Lesson 9
Salmon and Hydropower

Overview

In Investigation 4.1 students examined the negative impact that dams on the Columbia River and its tributaries have had on the native salmon and steelhead runs of the Columbia Basin. Investigation 4.3 helped students develop an understanding of the historical and present day importance of salmon to the Native American stakeholders. After experiencing these lessons students may come to the conclusion that dams are bad, and may ask the question "Why do we need dams?" Lesson 5 addressed the "Why dams?" question, helping students understand the many benefits that those living in the Columbia River Basin enjoy because of the 400+ dams in the region. At the conclusion of Lesson 5 students may very well be asking yet another question, "Can there be dams on the rivers of the Columbia Basin and healthy salmon runs too?" Lesson 8 gives students the chance to see how the Chelan County Public Utility District, Chelan County Natural Resources Department, and many other agencies and individuals have worked to demonstrate that there can indeed be dams and healthy salmon and steelhead populations in the Columbia Basin. Students view two DVD selections highlighting stakeholder efforts that are being undertaken, and have been completed to reestablish healthy salmon and steelhead runs. Students discuss these projects and read to learn more about the Columbia River.

- Students view the DVD selections Power and Fish, and Salmon Recovery: Getting It Done.
- Students discuss stakeholder efforts to reestablish healthy salmon and steelhead runs and brainstorm ways that they can help in these efforts.
- Students read to learn about the Columbia River.

Disciplinary Core Ideas

Social Studies

Economics 2.4.1 Understands how geography, natural resources, climate, and available labor contribute to the sustainability of the economy of regions of Washington State.

- Explains how dams impact the economic well-being of regions of Washington State

Science

- 4-ESS3-2 Generate and compare multiple solutions to reduce the impacts of natural Earth Processes on humans
- 4-ESS3-! Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

Scientific and Engineering Practices

Constructing explanations (for science) and designing solutions (for engineering)

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design

Crosscutting Concepts

Cause and Effect relationships are routinely identified, tested and used to explain change.

Student Learning Targets

I can relate information about salmon restoration projects by participating in class discussions.

I can describe at least three ways that stakeholders are working to restore healthy salmon runs in the Columbia Basin.

I can increase the information in my list of things I know about the Columbia River.

Teacher Background Information

Lesson 5 introduces students to numerous salmon restoration projects including the Chelan County PUD's 112 million dollar fish bypass system.

Chelan County Public Utility District – Fish Bypass System

Academic Vocabulary

Fish Bypass: a system to move young salmon and steelhead quickly and safely past a dam.

Juvenile fish: a young fish that is not yet an adult.

Migration: to pass from one region to another.

Oxbow: a U shaped bend in a river.

Riparian zone: the habitat situated on the banks of a river or body of water.

Habitat : the place that is natural for the life and growth of an organism.

Culvert : a drain or covered channel (like a large pipe) that crosses under a road, railway, etc.

Runoff : the water from melted snow and ice and rain that drains down a watershed.

An innovative juvenile fish bypass system helps move young salmon and steelhead quickly and safely past the Rocky Reach Hydro Project.

The bypass includes two main parts. The first is a collector system which relies on 29 large pumps to create a strong current, appealing to the natural instincts of the young fish to attract them to a collector in the dam's forebay.

Once the fish are in the collector, water moves them into the second part of the system -- a steel tube up to 9 feet in diameter. The tube passes through the dam and extends 4,600 feet around the back side of the powerhouse, across the face of the spillway and about one-third mile down the east side of the Columbia River before the fish are returned to the river. The entire trip will take young fish about six to eight minutes.

Construction of the permanent system was carefully planned so that all work in the river would be done between fish migrations. Some of the large components of the collector system, including the pump house, were built at a peninsula upriver from the dam during the summer, and then floated into place once salmon migrations were finished.

In addition to making the down-river trip easier for juvenile salmon and steelhead, the bypass system will also reduce the need to spill water over the dam. That water can then be used to generate electricity more than offsetting the $107 million cost of the bypass.

Bypass system background

Starting in 1985, the PUD developed laboratory models and tested prototype fish bypass *systems for intercepting and moving juvenile fish around Rocky Reach as* they travel downriver to the ocean. Screens were designed to steer young salmon and steelhead away from the turbines and into a bypass channel. None of the prototype screening systems tested achieved the results experienced at other Columbia River hydro projects. So a new approach was taken in 1995 -- a surface bypass and collection system that appeals to the young fish's natural instinct to migrate downriver near the surface, following the water flow. This differs from conventional turbine intake screens, which require fish to dive into the turbine intakes before they are intercepted by the screens. Also, after the prototype surface collector was added in 1995, the fish guidance effectiveness improved for the screen systems left in two units to enhance interim protection. Because of the

improvement in the screens' performance, they have been incorporated into the final design of the fish bypass system.

Sonar studies determined that fish generally travel in the upper 60 feet of the river. The prototype was designed to use natural and turbine-induced surface currents in the upper 60 feet of the flow to give fish an alternative to diving into the turbine intakes -- entering the bypass system instead. Attractive features of this concept include the minimal volume of flow that's lost, minimizing power losses, as well as the relatively low installation cost.

Flows through the bypass pipe were occasionally diverted to an evaluation facility, where the juvenile fish were examined to identify species and condition. A 24-hour videotaping system counted the number of fish using the bypass system.

To measure the collector's effectiveness in moving fish, a few of the young salmon and steelhead were implanted with electronic tags and released upstream of the hydro project during the spring and summer testing period. The movements of other test fish outfitted with acoustic tags were monitored as they moved through the forebay to determine how they reacted to the surface collector. These studies allowed biologists to view 3-dimensional movement of fish in the forebay as they approached the fish bypass system and dam. This technique was used for this reason first at Rocky Reach.

The prototype surface collection system was modified each year, based upon test results from the previous year. Increased flows into and through the collector, plus improvements to the diversion screen/gatewell collection system in certain units, provided very encouraging study results in 1997. A second entrance was added to the surface collector in 1998, but results in attracting fish were not as good as anticipated. So in 1999, the second entrance to the surface collector was modified to allow biologists to vary the entrance width from a minimum of 22 feet to a maximum of 44 feet. This allowed biologists to analyze how water flows affected, and which water flows were better at attracting fish.

By 2000 and 2001, the District, in coordination with the fisheries agencies and native American Tribes determined that the configuration of the fish bypass system had been tested satisfactorily and that installation of a permanent system was warranted.

The current system was installed in 7 months between fall 2002 and the beginning of the 2003 migration of juvenile salmon towards the ocean.

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Chelan County Natural Resources

The Chelan County Natural Resources coordinates a diverse and expansive menu of salmon restoration projects. See their website for a description of these efforts. http://www.co.chelan.wa.us/nr/default.asp

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Materials

For each student

1 science notebook

For every two students

1 Voyage to the Pacific student reader pp. 12-17

For the class

DVD player
River of Power DVD selection Power and Fish
DVD Salmon Recovery: Getting It Done 11:35 Minutes

Preparation

1. Preview the River of Power DVD Power and Fish, and make sure that a DVD player is available for use.
2. Preview the DVD Salmon Recovery: Getting It Done

Procedure

1. Review with students that in Lesson 4 the class examined how dams have had a dramatic effect on the native salmon and steelhead runs, as well as to greatly affect the lifeway of the Native American peoples of the Columbia Basin. In Lesson 5 the class discussed the question "Why dams?"

2. Ask students to list some of the benefits of dams that the stakeholders of the Columbia River Basin enjoy.

3. Tell students that, after looking at both how dams negatively impact salmon runs, and the benefits that dams provide to the stakeholders of our region students might want to ask another question, "Can there be dams and healthy salmon runs too?" Let students know that this is the question that we will be seeking to answer in today's lesson.

4. Introduce the student learning targets for Lesson 8 and check for understanding.

5. To review, ask students to respond to the following discussion questions.

- In the past, what are some of the ways that dams have had a negative effect on the salmon runs?

Student answers may include: dams prevent adults from reaching

spawning streams, smolt are diverted into irrigation canals and ditches, smolt can be caught in poorly designed fish screens, smolt may be killed as they pass through turbines, etc.

6. Ask students to turn to a partner and discuss possible solutions to these problems. After a few minutes ask student volunteers to share their thinking.

7. Ask students to take out their science notebook and head a new page with the title Salmon Recovery Projects. As students view the two DVD selections featuring salmon recovery projects, students should list the different ways that stakeholders are working together to restore healthy salmon runs.

8. Show the DVD Power and Fish

9. At the conclusion of the DVD ask students the following questions.

- What is one way that the Chelan County Public Utility District is helping to make sure that salmon smolt make it safely from the streams of the Columbia Basin to the Pacific Ocean? (construction of the fish bypass system)

- How much did the fish bypass system at Rocky Reach Dam cost? (112 million dollars)

10. Tell students that as they watch the next DVD selection they will learn about many other ways that stakeholders are working together to help restore salmon runs. They should add to the list they started in their science notebook.

11. Show the DVD Salmon Recovery: Getting It Done

12. At the conclusion of the DVD ask students to work with their table to list as many different ways that they can remember that stakeholders are working to restore salmon habitat. They should add these to their list in their science notebook.

13. Ask student pairs to share with the class their list of ways that stakeholders are working to help the salmon.

14. Ask students to discuss with their table group the following question.

    - Can you think of ways that students could get involved in helping the salmon recovery?

Final Activities

1. Read Voyage to the Pacific pages 12-17 From Lake Roosevelt to the Grand Coulee, and Paddling a Desert River.

2. Revisit student learning targets for Lesson 1 and use a formative assessment classroom technique to check for student understanding.

Where have all the Salmon Gone?

The following animals and plants all live in the area near the riparian ecosystem.

Animals		Plants	
black bear	hawks	aspen	oak
salmon	eagles	willow	poison oak
turtles	willow flycatcher	elderberry	snowberry

Johnny enjoys watching the various animals throughout the year. He really likes the salmon because he often fishes for them in the summer. One day Johnny began to wonder what would happen if there were no longer any salmon in the river.

He came up with the following ideas:

A. The bears and eagles depend on the salmon for food and would all die.

B. Bears and eagles all depend on the salmon for food. If the salmon were not there, some of the animals may not be able to live there anymore.

C. Even though the bears and eagles depend on the salmon for food, they would just find something else to eat, and stay in the area.

Which idea do you think best describes what might happen if the salmon in the riparian area disappear?

Explain your thinking through words or pictures.

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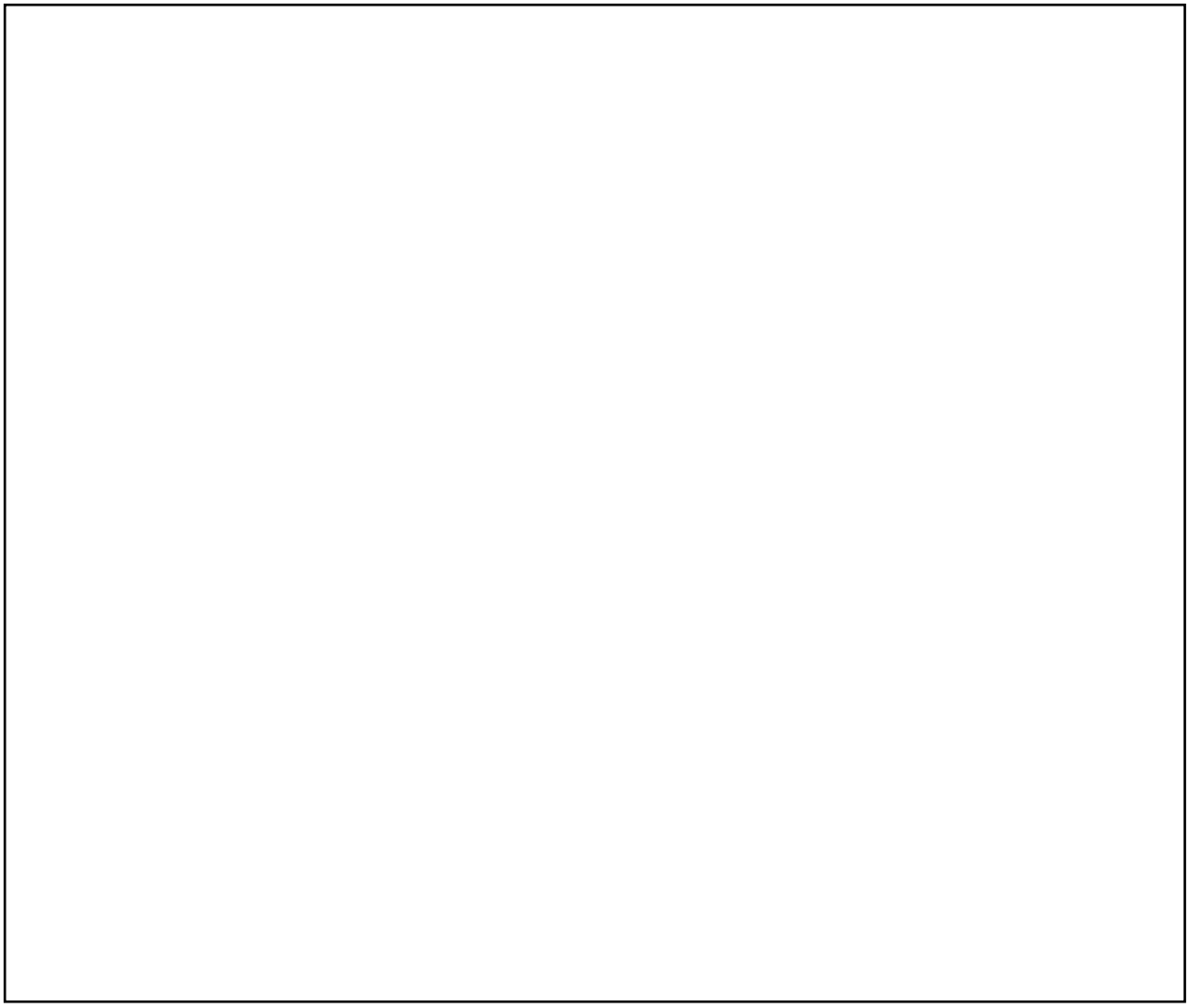

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Johnny also noticed that there was construction in the riparian area. Trees were being cut down and removed from the riparian area. The affect was that the water was becoming become murky. (dirty) He wondered what would happen to the salmon if the water was dirty and became warmer.

Johnny knows that salmon require certain things for survival. These include the following:

- Clear water
- Clean water
- Cool water (trees are needed)
- Consistent water (depth)

What harms salmon	Effect on Salmon

Riparian Habitat images from Google images
What affect does each picture have on the riparian ecosystem?

snowberry


hemlock tree

red tailed hawk

Riparian Habitat

A riparian habitat is an area characterized by vegetation areas along bodies of freshwater including streams, lakes and rivers. Many bird species depend on the riparian ecosystem for nesting, stop over sites during migration and places to live during the winter. Healthy riparian systems that support bird habitats also support other wildlife, including fish. Habitat loss and pollution are important factors in declining bird and fish populations.

Ways that people can improve riparian ecosystem:

1. Plant native riparian plants in clusters to promote use of the habitats for more wildlife.
2. Keep dead trees in the area as nesting sites and food sources.
3. Eliminate, reduce, or closely manage grazing, during spring and breeding seasons to maximize the understory.
4. Maintain or restore riparian understory by planting native plants.
5. Remove non-native plants to protect native plants from over population of the invasive plants.

Habitat Restoration (Getting it Done - Salmon DVD)

- Plant native trees
- Clean water
- Restore Oxbows
- Create fish friendly structures
- Connect waterways for fish to return to spawning grounds
- Restore riparian zones
- Connect tributaries

Need for Fish Ladders

Dams fragment aquatic ecosystems and affect fish populations such as stealhead, chinook, and lake sturgeon because they cut off migration patterns to spawning grounds.

Each fish ladder design will not accommodate all species. Trout and salmon have the ability to have a burst of speed so they can swim in fast moving water. When designing a fishway you need to understand characteristics of the fish.

Flows, energy dissipation, resting areas, drops between pools, and space in the pools all need to be considered.

Washington Department of fish and wildlife: Salmon Rescue Activity Book
http://www.critfc.org/wp-content/uploads/2012/11/activity_book.pdf

Salmon Coloring Book
http://www.fws.gov/pacific/publications/salmnbk.pdf