

LESSON TITLE: Helping and Harming: Human Impact on Salmon Populations

GRADE LEVEL: 8-10

TIME ALLOTMENT: Two or three 45-minute class periods

OVERVIEW: In this lesson, students use segments from *Nature: Salmon: Running the Gauntlet* to explore ways in which humans have impacted salmon populations. In the Introductory Activity, students explore different ways in which human actions have helped and hindered salmon populations, including efforts to artificially produce and raise salmon. In Learning Activity 1, students learn about challenges salmon face after being released from hatcheries into the wild, as well as efforts that humans are taking to restore streams and salmon runs. In Learning Activity 2, students explore issues surrounding dams and conduct research on specific dams in the US northwest. In the Culminating Activity, students review information presented in the lesson and debate the merits of human efforts to save salmon. Students write a critical essay about human impact on salmon and propose ideas for future actions. Students discuss their projects with the class.

SUBJECT MATTER: Science

Learning Objectives:

Students will be able to:

- Describe why humans are artificially producing salmon and then releasing them into the wild.
- Discuss at least four actions that humans have taken that have impacted salmon populations. Describe positive and/or negative impacts these actions have had on salmon.
- Describe the role of hatcheries.
- Describe obstacles salmon face in nature.
- Explain the issues surrounding dams and how dams impact salmon populations.
- Provide details about one specific dam and issues surrounding it.
- Describe efforts that humans are taking to restore streams and salmon runs.

STANDARDS

National Science Education Standards

www.nap.edu/openbook.php?record_id=4962

Grades 9-12:

Content Standard C: Life Science

Fundamental concepts and principles that underlie this standard include:

- **Biological Evolution**

- Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of

offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.

- The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.
- Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.

- **The Interdependence of Organisms**

- Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
- Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
- Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

- **The Behavior Of Organisms**

- Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.
- Like other aspects of an organism's biology, behaviors have evolved through natural selection. Behaviors often have an adaptive logic when viewed in terms of evolutionary principles.

Content Standard E: Science and Technology

Fundamental concepts and principles that underlie this standard include:

- **Understandings about Science and Technology**

- Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.
- Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

- Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems. Technology, by its nature, has a more direct effect on society than science because its purpose is to solve human problems, help humans adapt, and fulfill human aspirations. Technological solutions may create new problems. Science, by its nature, answers questions that may or may not directly influence humans. Sometimes scientific advances challenge people's beliefs and practical explanations concerning various aspects of the world.

Content Standard F: Science in Personal and Social Perspectives and Technology

Fundamental concepts and principles that underlie this standard include:

- **Natural Resources**
 - Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.
 - The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.
 - Humans use many natural systems as resources. Natural systems have the capacity to reuse waste, but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.
- **Science and Technology in Local, National, and Global Challenges**
 - Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land use—which decreases space available to other species—and pollution—which changes the chemical composition of air, soil, and water.

MEDIA COMPONENTS

Nature: Salmon/Running the Gauntlet, selected segments

- Producing Salmon
A look at how humans are producing salmon in an effort to protect the species.
- Humans and Salmon
An overview of how humans have impacted salmon populations for more than 150 years.
- Salmon's Journey
An overview of salmon's journey after being released from the hatcheries into the wild.
- Restoring Streams

A look at efforts to remove dams and restore streams and salmon runs.

Websites:

- **Bonneville Lock and Dam**

www.nwp.usace.army.mil/locations/bonneville.asp

This page on the US Army Corps of Engineers, Portland District website provides information about the Bonneville Lock and Dam and includes links to Bonneville Dam Fish Ladder Camera Views at the Oregon Shore and Washington Shore Counting Stations, featuring live images, updated every few seconds, of fish passing through the counting windows.

- **Dam Breaching and the Lower Snake River Dams**

<http://efw.bpa.gov/integratedFWP/DamBreachingFacts.pdf>

This fact sheet, created by the Bonneville Power Administration, provides information about the estimated costs and impact of breaching (removing the earthen portion of) the four Lower Snake River Dams.

- **Hatcheries and Dams of the Pacific Northwest**

www.pbs.org/wnet/nature/episodes/salmon-running-the-gauntlet/hatcheries-and-dams-of-the-pacific-northwest-map/6561/

This page on the *Nature* website features a map of major hatcheries and dams in the Pacific Northwest, as well as the approximate spawning grounds for each salmon species.

- **Large Dams in the Western United States**

www2.kenyon.edu/projects/Dams/index.html

This website provides information about the positive and negative effects of dams and specifically highlights the Glen Canyon Dam on the Colorado River and the Bonneville Dam on the Columbia River.

- **Save Our Wild Salmon**

www.wildsalmon.org

This website provides information about maintaining and restoring wild salmon populations. The following pages could be used in this lesson:

- *Myths and Facts about Lower Snake River Dam Removal*

www.wildsalmon.org/images/stories/sos/PDFs/Fact_Sheets/mythsfacts.sm.pdf

- *Why remove the 4 Lower Snake River Dams?*

www.wildsalmon.org/index.php?option=com_content&view=article&id=348&Itemid=63

- **Snake River Dam Operation**

<http://earthjustice.org/features/snake-river-dam-operation>

This website provides information about the Snake River Dams.

- **The Dam Challenge** (*Optional*)

www.pbs.org/wgbh/buildingbig/dam/challenge/index.html

This online activity, which is used in the optional activity in Learning Activity 2, challenges users to consider different scenarios where dams exist and to choose whether to repair the dam, keep the dam as is or remove it.

MATERIALS

For the class:

- Computers with internet access.
- Computer, projection screen and speakers (for class viewing of online/downloaded video segments).

PREP FOR TEACHERS

Prior to teaching this lesson, you will need to:

Preview all of the video segments and websites used in the lesson.

Download the video clips used in the lesson to your classroom computer(s) or prepare to watch them using your classroom's internet connection.

Bookmark any websites that you plan to use in the lesson on each computer in your classroom. Using a social bookmarking tool such as del.icio.us or diigo (or an online bookmarking utility such as portaportal) will allow you to organize all the links in a central location.

INTRODUCTORY ACTIVITY:

1. Let students know they will be learning about salmon and how humans have impacted salmon populations in positive and negative ways. Ask students to think about ways humans could positively impact salmon populations. (*Removing dams, implementing policies to protect salmon populations, etc.*) Ask students to brainstorm ways humans might negatively impact salmon populations. (*Possible answers: Fishing, building dams, etc.*)
2. Explain that students will learn about a variety of efforts that humans have undertaken which have directly impacted salmon populations. Provide students with the following items and ask them to categorize their overall impact on salmon populations as either positive, negative, mixed (both positive and negative) or not sure:
 - catching and killing salmon to retrieve their eggs
 - climate change
 - building dams
 - destroying dams

- creating fish ladders at dams
 - fishing
 - straightening rivers
 - adding rocks and logs to streams
 - pollution
 - using artificial means to help salmon reproduce and grow
 - taking salmon out of the water to transport them on a boat or truck
 - releasing salmon into the sea after raising them in hatcheries
3. Ask students to discuss the potential impact of each of the items listed above.
 4. Let students know they will now be viewing a video segment from ***Nature: Salmon: Running the Gauntlet*** about different ways humans are trying to help salmon populations. As students view the segment, ask them to write down what humans are doing to protect salmon populations.
 5. Play Producing Salmon. After showing the segment, ask students to discuss the efforts that humans are now taking to protect salmon populations. *[Fisheries biologists carefully control salmon reproduction. They remove eggs from the female salmon, fertilize them with milt (white liquid containing sperm) extracted from the male salmon and incubate the eggs in plastic bags and PVC pipes. They then release the salmon a year later into the river and ocean. Fish hatcheries throughout the Pacific Northwest incubate all 6 species of salmon until they are released. They release more than 100 million salmon each year into the Columbia River and its tributaries.]*
 6. Ask students to describe why humans have decided to produce salmon. *(The number of salmon has dramatically decreased and salmon are on “the brink of extinction.” From 1985 to 2007, an average of 18 sockeye returned to Idaho each year.)*
 7. Ask students to discuss their initial thoughts about the practice of removing salmon from the water to produce salmon.
 8. Let students know that you will now be showing a video segment which highlights the impact that humans have had on salmon populations for more than 150 years. As students view the segment, ask them to write down at least five different actions that humans have taken and how those actions have impacted salmon.
 9. Play Humans and Salmon. After showing the segment, ask student to discuss actions that humans have taken and the impact of those actions on salmon.
Possible points to discuss:
 - *Innovations in canning led to increases in the number of salmon caught during annual salmon catch and the subsequent overharvesting of salmon and decrease of salmon populations.*

- *Hatcheries were created to control reproduction and help salmon survive. Salmon in hatcheries have a much greater survival rate than salmon in nature.*
- *Humans straightened, diverted and impounded rivers and built dams. More than 400 dams now control the Columbia River and its tributaries. Some dams were built with fish ladders to enable fish to pass. Other dams, like Idaho's Hell's Canyon dams and the Grand Coulee, do not enable salmon to pass and, consequently, prevent salmon from reaching spawning grounds and reduce salmon runs.*
- *By blocking salmon from entering a stream, salmon are no longer using the adaptations they developed to survive in that stream.*
- *The natural productivity of the Columbia watershed has been replaced by more than 170 hatchery programs. Through the process of rearing fish in a controlled environment over the course of generations, the genetic diversity of salmon is lost through interbreeding and/or selection in the hatcheries.*
- *Human takeover of salmon reproduction has left salmon more vulnerable to changing conditions in their environment.*

LEARNING ACTIVITY 1

1. Explain that after salmon are released from hatcheries they still face many challenges on their journey to the sea. Let students know they will now be watching a video segment which highlights the obstacles salmon face. As students watch the segment, ask them to record at least five obstacles/threats salmon face after being released from hatcheries.
2. Play Salmon's Journey. After showing the segment, ask students to share some threats/obstacles salmons face on their journey to the sea.
Possible points to discuss:
 - *Accustomed to being fed at the surface of the water in the hatcheries, salmon that continue to swim near the surface when released into the wild are more vulnerable to becoming prey to other species.*
 - *Dams cause salmon to alter their route and swim downstream.*
 - *Idaho salmon face eight dams on their journey to the sea, which causes a strain on the species. A significant percentage of juvenile salmon die at each dam. Some salmon get swept into turbines.*
 - *Pikeminnow thrive in warm slow water between dams and feed on salmon.*
3. Ask students to describe how humans are trying to help salmon with their journey. (*Scientists remove salmon from the water, transport them down the river for 130 miles on a barge or a truck and then release them back into the water.*)
4. Explain that the next video segment highlights other efforts to help salmon. Ask students to observe steps that are being taken to help salmon.

5. Play Restoring Streams. After showing the video segment, ask students to describe steps being taken to help salmon.
Possible items to include:
 - *Removal of dams.*
 - *Restoring streams to a more natural state, by adding curves, pools and rocks to the river and woody structure along the banks.*
 - *Spilling water from the reservoirs of dams and allowing water to flow (as done in the spring of 2008 at the Columbia and Snake River dams).*
6. Ask students to discuss how the destruction of dams and restoration of streams impact salmon populations and streams.
 - *When streams are restored, salmon runs recover. An increase in salmon populations enhances the health of the streams.*
 - *It is estimated that as a result of destroying the Savage Rapids dam, the salmon steelhead population will increase by about 20%.*
 - *In summer 2010 more than 1300 Sockeye returned to the creek below Redfish Lake. This was the highest number of returning salmon since the dams were built.*
7. Ask students to describe efforts that humans could take to be less disruptive to salmon. (*Find new ways to generate electricity, water fields and transport materials.*)

LEARNING ACTIVITY 2

1. Explain that students will now have an opportunity to explore the issues surrounding dams and how they impact natural ecosystems and human communities. Ask students to work in small groups to conduct research on one particular dam and the issues surrounding the construction, maintenance and removal of that dam. Here are some possible dams that students can research:
 - The Lower Snake River Dams (Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, Lower Granite Dam)
 - Bonneville Lock and Dam
 - Glen Canyon Dam*Note: See the “websites” section at the beginning of the lesson for suggested sites with information about these dams.*
2. Ask students to research the following:
 - The location of the dam and why it was constructed.
 - The impact of the dam (on the natural ecosystem, on the local human community, etc.)
 - Issues surrounding this dam. (Reasons for keeping the dam, modifying the dam and/or removing the dam. Details about major changes that have been made to the dam over the years.)

- Current status (If the dam has been removed, describe the impact of the removal, if known.)
 - Additional facts about the dam.
3. Ask each group to present its findings to the class.
 4. *Optional Activity:* Play “The Dam Challenge”:
www.pbs.org/wgbh/buildingbig/dam/challenge/index.html
This online activity challenges users to consider different scenarios where dams exist and to choose whether to repair the dam, keep the dam as is or remove it.

CULMINATING ACTIVITY

1. Lead a discussion about how human actions have impacted salmon populations. Ask students to review the list they compiled at the beginning of the lesson and to add more items to the list, if desired.
2. Ask students to debate which actions have a positive impact, which have a negative impact and which have both positive & negative impacts on salmon populations. Ask students to re-categorize each item, as needed, and to explain their reasoning. (If students are not sure of the overall impact of an action, they can group that item in the “not sure” category.)
3. Ask students to write a critical essay about human impact on salmon. Ask students to write an opinion piece about next steps that should be taken and their potential impact on salmon and people. Encourage students to use specific examples to support their arguments.

Possible essay topics:

- Although humans have the technological ability to produce and raise salmon in hatcheries, do you feel that this practice should be continued or not? Explain your rationale.
 - Describe the impact that humans have had on the genetic diversity of salmon populations. Discuss possible ways to preserve their genetic diversity.
 - Describe positive and negative ways humans have impacted salmon populations in the Pacific Northwest. Propose a course of action that could have a positive long-term impact on salmon populations.
4. Conclude the lesson by having students discuss their essays with the class.