

Hooks and Ladders

Curriculum Objective

To teach students to recognize that some fish migrate as part of their life cycle and how to identify the stages of the life cycle of one kind of fish. To teach students about the limiting factors affecting Pacific salmon as they complete their life cycle, particularly about hazards that salmon must face when they are migrating upstream to spawn. To provide an opportunity for students to simulate the Pacific salmon and the hazards the fish faces in a fun activity that portrays the life cycle of these aquatic creatures. To teach students about the survival-mortality ratio of the salmon.

Washington State Essential Academic Learning Requirements (EALRs)

Science: 1.1 (basis of biological diversity BM 1,2 & 3)

Science: 1.2 (structure and organization of living systems BM 1,2&3)

Science: 1.3 (life processes and the flow of matter and energy BM 1& 2, biological evolution BM 1,2&3, interdependence of life BM 1,2 & 3, environmental and resource issues BM 1,2 & 3)

Science: 3.2: (careers and occupations using science, mathematics and technology BM 1&2)

Health & Fitness:1.2 (safely participates in a variety of developmentally appropriate physical activities BM 1&2)

Links: [trout and salmon spawning spawning gravel suitability| water quality](#) | [salmon life cycle](#) | [salmon facts](#)|



Course Description Prework

This course provides a comprehensive look at the spawning requirements of salmon in the Pacific Northwest to students as they simulate the migration journey to the ocean and back by the Pacific Salmon.

The instructor first leads the students in a discussion about fish migration by first asking them what they know about the life cycle of fish that live in their area. The students are asked if they know of any local fish that migrate to spawn. If yes, which ones? The students list and discuss the types of obstacles met by the Pacific salmon as it migrates as part of its life cycle to the ocean and back to a local stream to spawn.

This activity is about the hazards that salmon must face when they are migrating upstream to spawn. The students will be more prepared for this activity if they understand the meaning of fish migration and spawning. Before the activity, students should be able to:

- list, describe and illustrate the major stages in a Pacific salmon's life cycle:
 - Alevins hatch in the spring.
 - Fry emerge from the gravel.
 - Smots migrate downstream.
 - Enter the Pacific Ocean.
 - And grow to maturity in the ocean.
 - Silvery fish enter the rivers and head for the spawning areas.
 - Change in form and color as they advance.
 - In the fall spawning salmon deposit eggs in gravel nests and die.

- list and describe some of the factors that affect salmon as they complete their life cycle. Explore ways that dams can be modified to let fish safely pass downstream and upstream. Design a perfect fish ladder.
- identify and describe some limiting factors that might affect other animal populations.

Activity

Students enact the migration of a salmon on a 60x100' playing field that includes two stream passages (one upstream and one downstream) running lengthwise of the field between the spawning grounds and the open ocean. The downstream passage includes a dam turbine and predators. The upstream passage includes a fish ladder and waterfall.

The students are then assigned roles. Some will be salmon, others will be potential hazards to the salmon:

- Choose two students to be the turbine team. These are the ones who operate the jump rope which represents the turbines in hydroelectric

dams. Later in the simulation, when all the salmon have passed the turbine going down stream, these students move to the upstream side to become the waterfall-broad jump monitors.

- Choose two students to be predatory wildlife. At the start of the simulation, the predators will be below the turbines where they catch salmon headed downstream. Later in the activity when all the salmon are in the sea, these same two predators will patrol the area above the "broad jump" waterfalls. There, they will feed on salmon just before they enter the spawning ground.
- Choose two students to be humans in fishing boats catching salmon in the open ocean. These students in the fishing boats must keep one foot in a cardboard box to reduce their speed and maneuverability.
- All remaining students are salmon.

The activity begins at the spawning ground where the salmon start their journey downstream. The first major hazard is the turbines at the dam. At most dams, there are escape weirs to guide migrating salmon past the turbines. The student salmon cannot go around the jump rope swingers, but they can slip under the swingers' arms if they do not get touched while doing so. A salmon dies if it is hit by the turbine (jump rope). The turbine operators may change the speed at which they swing the jump rope.

NOTE: Any salmon that dies at any time in this activity immediately becomes part of the fish ladder. The student is no longer a fish, but becomes part of the physical structure of the human-made ladders now used by migrating salmon to get past barriers such as dams. The students who are the fish ladder kneel on the ground with a body-wide space between them.

Once past the turbines, the salmon must get past some predatory wildlife. The predators below the turbine must catch the salmon with both hands -- tagging is not enough. Dead salmon are escorted by the predator to become part of the fish ladder, which gets the predators and fishing boats off the field regularly, helping to provide a more realistic survival ratio.

Once in the open ocean, the salmon can be caught by fishing boats. The salmon must move back and forth across the ocean area in order to gather four tokens. Each token represents one year of growth. Once each fish has four tokens (four years' growth), that fish can begin migration upstream. The year tokens can only be picked up one token at a time on each crossing. Remember, the salmon must cross the entire open ocean area to get a token. The "four years" these trips take make the salmon more vulnerable and thus they are more readily caught by the fishing boats.

Once four of the year tokens are gathered, the salmon can begin upstream. The salmon must walk through the entire pattern of the fish ladder. This enforced trip through the fish ladder gives the students a hint of how restricting and tedious the upstream journey can be. In the fish ladder, predators may not harm the salmon.

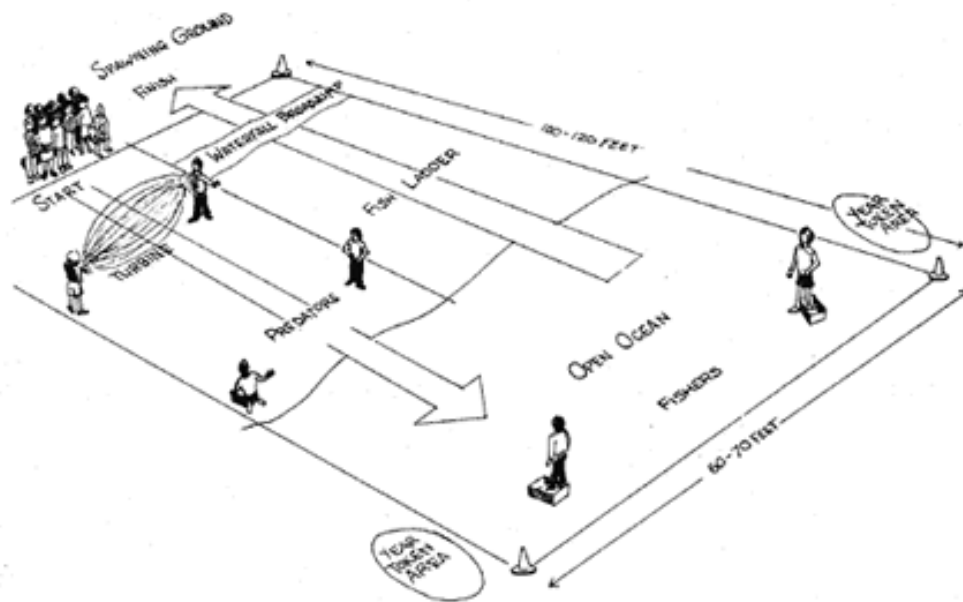
Once through the ladder, the salmon faces the broad jump waterfall. The waterfall represents one of the natural barriers the salmon must face going

upstream. Be sure the jumping distance is challenging but realistic. The two former turbine students will monitor the jump. The salmon must jump the entire breath of the waterfall to be able to continue. If the salmon fails to make the jump, then it must return to the bottom of the fish ladder and come through again.

Above the falls, the two predators who started the simulation as the predators below the turbines are now the last set of limiting factors faced by the salmon. They represent bears -- one example of predatory wildlife. Again, remember that the predators must catch the salmon with both hands. If they do catch a salmon, they must then take the student they caught to become part of the structure of the fish ladder.

The activity ends when all the salmon are gone before the spawning ground is reached or when all surviving salmon reach the spawning ground. The students then discuss the activity and summarize what they have learned (the roles of predatory wildlife, barriers and people fishing, where the losses were the greatest/least and what the consequences would be if all the eggs deposited made the journey successfully).

Field Layout:



Classroom Activity

Have students cut out pictures of sand, gravel, or rock to depict the substrate, or stream bottoms preferred by salmon for spawning.

(NOTE: salmon and trout require clean, un-silted gravel beds for spawning and egg incubation. All streams naturally carry silt and other sediments suspended in the water, but too much silt can cover up gravel beds and reduce spawning habitat. When the spaces between the gravel are plugged with sediments, oxygen rich water can not flow past eggs incubating in the gravel and the eggs will suffocate and die)

Research and illustrate the life cycle of any local fish. If possible, look for one that migrates. Compare how the life cycle of a Pacific salmon is similar and different to the life cycle of one or more local fish.

Salmon Life Cycle: Spawning

When a female salmon arrives at her home stream, she chooses a nesting site with just the right combination of clean gravel, adequate depth, and good flow to provide oxygen for her eggs. She digs her nest by rolling onto her side and pumping her tail against the gravel. Stones are dislodged and carried downstream by the current. Every so often, she checks the depth of the nest by "crouching": lowering herself into the nest and inserting her anal fin into the spaces between the stones.



Males fight for access to nest-building females. The dominant male courts the female by quivering and crossing over her back.



When she is ready to lay, he moves alongside her and together they release eggs and milt. At the last moment subordinate males rush in and may manage to fertilize some of the eggs. The eggs settle into the spaces between the stones. The nest is covered with loose gravel as the female builds another nest upstream. Both male and female soon die after spawning, but females will defend the nest until they are too weak to do so.



Challenges to Spawning

- People can disrupt courtship behavior or frighten spawning salmon from their nests if they approach too closely
- Drought and water diversions lower water levels, making nests vulnerable to freezing in winter.
- Erosion, following clearcutting or fires, smothers nests with silt.
- Floods can sweep eggs out of gravel.
- Fish and birds eat salmon eggs.
- If good spawning habitat is scarce, females may dig up each others' nests.
- Clear-cutting along streams raises water temperatures and reduces oxygen in water - eggs suffocate.
- By controlling and diverting water, human activity interferes with natural cycles of flushing and gravel deposition that create new spawning habitat.

From the U.S. Fish and Wildlife Service brochure: Salmon of the Pacific Coast

Illustrations © 1994 by Shari Erickson

Background Information

Source of Lesson Plan: Project WILD Aquatic Education activity Guide, pp. 76-81. copyright 1987, 1992 Western Regional Environmental Education Council, Inc. Reprinted with permission from Project Wild.

Many fish live part of their lives in one habitat and then migrate to another habitat. Some make their migratory journeys to mature and reproduce. Pacific salmon are an example of one of the most spectacular of the migrating species. Pacific salmon are destined to spawn only once in their lifetime. Within their genetic fiber is an encoded instinct that drives them from the time of hatching along a monumental journey from their freshwater spawning beds downstream into the sea. Once in the sea, they spend several years reaching the maturity needed for their single return journey to their original hatching ground. Once there, the salmon spawn and die.

Salmon must face a myriad of hazards that serve as limiting factors in the completion of their life cycle. Limiting factors are factors that reduce the populations of living organisms. Sometimes the limiting factors are natural and sometimes they result from human intervention with natural systems.

The female Pacific salmon deposits 1,500 to 7,000 eggs in her freshwater spawn. The eggs are deposited in a shallow gravel depression scooped out by the female. Once deposited, the eggs are fertilized by the male and then both fish nudge the gravel back over the eggs to offer as much protection as possible. Within a few days both the male and female salmon have completed their reproduction and soon die.

The eggs, before and after hatching, are susceptible to many limiting factors. Smothering silt can be washed in suddenly from watersheds damaged by a variety of land-use practices and events -- including erosion following some road building, logging, and fires. Predators can eat some of the eggs and damage hatching populations. Dropping water levels can isolate salmon offspring in streamside depressions where they will die. After hatching, the small fish -- called "alevins" -- spend their first two weeks hiding in the gravel. Gradually they absorb their yolk sac and become known as "fry." If they survive the first two weeks, they then begin their journeys. Some head directly to the sea. Depending on the species, young salmon may spend several months to as much as a year or more in the river before migrating to the estuary and then to the open ocean.

The small ocean-bound salmon, now called "smolts," are at once confronted by hazards on their downstream journey. Examples are dams; low water in streams; and predatory birds, mammals and larger fish. Up to 90 percent of the salmon that hatch never reach the sea.

Spawning is the process of fish reproduction. The male fish produces milt, or sperm, which fertilizes the female eggs, rich are deposited in the substrate, or bottom, of bodies of water. Some fish such as salmon, are born in fresh water, make a journey to the ocean and live there 1-4 years, and return to the place where they were born to spawn. Other fish, such as trout, migrate up and down the freshwater system. Although salmon used to be plentiful in northeastern Washington, dams have blocked their ability to return to the streams in this area, so they no longer exist here. However, water quality and quantity here in northeastern Washington affect salmon since the water flows downstream toward the ocean.

Pictures



Materials

- One jump rope (10-15 feet long)
- Traffic cones for marking boundaries
- Two cardboard boxes
- 100 tokens (poker chips)
- One large playing area (100 feet x 50 feet)

[back to top](#)