionary War.

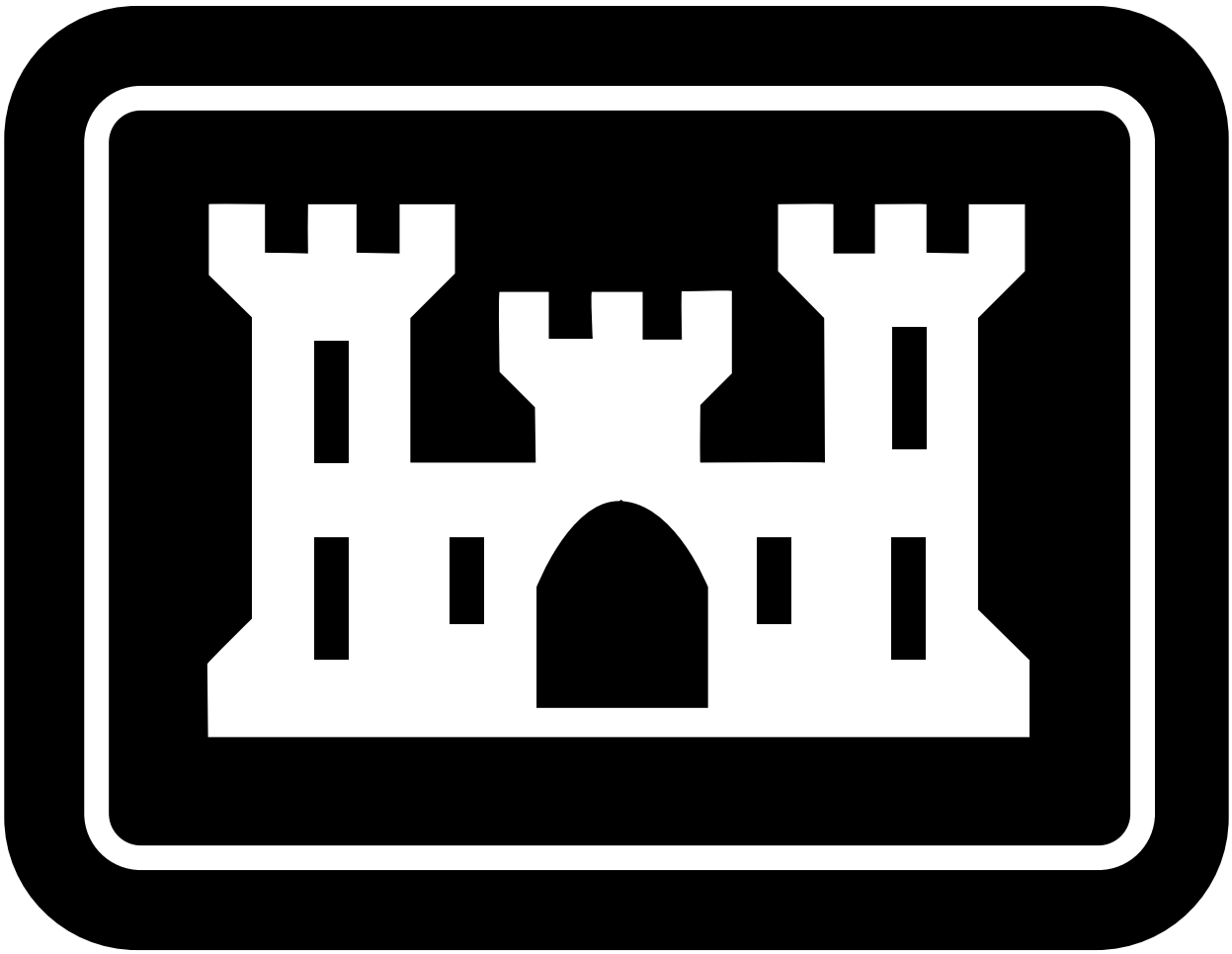
After the war the new nation needed roads and bridges and forts. As the nation's only organized engineers, the Corps was assigned the challenge and began its dual role in defense and civil works.

Later the Corps was given the task of making the Mississippi River **navigable**, and thus taken the role of a **water management agency**.

As a water management agency, the Corps has several missions. They are: **producing hydropower**, improving **navigation** by providing locks, maintaining inland **waterways** and harbors, managing **natural resources** in such a way as to provide **environmental protection** and enhancement, managing **recreation sites**, providing **flood control**, supplying water for **irrigation**, industry and municipalities.

At Bonneville Dam we do four of those things: produce hydropower, provide navigation locks, manage for recreation, and manage the natural resources.

The castle you see below is the Corps insignia. It symbolizes fortification, a traditional activity of military engineers.



The U.S. Army Corps of Engineers Before Your Visit

The two following activities, the Water Cycle Game, and Mission: Decode, are intended to introduce your students to the Corps role as a water resource management agency.

Activities

The Water Cycle Game

The Water Cycle Game, complete with directions and rules, is attached. After you have played the basic Water Cycle Game a few times, you can add these advanced rules to make the game more challenging!

Pre-game Discussion:

To help your students make the connection between the water cycle and the missions of the Corps at Bonneville Dam, talk briefly about these before the game. Four missions have been mentioned on the board: navigation, resource management and hydropower generation.

Beginning and Taking Turns:

Begin and proceed with the game in the same manner as before.

Special Instructions:

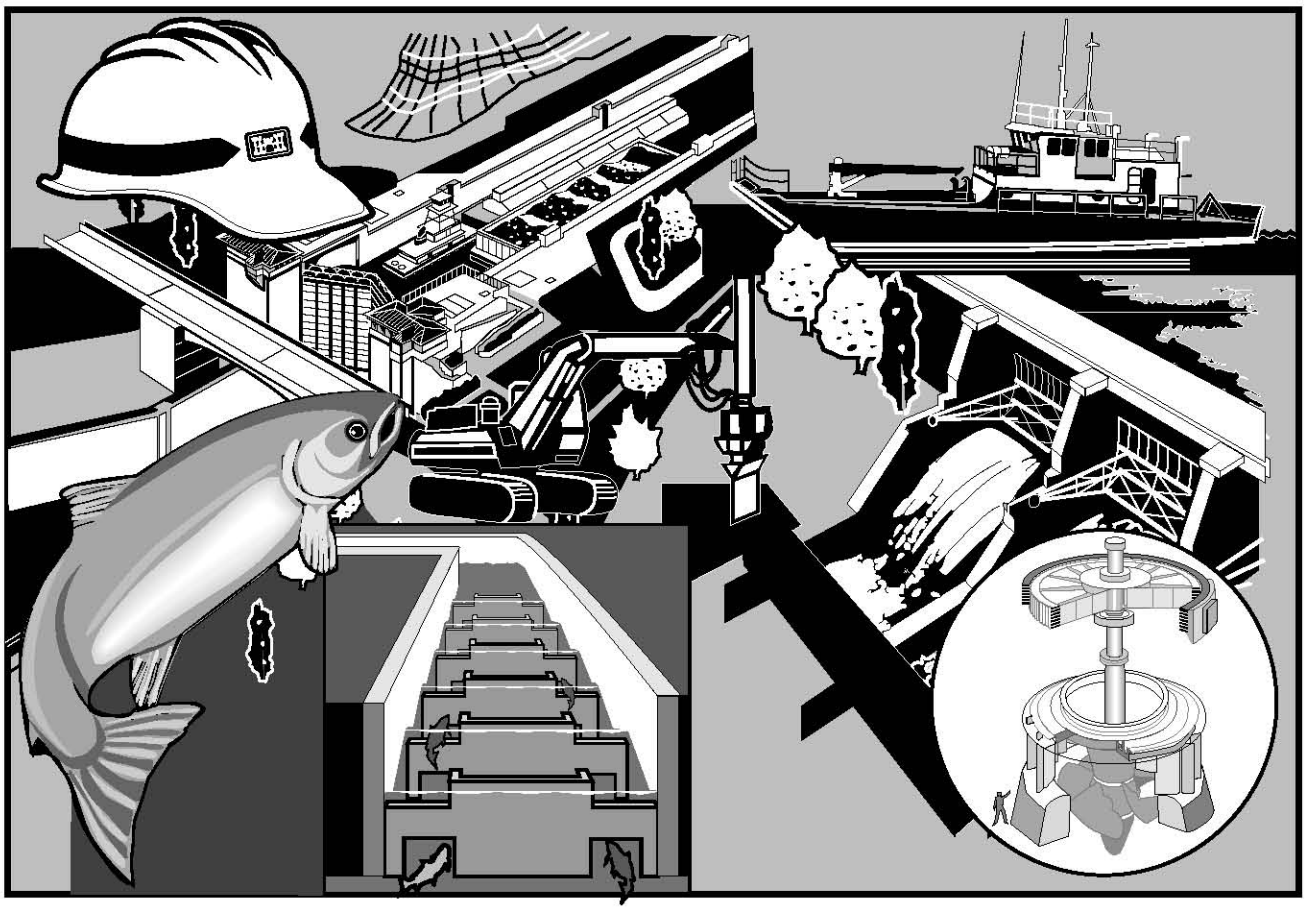
For this advanced version, each student will need paper and pencil. When a player lands on a blue drop, follow the instructions and answer the question listed below for that drop number. If the correct answer is given, one point is scored. Keep track of the score!

Ending:

Go through the Water Cycle Game twice. After all markers have evaporated to the clouds the second time, add each person's points. The person with the most points is the winner.

Mission: Decode

This activity will give students a chance to discover and understand the responsibilities or missions of the U.S. Army Corps of Engineers.



The Water Cycle Game

Drop Number	Question
2a	How is a glacier different from a patch of snow?
2b	What is precipitation?
5a	In which season are floods most likely to happen?
5b	In which season are droughts most likely to happen?
7a	What does' 'transpiration" mean?
7b	What is a water table?
11a	What does "irrigate" mean?
11b	Why do farmers irrigate?
19a	What is "navigation"
19b	What are some of the products that are taken through the navigation locks
28a	What is wrong with dumping garbage into the river?
28b	How can litter hurt wildlife?
33a	What is the minimum number of people you should have in a boat when pulling a water skier?
33b	What is a "P.F.D."?
39a	Why do salmon swim up the river?
39b	What are fish ladders for?
41a	What is another word for "making" electricity.
41b	Which federal agencies build and operate dams to make electricity?
46a	What is an "estuary"?
46b	What is a tide?
50a	What does "evaporate" mean
50b	Name three types of precipitation?

The Water Cycle Game

Answers:

Drop Number	Question
2a	How is a glacier different from a patch of snow? ***A patch of snow will melt in the spring. A glacier has many layers of snow that have turned into ice and will remain through the seasons.***
2b	What is precipitation? ***Precipitation is water falling from the sky in some solid or liquid form.***
5a	In which season are floods most likely to happen? ***Spring, in the Columbia River Basin.***
5b	In which season are droughts most likely to happen? ***Summer, in the Columbia River Basin***
7a	What does' 'transpiration" mean? ***A tree has specialized cells called stomata in its leaves and stems which are like the pores in our skin. Water evaporates from these stomata when they are open. This is called transpiration.***
7b	What is a water table? ***The water table is the level of the water in the ground, or how far you have to dig to have a well.***
11a	What does "irrigate" mean? ***Irrigate means to "supply water for use on farm land, by artificial means"***
11b	Why do farmers irrigate? ***Many times farmers irrigate when their farms are in a warm, sunny location with fertile soil, but not enough rain to support the crops they are trying to grow. Therefore, they bring the water to the plants.***
19a	What is "navigation" ***Navigation is like driving somewhere in your car using a road map, except that it is done in a boat on the water.***
19b	What are some of the items that are taken through the navigation locks? ***Grains, wood chips, lumber, petroleum products, salmon and trout fingerlings***
28a	What is wrong with dumping garbage into the river? ***A river is home for many types of life. Pollution can kill native plants, animals and fish.***

28b How can litter hurt wildlife?
Litter usually isn't biodegradable (does not decompose on its own) Even slowly degrading litter can ensnare or be toxic to animals.

33a What is the minimum number of people you should have in a boat when pulling a water skier?
At least two; one to operate the boat and one to watch the skier.

33b What is a "P.F.D."?
Personal flotation device...a life jacket.

39a Why do salmon swim up the river?
Salmon swim upstream to return to the place they were spawned, where they will lay their eggs and die.

39b What are fish ladders for?
Fish ladders make it possible for returning adult salmon to pass over the dam by providing "steps".

41a What is another word for "making" electricity?
"Generating" electricity.

41b Which federal agencies build and operate dams to make electricity?
Army Corps of Engineers and Bureau of Reclamation.

46a What is an "estuary"?
An estuary is a partially enclosed coastal area where ocean water flows into the mouth of a river during high tide. It is a zone of both salt and fresh water. Where these two environments meet, a unique and biologically productive area is formed.

46b What is a tide?
A tide is the periodic rise and fall of water in the ocean caused by the gravitational pull of the moon.

50a What does "evaporate" mean?
Evaporate means to change water from a liquid state to a gaseous state. In nature, this process is powered by the energy of the sun.

50b Name three types of precipitation?
Rain, sleet, hail, snow.

19,5,3,18,3,20 SECRET

Hold up to mirror to decode

Mission: Decode

Your mission is to decode the messages below.

Here is how the code works. The numbers 1 through 26 stand for the letters A through Z respectively. Therefore
1 = A, 2 = B, 3 = C, etc. Fill in the correct letters and decode the message.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
A	B	C	D	E	F	G	H	I	J	K	L	M	N	0	P	Q	R	S	T	U	V	W	X	Y	Z

1. The Army Corps of Engineers is a part of the **21, 14, 9, 20, 5, 4 19, 20, 1, 20, 5, 19** government. The **12, 5, 1, 4, 5, 18** of the Corps and of our **3, 15, 21, 14, 20, 18, 25** is the **16, 18, 5, 19, 9, 4, 5, 14, 20** of the United States.
2. The Army Corps of Engineers and other parts of the United States government are **6, 21, 14, 4, 5, 4** by the **20, 1, 24, 5, 19** that people pay.
3. Three of the main jobs of the Corps of Engineers are building and maintaining **4, 1, 13, 19**, navigation **12, 15, 3, 11, 19,** and **10, 5, 20, 20, 9, 5, 19**.
4. **6, 12, 15, 15, 4** control and **9, 18, 18, 9, 7, 1, 20, 9, 15, 14** are two reasons that some dams are built.
5. The Army Corps of Engineers **4, 5, 19, 9, 7, 14, 5, 4** and operates **2, 15, 14, 14, 5, 22, 9, 12, 12, 5** Lock and Dam.
6. The main missions of the Corps of Engineers at Bonneville Dam are generating hydroelectric power, maintaining and improving **14, 1, 22, 9, 7, 1, 20, 9, 15, 14**, managing natural **18, 5, 19, 15, 21, 18, 3, 5, 19**, and providing recreational opportunities.
7. The Bonneville project includes navigation **12, 15, 3, 11, 19,** a **19, 16, 9, 12, 12, 23, 1, 25** dam, two power houses, two visitor centers, and a fish **8, 1, 20, 3, 8, 5, 18, 25**.
8. Hydroelectric power allows all of us to use **5, 12, 5, 3, 20, 18, 9, 3, 9, 20, 25** generated by the energy of 18,9,22,5,18 water. This electricity comes to us in a **16, 15, 12, 12, 21, 20, 9, 15, 14**-free, renewable form.
9. Navigation locks at dams make it possible for large **2, 1, 18, 7, 5, 19** pushed by **20, 21,** 7 boats to transport oil, **7, 18, 1, 9, 14**, and wood products up and down the river.
10. Lots of people use Corps of Engineer's areas for recreation. Many people **6, 9, 19, 8,** swim, **3, 1, 13, 16,** and boat in these areas.
11. The Corps of Engineers is also responsible for **13, 1, 14, 1, 7, 9, 14,** 7 natural resources. One important **18, 5, 19, 15, 21, 18, 3, 5** in the Columbia River is fish.
12. At Bonneville Dam, fish 12, 1, 4, 4, 5, 18, 19 were built to help fish swim upstream to their **19, 16, 1, 23, 14, 9, 14,** 7 grounds.

19,5,3,18,3,20 SECRET

Hold up to mirror to decode

Mission: Decode

Answers:

1. ***United States, leader, country, President***
2. ***Funded, taxes***
3. ***Dams, locks, jetties***
4. ***Flood, irrigation***
5. ***Designed, Bonneville***
6. ***Navigation, resources***
7. ***Locks, spillway, hatchery***
8. ***Electricity, river, pollution***
9. ***Barges, tug, grain***
10. ***Fish, camp***
11. ***Managing, resource***
12. ***Ladders, spawning***

The U.S. Army Corps of Engineers During Your Visit

Your students can learn more about the Corps of Engineers during their visit to Bonneville Dam. Here are some suggestions to accomplish that goal.

What To Do On Your Way To The Project:

While traveling to the project, your students can look for barges in the river. Most of these barges have to pass through the locks at Bonneville Dam. Also, look for transmission lines. These lines may be carrying the electricity produced at Bonneville Dam to the homes of your students.

Ask The Visitor Center Employees:

The staff at the Bradford Island Visitor Center and at the Visitor Orientation Building will be happy to tell your group about the roles of the Corps of Engineers.

Bradford Island Visitor Center:

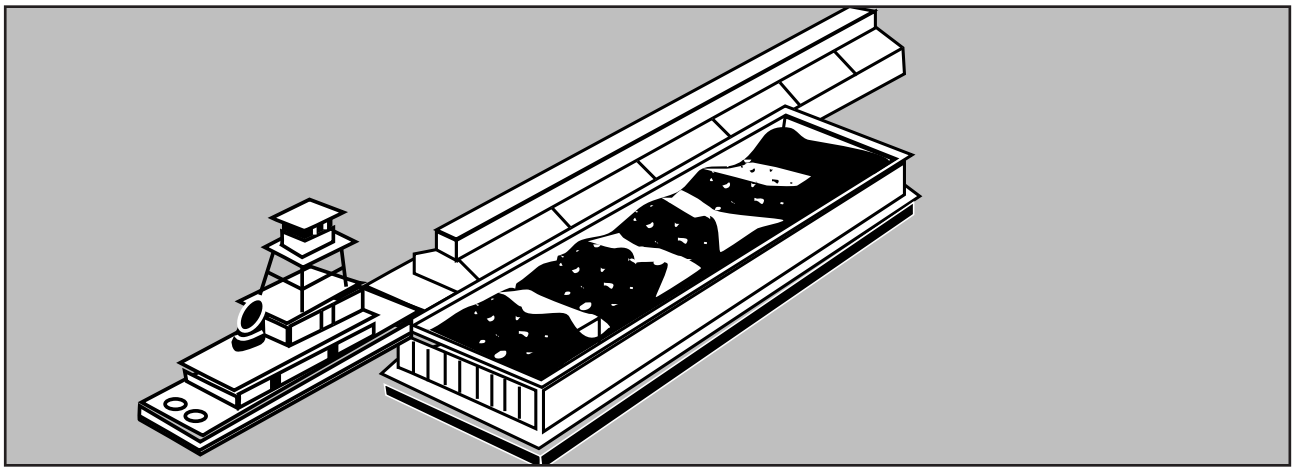
Exhibits on the fourth floor of the Bradford Island Visitor Center will introduce your students to the role of the Corps of Engineers. There are also displays on the fourth floor about the jobs done by Army Corps employees.

Films:

Films about the Corps of Engineers are shown in the theaters at the Bradford Island Visitor Center and the Visitor Facility at the second powerhouse. Please request a film showing when you schedule your visit.

Visitor Orientation Building:

On the main floor of the Visitor Orientation Building (on the Washington shore), you will find talking figures that explain the duties and tasks of five employees at Bonneville Dam.



The U.S. Army Corps Of Engineers After Your Visit

The following activities are to be completed after your visit to Bonneville Dam. They are intended to reinforce vocabulary and concepts learned before and during the visit.

Activities

Name The Missions Of The Corps:

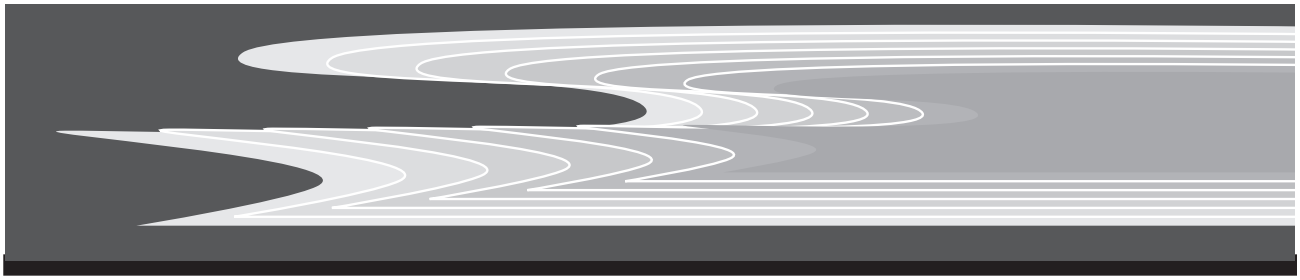
This activity will reinforce understanding of the missions or responsibilities of the U.S. Army Corps of Engineers.

Who Am I?:

Many people work at Bonneville Dam keeping it operating smoothly, helping visitors and working to maintain the natural resources of the area. This activity gives students an opportunity to match the employee with the tasks they accomplish.

Visit Other Projects:

The Dalles, John Day and McNary dams are the next three dams on the Columbia River, they also were designed and are operated by the Corps of Engineers.



Name The Missions Of The Corps!

Match the words in the list of missions of the Corps with their definitions.

The list of missions:

1. Navigation
2. Hydropower
3. Flood Control
4. Irrigation Water Storage
5. Resource Management
6. Water Based Recreation Management

Definitions to match them to:

A. ___ A clean renewable source of electricity
B. ___ Improving and maintaining waterways for the passage of ships
C. ___ Managing resources for the safe enjoyment of waterways
D. ___ Using, protecting and enhancing environmental resources
E. ___ Controlling the river's flow to prevent flooding
F. ___ Impounding water used to grow crops in dry areas

Name The Missions Of The Corps!

Answers:

A. **(2)** Hydropower

B. **(1)** Navigation

C. **(6)** Water Based Recreation Management

D. **(5)** Resource Management

E. **(3)** Flood Control

F. **(4)** Irrigation Water Storage

Who Am I?

Match the job title with the description of the tasks performed on the job.

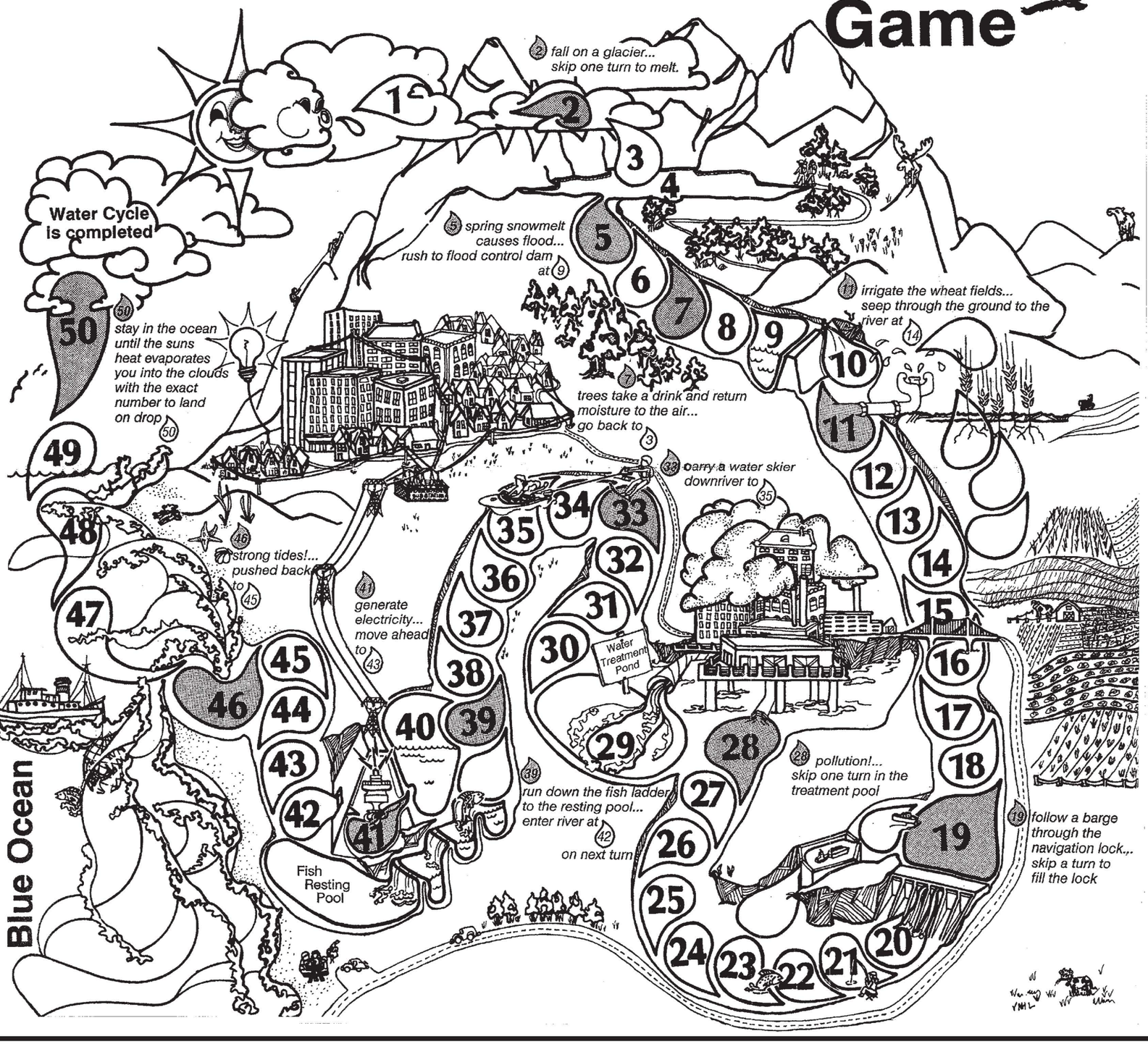
Job Title:		Task Performed:
Carpenter	1._____	I paint everything from turbines to cabinets.
Fish Biologist	2._____	I start and stop generators and control the flow of water through the dam.
Fish Counter	3._____	I ensure the safety of the public. I am trained in rescue and first aid.
Garage Mechanic	4._____	I evaluate fish passage and perform research to improve salmon runs.
Welder	5._____	I operate the navigation lock which lifts boats past the dam.
Lock Operator	6._____	I keep the generators in good condition.
Electrician/ Mechanic	7_____	I provide information and services for the public.
Painter	8._____	I type, file and work as a receptionist
Park Guide	9._____	I count fish as they pass by the dam. Many agencies use my information to help fish.
Park Ranger	10._____	I perform a wide variety of tasks all involving wood.
Powerhouse Operator	11.___	I keep all vehicles in good condition.
Project Manager	12.___	I join metal to metal with my torch. I make and repair anything metal.
Secretary	13.___	I supervise the entire project and all employees.

Who Am I?

Answers:

1. Painter
2. Powerhouse Operator
3. Park Ranger
4. Fish Biologist
5. Lock Operator
6. Electrician/Mechanic
7. Park Guide
8. Secretary
9. Fish Counter
10. Carpenter
11. Garage Mechanic
12. Welder
13. Project Manager

The Water Cycle Game



Markers

Directions

Cut out the spinner, arrow and markers. Glue them to a piece of thick cardboard.

Stick a pin through the dot on the arrow and into the center of the spinner.

Color the markers and tape a penny to the back of each one

You are ready to play!!

Rules

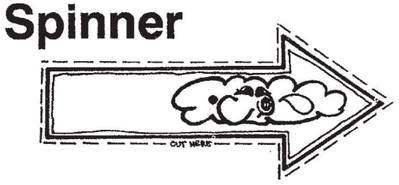
Beginning: place your marker in the clouds. You must spin a "1" (single drop) to leave the clouds and enter the Water Cycle on 1.

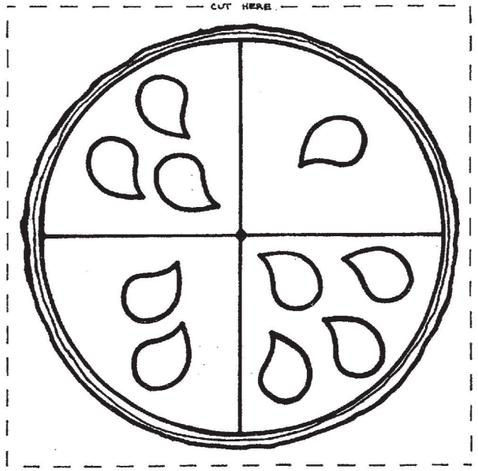
Turns: Take your turn by spinning the arrow and moving forward the number of water drops shown by the arrow.

Special Instructions: when you land on a dark water drop, follow the instructions on the board for that drop number.

Ending: you must spin the exact number needed to land on 50. The first marker to complete the Water Cycle is the WINNER!!!

Spinner





Hydropower

Hydropower An Introduction

The purpose of this subject area is to familiarize students with the production of hydropower at Bonneville Dam.

The first section includes activities which may be used to introduce hydropower concepts in the classroom. Next are self- guided tours of each powerhouse and an on-site activity. Finally, activities are included for after your visit to help reinforce what has been learned about the production of hydropower.

History Quickie

Bonneville Dam was built in the 1930's during the Great Depression. At this time Franklin D. Roosevelt campaigned for president of the U.S. promising, if elected, the would bring work to the Northwest by constructing the next federal hydropower dam on the Columbia River. Bonneville Dam was funded by the PWA or Public Works Administration. The dam was originally designed with only two generators and room for an additional four. People called it the "Dam of Doubt" and "Roosevelt's White Elephant" because they doubted whether they were going to be able to use all that electricity. Some believed that building the dam was an extravagant waste of federal funds.

Because the electricity made at Bonneville Dam was much less expensive than that from other sources, the demand for electricity grew rapidly. Even before the completion of the dam in 1938, four more generators were installed.

The addition of another four generators was started in 1939 and finished in 1943. This brought the number of generators in the first powerhouse to ten.

Important Concepts

The activities in this section will help the students understand the following concepts. Important vocabulary words are in bold print.

Energy is the work a physical system is capable of doing in changing from one state to another. Electricity is a form of energy.

An **electrical current** is the flow of electrons. An **electron** is a very small particle that orbits around the nucleus of an atom. Electrons have a negative electrical charge.

There are **atoms** that are good electrical **conductors**, such as copper or aluminum atoms. They have electrons that can be easily pulled from their orbit. Passing a magnet over a copper wire will excite the electrons in the copper atoms.

When there is work for electricity to do, we call it a "load." A load or the completion of an **electrical circuit**, will cause the excited electrons to jump from their original atom to the next atom, leaving a space to be filled by another excited electron. This exchange of electrons becomes a flow, this flow is an electrical current.

Generators produce electricity. A generator is a machine that spins magnets past coils of copper wire.

A commercial turbine generator unit, such as those at Bonneville Dam, consists of two main parts; the generator and the turbine. The generator (upper half of the unit) consists of two main parts, the **rotor** and the **stator.** The rotor is an electromagnet, the stator is coils of copper wire.

The generator is connected to the turbine (lower half of the unit) by a shaft. When a potential energy source is harnessed (i.e. wind, sun, water, or steam power) it can be forced to turn the turbine which is like a giant propeller.

Water falls through a hydropower dam (due to the force of gravity), turns the turbine, the turbine turns the shaft, the shaft spins the rotor which spins inside the stator and produces electricity.

Hydropower means water power, and is the term used for electricity generated at a dam.

The part of the dam that houses the generators is called the **powerhouse.** There are two powerhouses at Bonneville Dam, one on the Oregon side and one on the Washington side of the Columbia River. The part of the dam in the middle is called the spillway.

The **spillway** is the part of the dam that holds back, or releases, extra water. The spillways along the river help control the water so that it can be used for many uses. Water is spilled at Bonneville Dam mainly in the springtime for two reasons: 1) to help fingerlings that are on their way to the ocean; and 2) to pass river flow that exceeds the hydroelectric capacity of the two powerhouses.

We measure electricity in watts. 1 volt x 1 ampere = 1 watt. Amperage is the amount of electricity that is present, voltage is the force of the electricity. A **kilowatt** is a thousand watts. A **megawatt** is a million watts. Bonneville Dam can produce over a million kilowatts of continuous output when operating at full capacity. That is over one thousand **megawatts.**

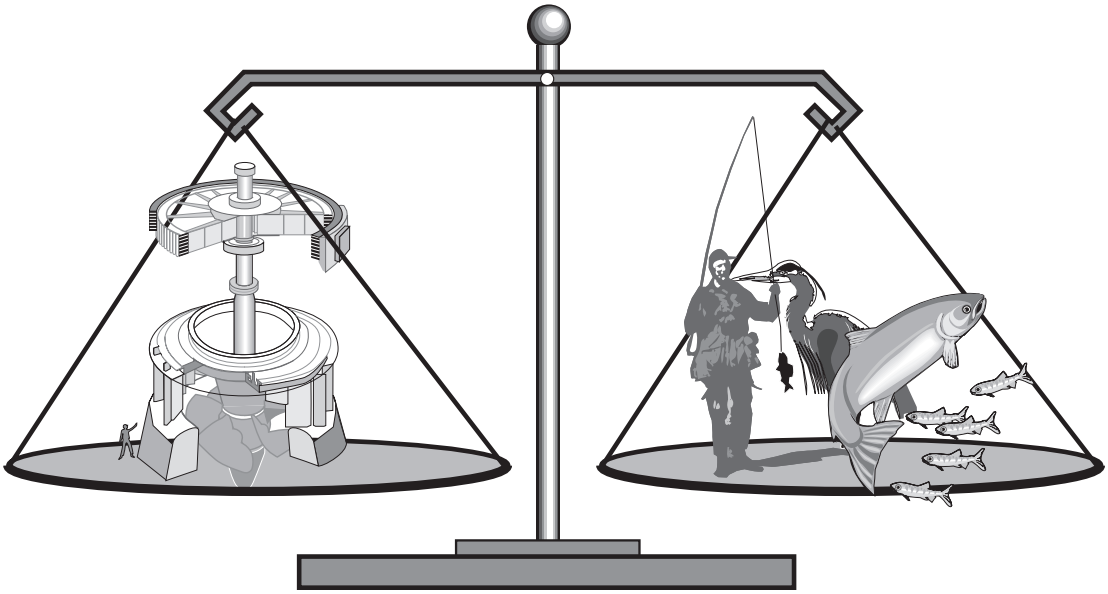
The electricity is delivered to your house through transmission lines. The excited electrons in the copper coils of the generator cause the electrons in the connecting wires to also be excited and flow.

Transmission lines are built by the **Bonneville Power Administration.** The B.P.A. is a **government marketing agency** formed to market and distribute the electricity produced at federal dams. They sell electricity to local utilities, the **local utilities** sell the electricity to users.

Conservation means using a **resource**, such as a river, to fulfill people's needs while not overusing it and depleting or destroying it. At Bonneville Dam we use the Columbia River to make electricity, facilitate transportation and to provide recreational opportunities. We also manage the natural resources in order to protect the river's fish and wildlife.

When we attempt to practice conservation we become involved in **trade-offs**. A trade-off means balancing one **benefit** against another. When we build a hydropower dam we trade a wild and

natural river for electricity, easier river navigation etc.. Some of the advantages associated with hydropower are: it is **renewable** due to the **water cycle**; it rarely **pollutes** the air or water; it can create or enhance habitat for some fish and wildlife; and it provides relatively inexpensive power. Some of the disadvantages associated with hydropower are: the high monetary costs to build a hydropower dam; the lake behind the dam covers up lands that may have had farms, towns, wildlife, and fish spawning grounds on them; dams and the lakes they create are difficult for **anadromous fish** like salmon to get past; and the loss of wild river scenery and recreation.



Hydropower
Before Your Visit

The following activities about hydropower are designed to be used before you bring your students to Bonneville Dam.

Activities

Label The Powerhouse:

Students should be given a copy of the activity "LABEL THE POWERHOUSE." They may label the powerhouse by reading the descriptions of the various "parts" and by filling in the blank spaces which have been provided. Students may also color the different parts of the powerhouse.

What Is A Watt?

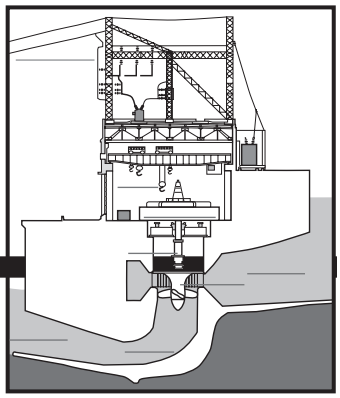
This sheet, to be completed by the student, will help students learn about watts. Utility companies use watts for billing users. They charge according to the number of watts used multiplied by the amount of time they have been used.

You And Your Electric Bill/Energy Eaters:

These activities will give students an idea about what appliances in the home use the most electricity and about how much these appliances cost to operate.

Energy Riddles:

These energy riddles are designed to help build a "hydropower" vocabulary. We suggest that you first have your students complete the activity, "LABEL THE POWERHOUSE," before you try the riddles.



Label The Powerhouse

Read the following definitions of the "parts" of a powerhouse. Then, label the powerhouse. There is one space on the diagram for each word.

Turbine A turbine is a large metal machine which is turned as the water passes through the power house. It looks like a giant pinwheel or propeller.

Generator A generator is the part of the powerhouse which makes electricity. Part of the generator is attached to the turbine. So, when the turbine turns, so does a part of the generator. The generator has two parts, coils of wire and magnets.

Intake The opening in the dam that lets water through to turn the turbine.

Shaft The shaft connects the turbine to the generator so that when the turbine spins it also spins the rotor which is inside the generator.

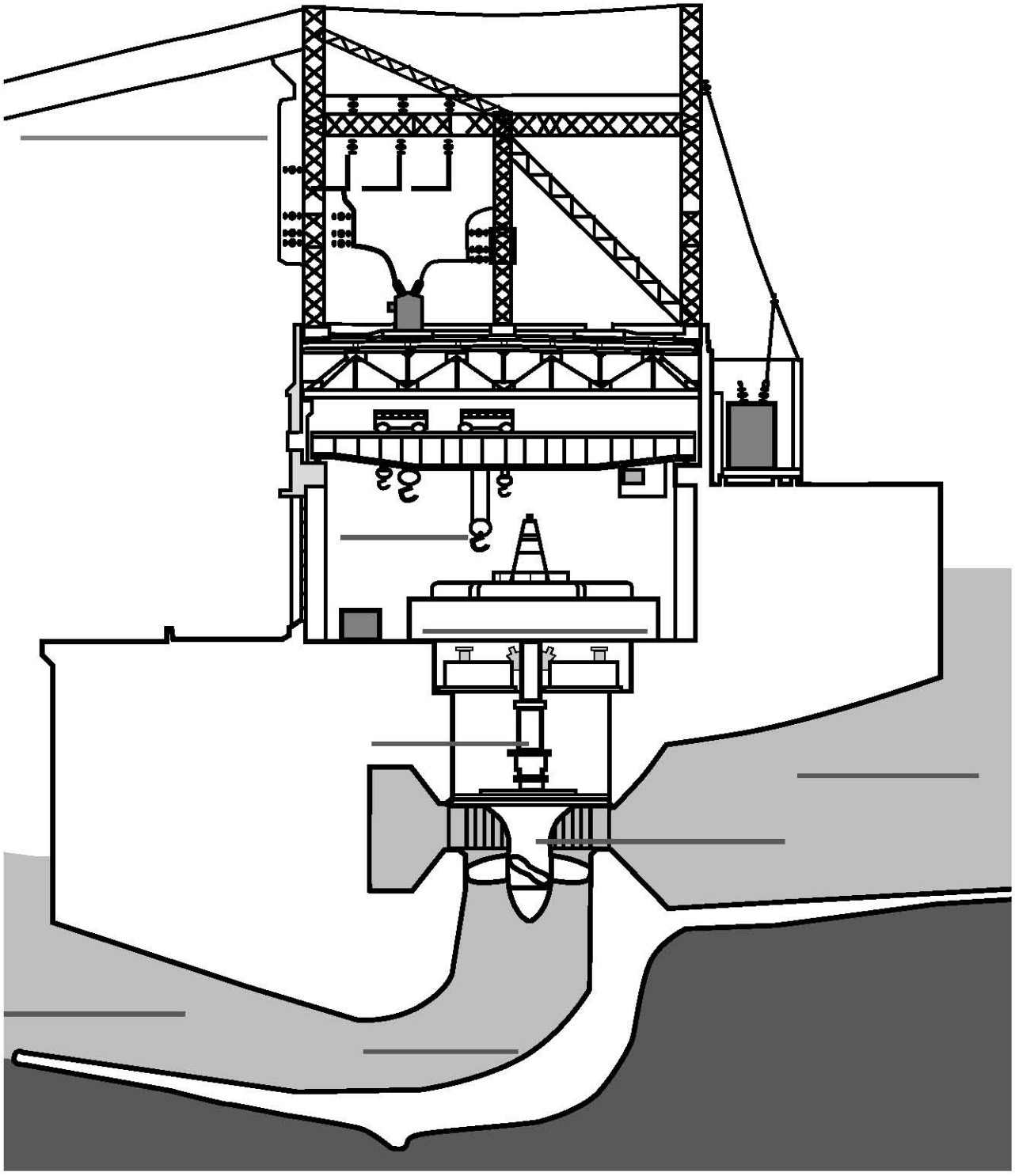
Exit The exit is where the water goes immediately after falling through the turbine.

Transmission Lines The transmission lines carry electricity from the powerhouse to your house.

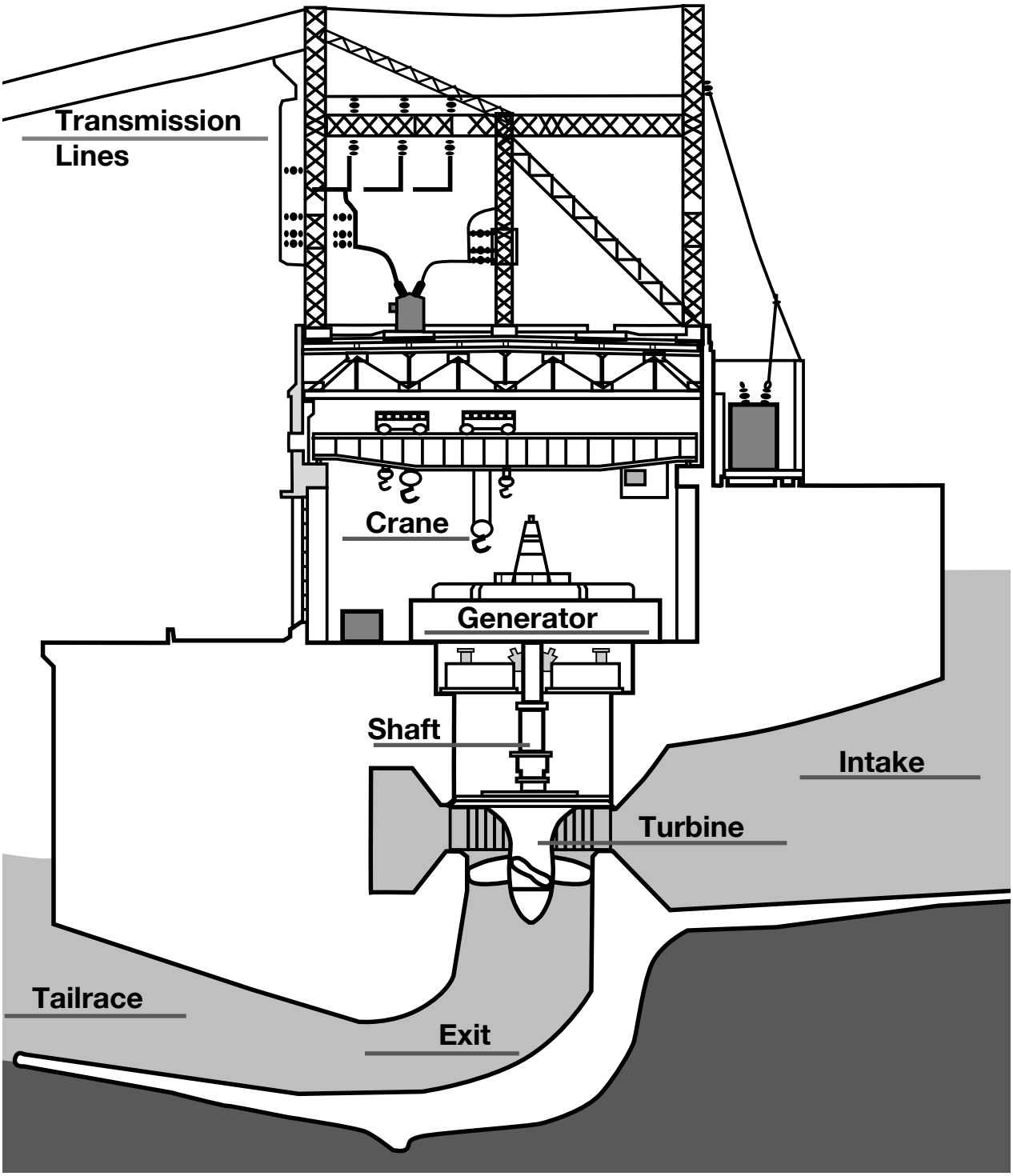
Tailrace The tailrace is where the water comes out of the powerhouse. If you stand on the down river side of the powerhouse you will see the water, or tailrace, churning and bubbling.

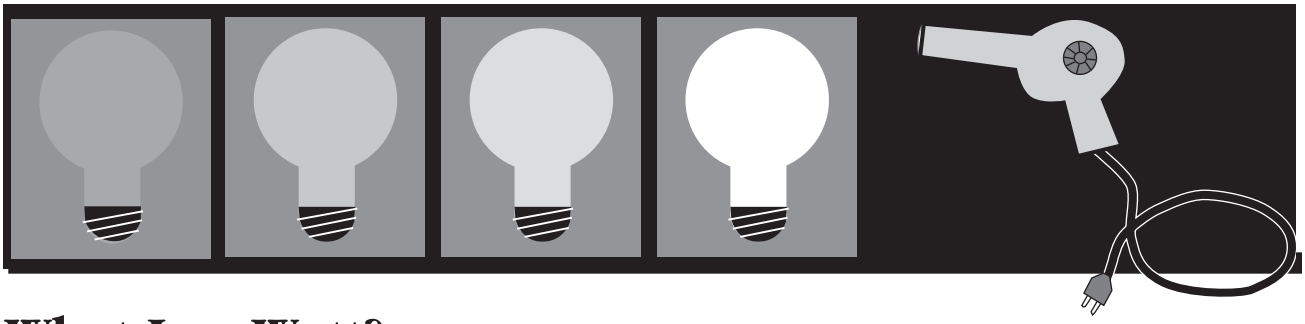
Crane The crane is used to lift parts of the generator straight up so that the generator can be fixed. It slides across the ceiling of the powerhouse on rails.

Label the Powerhouse



Label the Powerhouse, Answers:





What Is a Watt?

A **Watt** is an amount of electrical power. For example a 60 **Watt** light bulb uses 60 **Watts** of electricity. Likewise, a 100 **Watt** light bulb uses 100 **Watts** of electricity.

When you go home tonight, ask your Mom and Dad to help you find out how many **Watts** are used by any of the following things in your home. The number of **Watts** that an appliance uses should be written on the appliance.

1. Any light bulb in your home _____WATTS
2. An electric toaster _____WATTS
3. A television _____WATTS
4. A plug-in radio _____WATTS
5. A hair dryer _____WATTS
6. An electric blanket _____WATTS
7. A refrigerator _____WATTS
8. _____(other) _____WATTS

Kilowatts: Bonneville Dam generates so much electricity that it is measured in thousands of Watts. Another name for 1,000 Watts is a **Kilowatt. Kilo** means 1,000. Bonneville Dam produces over **One Million Kilowatts!**

How many 100 watt light bulbs would it take to use one kilowatt of electricity?

_____

How many 50 watt light bulbs could be lit by one kilowatt?

_____

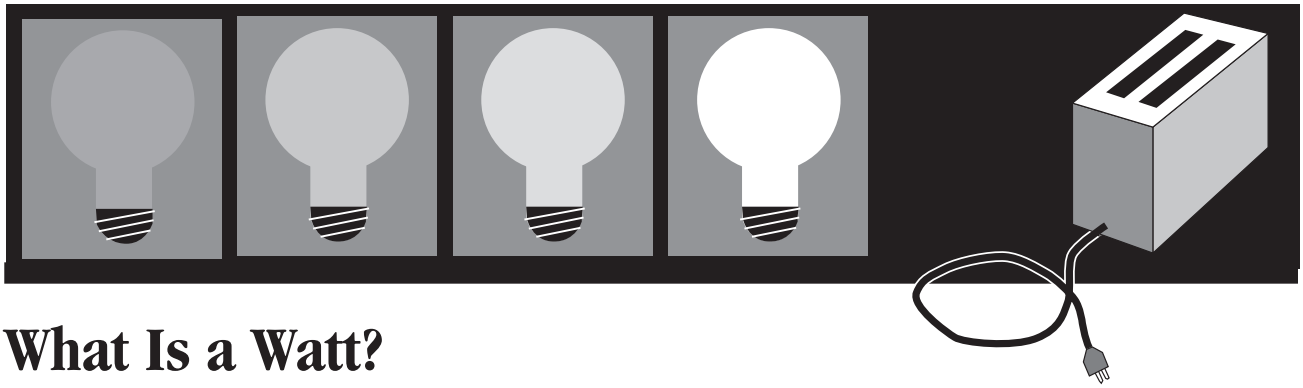
Kilowatt Hours: If you use 1 kilowatt for 1 hour you will use 1 kilowatt hour!
One kilowatt x 1 hour = 1 kilowatt hour.

When you use ten 100 watt light bulbs for one hour how many kilowatt hours would you use?

_____

If you used a 6,000 watt air conditioner for 2 hours, how many kilowatt hours would you use?

_____



What Is a Watt?

Answers:

1.	**Any light bulb in your home**	**100 WATTS**
2.	**An electric toaster**	**1,146 WATTS**
3.	**A television**	**145 WATTS**
4.	**A plug-in radio**	**71 WATTS**
5.	**A hair dryer**	**600 WATTS**
6.	**An electric blanket**	**630 WATTS**
7.	**A refrigerator**	**1,450 WATTS**
8.	**(other)**	**_____ WATTS**

Kilowatts: Bonneville Dam generates so much electricity that it is measured in thousands of Watts. Another name for 1,000 Watts is a **Kilowatt. Kilo** means 1,000. Bonneville Dam produces over **One Million Kilowatts!**

How many 100 watt light bulbs would it take to use one kilowatt of electricity? 10

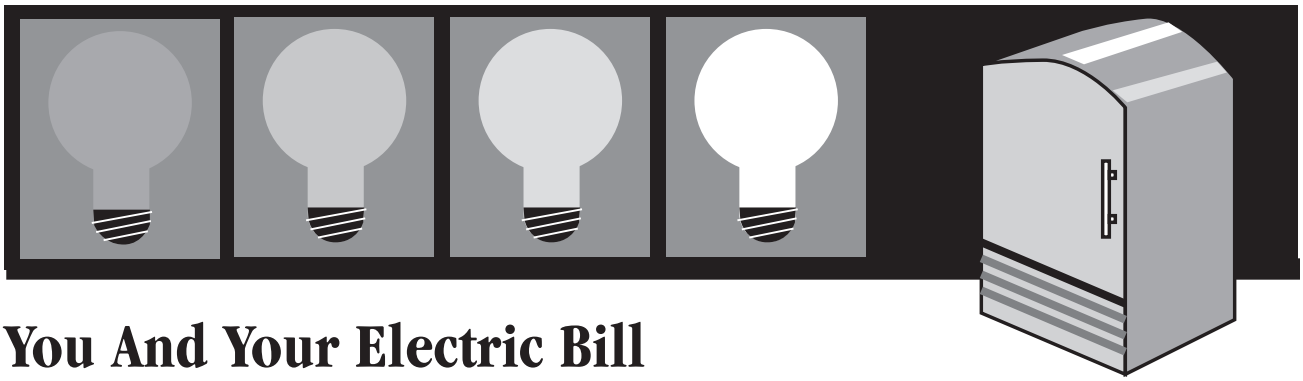
How many 50 watt light bulbs could be lit by one kilowatt? 20

Kilowatt Hours: If you use 1 kilowatt for 1 hour you will use 1 kilowatt hour!

One kilowatt x 1 hour = 1 kilowatt hour.

When you use ten 100 watt light bulbs for one hour how many kilowatt hours would you use? 1

If you used a 6,000 watt air conditioner for 2 hours, how many kilowatt hours would you use? 12



You And Your Electric Bill

Before you read this page, be sure you have read the page titled, **What Is A Watt?**

Look at the electric bill from your electric company. Who is your electric company? What do they charge for a kilowatt hour of electricity?

Let's suppose that it costs you 5 cents for 1 kilowatt hour. That means if you use 1000 watts (one kilowatt) for one hour you will use 5 cents worth of electricity!

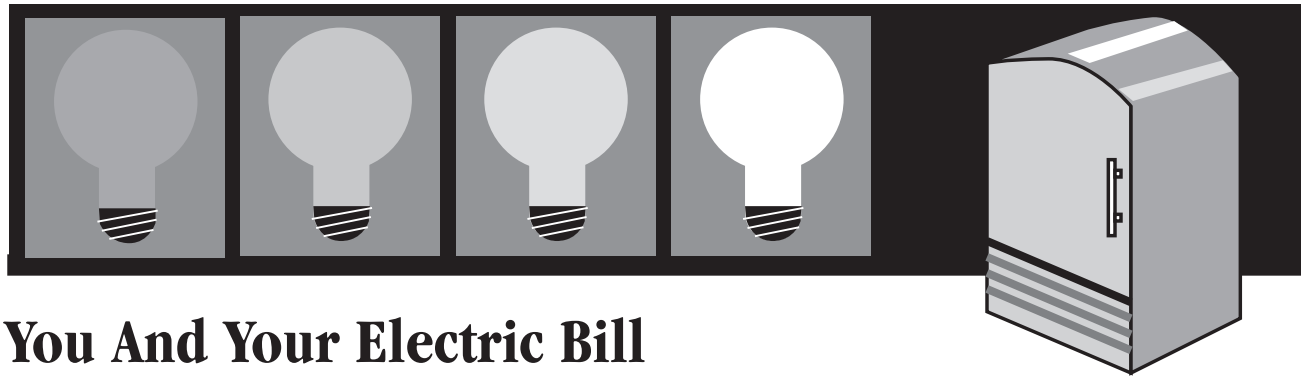
Assume that electricity costs you 5 cents for one kilowatt hour. How much would it cost to run the following: (see the sample below)

1. **A 1000 watt light bulb for 2 hours** _____
2. **A 100 watt light bulb for 24 hours** _____
3. **A 50 watt stereo for 10 hours** _____
4. **A 1000 watt refrigerator for 24 hours** _____
5. **A 2000 watt air conditioner for 24 hours** _____

SAMPLE: How much would it cost to run a 2000 watt clothes dryer for 3 hours if electricity costs 5 cents a kilowatt hour?

SOLUTION: 2000 watts = 2 kilowatts
2 kilowatts for 3 hours = 6 kilowatt hours (because 2x3 = 6)
6 kilowatt hours x 5 cents = 30 cents (6x5 = 30)

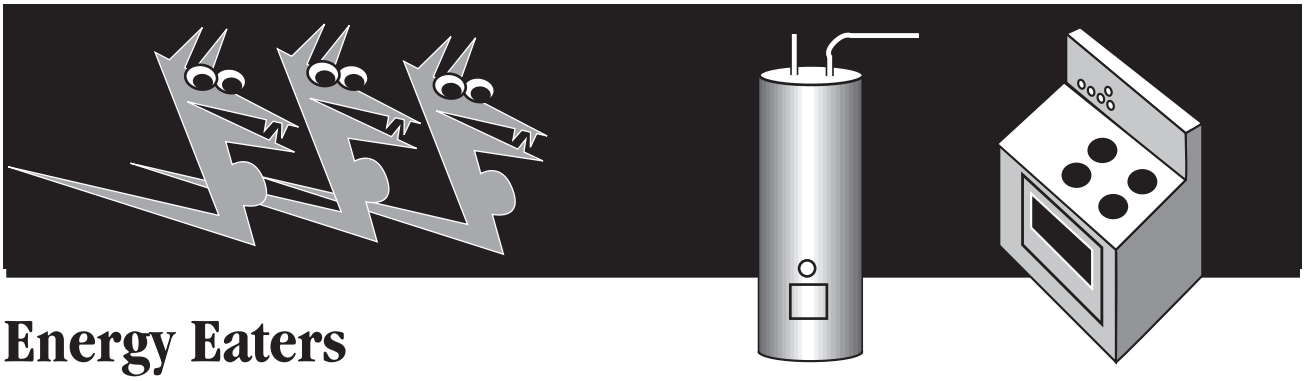
SO: It costs 30 cents to run a 2000 watt clothes dryer for 3 hours.



You And Your Electric Bill

Answers:

1.	A 1000 watt light bulb for 2 hours	$.10
2.	A 100 watt light bulb for 24 hours	$.12
3.	A 50 watt stereo for 10 hours	$.025
4.	A 1000 watt refrigerator for 24 hours	$1.20
5.	A 2000 watt air conditioner for 24 hours	$2.40



Energy Eaters

Find some "energy eaters" in your home. How much electricity do they use? (it should be written on them somewhere)

List the "energy eater" and how much electricity it uses.

1. _____

2. _____

3. _____

4. _____

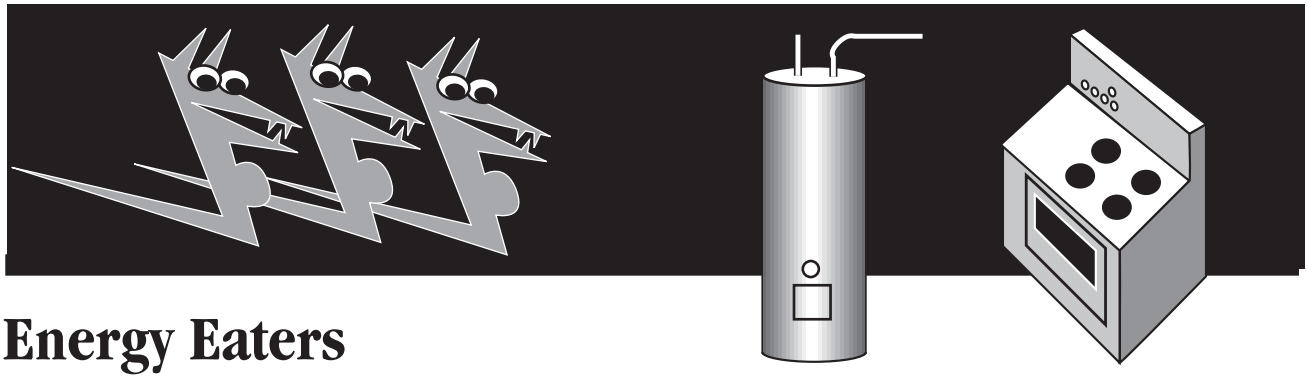
List four ways you can save electricity and save your parents some money and help conserve our Natural Resources.

1. _____

2. _____

3. _____

4. _____



Energy Eaters

Answers:

Some appliances in your home use a lot of electricity. We call these "energy eaters." They include: freezers, refrigerators, dishwashers, clothes dryers, heaters, air conditioners and hot water heaters.

Find some "energy eaters" in your home. How much electricity do they use? (it should be written on them somewhere)

1.	**range and oven**	**12,000 watts**
2.	**clothes dryer**	**5,000 watts**
3.	**air conditioner**	**2,300 watts**
4.	**Water heater**	**2,475 watts**

List four ways you can save electricity and save your parents some money plus help conserve our natural resources.

1. **turn off lights and other appliances when done using them**
2. **turn thermostat down to 55 degrees at night and 68 degrees during the day**
3. **use air cooler in only one room**
4. **use alternatives to your oven such as, toaster or microwave**

Energy Riddles

We have included these riddles to help you become familiar with some hydropower vocabulary words.

I spin like a top, but I'm made of steel. Water makes me turn, like a giant pinwheel.

What am I?_____

We built the dam you are going to see. We run it night and day to make electricity.

Who are we?_____

I am a kind of energy sent through the lines. I am moving electrons to run things of all kinds.

What am I_____**?**

I spin around and around for you see, my magnets move past coils of wire to produce electricity.

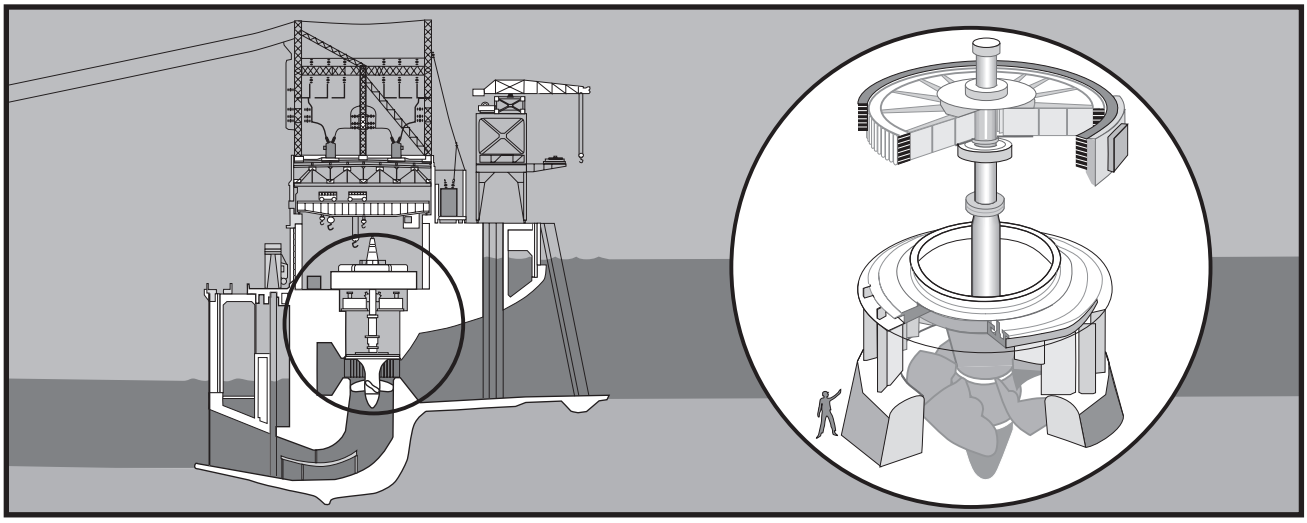
What am I_____**?**

I'm part of a dam, and see me you will! I can hold water back, I can let water spill!

What am I_____**?**

I'm the part of the dam, where power comes from. You can come inside me and hear my machines hum! _____

What am I?



Energy Riddles

Answers:

I spin like a top, but I'm made of steel. Water makes me turn, like a giant pinwheel.

What am I? **a turbine**

We built the dam you are going to see. We run it night and day to make electricity.

Who are we? **U.S. Army corps of Engineers**

I am a kind of energy sent through the lines. I am moving electrons to run things of all kinds.

What am I? **electricity**

I spin around and around for you see, my magnets move past coils of wire to produce electricity.

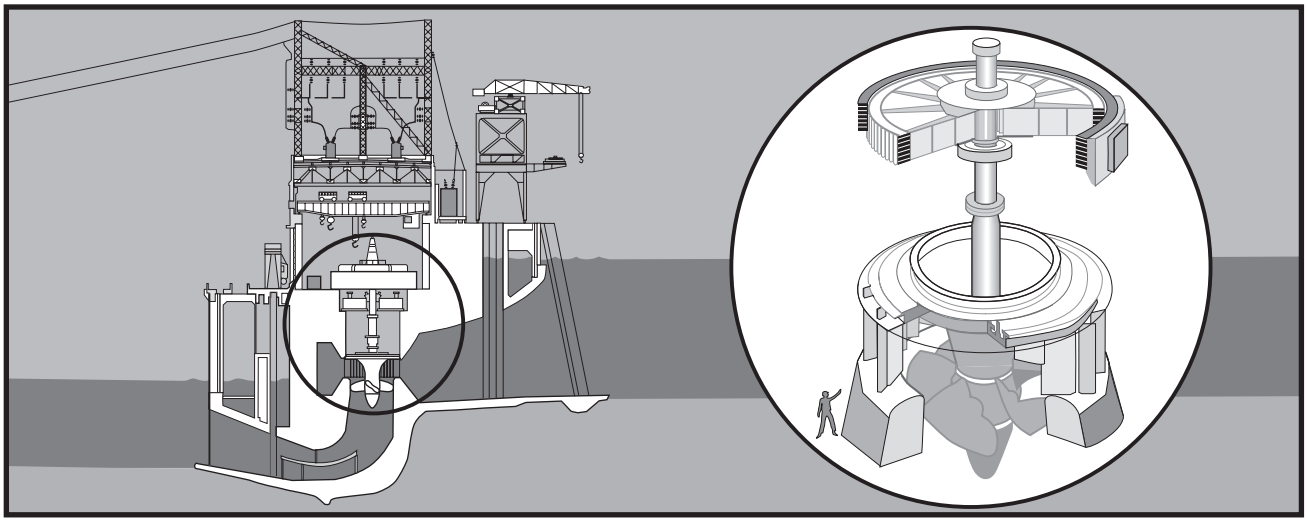
What am I? **a generator**

I'm part of a dam, and see me you will! I can hold water back, I can let water spill!

What am I? **the spillway**

I'm the part of the dam, where power comes from. You can come inside me and hear my machines hum!

What am I? **a powerhouse**



Hydropower During Your Visit

The activities in this section are intended for use during your visit to Bonneville Dam. They will give your students a chance to learn about electricity and the production of electricity at their own pace.

Activities

On Your Way To Bonneville Dam:

Ask your students to look for transmission lines, power poles and other things which have something to do with electricity.

What To Do At Bonneville Dam:

There are two powerhouses at Bonneville Dam. The first powerhouse is accessible from Oregon, the second powerhouse from Washington. The second powerhouse provides better access to the generators. It is possible to make reservations for a guided tour at both powerhouses. (541)374-8820.

I Am A Copper Atom:

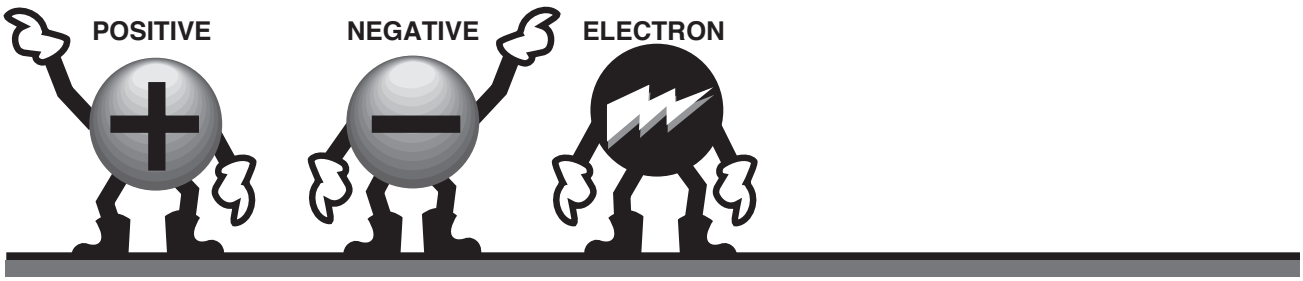
This activity has students model the production of electricity. It will require some pre-planning and some leadership from the teacher. It will be helpful to do this activity prior to the following activities.

Electricity: From The Powerhouse To Your House (Powerhouse One Version)

Every student, or group of students, will need a copy of this "self-guide" to the first powerhouse.

Electricity: From The Powerhouse To Your House (Powerhouse Two Version)

Every student, or group of students, will need a copy of this "self-guide" to the second powerhouse.



I Am A Copper Atom

"**I Am A Copper Atom**" is a game in which you pretend you are generating electricity. It will require your teachers direction and explanation of what an atom and its parts are. Ask the rangers to let you know where a diagram of a generator is. The diagram can be a reference for understanding this activity.

Ask volunteers to make two circles, one inside the other. The outside group of volunteers pretend that they are electrons in the stator. The stator is coils of copper wire. The inside group of volunteers pretend that they are the rotor. The rotor consists of magnets which spin inside the stator.

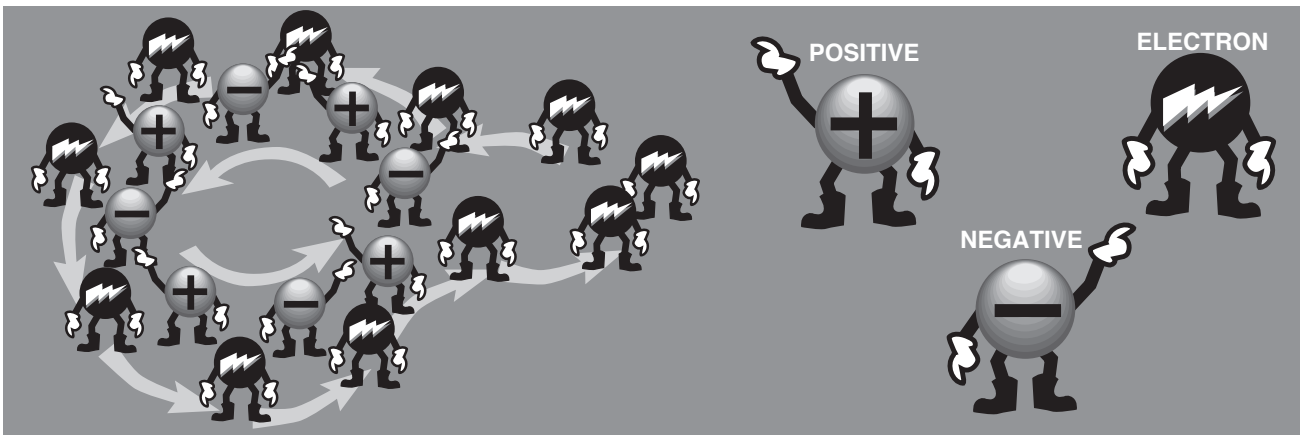
Water coming through the dam spins the turbine, which spins the shaft, that is connected to the rotor. The rotor spins around inside the stator. As the magnets of the rotor spin inside the stator, the electrons in the coils of copper wire become excited.

Those the inside group are magnets and those in the outside group are electrons in the atoms of the copper coils.

The inside group walks in a circle holding hands. Every other set of hands should be held up, this represents the positive pole. As the inside group walks around and the set of upheld hands comes by, each member of the outside group becomes excited and bumps the person next to them and stands in their place. When the teacher says "negative pole", the inside group will hold up the opposite set of hands, causing the outside group to bump their neighbor in the opposite direction.

After the current leaves the generators, it travels through transmission lines to get to our homes. You can add a transmission line. Two lines of students, with one on the end connecting the two lines, can be attached to the outside circle.

This game demonstrates alternating current (A. C.) electricity.



Electricity:
From The Powerhouse To Your House!
(*First* Powerhouse Version)

This is a "do it yourself" tour of the first powerhouse at Bonneville Dam. You will discover how electricity is made and how it is sent from the powerhouse to your house.

To get to the powerhouse, contact Bonneville Rangers to schedule a program, 541-3748820.

Stop #1 Look At The Large, Steel Turbine Blade.

This is just one of five turbine blades on each turbine! Imagine how much water it must take to turn each turbine. Every second, each turbine blade is struck by enough water to fill an average three bedroom house!

When the turbine spins, it causes the generator to spin. Go to the model of the generator next.

Stop #2 Spin The Generator!

What are the green coils?_____

What are the red and blue pieces of metal?_____

If you answered coils of wire, and magnets, you are really thinking! The real generators work just the opposite way with the magnets spinning around inside the coils of wire.

When the magnets spin inside the coils of copper wire, they cause the electrons (which are small parts of the atoms) in the coils of wire to get exited and move. The electron is pulled to a different atom and another electron jumps in to take its place. Pretty soon all the electrons are jumping from one atom to the next in a sort of "flow". This flow is electricity. You cannot see the electrons move but you can tell it is happening if you look at the gauge.

How many volts did you make?_____

Stop #3 Go To The Diagram Of The Powerhouse.

Look at the wires on top of the powerhouse in the drawing. After the electricity is generated, it is sent to wherever it is needed (maybe your house).

Most of the electricity used in the Northwest is generated at dams.

Where do dams get their "fuel" to keep them going? Go to the exhibit labeled "THE WATER CYCLE AND ELECTRICITY" and find out.

Stop #4 Hydropower And The Water Cycle.

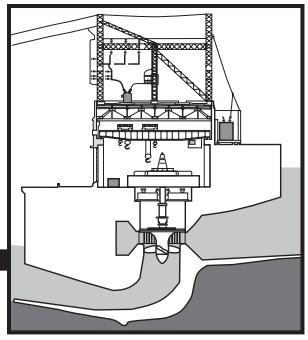
Stand behind the rotating discs and while spinning them, look at the display. You will see how water gets "recycled" by nature.

Stop #5 Have One More Look At The Generators.

If a light bulb uses 100 watts, can you figure out how many light bulbs you could light with all the generators in the powerhouse? Together, the generators in this powerhouse can generate 518,000,000 watts.

Stop #6 The Last Stop Of This Tour Is Your House.

That is where some of this electricity may go. We make a lot of electricity at Bonneville Dam. That does not mean you can waste it. You can see how we had to block the river to build this powerhouse which is not good for some fish and wildlife. The more electricity we use the more powerhouses we may have to build. You know that your parents must pay money for the electricity you and your family uses. Those are two good reasons to CONSERVE ELECTRICITY!



Electricity:
From The Powerhouse To Your House!
(*Second* Powerhouse Version)

This is a "do it yourself" tour of the second powerhouse at Bonneville Lock and Dam. You will discover how electricity is made and how it is sent from the powerhouse to your house!

Start in the glass-walled building (The Visitor Orientation Building). Go up the escalator and cross the skywalk toward the Powerhouse.

Stop #1 On The Skywalk

In the middle of the skywalk, stop and look at the difference between the levels of the water upstream and downstream. (The water is about 60 feet higher on the upstream side.)

Stop #2 Go To The Display Gallery

Look at the generators. How many are there? _____

How many are turned on? _____ (look for the ones with lights lit up on top)

These generators make enough electricity to meet the electrical needs of about 250,000 homes for one year! Next learn how they work.

Stop #3 Go To The Generator Model

Turn the generator with your finger.

What are the green coils?_____

What are the red and blue pieces of metal? _____

If you answered coils of wire, and magnets, you are really thinking! The real generators work just the opposite way with the magnets spinning around inside the coils of wire.

When the magnets spin inside the coils of copper wire, they cause the electrons (which are small parts of the atoms) in the coils of wire to get exited and move. The electron is pulled to a different atom and another electron bumps in to take its place. Soon all the electrons are jumping from one atom to the next in a sort of "flow". This flow is electricity. You cannot see the electrons move but you can tell it is happening if you look at the gauge.

How many volts did you make? _____

Stop #4 Go to the Transformer Model.

Electricity is transformed before it leaves here. Transformers increase the voltage to give the electricity a "push" so it can travel to your house. A transformer is like the nozzle on your garden hose at home. What happens to the water in the hose as it passes through the nozzle? It comes out with more force. This is what a transformer does to electricity.

Stop #5 Look at the Water Cycle Display

Water is recycled by nature. This makes it a renewable resource.

Stop #6 Go to the "power Planning" Display

The Bonneville Power Administration (BPA) is a government marketing agency set up to sell the electricity produced on the Columbia River and elsewhere. Push the button and the transmission lines light up. The BPA builds these transmission lines to get the electricity to the buyers.

Stop #7 The Last Stop of this Tour is Your House

That is where some of this electricity may go. We make a lot of electricity at Bonneville Dam. That does not mean you can waste it. You can see how we have had to block the river to build this powerhouse which is not good for fish and wildlife. The more electricity we use the more powerhouses we will have to build. The more electricity you use the more your parents must pay their electric bills. Those are two good reasons to CONSERVE ELECTRICITY:

You can continue on down through the powerhouse by following the arrows painted on the floor beginning through the double doors on the other side of the gallery.

Hydropower
After Your Visit

In this section, you will find activities to be completed after your visit to Bonneville Dam. These activities are intended to reinforce vocabulary and important concepts learned earlier.

Activities

Fill In The Energy Blanks:

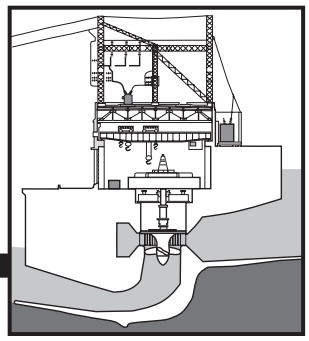
This activity works well either for individuals, small groups or large groups. If done individually, every student will need a copy.

The Water Cycle And Energy Relay Race:

If you have some active students, this game may be a good alternative way of teaching the important concepts of a renewable resource and transfer of energy.

Different Ways To Generate Electricity:

You may want your students to understand that waterpower is not the only resource used to power generators that make electricity. To facilitate this understanding you could ask students to write a small paper on forms of energy used to run generators that make electricity and the trade-offs associated with each.



Fill In The Energy Blanks

Fill in the energy blanks. Use each word from the list only once.

Word List:

salmon
Bonneville Power Administration
powerhouse
magnets
electricity
conserve
U.S. Army Corps of Engineers
generator
turbines
kilowatt hours
hydropower

_____is a form of energy. When it is produced at a dam, it is often called _____, which means water power.

When electricity is generated at a dam, water must fall through the dam and strike the _____causing these pinwheel-like machines to turn. When these large machines turn, they cause a part of the_____to spin and generate electricity.

Generators make electricity by spinning_____past coils of copper wire. After electricity is generated in the_____(which is the building at the dam where electricity is generated) it is sent through power lines to your house.

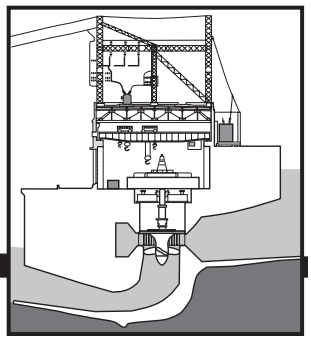
The dam is operated by the_____which is a part of the federal government that builds dams, navigation locks, harbors, and other water-related structures.

When electricity leaves the dam, it becomes the responsibility of another part of the government called the_____This agency may sell electricity to your power company.

Your electric power company charges you according to how many_____you use. A kilowatt is 1,000 watts and if you use that much electricity for an hour it is called a kilowatt hour.

Generating electricity at a dam is clean and does not use coal or oil, which are in limited supply. One of the major disadvantages to generating electricity at Bonneville Dam is that it makes life difficult for_____which must get past the dam twice during their lives.

Remember to _____, or use less electricity whenever you can!



Fill In The Energy Blanks

Answers In Order:

electricity

hydropower

turbines

generator

magnets

powerhouse

U.S. Army Corps of Engineers

Bonneville Power Administration kilowatt hours

salmon

conserve

Electricity is a form of energy. When it is produced at a dam, it is often called **hydropower**, which means water power.

When electricity is generated at a dam, water must fall through the dam and strike the **turbines** causing these pinwheel-like machines to turn. When these large machines turn, they cause a part of the **generator** to spin and generate electricity.

Generators make electricity by spinning **magnets** past coils of copper wire. After electricity is generated in the **powerhouse** (which is the building at the dam where electricity is generated) it is sent through power lines to your house.

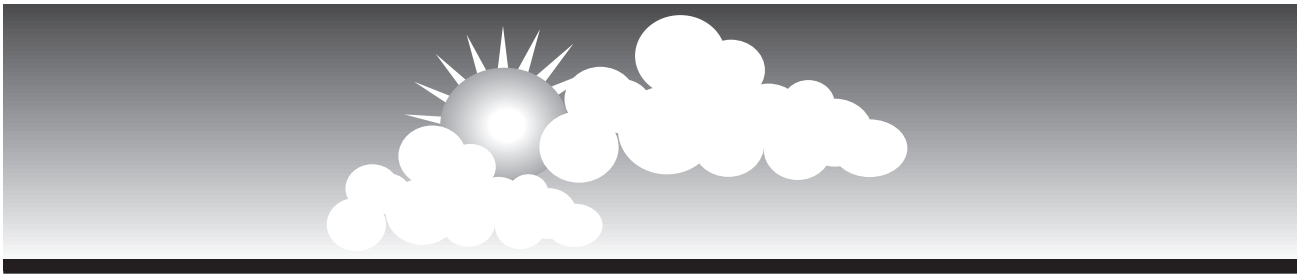
The dam is operated by the **U.S. Army Corps of Engineers** which is a part of the federal government that builds dams, navigation locks, harbors, and other water-related structures.

When electricity leaves the dam, it becomes the responsibility of another part of the government called the **Bonneville Power Administration**. This agency may sell electricity to your power company.

Your electric power company charges you according to how many **kilowatt hours** you use. A kilowatt is 1,000 watts and if you use that much electricity for an hour it is called a kilowatt hour.

Generating electricity at a dam is clean and does not use coal or oil, which are in limited supply. One of the major disadvantages to generating electricity at Bonneville Dam is that it makes life difficult for **salmon** which must get past the dam twice during their lives.

Remember to **conserve** or use less electricity whenever you can!



The Water Cycle And Energy Relay Race

Materials:

This activity consists of three phases. A discussion phase; an active phase and another discussion phase. Materials needed are: identical shallow bowls or spoons or anything in which it is difficult to carry water!

Briefly discuss the water cycle and it's importance to hydroelectric production. Good questions include: Where does the energy come from which powers the water cycle? (sun, gravity) What makes water evaporate? (the sun) Where does the water go? (it eventually condenses and rains) How does it get to the river? (run-off from the land) What makes the water flow in the river and through the powerhouse? (gravity)

By discussing the above questions, you have come to understand that the water moves through the powerhouse because of gravity. Everybody knows that water flows downhill but not everyone realizes that hydroelectricity is made possible by gravity. As the water falls through a powerhouse, the gravity energy is changed to mechanical energy. This takes place when water strikes the turbine blades causing rotation of the turbines. The turning turbines are attached to generators. Therefore, as the turbine spins, so does the generator. The mechanical energy of the turbine is changed to electrical energy as the magnets of the rotor are spun past the coils of copper wire in the stator. The transformer increases the voltage so electricity may be sent more efficiently through transmission lines. The transmission lines usually take it to another transformer which decreases voltage again and it is then sent to homes and businesses for people to use. This sequence should be quickly explained to the group before the next phase of this activity.

For the active phase, divide the group into teams of seven people each. Any "leftover" people can help decide the winner. The seven people in each team will represent **1.** river; **2.** turbine; **3.** a generator; **4.** a transformer; **5.** a transmission line; **6.** a transformer in their neighborhood; **7.** a light bulb. Each team should be arranged as shown just before the race begins.

■ ■ ■ ■ ■ ■ ■

7 5 3 1 2 4 6

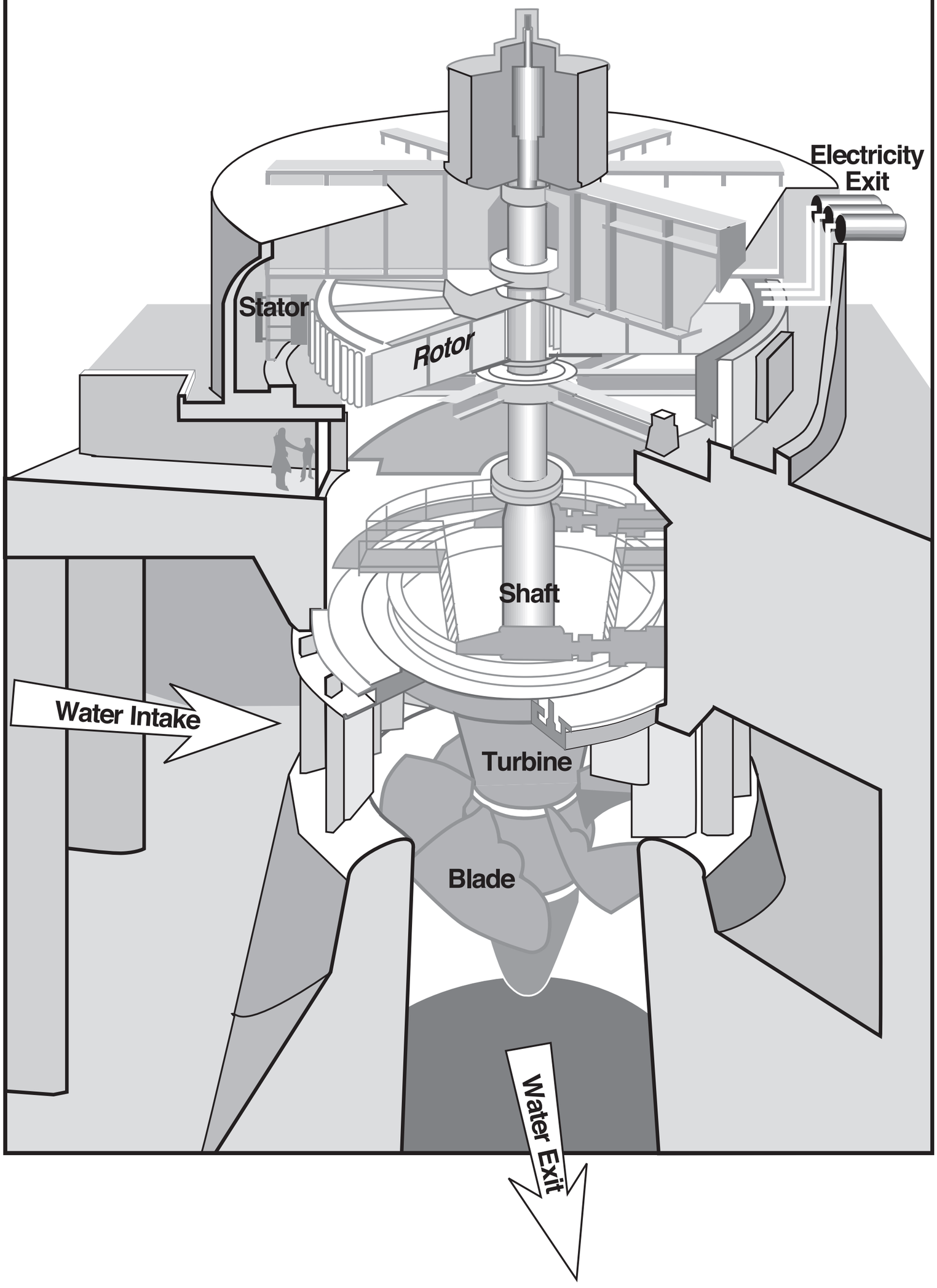
Every player should have an identical container in which to carry water. The best containers are spoons or anything which is likely to spill. Get the teams into the starting positions and fill the first player's (the person in each team that represents the river) container as full as possible. Water will symbolize energy. In this relay race, the winner will be the team with the most water at the end of the race! That team has "saved the most energy!"

To start, the first player must race to the second player and "transfer" the energy (water) to that person. The second player races to the third and so on until the water (if there is any left) is "transferred" to the last player, the light bulb.

Next, congratulate the team who has saved the most energy (the team with the most water). Dis-

cuss how energy is lost in the form of heat every time it is transferred. This game illustrates the second law of thermodynamics which, simply stated, says that whenever energy is transferred, some is lost in the form of heat. Heat, of course, radiates away from the earth and approximately equals what comes in from the sun. Discuss the importance of conserving energy.

Turbine and Generator



Navigation

Navigation An Introduction

Boats can pass Bonneville Dam on their way up or down the Columbia River by using the navigation lock. This subject area is designed to familiarize students with the navigation lock and inland trade.

The first section includes activities for the classroom intended to introduce the subject of navigation to your students. Next, are activities that can be conducted at Bonneville Dam while visiting the navigation lock. Finally, there are activities included to reinforce what has been learned.

History Quickie

When Bonneville Dam was built it greatly facilitated navigation. Bonneville Dam flooded the Cascade Rapids that were just upstream. The Bonneville lock, at the time it was built, was the largest single lift lock in the world. The dam flooded the lock at Cascade Locks, Oregon (previously called Whiskey Flats).

Important Concepts

The activities in this section will help the students understand the following concepts. Important vocabulary words are in bold print.

Navigation Lock

The first Bonneville **navigation lock** was constructed between 1933 and 1938. The original lock is 500 feet long, 76 feet wide and 24.2 feet deep above the sill with an average lift of 60 feet. The construction used 105,000 cubic yards of cement and 2,700,000 lbs. of structural steel.

There is a **lock operator** on duty 24 hours a day, 365 days a year. **Lockages** are provided at no charge for all **watercraft** including; military, commercial, and pleasure craft. Commercial craft do however pay a fuel tax that goes into the Waterways Trust Fund which is used to maintain waterways and helped fund construction of the new navigation lock at Bonneville Dam.

There are strict priorities that guide the operation of federal locks, providing the highest priority for military craft, second highest to commercial craft, and a lowest priority for pleasure and recreational craft. This means pleasure craft may be asked to wait three hours or more during busy periods. Often, pleasure craft will be locked through with non-hazardous barge loads. This is done to conserve the large amounts of water used to operate the lock and expedite lockages.

When a boat is ready to go through the lock, **vessels** with a marine radio can call the **lock operator** and request passage. Those vessels without a radio can speak to the lock operator via the speaker on the entrance wall.

The lock is a simple way of passing boats from one elevation to another. It is like an elevator but it uses water. Water fills and empties from the lock by **gravity flow**.

It takes about 10 minutes to either fill or drain the lock. Allowing for time to enter, tie the craft to a **floating mooring** bit, then later to untie and leave the locks, the entire lockage process takes

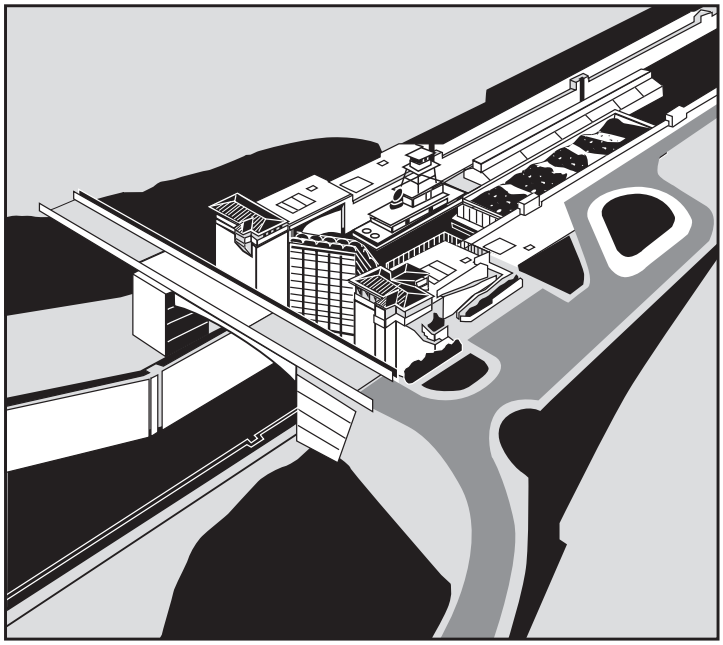
about 30 to 35 minutes. The average lift is 60 feet, with a minimum of 30 feet and a maximum of 72 feet. Each lockage uses about 28 million gallons of water, or enough water that if passed through a generator would supply the electrical energy needs of one Northwest home for a year.
.

The lock at Bonneville is the busiest lock on the Columbia-Snake river system. More than 10 million tons of cargo pass through Bonneville's lock each year. Frequent cargoes moving upriver include petroleum, oil, gasoline, and fuel oil. **Barges** going **downstream** contain cargoes such as barley, wheat, oats, and other grains, wood products, and building materials. River navigation is possible as far inland as Lewiston, Idaho, some 465 miles from the ocean and an elevation change of about 740 feet.

New Navigation Lock

The new navigation lock was completed in 1993. The old lock at Bonneville Dam, completed in 1938, was the first and the smallest of eight locks built on the Columbia-Snake Inland Waterway. Construction of the new navigation lock was very important to the region to improve the speed and safety of navigation on the river.

The new lock is 175 feet longer and 10 feet wider than the old lock. It increased the commercial shipping capacity at Bonneville to 30 million tons a year. That should be large enough to handle projected increases in shipping for the next 50 years.



Navigation
Before Your Visit

This section consists of activities designed to prepare your class for their visit to the Navigation Lock at Bonneville Dam.

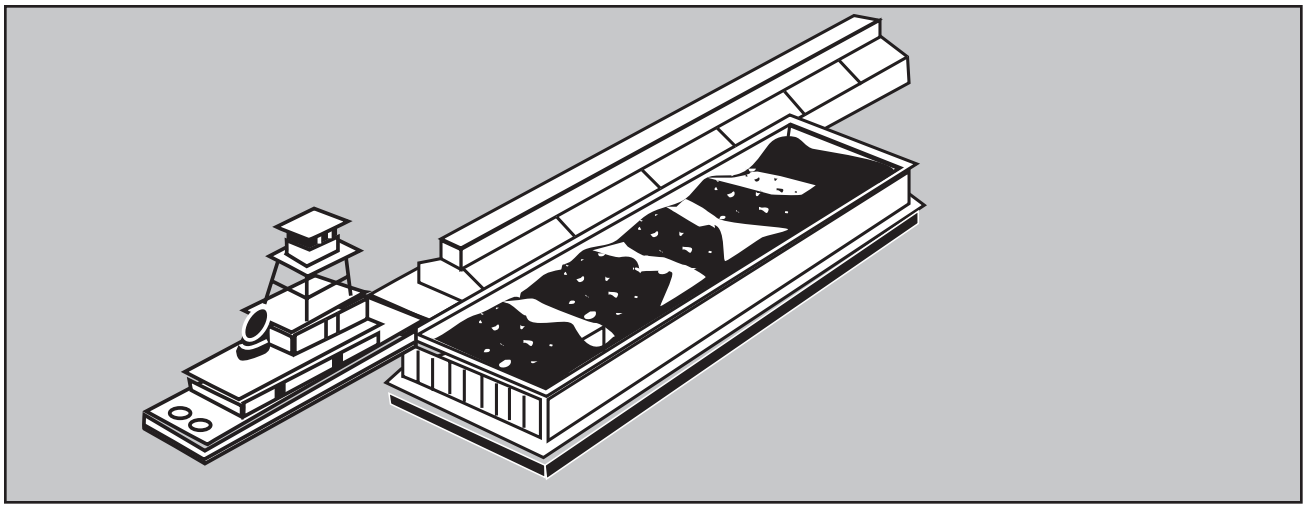
Activities

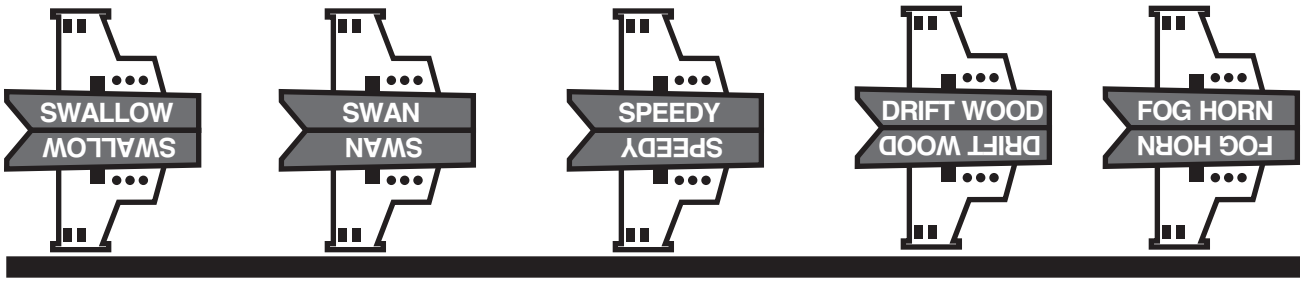
The River Navigation Game:

By playing this game your students will get a good idea of how a lock works and how it is used. You will need to make one copy of the game for every four students.

Columbia River Navigation:

This is a problem solving activity designed for groups. It will be useful in explaining why locks are needed.





The River Navigation Game

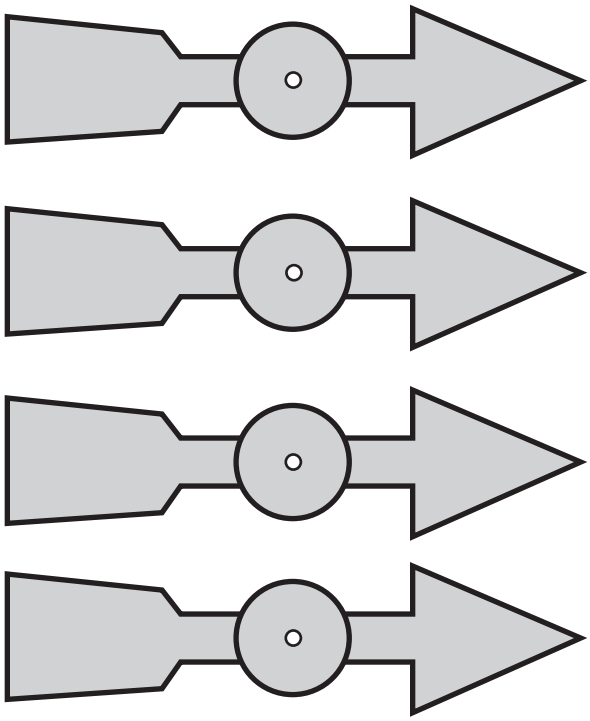
This game will familiarize you with some of the complexities of river navigation, including passage through a lock.

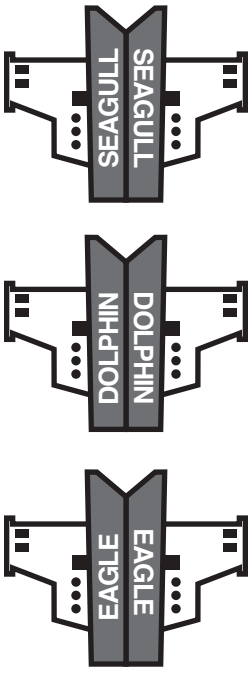
Visits to the lock do not always coincide with the times when the lock is being used. This game will help you understand the process of passage through a lock, even if the lock is not operating.

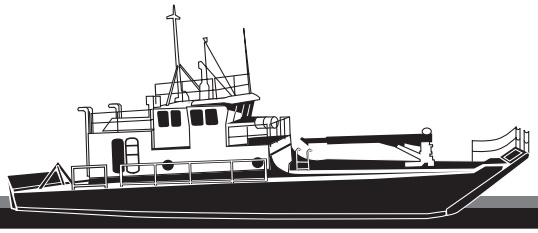
To Play This Game:

1. **Color the game board and spinner, arrow, and tugboats.**
2. **Cut them out with scissors.**
3. **Paste them to cardboard.**
4. **Attach the arrow to the spinner by piercing the center of both with a pin.**

TO PLAY: Players spin the spinner to determine who will play first. The player who spins the highest number takes the first turn. Play should then proceed in a clockwise direction. All players should start their boats on the space labeled, "start." The winner is the first player who navigates back and forth through the locks and arrives at the space labeled, "finish." Movement "up and down the river" is determined by the number on the spinner and by the hazards and opportunities encountered along the way.







Columbia River Navigation: Problem Solving

Conduct this activity by dividing the class into groups. Every group should "brainstorm" solutions for every problem and all of the solutions should be written on the blackboard at the end of the brainstorming session.

Brainstorming involves thinking of as many solutions as possible for a problem. No judgments should be passed during this phase. The goal is to collect alternatives. Later, after all of the potential solutions have been collected for a problem, the advantages and disadvantages should be discussed. The solution with the fewest and least important disadvantages and most important advantages is usually the best alternative.

Here are some navigation problems:

PROBLEM 1. In the past huge sand bars formed at the mouth of the Columbia River. Many ships ran aground. How would you solve this?

SOLUTION: _____

_____

PROBLEM 2. During the 1800's, huge rapids called the Cascades of the Columbia River made it difficult for boats to navigate the Columbia River. How would you solve the problem of improving extremely important river transportation?

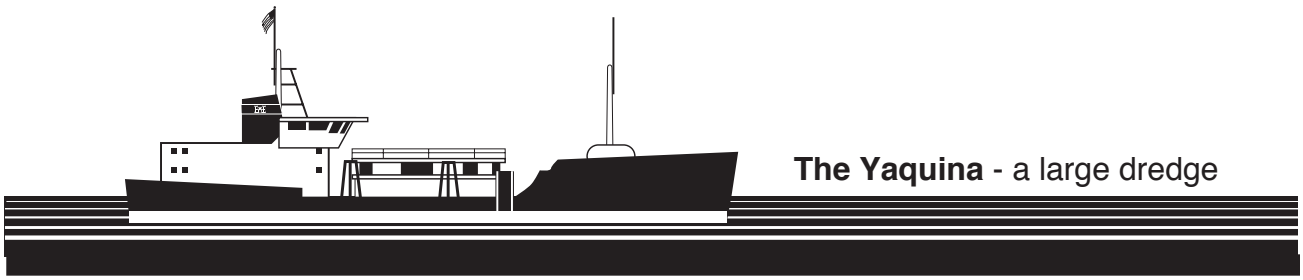
SOLUTION: _____

_____

PROBLEM 3. You want to find an inexpensive way to move bulky items back and forth between the mouth of the Columbia River and places upriver as far as Lewiston, Idaho. Due to many rapids, the river is not completely navigable.

SOLUTION: _____

_____



The Yaquina - a large dredge

Columbia River Navigation: Problem Solving

Answers:

PROBLEM 1. In the past huge sand bars formed at the mouth of the Columbia River. Many ships ran aground. How would you solve this?

SOLUTION: ***The Corps of Engineers dredges the channel and builds jetties to block sand accumulation at the mouth of the river.***

PROBLEM 2. During the 1800's, huge rapids called the Cascades of the Columbia River made it difficult for boats to navigate the Columbia River. How would you solve the problem of improving extremely important river transportation?

SOLUTION: ***The Corps of Engineers helped build a lock near the present location of Cascade Locks. Later, when Bonneville Dam was built, the water rose above the rapids, eliminating them. The Bonneville lock replaced the lock at Cascade Locks.***

PROBLEM 3. You want to find an inexpensive way to move bulky items back and forth between the mouth of the Columbia River and places upriver as far as Lewiston, Idaho. Due to many rapids, the river is not completely navigable.

SOLUTION: ***The Corps of Engineers built four dams with locks on the lower Columbia and four dams with locks on the lower Snake River. The dams caused the water to cover the rapids, making the river navigable.***

Navigation During Your Visit

The following are some suggestions for studying navigation at Bonneville Dam.

The locks are accessible from the Oregon side of the dam. Please contact the Bonneville Ranger Staff to schedule your visit, (541-374-8820). Exhibits at the lock explain its use.

If you are visiting the Washington side, see the lock operator exhibit on the main floor of the Orientation building. Push the button, pick up the phone and listen to information about navigation locks.

Activities

On Your Way To Bonneville Dam:

Ask your students to look for and identify boats that may be heading for the lock. You may also be interested in seeing the remains of the lock at Cascade Locks. This lock, located in the Cascade Locks Marine Park, was built by the Corps of Engineers (date). It was partially submerged in the 1930's when the Bonneville Lock and Dam was completed.

Look At A Lock:

Displays at the navigation lock have information about how boats go through the lock. This activity allows your students to use their imagination to discuss the process of using a lock.

Scavenger Hunt:

This activity will help students identify the different parts of the lock and what they are used for.

Look at a Lock

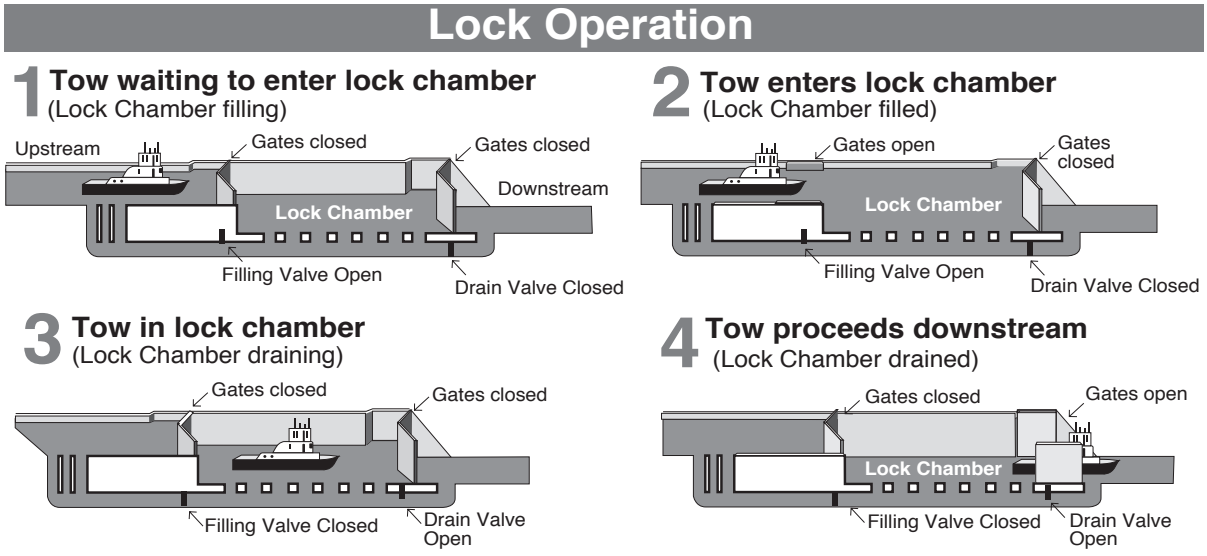
The lock at Bonneville Dam may be thought of as a water-filled elevator which is used by boats to get past the dam. Water enters or leaves the lock through large valves located in the bottom of the lock. No pumps are needed because gravity moves the water in and out of the lock. To fill the lock, the intake valve is opened and water flows into the lock. To drain the lock, a drain valve is opened and water flows out of the lock. The amount of water used for one lockage could, if passed through turbines, generate enough electricity to meet the electrical energy needs of one home for one year!

Walk up to the lock viewpoint. Imagine that a ship is coming. Explain, step by step, how you will help the ship through the lock. Volunteer to explain the first step in the process of locking through. Continue the process with other volunteers until the entire lockage sequence has been explained.

How It Works

A boat operator coming upriver will radio the lock master and announce when they expect to be at Bonneville Dam. The lock master will open the downstream gates and turn on a green signal light so the boat operator knows the lock is ready to enter. A red signal light tells the boat operator the lock is not ready. The boat will enter the navigation lock and tie up to the floating mooring bits. The lock master will then close the gates and open the upstream water valve to fill the lock. The water has to rise an average of 60 feet, this is the difference in the water level above and below the dam. Pumps are not needed; the force of gravity does all the work. When the lock is full the upstream gate is opened and the boat exits upriver.

Boats going downstream use the same process except that the water is drained from the navigation lock.



Scavenger Hunt

This activity will describe some of the more obvious equipment used while operating a navigation lock. Can you find the particular piece of equipment? The first one to find it gets a point. You can double your point if you can explain what the equipment is used for. If you find it and are unable to explain what it is used for, then the first person who can, gets the point.

Here Are Some Objects To Look For:

Gates: The huge metal gates of the lock are hydraulically controlled and weigh about 260 tons each.

Floating Mooring Bits: Located in slots on the inside of the lock, these are the devices that the boats must be tied to. The water level changes in the lock (usually 60 feet) so these mooring bits must float. If they did not float, any boat attached firmly to them would either be suspended above the water or held under water as the water level changed.

Traffic Lights: Like traffic lights on roads, these lights tell the pilot of a boat when to stop or when to proceed**.**

Stoplogs: These steel reinforced structures are to prevent water from flowing into the lock when the gates are being repaired**.**

Office: This is where the lock operator works, controlling the gates and valves that let water in and out and receiving messages that boats are coming and would like to use the lock**.**

Navigation
After Your Visit

These activities are designed to encourage students to review what they learned about the navigation lock.

Activities

Lock Operator:

This is an activity involving matching words with their definitions. It deals with the information a lock operator must have.

Word Association Game:

This game is intended to stretch the students' vocabulary. They must think of words that start with particular letters and are associated with navigation or watercraft.

Did You Know:

This is a short quiz on navigation.

Lock Operator

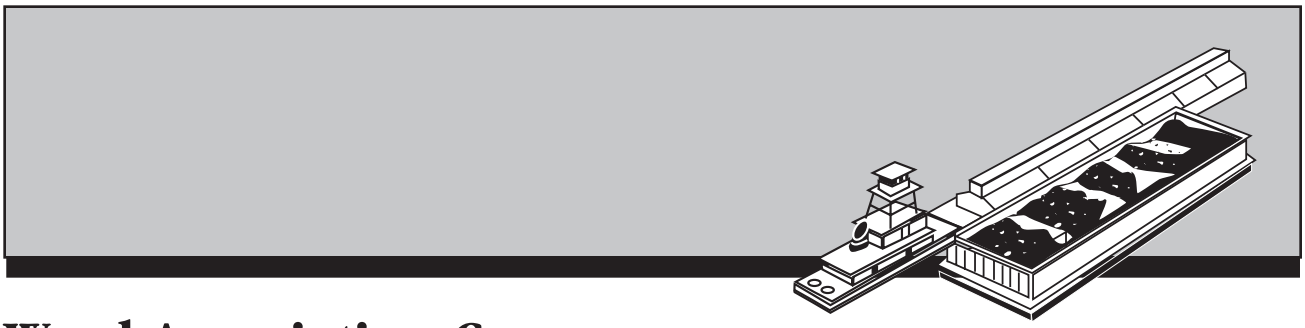
The following is some of the information that a lock operator must know to operate a lock at Bonneville Dam. See how much you know about the lock and about navigation on the Columbia. Write the number of the word in front of the correct definition.

1.	**Barge**	_____	a deep trench in the river bottom dug for safe passage of boats
2.	**Channel**	_____	one definition of this word' 'to travel on water"
3.	**Corps of Engineers**	_____	a special boat that digs channels in rivers
4.	**Dredge**	_____	a long pile of rocks that make a wall out into the ocean; used to prevent unwanted sand deposits at the mouth of a river
5.	**Floating Mooring Bit**	_____	an "elevator" for boats, this elevator uses water to raise or lower boats
6.	**Grain And Wood**	_____	a part of a lock used to tie boats to; it floats
7.	**Jetty**	_____	a large, floating box-shaped boat which is used to move very bulky cargo
8.	**Lewiston, Idaho**	_____	a powerful boat which is used to move barges
9.	**Lock**	_____	this is how far inland a tug may take a barge
10.	**Navigate**	_____	two cargoes which are sent up the Columbia River
11.	**Oil and Fertilizer**	_____	two cargoes that are transported on the Columbia River
12.	**Tug Boat**	_____	the government agency which built and operates the locks on the Columbia River

Lock Operator

Answers:

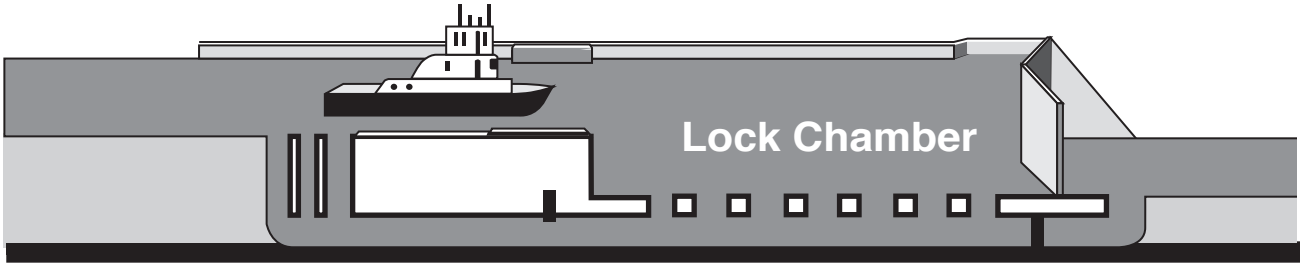
1.	**Barge**	2	a deep trench in the river bottom dug for safe passage of boats
2.	**Channel**	10	one definition of this word' 'to travel on water"
3.	**Corps of Engineers**	4	a special boat that digs channels in rivers
4.	**Dredge**	7	a long pile of rocks that make a wall out into the ocean; used to prevent unwanted sand deposits at the mouth of a river
5.	**Floating Mooring Bit**	9	an "elevator" for boats, this elevator uses water to raise or lower boats
6.	**Grain And Wood**	5	a part of a lock used to tie boats to; it floats
7.	**Jetty**	1	a large, floating box-shaped boat which is used to move very bulky cargo
8.	**Lewiston, Idaho**	12	a powerful boat which is used to move barges
9.	**Lock**	8	this is how far inland a tug may take a barge
10.	**Navigate**	11	two cargoes which are sent up the Columbia River
11.	**Oil and Fertilizer**	6	two cargoes that are sent down the Columbia River
12.	**Tug Boat**	3	the government agency which built and oper ates the locks on the Columbia River



Word Association Game

To play this game you must think of a word that relates to both the Columbia River and to navigation lock or watercraft. The word must start with a letter in the word "Columbia" which is written vertically on the page. For instance; the letter "C" in Columbia will have two words that start with the letter "C" and associate with either navigation lock or watercraft, horizontally next to it. There are no incorrect answers as long as the answer can be explained.

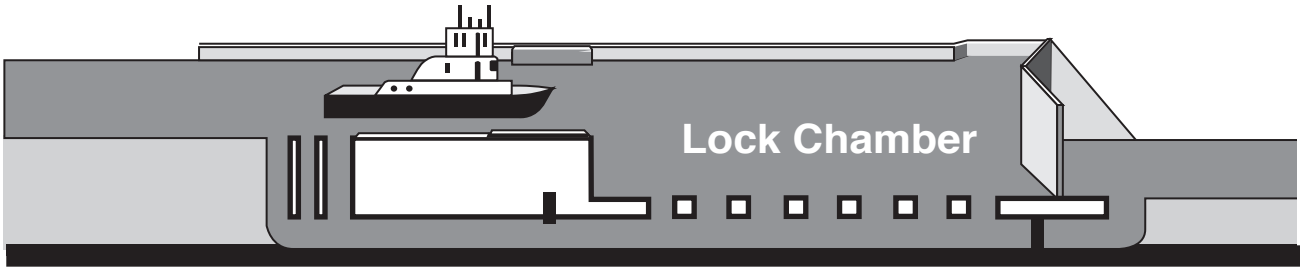
	Navigation Lock	Watercraft
C	_____	_____
O	_____	_____
L	_____	_____
U	_____	_____
M	_____	_____
B	_____	_____
I	_____	_____
A	_____	_____



Word Association Game

Example For Teachers:

	Navigation Lock	Watercraft
C	cargo	commercial
O	operator	ocean liner
L	lumber	loaded
U	up river	untie
M	mooring bits	move
B	boats	barges
I	inside	inland trade
A	Army Corps of Engineers	agricultural products



Did You Know?

Did you know that if the water which is used for filling the lock were passed through a turbine, it would make enough electricity to meet the electrical needs of a home for one year! The new navigation lock can conserve water by passing the same amount of barges by the dam in one lockage that the old lock passed in five lockages.

The water to fill the lock comes from _____

The water drained from the lock goes _____

Why are locks necessary for river transportation _____

_____

Why is river transportation important _____

_____

How is a lock like an elevator? How is it different _____

_____

How is a lock like your bathtub? How is it different _____

_____

How else is the water from the Columbia River used _____

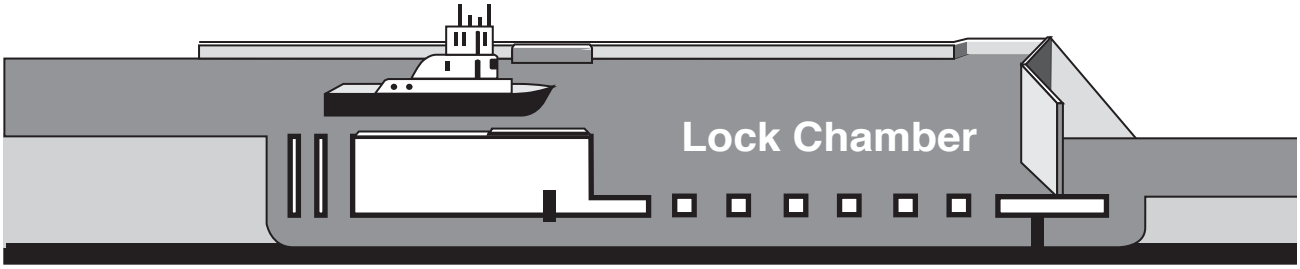
_____

What does "conserve" mean _____

_____

Why is it important to conserve the water in the Columbia River _____

_____



Did You Know?

Answers

The water to fill the lock comes from **Upriver.**

The water drained from the lock goes **Downriver.**

Why are locks necessary for river transportation **Locks are built so boats can get around dangerous rapids or past a dam.**

Why is river transportation important **Goods are transported quickly, safely and economically on a river.**

How is a lock like an elevator? How is it different **A lock lifts boats from one elevation to another like an elevator. It uses water, an elevator doesn't.**

How is a lock like your bathtub? How is it different **The lock is filled and emptied with the force of gravity upon water like a bathtub but the lock is much larger than a bathtub**

How else is the water from the Columbia River used **Columbia River water is used to make electricity, irrigate and for recreation. Fish and wildlife also use Columbia River water.**

What does "conserve" mean **To conserve means to use something without destroying it.**

Why is it important to conserve the water in the Columbia River **The Columbia River water is used for many important things**

The River Navigation Game

DANG ER

Win!

33 Swept away by strong current Go back to #30

32 Avoided a collision! Move ahead to #34

36

34

35 Returned your barges and cargo Move to #36

31

30

29

28

Barge #1 Barge #2 Barge #4 Barge #3

4 Tie up to barge

3

2 You forgot your life jacket! Start over!

5 Good wind! Move ahead to #8

6

7

Call Lock Master 8

Automobile Bridge

Start

1

4 2

3

Powerho use

Wait for downstream gate to open Go to #28

Wait for lock to drain Go to #27

Tie to floating mooring bit. Go to # 26

27 26 25

9 10 11

Tie to floating mooring bit. Go to # 10

Wait for lock to fill Go to # 11

Wait for upstream gate to open Go to # 12

Downstrea m Gate

Upstream Gate

21 Off course! heading for the turbine intake! Go back to # 19

DANG ER

20 Hit a sandbar! lose 1 turn

TO LOCK GO GO

Call Lock Master

22

Wait for hazardous cargo! Lose 1 turn

23

19

18

17

Wait for lock to fill. Lose one turn

24

Pick up wheat cargo 16

12

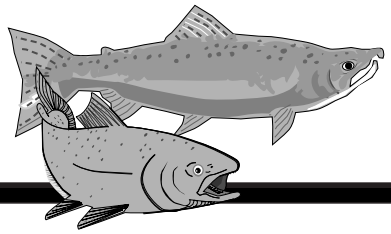
13

14

15 Drop off gasoline cargo

Dock

Natural Resources



Natural Resource Management
An Introduction

The purpose of this subject area is to introduce your students to the subject of anadromous fish and provide a basic understanding of natural resources. Since hydropower dams like Bonneville Dam have changed the historic migration routes of salmon, steelhead, shad and other fish species, part of our natural resource management responsibilities include facilitating fish passage past the dam.

The first section includes activities to acquaint your students with the management of natural resources featuring anadromous fish. Next, are self-guided tours of the fish ladders on either side of the river, and the fish hatchery. Also included are charts for your students to use to keep track of the natural resources they might see while at Bonneville Dam. Finally there are activities included to reinforce what has been learned.

History Quickie

Throughout history and prehistory, Columbia River salmon have been harvested in many ways. In the 1870's contraptions known as fishwheels appeared on the Columbia River. These devices worked like waterwheels, capturing fish in scoop-like buckets and depositing them on a boat or platform. The fishwheels worked 24 hours a day and some were very successful, catching as many as 6,000 fish a day. Gill netting and purse seining were even more successful methods of salmon harvest.

Over-harvesting was a major factor in the depletion of the salmon runs. Bonneville Fish Hatchery was built in 1909 to supplement the decreasing fish runs.

Fishwheels were outlawed in Oregon in 1926. The state of Washington followed suit in 1934. There is a model of a fishwheel on display in the Fish Viewing Building at the visitor center on the Washington side of the dam.

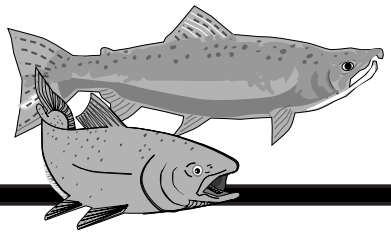
Important Concepts

The activities in this section will help the students understand the following concepts. Important vocabulary words are in bold print.

Natural Resources

A **natural resource** is something found in **nature** that can be useful to people in some way. Humans have the power to change, use, take care of, or destroy natural resources. People also are dependent on natural resources so it is to our benefit to manage natural resources wisely.

A natural resource can be living or non-living. A couple of the non-living natural resources found at Bonneville Dam are water and air. Some of the living resources found near Bonneville Dam are: anadromous fish, osprey, Canada geese, deer and elk.



Natural resources are **interdependent**; they are connected together and interact to form what we call the natural **environment**. When one natural resource is changed it affects all the others.

When we manage natural resources we must think about how a change we make to one resource might affect other resources. We change a river to make hydropower. This change affects other natural resources that depend on the river. We need electricity, irrigation water and river transportation but we also need fish, birds, deer and other animals. Fish, wildlife and plants have adapted to the natural seasonal fluctuations of the river. Building a dam disrupts this natural pattern and steps must be taken to artificially duplicate nature or in some way make up for the harm done. This is called natural resource management.

Anadromous Fish

Because dams effect the migration of **anadromous fish**, the Army Corps of Engineers is highly involved in finding ways to get them around dams safely.

An anadromous fish spends a part of its early life in fresh water (a river, creek or lake), migrates to and grows to adulthood in salt water (the ocean) and then returns to the same river, creek or lake to spawn. These fish are an important source of food for humans and other animals. These fish include salmon, steelhead, shad and lamprey.

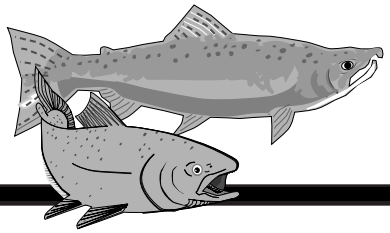
In general, the **Columbia River** salmons' **life cycle** begins in the fall when the adults **spawn** in the same stream bed where they were hatched. An adult salmon can go 900 miles or more inland to spawn in a shallow, clear mountain stream that has a clean bed of gravel. The female makes a nest in the bed of gravel called a **redd**. There she lays her eggs. The male passes over the redd and fertilizes the eggs by releasing **milt** or sperm. Both male and female salmon die after spawning.

The eggs hatch in about six weeks and the little fish live and grow in the stream from 2 to 18 months. The little fish, called **fingerlings**, grow to about the size of a human finger. Fingerlings migrate to sea between the spring and late summer time runoff. A fingerling goes to sea and is called a **smolt**. A smolt's body is changing so that it can live in salt water. This is called **smoltification**.

After the smolts make it to the ocean they will spend one to five years there. Because there is a lot of food in the ocean they become very large. During their rearing time in the ocean, they become adults and instinct tells them they must return to the place where they were spawned. They return to the Columbia River and eventually find their way back to the spawning stream.

Scientists think the fish find their way back to that stream where they were reared by sensing the **chemical composition** of the water. This is much like our sense of smell or taste.

Steelhead and shad also return to fresh water to spawn but do not necessarily die afterward. Their life cycle is similar to salmon except that they can potentially spawn several times. Steelhead spawn in a shallow, clear mountain stream that features a clean, bed of gravel. Shad spawn mainly in the reservoirs (lakes) created by the dams.



Fish Facilities

Fish Ladders

The returning adult fish get around a dam using **fish ladders**. The fish are attracted into the ladders through a series of entrances along the face of the powerhouse and at the edge of the spillway. Water from the lake is added to the ladder water to create a strong flow into the river downstream, which attracts fish up and into the fish ladders. At Bonneville Dam they must swim up 60 steps, each step is 1 foot. Fish ladders were built during the construction of Bonneville Dam.

The fish ladders have been modified several times in the last 50 years. The submerged orifices or holes in the weirs or walls of the ladders were constructed to make it easier for the migrating fish. They no longer have to jump over each of the weirs, they can swim through the holes. The fish ladders now also feature underwater windows where migrating fish can be viewed.

There are four fish ladders at Bonneville Dam. One allows fish to migrate past the first powerhouse and joins one that attracts fish from the south side of the spillway. That set goes past the Visitor Center on the Oregon shore where the underwater windows allow viewing on the first floor. Another allows fish to migrate past the second powerhouse and joins one that attracts fish from the north side of the spillway. This set goes past the Fish Viewing Building on the Washington shore where the underwater windows allow viewing.

Fingerling Bypass

There are four major ways that the Army Corps of Engineers attempts to get juvenile fish migrating to the ocean past dams safely.

Spillway

Water is allocated in the spring to help the smolts on their way to the ocean. Generally, smolt bodies have adapted to migrating to the ocean in close to 30 days. Reservoirs slow their migration which can effect their survival rate.

Water that would normally be saved for use at low water times is passed by dams to increase the flow between reservoirs and speed juvenile fish migration. The water budget is used to bring the flow of the river up to a certain minimum, but the water can be passed through the turbines if the resulting power is marketable.

Submerged Traveling Screens

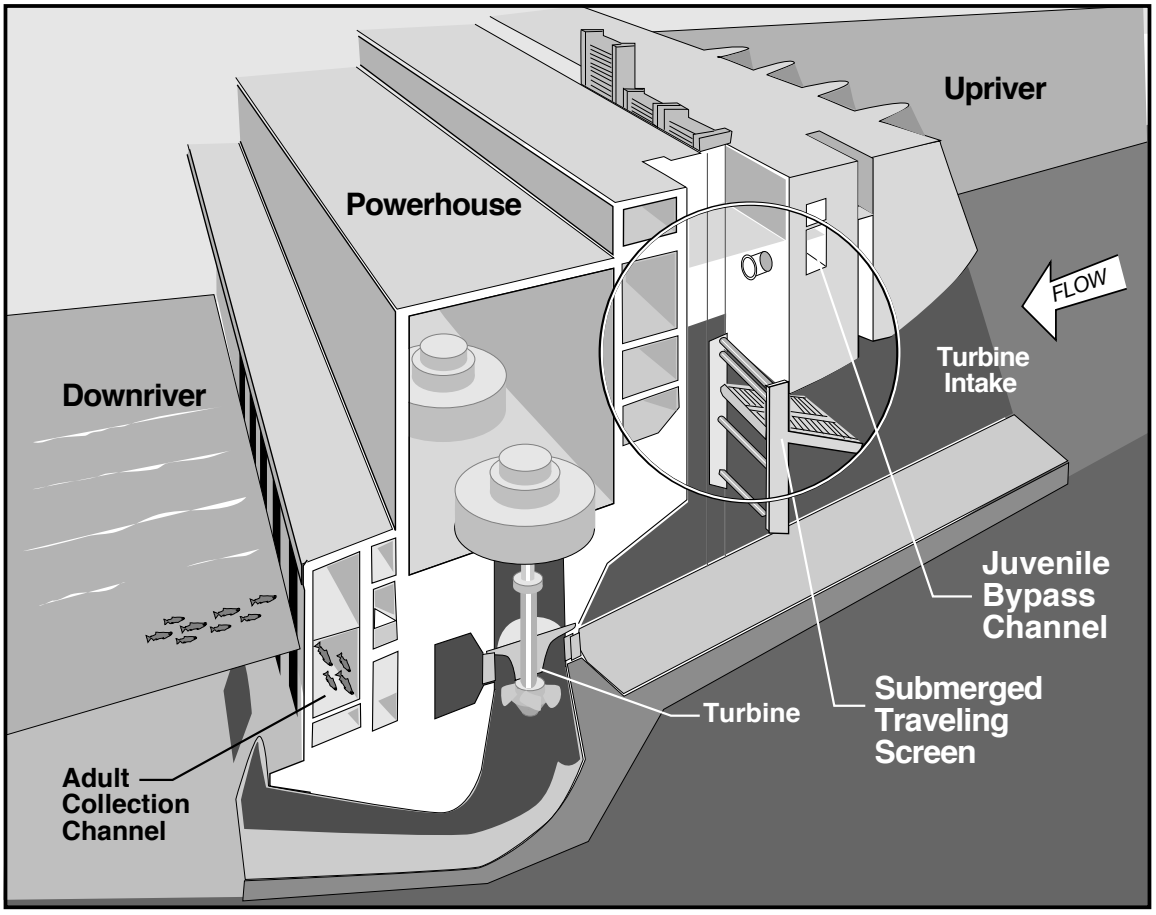
Engineers have designed what are known as submerged traveling screens that are placed near the roof of the intakes (where the water runs through the powerhouse). The screens guide some of the smolts out of the turbine intakes and into the juvenile bypass channel. The juvenile bypass channel is a channel that runs the length of the dam and leads the smolts to the downriver side of the dam.

Juvenile Fish Transport

The Army Corps of Engineers has developed a program of transporting smolts in trucks and barges from collection stations at upstream dams to below Bonneville Dam. This speeds the time it takes the smolts to make it to the sea and avoids the dangers of the dams and lakes.

Hatcheries

The Army Corps of Engineers also helps fund many fish hatcheries. Fish hatcheries supplement the fish that wild runs produce by mitigating for lost spawning ground. Many things have reduced the amount of spawning ground available to the salmon. Access to nearly half of the once available spawning ground was blocked by Chief Joseph dam on the Columbia and Hells Canyon dam on the Snake River. Other factors such as badly engineered logging and road construction, grazing cattle too close to the banks of a stream, pollution, and residential or commercial building destroy spawning grounds by silting in, warming or covering the stream.



Natural Resource Management Before Your Visit

The following fish and natural resource-related activities may be used to prepare your students for a visit to Bonneville Dam.

Activities

Salmon In The News:

Salmon are often in the news. Beginning a few weeks before your visit, ask your students to bring in articles about salmon and other anadromous species. Students who are aware of current events often seem to get more out of their visit to Bonneville Dam. Use a bulletin board in the class for posting the articles. Discuss each article.

Salmon Life Cycle:

Ask your students to draw a representation of the life cycle of a salmon. The drawing may include: eggs, hatchlings, fingerlings, and adults.

Fish Migration Game:

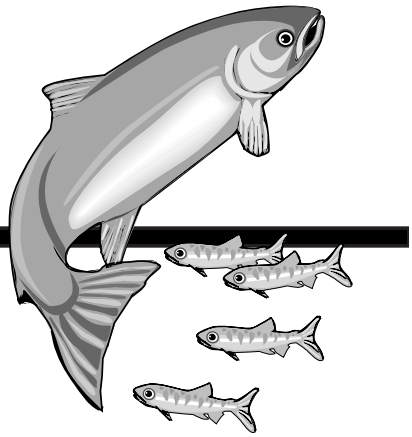
This game can be played either at Bonneville Dam or at the school in an outdoor or large indoor area. It will help students understand the lifecycle of anadromous fish, survival of the fittest and how this supports the food web.

The Anadromous Fish Game:

By playing the enclosed "ANADROMOUS FISH GAME," your students will become familiar with the life cycle of anadromous fish and they will learn how these fish get past Bonneville Dam.

Natural Resource Identification:

This game will help students to identify what resources are useful to us. Some natural resources are taken for granted because they are so familiar.



Fish Migration Game

Special Requirement!

Because this game involves large amounts of movement, ample space is needed. Play either indoors or outdoors.

This is a three-part activity (with a pre-game discussion, the game, and a post-game discussion) designed to acquaint participants with some of the difficulties encountered by anadromous fish during the migratory phases of their lives and show how the anadromous fish life cycle supports the food web.

In nature, survival of the fittest is an important element in the survival of a species as a whole.

The Pre-game Discussion:

Bring the children together and ask them, "What problems do salmon face as they come up the river?" (Students should be somewhat familiar with the life cycle of salmon or other anadromous fish.) Problems could include anglers, predators, and migrating past dams, etc. Make a similar list of problems affecting juveniles migrating downstream. Predatory birds and fish, passing through turbines at powerhouses and any other problems that the students can think of. This discussion sets the number of variables for the game. Every problem mentioned becomes one of the active roles taken by those who volunteer to play the parts. Each person, or group of people will thus be identified as either young salmon, a dam, predatory fish or birds, anglers, etc.

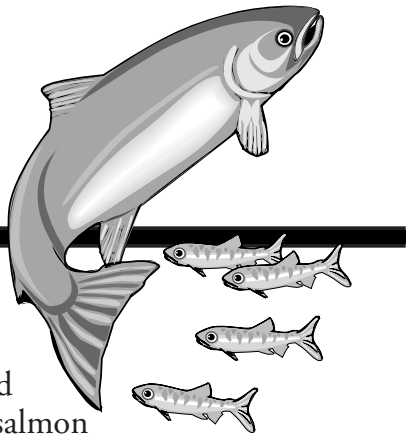
The Game:

Designate a pathway (about 50-100 feet long) as the stream or river. It should lead from the "spawning area" to the "ocean". Problems (represented by children) should be placed along the pathway in their natural sequence (i.e. predators, anglers, etc.). The rest of the children are the migrating fish.

The young fish should follow the path to the ocean. As they travel, they should try to avoid being caught. A catch requires a touch on the shoulder. If caught, they should sit out the rest of the game and watch what happens. When the surviving young salmon reach the ocean, stop the game, talk about the loss of the juvenile fish and how they support the food web. Also talk about their years in the ocean where predators and ocean trawlers will take their toll and then let the survivors, who are now "adult" salmon, return to the spawning stream. Again, they should travel and avoid problems. At the end of the game their should only be one to two percent of the fish left.

Post-game Discussion:

After the adult salmon have returned to the spawning area, gather the group together to reinforce important concepts by comparing the game to reality.

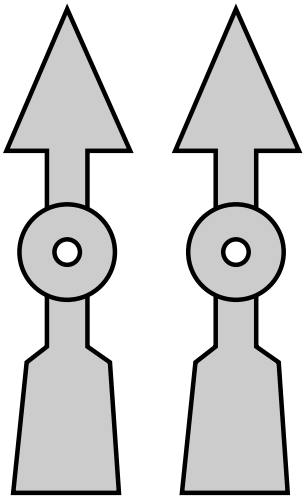


In reality a very small percent of the salmon will live to spawn. It is important to discuss the salmon life cycle and how it is affected by the problems encountered during their migratory life, how the salmon support the food web, and how survival of the fittest ensures a healthy, strong population of fish.

The Anadromous Fish Game

Here's a board game with all the parts and direction provided. Just put it together and have fun!

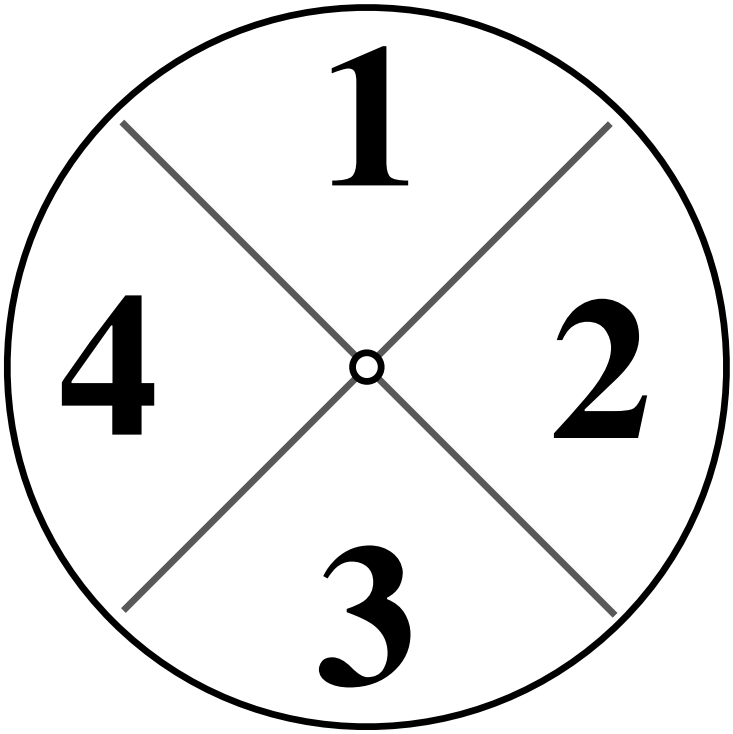
Directions:

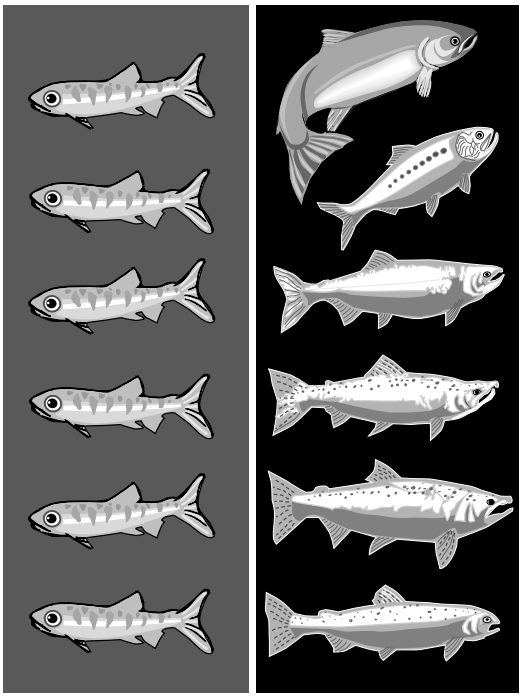


1. Color the game board, arrow, fish, and spinner.
2. Cut them out with scissors.
3. Paste them to cardboard.
4. Attach the arrow to the spinner by piercing the center of both with a pin.

TO PLAY: Each player should spin the spinner once. The highest number goes first, then play in a clockwise direction. Everyone should start in the space marked start. This space is connected to the spawning stream and the hatchery which are two places where salmon are born.

The winner is the first player to move a salmon to the "ocean" and back to either the "spawning stream" or the "hatchery." Good luck!



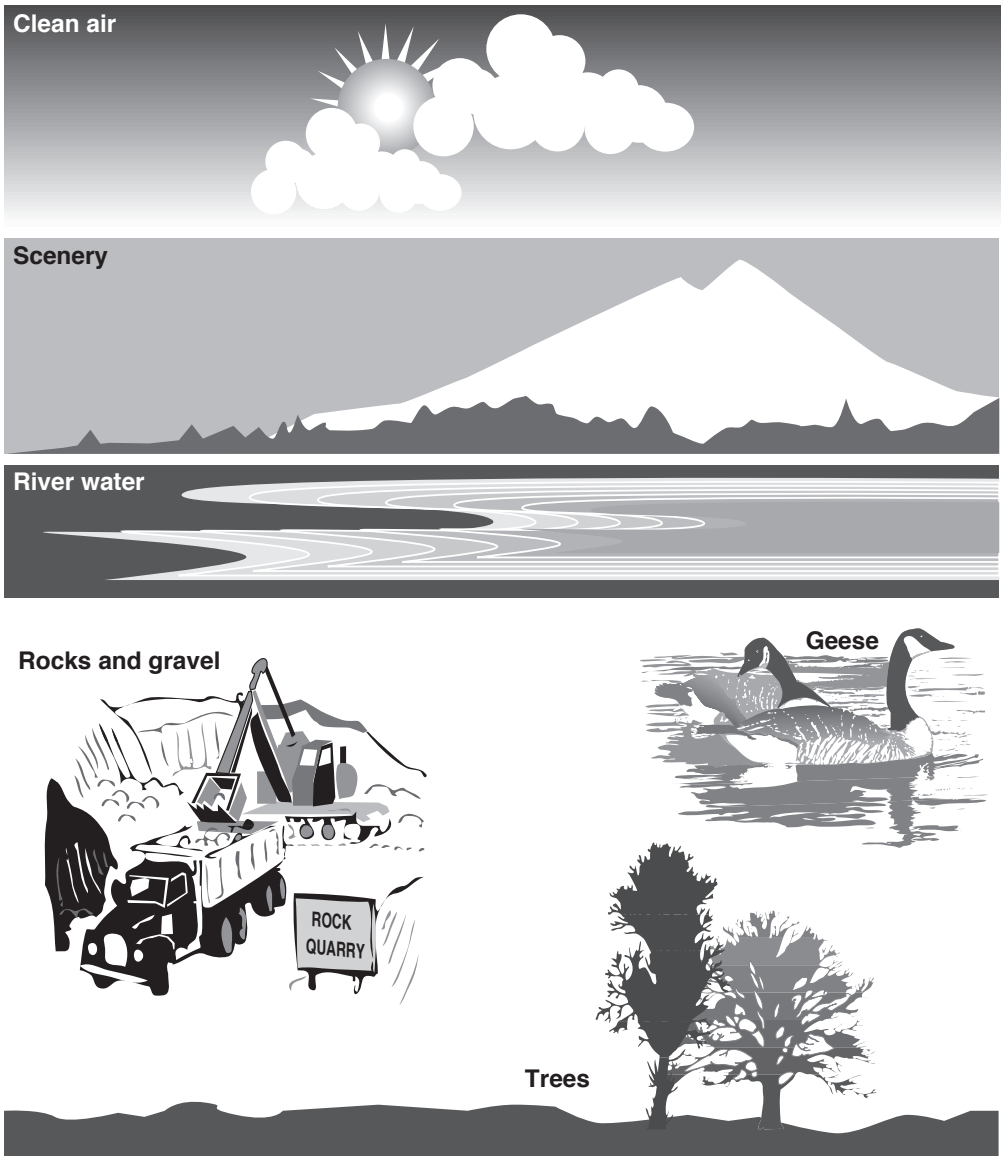


Natural Resource Identification

Natural resources are things in nature that may be useful to us in some way.

Below, you will see drawings of some of the natural resources that the Corps of Engineers takes care of at Bonneville Dam. Under each drawing, write how each of the living or non-living natural resources may be useful to people.

Next, draw lines between any of these natural resources which are connected somehow to one another. For example, geese need water so draw a line from the geese to the water. What other connections are there?



Natural Resource Management During Your Visit

The purpose of this section is to give your students a self-taught learning experience while they are at Bonneville Dam. It includes self-guided tours of the facilities.

Most of the following activities are intended for a specific location. For many, the students will need copies of the activities and pencils.

Activities

On Your Way To The Dam:

Visit other dams and/or fish hatcheries. Stop at some of the many park and recreation lands in the Columbia Gorge to enjoy this spectacular natural area.

Bradford Island Visitor Center:

At the Bradford Island Visitor Center you will be able to view the fish ladder from both above and below water level. Exhibits on the lower floor will inform you about fish passage and life cycles. See the activity titled, Self-Guided Tour of The Fish Ladder at the Bradford Island Visitor Center."

The Second Powerhouse Visitor Complex:

Facilities at the Second Powerhouse include fish ladder viewing from above and below water level, an exhibit about the history of fishing in the Gorge and exhibits about other aspects of fish migration and life cycles. See the activity entitled, "A Self-Guided Tour of the Fish Ladder at the Visitor Orientation Building."

The Bonneville Hatchery:

Highlights of the fish hatchery include rearing ponds, in which salmon are raised, sturgeon and trout ponds, where these fish are exhibited, and a building where you can learn how salmon are processed.

Charting Resources And Animal Checklist:

A copy of this game should be given to each of your students. It will help them identify the natural resources at Bonneville Dam and what we have done to use or change the resource. After your visit you can discuss the importance of the resources the students have observed.

A Self-guided Tour of The Fish Ladder
Bradford Island Visitor Center, Oregon

Use this sheet to find out how salmon get past Bonneville Dam.

Stop #1: Go To The First Floor Of The Visitor Center

Walk out the door to the right as you face the windows. Walk up the ramp. You will be outside looking at the fish ladders. Walk up them (south) and see if you can pick out each different section.

Walk down the steps to the first floor windows again. The windows you are looking through give you a view into the fish ladder.

Which way are the adult fish going in the ladder?

- ❑ a. with the current
- ❑ b. against the current

Is the fish ladder used mostly by adult fish or juvenile fish? _____

Stop #2: Look At The Models Of The Fish.

Name five kinds of fish seen in the ladder here at Bonneville Dam. Use the models to help you identify the fish you see in the ladder.

1. _____ 2. _____

3. _____ 4. _____

5. _____

Where are the adult fish in the fish ladder going after they are out of the ladders?

- ❑ a. upriver
- ❑ b. downriver

Why do they have to get past Bonneville Dam?

True or False? At Bonneville Dam, fish are counted as they come up the ladder.

❑ **True** ❑ **False**

Stop #3: Look At The Fish Count.

Which fish are counted?

1 _____ 2. _____

3. _____ 4. _____

5. _____ 6. _____

7. _____

Why are the fish counted? _____

_____

Stop #4: Look At The Migratory Patterns Exhibit.

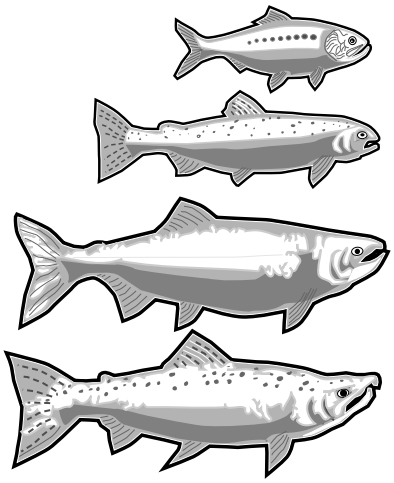
Columbia River Chinook spend _____ to _____ years at sea.

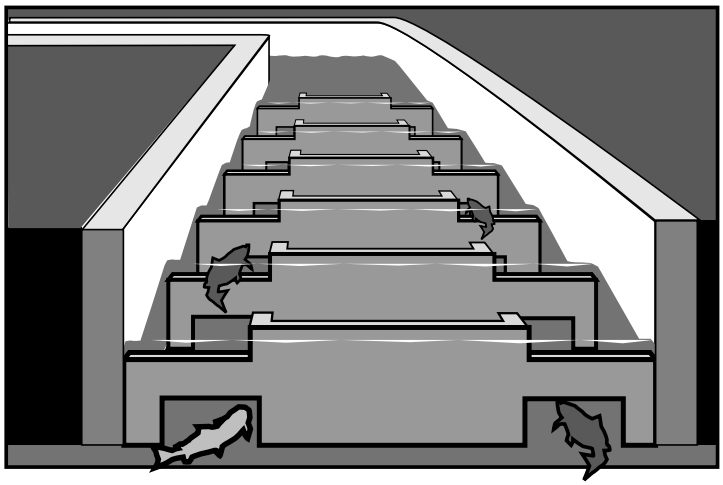
Bonus Question

As you have discovered, the ladders are mostly used by the adult fish going upstream to spawn. The fish going downstream go past the dam in several ways. Can you name two ways, other than the ladders, juvenile fish going downstream get past the dam?

1 _____ 2. _____

If you have questions about the fish or fish ladders, please ask at the information desk on the fourth floor.





A Self-guided Tour of The Fish Ladder
Bradford Island Visitor Center, Oregon

Answers:

Use this sheet to find out how salmon get past Bonneville Dam.

Stop #1: Go To The First Floor Of The Visitor Center

Which way are the adult fish going in the ladder?

- ❑ **b. against the current**

Is the fish ladder used mostly by adult fish or juvenile fish? **adult fish**

Stop #2: Look At The Models Of The Fish.

Name five kinds of fish seen in the ladder here at Bonneville Dam. Use the models to help you identify the fish you see in the ladder.

1. **Chinook salmon** 2. **coho salmon**
3. **shad** 4. **steelhead trout**
5. **sockeye salmon**

Where are the adult fish in the fish ladder going after they are out of the ladders?

- ❑ **a. upriver**

Why do they have to get past Bonneville Dam?
Salmon spawn in the same place they were reared which could be hundreds of miles past Bonneville Dam.

True or False? At Bonneville Dam, fish are counted as they come up the ladder.
True

Stop #3: Look At The Fish Count.

Which fish are counted?

1. **Chinook** 2. **coho** 3. **steelhead** 4. **chinook jack**
5. **shad** 6. **sockeye** 7. **coho jack**

Why are the fish counted?
The fish count helps set regulations, guide hatchery production and assists research.

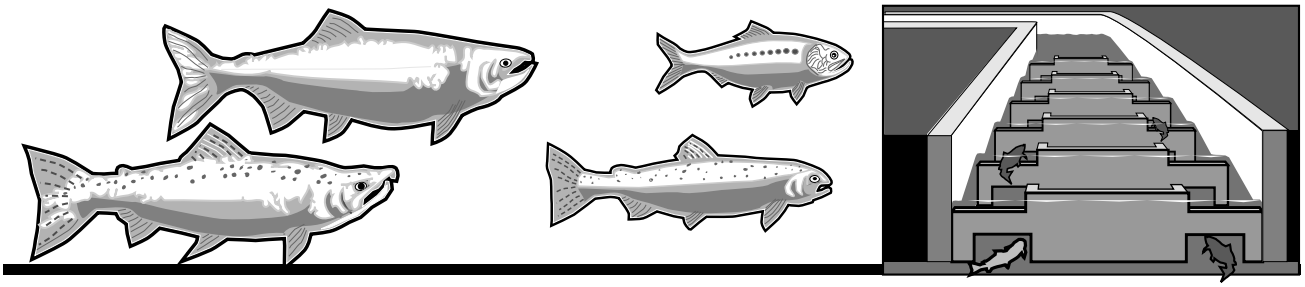
Stop #4: Look At The Migratory Patterns Exhibit.

Columbia River Chinook spend **two** or **five** years at sea.

Bonus Question

As you have discovered, the ladders are mostly used by the adult fish going upstream to spawn. The fish going downstream go past the dam in several ways. Can you name two ways, other than the ladders, juvenile fish going downstream get past the dam.

1. **Many go over the spillway which is opened in the spring**.
2. **The fingerlings are collected at dams and hatcheries upriver then trucked and barged downriver to be released into the river just below Bonneville Dam.**



Natural Resources

A Self-guided Tour of The Fish Ladder
Visitor Orientation Building, Washington

Use this as a guide to the fish ladder at the second powerhouse.

Stop #1: Go down the escalator in the Visitor Orientation Building to the Fish Ladder. Walk along the fish ladders and see if you can pick out the different sections.

Stop #2: Go To The Fish Viewing Building.

Go down to the lower floor of the Fish Viewing Building. The windows you are looking through give you a view into the fish ladder.

Which way are the fish moving in the ladder?

- ❑ a. against the current
- ❑ b. with the current

Where are the fish in the ladder going after they pass the dam?

- ❑ a. upriver
- ❑ b. downriver

Is the fish ladder used mostly by adult fish or juvenile fish? _____

Why do the fish in the ladder have to get past Bonneville Dam? _____

Stop #3: Look At The Fish Count.

Which fish are counted?

1._____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

7. _____

Why are the fish counted? _____

Stop #4: Look At The Migratory Patterns Exhibit.

Columbia River Chinook spend _____ or _____ years at sea.

Stop #5: Look At The Models Of The Fish.

Name five kinds of fish seen in the ladder.

1. _____ 2. _____ 3._____

4. _____ 5. _____

Use the models of the fish to help you identify the fish.

Stop #6: Go Upstairs To The Exhibit About Early Fishing.

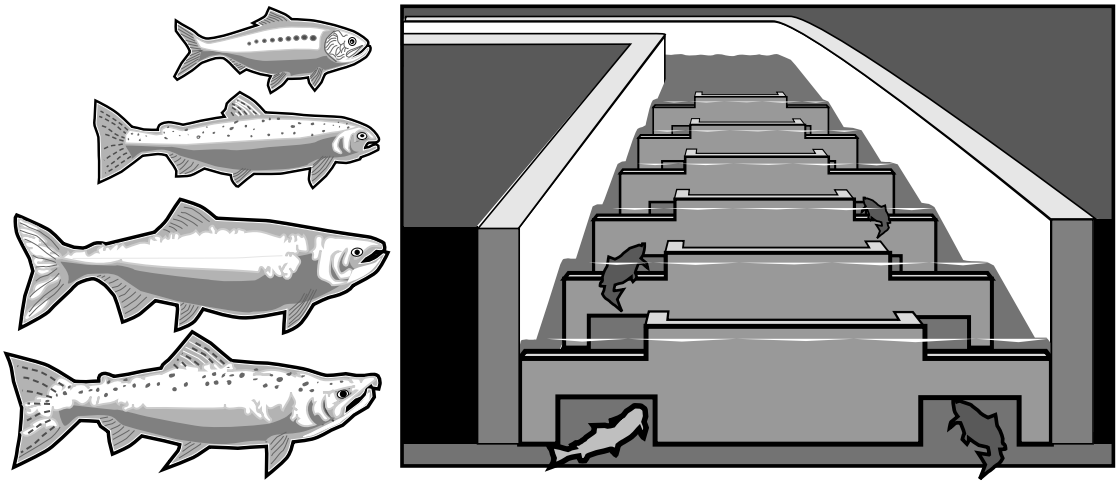
Who were the first people to fish in the Columbia River?

Bonus Question

The fish ladders are used mostly by the adult fish going upstream to spawn. Can you name two ways, other than the ladders, juvenile fish can get downstream past the dam?

1. _____ 2. _____

If you have questions about fish or fish ladders, please ask at the information desk.



A Self-guided Tour of The Fish Ladder
Visitor Orientation Building, Washington

Answers:

Use this as a guide to the fish ladder at the second powerhouse.

Stop #1: Go down the escalator in the Visitor Orientation Building to the Fish Ladder. Walk along the fish ladders and see if you can pick out the different sections.

Stop #2: Go To The Fish Viewing Building.

Go down to the lower floor of the Fish Viewing Building. The windows you are looking through give you a view into the fish ladder.

Which way are the adult fish going in the ladder?

b. against the current

Where are the fish in the ladder going after they pass the dam?

a. upriver

Is the fish ladder used mostly by adult fish or juvenile fish? **adult fish**

Why do the fish in the ladder have to get past Bonneville Dam**?**
They spawn in the same place they were reared which could be hundreds of miles past Bonneville Dam.

Stop #3: Look At The Fish Count.

Which fish are counted?

1. **chinook**
2. **coho**
3. **steelhead**
4. **chinook jack**
5. **shad**
6. **sockeye**
7. **coho jack**

Why are the fish counted? **The fish count helps set regulations, guide hatchery production and assists research.**

Stop #4: Look At The Migratory Patterns Exhibit.

Columbia River Chinook spend **one** or **six** years at sea.

Stop #5: Look At The Models Of The Fish.

Name five kinds of fish seen in the ladder.

1. **chinook salmon** 2. **coho salmon** 3. **shad**
4. **steelhead trout** 5. **sockeye salmon**

Use the models of the fish to help you identify the fish.

Stop #6: Go Upstairs To The Exhibit About Early Fishing.

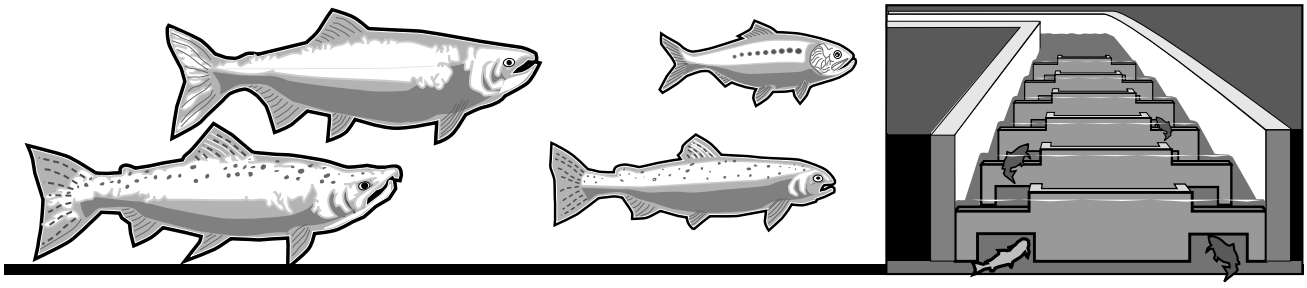
Who were the first people to fish in the Columbia River? **Native Americans**

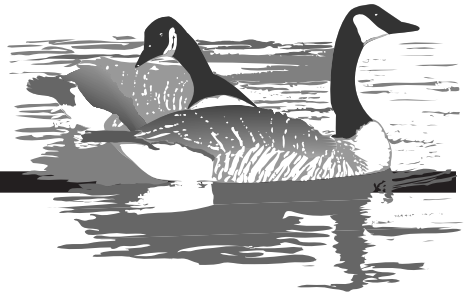
Bonus Question

The fish ladders are used mostly by the adult fish going upstream to spawn. Can you name two ways, other than the ladders, juvenile fish can get downstream past the dam?

1. **Many go over the spillway which is opened in the spring.**
2. **The fingerlings are collected at dams and hatcheries upriver then trucked and barged downriver to be released into the river just below Bonneville Dam.**

If you have questions about fish or fish ladders, please ask at the information desk.





Charting Resources

The Corps of Engineers has the job of managing, or taking care of, some of the natural resources found at the dam. While you are at Bonneville Dam, use this page to make a list of the natural resources you see.

Fill In The Chart Below:

Name of The Natural Resource	What Have People Done To It?	What Can We Do To Take Care of It?
Example: GEESE	When the dam was built and the water rose behind it, some nesting sites were flooded but other nesting sites were formed.	During nesting season we can control the water level in the river to make sure that nesting sites are not flooded.

Animal Checklist:

Animals are important natural resources. The animals listed below are often seen at or near Bonneville Dam. Put a check by each of the animals you see during your visit and write a description of what it looks like.

_____ osprey _____

_____ gull _____

_____ Canada goose _____

_____ deer _____

_____ elk _____

_____ coyote _____

_____ beaver _____

_____ squirrel _____

_____ mink _____

_____ other _____

_____ other _____

Natural Resource Management After Your Visit

The following activities are suggested for after your visit to Bonneville Dam. These are intended to reinforce what has been learned before and during your visit.

Activities

Make A Fish Mobile:

Use drawings of salmon, cardboard to reinforce them, and some sticks and string to make a hanging fish mobile. This will be a good reminder of your visit to Bonneville Dam. Sporting magazines could be a source of pictures.

Fishing For Facts:

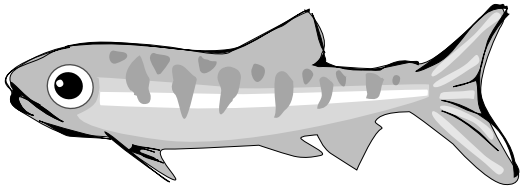
Quiz your students with the enclosed sheet labeled, "Fishing for Facts."

Managing A Resource:

This is a role playing activity designed to highlight the difficult decisions that must be made to manage a natural resource and the trade-offs that occur.

Fill In The Blanks Naturally:

This fill-in-the-blank activity will help students define "natural resource."



Fishing For Facts

Match the following by writing the number of the word in front of the correct definition.

Fishy Words		Fishy Definitions
1) Anadromous	_____	A place where people raise fish
2) Corps of Engineers	_____	A passageway around a dam for adult fish going upstream
3) Fish Bypass Channel	_____	A fish that is born in a river, migrates to the ocean, then returns to the river to spawn
4) Operation Fish Run	_____	A passageway for fish migrating downstream past a dam
5) Fish Counter	_____	Young salmon are brought past dams in barges and trucks to increase their chances of survival
6) Fish Ladder	_____	The government agency which built and operates Bonneville Dam
7) Hatchery	_____	A word for salmon reproduction
8) Spawning	_____	A person who counts fish at Bonneville Dam

True Or False

Here are some true and false questions to answer:

Small young salmon which are about as long as your finger are called fingerlings. _____

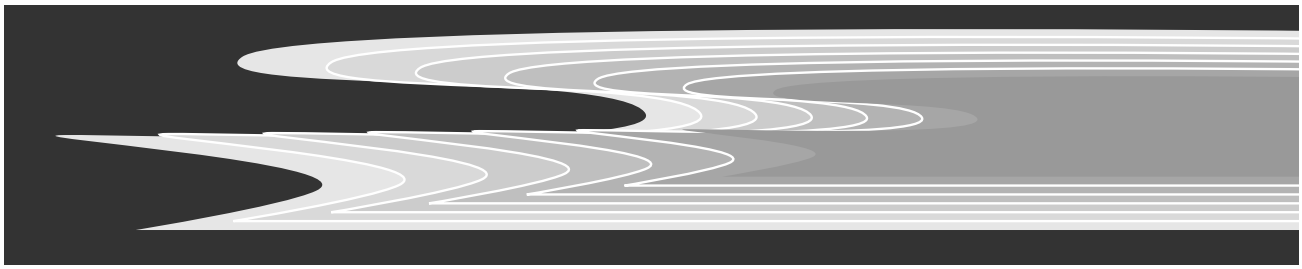
Adult salmon swimming in the river are usually going against the current. _____

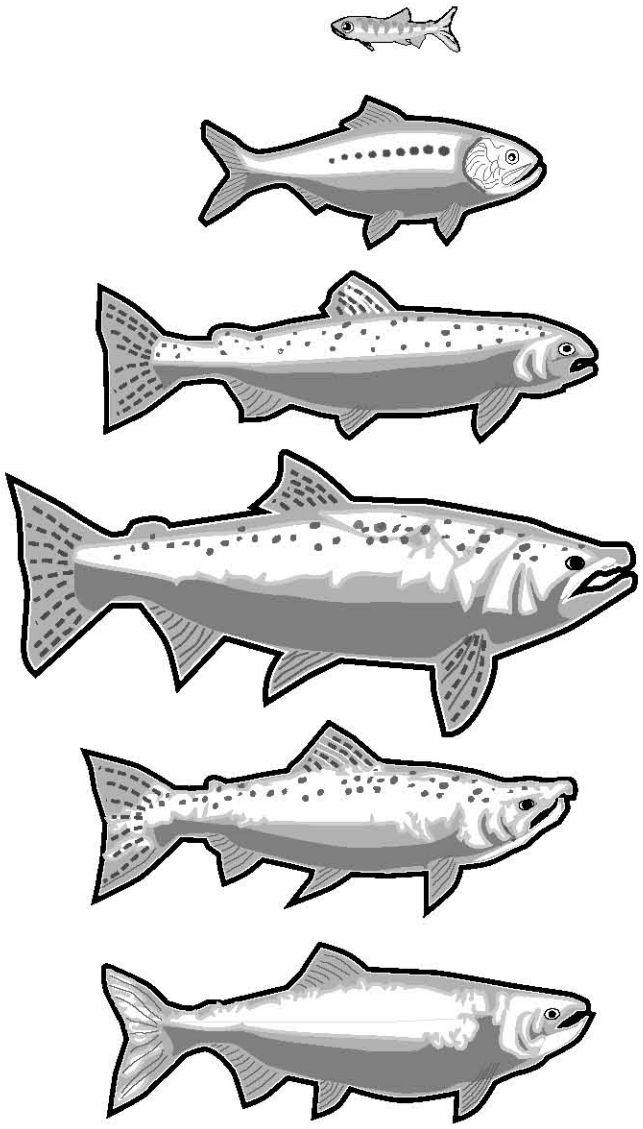
Salmon spawn two or three times. _____

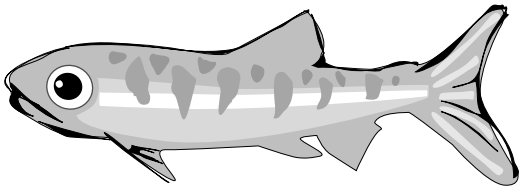
Smolts are young salmon which are migrating to the ocean. _____

Adult salmon eat a lot while swimming back up the river. _____

Salmon return to where they were hatched to reproduce (spawn). _____







Fishing For Facts

Answers: 7, 6, 1, 3, 4, 2, 8, 5

Match the following by writing the number of the word in front of the correct definition.

Fishy Words		Fishy Definitions
7) Hatchery	_____	**A place where people raise fish**
6) Fish Ladder	_____	**A passageway around a dam for adult fish going upstream**
1) Anadromous	_____	**A fish that is born in a river, migrates to the ocean, then returns to the river to spawn**
3) Fish Bypass Channel	_____	**A passageway for fish migrating downstream past a dam**
4) Operation Fish Run	_____	**Young salmon are brought past dams in barges and trucks to increase their chances of survival**
2) Corps of Engineers	_____	**The government agency which built and operates Bonneville Dam**
8) Spawning	_____	**A word for salmon reproduction**
5) Fish Counter	_____	**A person who counts fish at Bonneville Dam**

True Or False Answers

Small, young salmon which are about as long as your finger are called fingerlings. ..... **True**

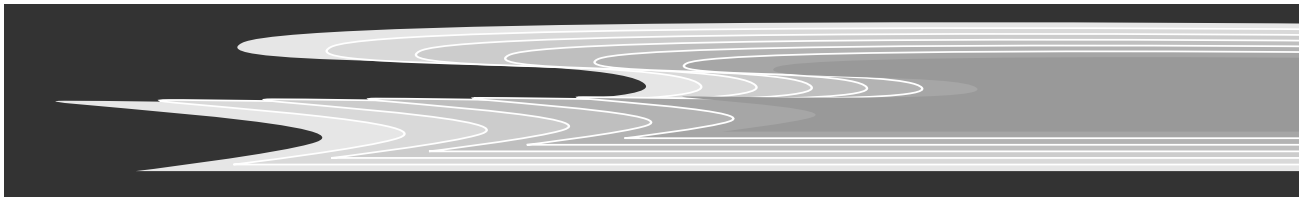
Adult salmon swimming in the river are usually going against the current. ..... **True**

Salmon spawn two or three times. ..... **False**

Smolts are young salmon which are migrating to the ocean. ..... **True**

Adult salmon eat a lot while swimming back up the river. ..... **False**

Salmon return to where they were hatched to reproduce (spawn). ..... **True**



Managing A Resource

This role playing activity will help students understand some of the problems associated with managing a resource. Select a student or group of students to represent each of the following special interest groups. The issue to be discussed is the building of a new navigation lock at Bonneville Dam.

The "Actors":

Engineer - You want to build this lock to provide efficient and safe passage of commercial and pleasure craft. You want to make it the best and least expensive possible.

The Tug Boat Owner - You want a new lock that will be the same size as the others locks upstream from the dam. The present lock is much smaller. This will make it easier and less expensive for goods to go upriver.

Historian - An important historical structure, located near the lock may have to be torn down. This building houses a gym, theater, meeting rooms and is architecturally unique. You want to save it.

Wildlife Biologist - Construction of the new lock may destroy some nesting areas for geese. You want to save these or at least have some new areas made which geese can use for nesting.

Construction Worker - You want the lock to be built so you will have a job!

Resource Manager - You want to protect all of the natural resources at Bonneville Dam. You also will be running this meeting.

Logger - You want to buy the trees which will be cut down to make room for the construction of the lock.

Get these people together to discuss protecting resources while planning the construction of the lock. The group should discuss what can be done to protect resources like the river, geese, trees, and animals in the area. One good point to make is that it is sometimes possible to damage one resource while protecting another.

Another good point is that managing resources is usually only necessary when people change the natural situation for some reason.

Fill In The Blanks Naturally

If you worked as a park ranger or natural resource manager you would have to know about protecting and managing natural resources. To give you an idea of some of the things you will have to know about, fill in the blanks below.

1. Natural resources are things found in nature that may be useful to us in some way.

   List four examples of natural resources found at or near Bonneville Dam including:

   a. two living _____ _____

   b. two non-living _____ _____

2. Give an example of how two of the above are connected and interdependent.

   _____

3. List two ways that people have changed natural resources at or near Bonneville Dam.

   _____

4. How have these changes affected other natural resources?

   _____

5. Trade-offs are decisions we make to trade the benefits of some things to gain increased benefits from others. With this in mind:

   List one trade-off made at the dam.

   _____

   For example: We trade a wild river for a series of reservoirs so that we can use water to meet a number of industrialized society's needs.

6. List one way the Corps of Engineers manages a resource.

   _____

7. List two ways you can help take care of natural resources.

   _____

8. List two jobs related to natural resources at a dam.

   _____

Fill In The Blanks Naturally

Answers:

1 Natural resources are things found in nature that may be useful to us in some way. List four examples of natural resources found at or near Bonneville Dam including:

a. two living **fish** **trees**

b. two non-living **air** **water**

2. Give an example of how two of the above are connected and interdependent.
Fish need cool water; trees need water. Trees that grow next to water help cool the water for the fish that live in it.

3. List two ways that people have changed natural resources at or near Bonneville Dam.
We have changed the river into a series of reservoirs. Most of the fish in the river are raised in hatcheries instead of the wild.

4. How have these changes affected other natural resources?
Flooding has been reduced, habitat has improved for some fish and the reservoirs provide additional food sources for the birds of prey.

5. Trade-offs are decisions we make to trade the benefits of some things to gain increased benefits from others. With this in mind:

List one trade-off made at a hydropower dam.
We trade an abundance of wild salmon for hatchery salmon so we can have electricity and other benefits associated with dams.

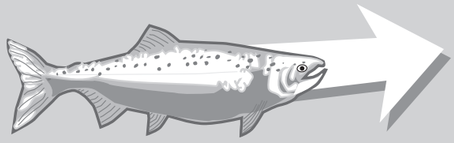
For example: We trade a wild river for a series of reservoirs so that we can use the water to meet a number of industrialized society's needs.

6. List one way the Corps of Engineers manages a resource.
The Corps builds dams so that the water resource can be used to meet a variety of society's needs.

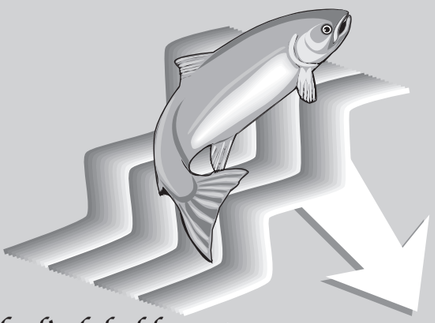
7. List two ways you can help take care of natural resources.
conserve electricity, don't litter.

8. List two jobs related to natural resources at a dam.
park ranger, fish biologist.

Salmon Life Cycle

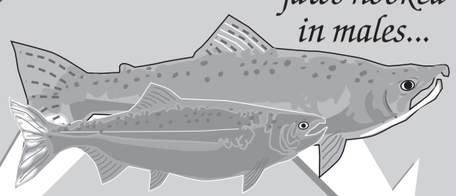


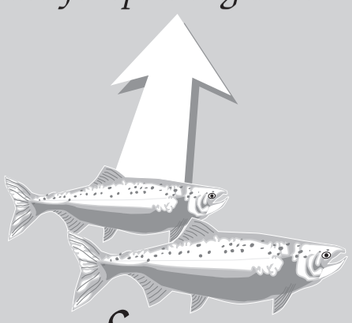
Adult fish enter the rivers headed for spawning areas...



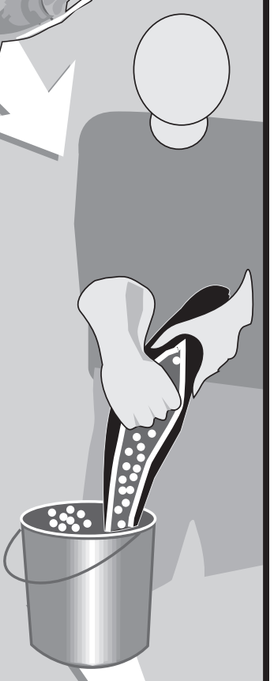
Fish climb ladders at dams heading for spawning areas...

Change in body color and form (Sockeye turn red) jaws hooked in males...

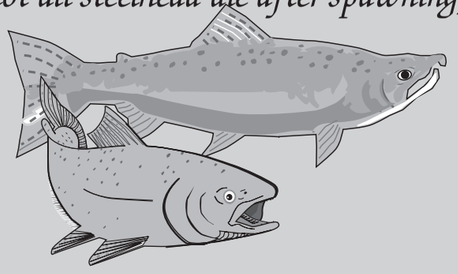




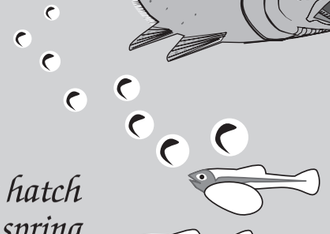
Survivors grow to maturity in ocean...



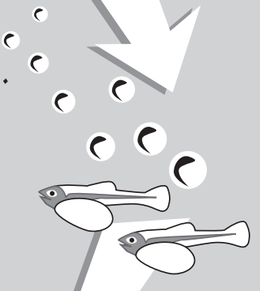
Natural Propagation... In the streams,spawning salmon deposit eggs in gravel nests and die (not all steelhead die after spawning)



Ocean harvest...

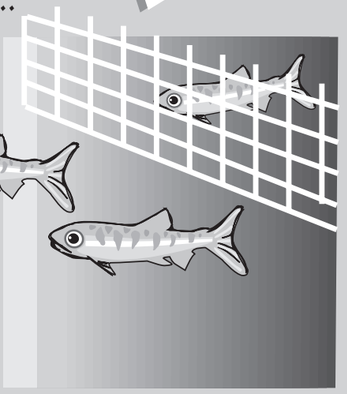


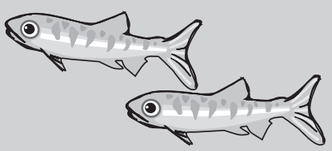
Eggs hatch in the spring and young fish rear in streams...



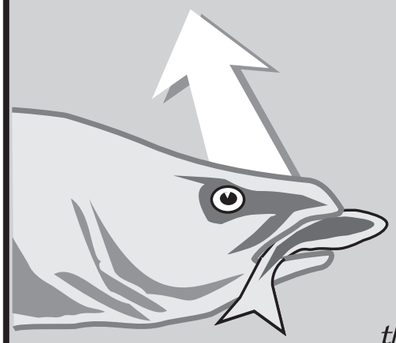
Hatchery Propagation... Fish artificially spawned in hatchery. Eggs taken from adult females and fertlized. Eggs and young are cared for in the hatchery. Smolts are released into streams...

Enter the ocean





Smolts move into the main rivers, they travel downstream through the estuary trying to avoid predators...



The Anadromous Fish Game

Spawning Stream

Ocean

Columbia River

Fish Ladder

Powerhouse

Fish Bypass Tunnel

Fish Hatchery

START

FINISH

25 — You have just spent 3 years in the ocean!

26

27

28 — Hooked by a fisherman! Lose a turn

29 — Cannot adjust to fresh water Go back to # 29

30

31

32

33 — Pollution makes it difficult to "smell" your spawning water Go back to # 33

34

35

36

37 — Confusing currents! You cannot find the fish ladder Go back to # 37

38

39

40 — You have found the ladder! Go to # 45

41

42

43

44

45

46 — Tagged by a fish biologist! Lose a turn

47 — Nearly caught in a net! Go back to # 47

48

20

19 — Cannot adjust to salt water Go back to # 17

18

21

17

22

16 — Attacked by a Gull Go back to # 13

15

14 — Spring flood Move ahead 4 spaces

13

12 — Attacked by a Northern Pike Minnow Return to # 9

11

10

9

8

7

6

5 — Fish Bypass Tunnel will take you to #10

4 — Slow currents Return to #3

3

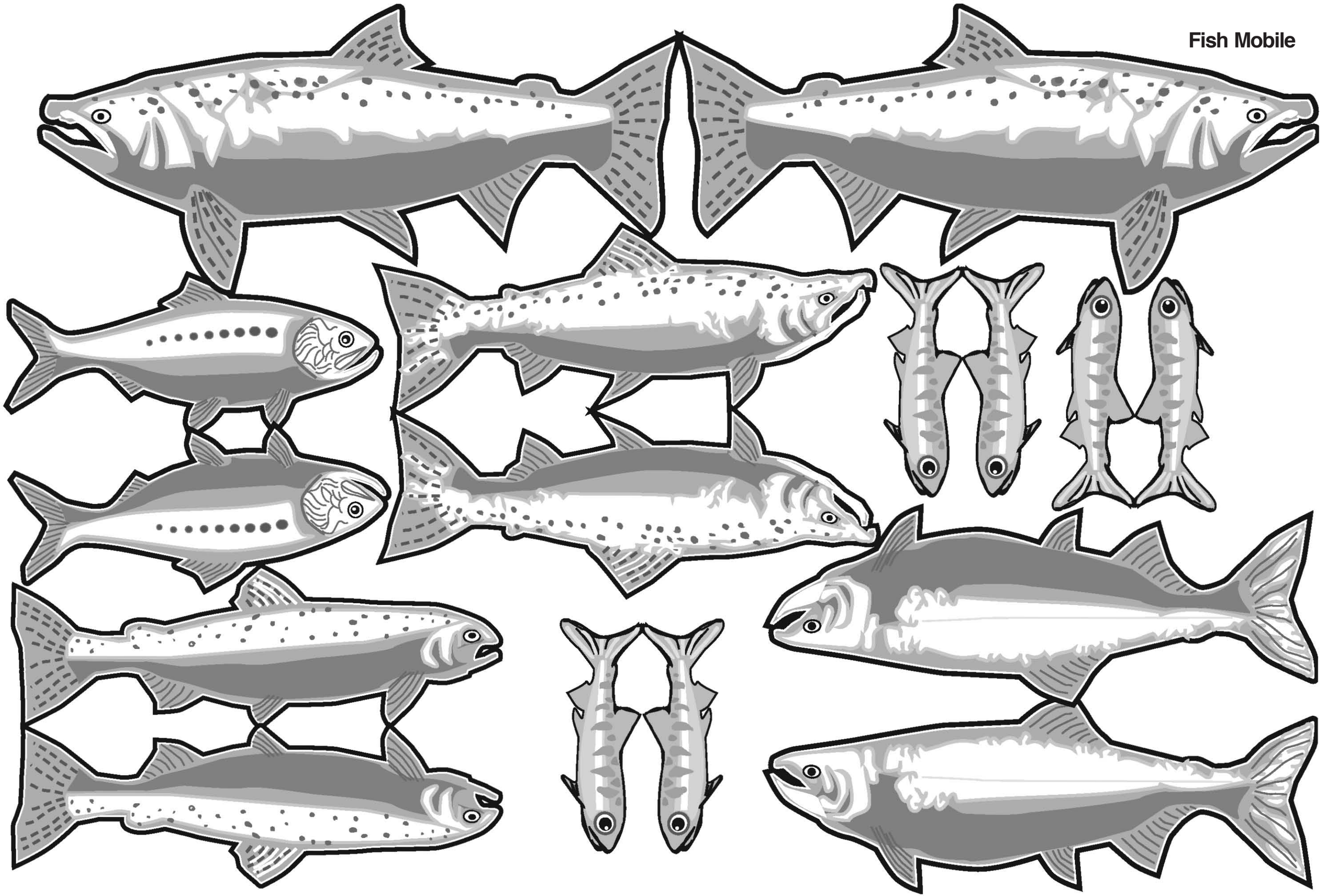
2 — Too young to migrate to sea! Lose one turn while you become a"SMOLT."

1 — Operation Fish Run gives you a ride to #9

23

24 — Migrate through the ocean. Grow to an adult salmon and go # 25

Fish Mobile



Recreation

Recreation
An Introduction

Visiting fish ladders, navigation locks, visitor centers and the fish hatchery are important recreational activities here at Bonneville Dam. Other recreational activities occurring around Bonneville Dam include fishing, boating, swimming, windsurfing and picnicking. Our goal is to make each visit and recreational activity a safe one. The purpose of this subject area is to inform your students about the recreational opportunities at Bonneville Dam and help them be safety conscious.

The first section includes activities for the classroom before your visit. Next, there are activities that can be conducted at Bonneville Dam. Finally there are activities included to reinforce what has been learned.

History Quickie

Fishing is and has been historically a major form of recreation on the Columbia River. The pioneers used to pull very large sturgeon out of the Columbia River with teams of horses. Now it is legal for sport or recreational anglers to take home only certain sized sturgeon. This is to protect the sturgeon so that future generations of people can also enjoy fishing sturgeon. Most sturgeon are ready to spawn only after growing to six or more feet in length.

Important Concepts

The activities in this section will help the students understand the following concepts. Important vocabulary words are in bold print.

The word **recreation** means the act of refreshing one's self. **The Army Corps of Engineers** has responded to public demand and provided recreation sites at Bonneville Dam and the surrounding area. You can fish, water-ski, camp, hike, windsurf and sight-see at or near Bonneville Dam.

The visitor center was built to provide people with a **recreation opportunity** and to help the public understand what the Army Corps of Engineers does. The visitor center provides the public with **interpretive services**. **Interpretation** is a way of teaching or informing the **public** while making the learning fun. At the visitor center you can learn about the history of the **Columbia River Gorge**, about how electricity is produced, or about the fish in the river.

Rangers are the people who take care of recreation sites. Their job is to answer any questions visitors might have, save a drowning person, give a visitor a citation for littering, or they might be called to put out a fire or help a heart attack victim. Sometimes they just end up picking up litter or fixing things damaged by **vandalism**.

You as a visitor can help the rangers by practicing **safety** and **consideration**. When boating in the Columbia River remember to wear a **P.F.D. (personal flotation device)**. They come in

many varieties including: **life jackets, rings** or cushions. Use your **seatbelt** while in your vehicle. Remember to check the **fishing regulations** before going fishing. Always carry a **first aid kit** when out on an **excursion**. Remember to put litter in its place. When you see someone violating the rules of safe and considerate conduct, please let a ranger know so a bad situation can be stopped before it becomes worse.

Why is recreation important? Why does it lead the participant to a sense of **fulfillment**, of improved mental and physical health? You might discuss this with your students and get their feelings on the subject. We hope when you come to Bonneville Dam you will have a good experience which will leave you and your students with an **appreciation** for the recreational opportunities and natural resources here. We hope this appreciation will help build a sense of **stewardship** toward all **natural resources**.

Recreation
Before Your Visit

The following activities will introduce your students to the recreation opportunities available at Bonneville Dam and along the Columbia River. The emphasis is on safety and learning to be considerate of other people who might be recreating at the same place and time or who might recreate there in the future.

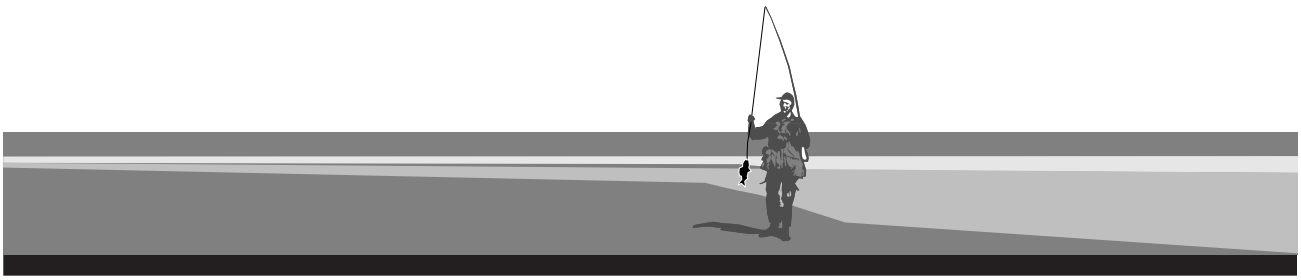
Activities

Recreation Scramble:

This activity involves the students in unscrambling phrases related to recreation. The answers are on the page following the activity. You will want to make a copy of the sheet for each student.

Saving Sam:

One of the recreation opportunities available in the Columbia River is swimming. This activity will have the students think about how to be safe while swimming and what can be done in an emergency involving a drowning person. If your students are not familiar with first aid techniques emphasize knowing where a phone is to call for help, knowing what number to call, (such as 911), and finding a ranger if an accident occurs. Also, students should never jump in the water themselves to save someone drowning. It could mean two or more people drown instead of one. (The American Red Cross will teach first aid classes to children age 13 and above.)



Recreation Scramble

Recreation means to do something which provides relaxation and enjoyment. We want you to enjoy yourself when you come to Bonneville Dam. We also want you to have a safe visit.

Here are some enjoyable things you can do at Bonneville Dam. Circle your favorites!

See the powerhouse

Look at the fish swimming in the fish ladder

See a film

Look at a boat going through the lock

Visit the big sturgeon at the fish hatchery

Have a picnic

Go fishing

Here are some other things which some people do at Bonneville Dam. Unscramble the phrases and think about whether or not you would like to do that activity and the effects of your choice.

1 wear a life jacket (P.F.D. personal flotation device) or
orwdn fi rouy taob nikss

_____

2 keep your dogs on a leash ***or***
etl oyru ogd nur onruda dan therbo lopepe nda milsana

_____

3 wear your seatbelt in your car in case of an accident ***or***
etg jeinurd ni a rac cednatic

_____

4 carry your litter to a trash can ***or***
veha a epinei ni a tidelret akrp

_____

5 keep the volume of your radio low enough so it doesn't bother anyone else ***or***
veha ot sentil ot emsoneo lesse' ODUL sueim

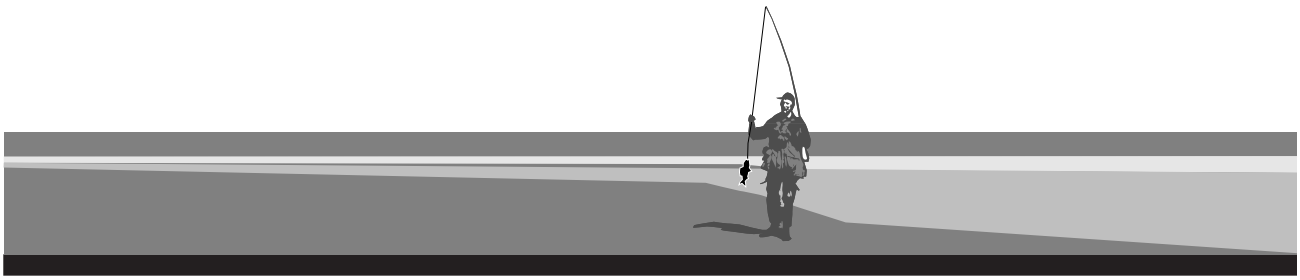
_____

6 have a restroom to use when you need one ***or***
nfid a rerosotm sod lee aeubsee fo dislamanv

_____

7 have beautiful old trees to have a picnic under ***or***
yrosedt etres yb virgane uroy tilasini ni meht

_____



Recreation Scramble

Answers:

Here are some other things which some people do at Bonneville Dam. Unscramble the phrases and think about whether or not you would like to do that activity and the effects of your choice.

1 wear a life jacket (P.F.D. personal flotation device) ***or***
drown if your boat sinks

2 keep your dogs on a leash ***or***
let your dog run around and bother people and animals

3 wear your seatbelt in your car in case of an accident ***or***
get injured in a car accident

4 carry your litter to a trash can ***or***
have a picnic in a littered park

5 keep the volume of your radio low enough so it doesn't bother anyone else ***or***
have to listen to someone else's LOUD music

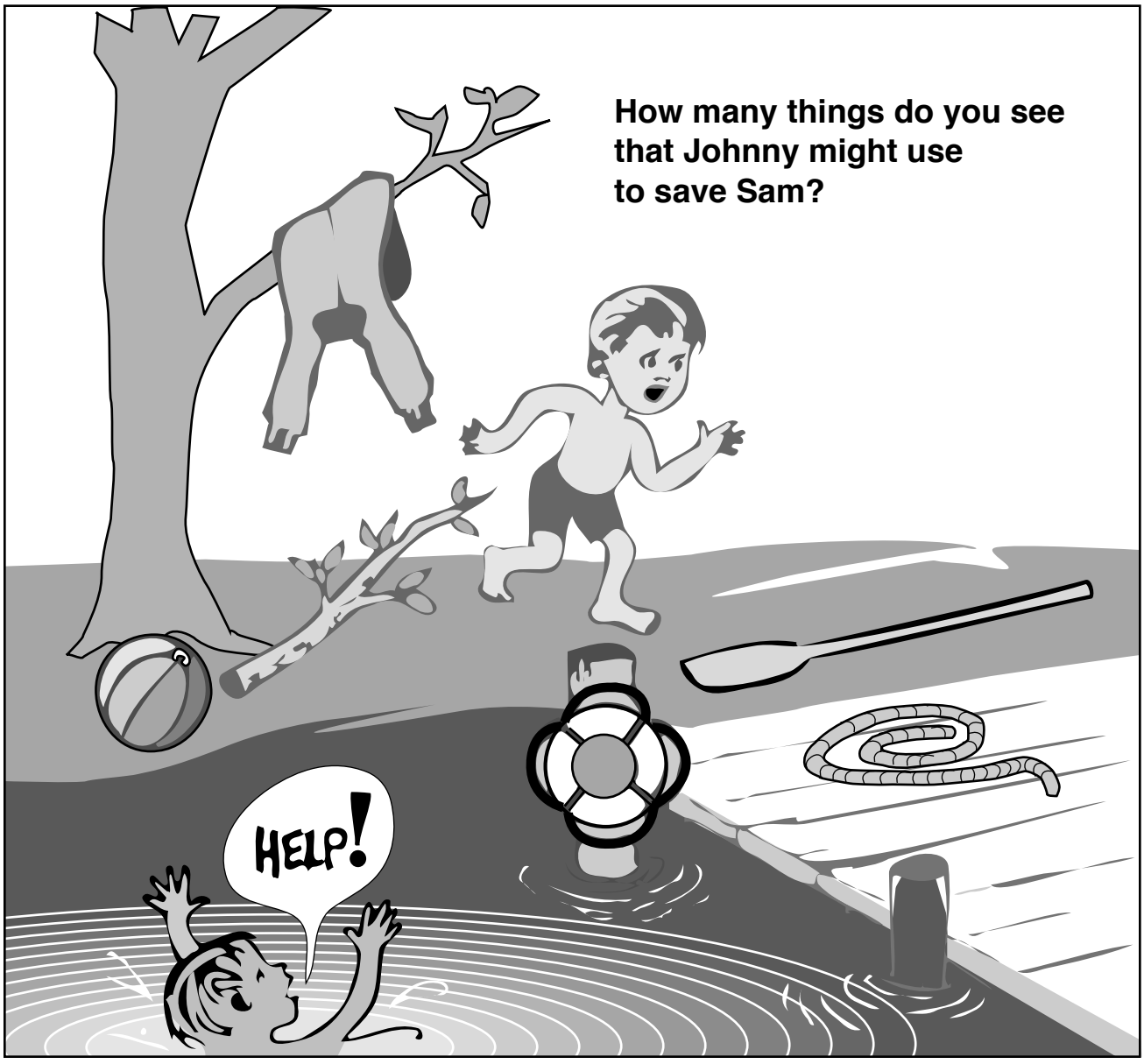
6 have a restroom to use when you need one ***or***
find a restroom closed because of vandalism

7 have beautiful old trees to have a picnic under ***or***
destroy trees by carving your initials in them

SAVING SAM

How will you save Sam?

Write a story telling what you will use to save Sam and what you will do when you get him out of the water. Be sure to include in your story what things you have done to be sure you have a safe swim.



Recreation

During Your Visit

The following activities will help your students record the great diversity of recreational activities available to them at Bonneville Dam and emphasize how to enjoy the recreation safely and considerately. While at Bonneville Dam, have your students practice these concepts.

Activities

On Your Way To The Dam:

As you travel to the dam, some of your students can keep a list of all of the recreational activities they see. When you return to the classroom, you could lead a discussion of how building a dam on a river can change the type of recreational opportunities.

Have A Nice Time:

This activity will allow the students to record some of the recreational behavior they see while at Bonneville Dam. You might discuss the activities they see. What could have been done more safely or with more consideration for others and why. Why is recreation important? They will need pencils and a copy each of the activity.

Recreation In Pantomime:

This activity should be conducted in a large area. It will give the students a chance to act out correct and incorrect recreational behavior.

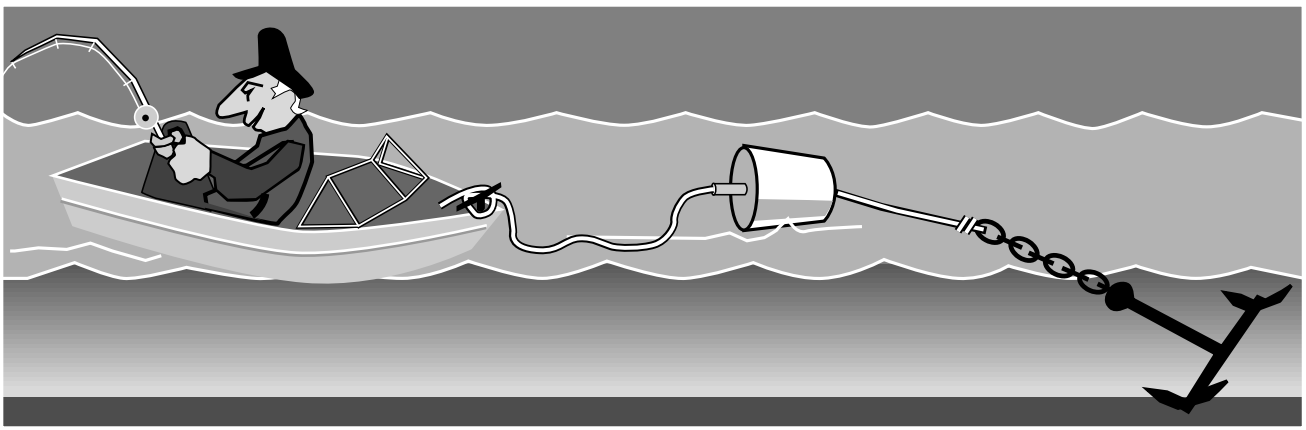
Have A Nice Time

Recreation means to do something that provides relaxation and enjoyment. We want you to have a good time at Bonneville Dam.

Make a list of all of the recreation possibilities at (or near) Bonneville Dam. Write these beside the numbers in the column labeled "recreation".

In the columns labeled "safety hazards?" and "safe solutions!", write any hazards and ways of avoiding these hazards. See how many you can find!

	Recreation	Safety Hazards?	Safe Solutions!
1.	fishing	hooking someone in the eye while casting your line	look behind you before casting
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____
7.	_____	_____	_____
8.	_____	_____	_____



Recreation In Pantomime

This game requires a lot of space. Find a large grassy area to conduct this activity. It can be played with partners or teams. One or a couple of team members are designated the pantomimists. These people are given the situation to pantomime for the others. The others have to guess what the person is pantomiming. The first team to guess what is being pantomimed, gets a point. If they can tell everyone what an appropriate solution to the situation might be, they can gain another point. The team with the most points at the end of the game wins.

Pantomimists change each situation so that all the students get a chance to pantomime and guess.

Situations

A person getting into a car without putting on a seatbelt. They crash and are thrown headlong out the front window.

A person going water-skiing without a life jacket or P.F.D.

A person going boating without having first checked to be sure everything is in good working order.

A person going hiking without a water bottle and finding no water on the trail.

A person carving their name into a tree or picnic table.

A person with some unleashed dogs in a busy public area.

A person or people littering a swimming area and one stepping on a piece of broken glass.

A person or people going camping and realizing they have forgotten a flashlight.

A person riding a bike without wearing a helmet or having a first-aid kit in their backpack.

A person trying to get into a restroom and finding it has been locked due to vandalism.

Make up a few situations for the students to pantomime or have them make up some situations.

Recreation
After Your Visit

These activities will not only reinforce the recreation concepts learned previously, but will also give the students an idea of what the people who work to provide these recreational opportunities do.

Activities

Ask A Ranger:

Rangers are available to answer the public's questions. This activity has the students match the question with the rangers response

Hidden Ranger Words:

This word search activity will show what rangers do and how to identify them.

Ask A Ranger

This is your chance to pretend you are a ranger at a Corps of Engineers project. As a ranger, you will be asked many questions by people who come to recreate. Match the questions listed in the first column by writing the number of the question in front of the answers in the second column. There is only one answer for each question.

	Recreation Questions		**Ranger's Responses**
1	What are some things rangers do here?	_____	One of the Corps many responsibilities is providing for safe recreation.
2	Why was a visitor center built at this dam?	_____	Another name for a life vest.
3	What is a personal flotation device (P.F.D.)?	_____	Keep your dog on a leash and keep your stereo turned down low.
4	What are the most common accidents that occur here and how can we prevent them?	_____	Almost anywhere! Especially in the visitor center and fish hatchery.
5	How can I show consideration for others when I recreate?	_____	We answer questions and tell why the area is special.
6	What are two good ways to help this camp ground stay clean?	_____	Swimming, boating, hiking, wildlife watching, picnicking, and fishing!
7	Where can we have fun here?	_____	Pick up litter and clean up after your pets.
8	What are some of the things that we can do around here?	_____	We answer questions and help you in emergencies.
9	What is a park interpreter or a park guide?	_____	To tell the public what we are doing.
10	Why does the Corps of Engineers let us recreate here?	_____	Car accidents and boating accidents are serious problems. You can help by wearing your seatbelt and your P.F.D.

Ask A Ranger

Answers

Recreation Questions		Ranger's Responses	
1	What are some things rangers do here?	10	One of the Corps many responsibilities is providing for safe recreation.
2	Why was a visitor center built at this dam?	3	Another name for a life vest.
3	What is a personal flotation device (P.F.D.)?	5	Keep your dog on a leash and keep your stereo turned down low.
4	What are the most common accidents that occur here and how can we prevent them?	7	Almost anywhere! Especially in the visitor center and fish hatchery.
5	How can I show consideration for others when I recreate?	9	We answer questions and tell why the area is special.
6	What are two good ways to help this camp ground stay clean?	8	Swimming, boating, hiking, wildlife watching, picnicking, and fishing!
7	Where can we have fun here?	6	Pick up litter and clean up after your pets.
8	What are some of the things that we can do around here?	1	We answer questions and help you in emergencies.
9	What is a park interpreter or a park guide?	2	To tell the public what we are doing.
10	Why does the Corps of Engineers let us recreate here?	4	Car accidents and boating accidents are serious problems. You can help by wearing your seatbelt and your P.F.D.

Hidden Ranger Words

Here's a "word search" activity that tells you some of the activities rangers at Bonneville Dam do during the day. GOOD LUCK! If you find all the words, a secret message will be left behind.

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

The **BOLD** words below are hidden in the puzzle above. See if you can find them. They can be found up, down or backwards, but not diagonally. Some letters are used more than once. The words that go together in the sentences below won't necessarily be found together in the puzzle. Once you have found the words, black them out. The remaining letters will spell out a special message.

This is all about the **ARMY CORPS OF ENGINEERS PARK RANGERS**. You will see them around the project as they go about their duties. They are the ones in the uniform with the white shoulder patch, gold **BADGE**, flat **HAT**, and usually carrying a two-way **RADIO.**

One **DUTY** of theirs is to provide for the **PROTECTION** of the **ENVIRONMENT**. This

includes the **FOREST** and the **WILDLIFE**, as well as the **WATER** and the **FISH.** Each of these is a natural **RESOURCE**. The rangers are also responsible for the **SAFETY** of the **PUBLIC**. This requires that they be able to operate the **FIRE** engine and a water **TANKER**, and to use a **PATROL CAR**. They must be able to **PILOT** a **RESCUE BOAT**, and be able to call an **AMBULANCE**. They must know how to give **FIRST AID** or any other kind of **HELP** necessary. This includes being able to **INFORM** the visitors of places to go **CAMPING**, boating or many other forms of **RECREATION**.

The rangers are also involved in **INTERPRETATION** of the project. They may be called upon to give **WALKS**, **TALKS**, and **SHOW FILMS**. They would be happy to arrange a special **TOUR** upon request. All in all, the rangers are kept busy, but they like it that way.

Hidden Ranger Words

Answers

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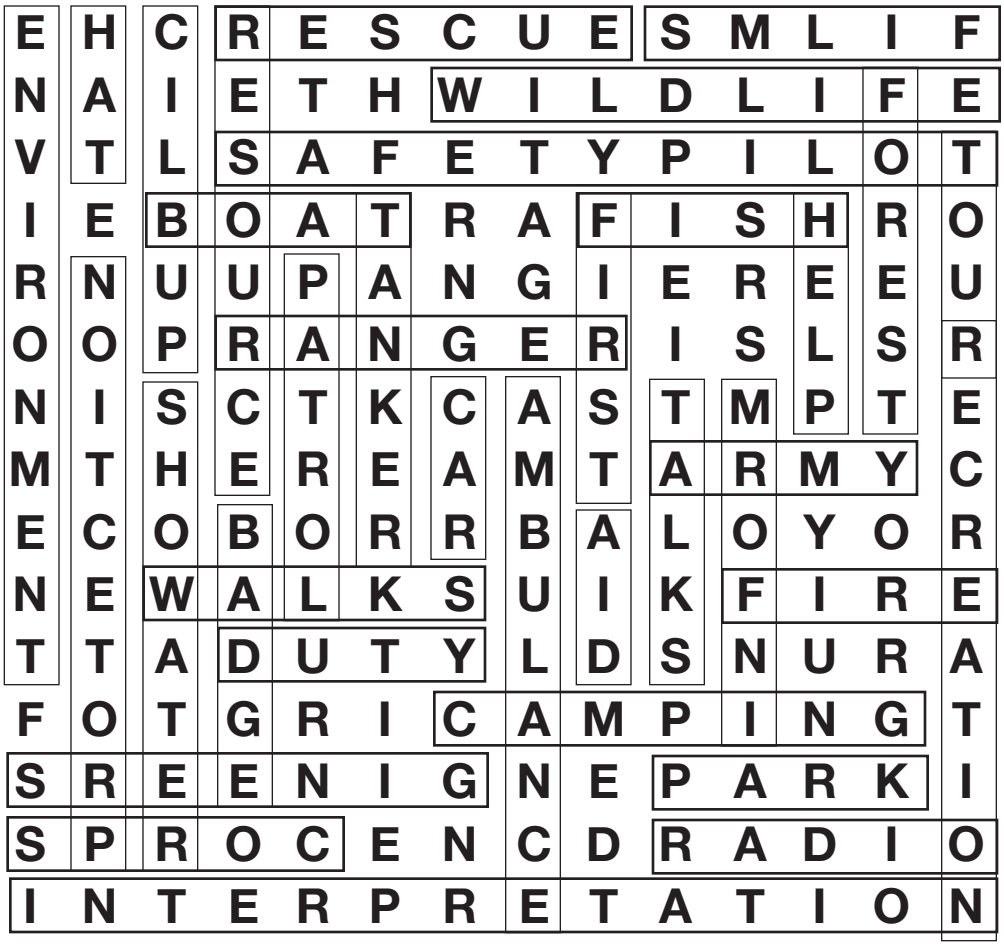

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