Activity 16: Hooks and Ladders
- Aquatic WILD-

Age:

Grades 3-9

Time:

30-60 minutes

State Essential Learning Requirements

Mathematics: 1.1, all of 3, 5.2

Communication: 1.1, 1.2, 2.5, All of 3.

Science: 1.2,

Geography: 2.4, 3.1, 3.2

Arts: 4.1

Materials provided:

Aquatic WILD Activity provided: Trunk contains 14 foot jump rope, and 4 boundary flags.

Description:

Students simulate Pacific salmon and the hazards faced by salmon in an activity portraying their life cycle. Students role play salmon, predators, fishing boats and turbines of dams.

Objectives:

- To predict the challenges for salmon in your watershed based on the "Hooks and Ladders" WILD activity.

Critical Questions Addressed:

2. Endangered

Washington Adaptation

Extensions:

For your watershed discuss what salmon challenges are represented in the outdoor simulation

- Predators
- Barriers:
  - Hydropower
  - Culverts
- Habitat:
- Harvesting Groups
  - Treaty
  - Non-Treaty
  - Commercial
- Water Quality
- Life Cycle
- Provide a summary on the health of your watershed for salmon based on what you know about the challenges described above.

HOOKS AND LADDERS

OBJECTIVES

Students will: 1) recognize that some fish migrate as part of their life cycle; 2) identify the stages of the life cycle of one kind of fish; 3) describe limiting factors affecting Pacific salmon as they complete their life cycle; and 4) generalize that limiting factors affect all populations of animals.

METHOD

Students simulate Pacific salmon and the hazards faced by salmon in an activity portraying the life cycle of these aquatic creatures.

BACKGROUND

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. Both the Atlantic and Pacific salmon are spectacular examples of migrating fish. (See this activity's "Variation" section for adapting "Hooks and Ladders" to Atlantic Salmon.)

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.

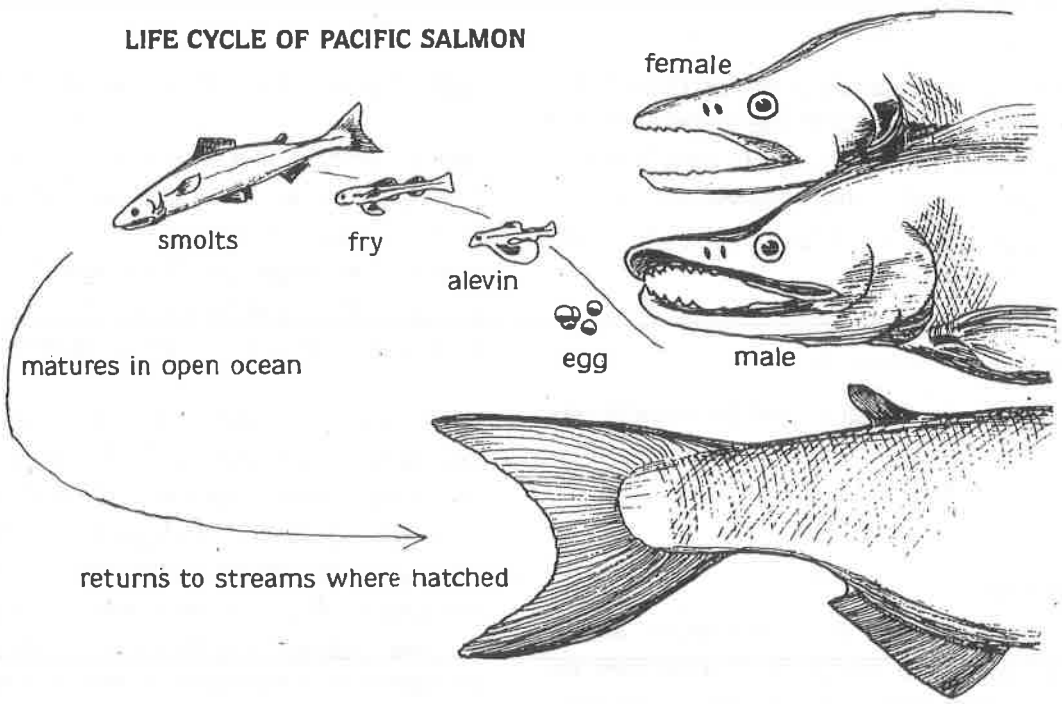
Age: Grades 3-9
Subjects: Social Studies, Geography
Skills: analysis, description, discussion, generalization, inference, interpretation, kinesthetic concept development, observation, psychomotor development, recognition, synthesis, using time and space
Duration: 30 to 60 minutes
Group Size: 20 to 30 students or more
Setting: outdoors or large indoor area
Conceptual Framework Reference: III.E., III.E.1., III.E.2., III.A., III.A.1., III.A.2., III.A.3., III.B., III.B.1., III.B.2., III.B.3., III.B.4., III.B.5., III.B.6., III.C., III.C.1., III.C.2., III.D., III.D.1., III.D.2., III.D.3., III.D.4., III.D.5., III.F., III.F.1., III.F.2., III.F.3., III.F.4., III.F.5., VI.A., VI.A.2., VI.A.3., VI.A.4., VI.A.5., VI.B., VI.C., VI.D., VII.A., VII.A.1., VII.A.2., VII.A.3., VII.A.4., VII.B., VII.B.1., VII.B.7.
Key Vocabulary: life cycle, limiting factors, population, migration
Appendices: Simulations, Ecosystems

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 to remain isolated and 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. Dams slow salmon migration. Because salmon cannot find the current behind dams they become disoriented in reservoirs. When disoriented, salmon are extremely vulnerable to predators. Low water in streams, predatory birds, mammals, and larger fish pose additional hazards. Up to 90% of the salmon that hatch never reach the sea.



When in the ocean, the salmon grow rapidly by feeding on the ocean's rich food supply. Predators such as sharks, killer whales and other marine mammals take their toll. In addition, humans fish for salmon commercially and for personal reasons, including food and recreation.

In two to five years, the Pacific salmon start the journey that will guide them back to the rivers and streams leading to their own hatching site. The upstream migration from the ocean is also a series of hazards. For example, dams hinder their journey and would block it completely if fish ladders were not installed. Fish ladders are water-filled staircases that allow the migrating fish to swim upstream around the dam. Humans who fish, eagles, bears, and other predatory mammals also reduce the numbers along the way to the spawning ground. Sometimes landslides and logjams provide unexpected new barriers. So too do the natural waterfalls and rapids that the now weighty salmon must overcome. Once back at the spawning ground the life cycle of the Pacific salmon begins anew. To maintain the Pacific salmon population, some biologists believe that only one pair of fish from each spawn must return to deposit and fertilize eggs.

All possible conditions are not covered by the design of this activity. However, the activity does serve simply and effectively to illustrate three important concepts—life cycle, migration, and limiting factors.

The major purpose of this activity is for students to gain an understanding of some of the complex characteristics of the life cycle of one representative aquatic species, the Pacific salmon.

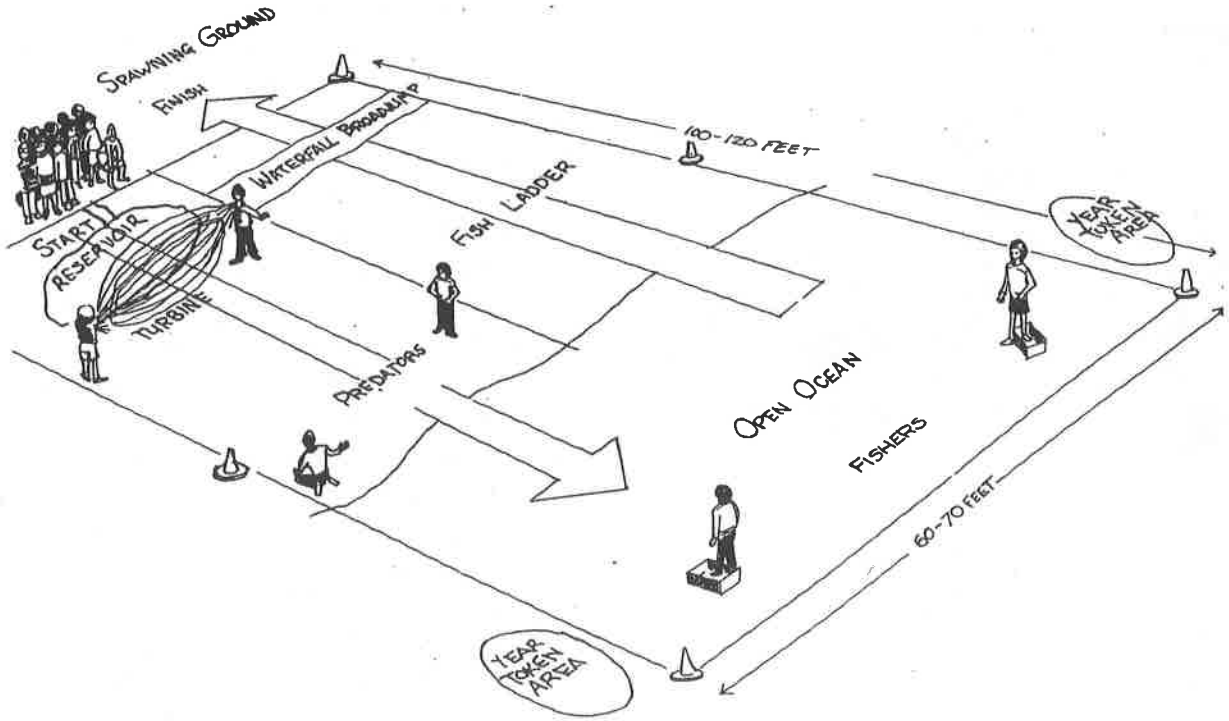
MATERIALS

large playing area (100 feet x 50 feet); about 500 feet of rope, string, or six traffic cones for marking boundaries (masking tape may be used if area is indoors); two cardboard boxes; 100 tokens (3 x 5 cards, poker chips, etc.); jump rope

PROCEDURE

1. Begin by asking the students what they know about the life cycle of fish that live in their area. Do any local fish migrate to spawn? If yes, which ones? (Mullet, shad, lake trout, striped bass, suckers, carp and salmon are examples of fish that migrate to spawn.) In this activity, students will learn about some of the characteristics of one species of fish that migrates as a part of its life cycle—the Pacific salmon.
2. This is a physically involving activity! Set up a playing field as shown in the diagram, including spawning grounds, reservoir, downstream, upstream, and ocean. The area must be about 100 feet by 50 feet. Assign roles to each of the students. Some will be salmon, others will be potential hazards to the salmon. Assign the students roles as follows:
   - 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 downstream, these students move to the upstream side to become the waterfall-broad jump monitors. (See diagram.)
   - Choose two students to be predatory wildlife. At the start of the simulation, the predators will be stationed in the reservoir above the turbines to catch the salmon fry as they try to find their way out of the reservoir and downstream. Then, they will move to 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 "broadjump" waterfalls. There they will feed on salmon just before they enter the spawning ground. (See diagram.)
   - 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.

NOTE: These figures are based on a class size of 25 to 30. If the group is larger or smaller, adjust the number of people who are fishing and predatory wild animals accordingly.



3. Begin the activity with all the salmon in the spawning ground. The salmon first move into the reservoir above the dam. They must stay in the reservoir while they count to 30. This simulates the disorientation that salmon face due to a lack of current in the lake to direct them on their journey. During this time, the predators may catch the salmon and escort them one at a time to become part of the fish ladder. The salmon then start their journey downstream. A 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 must immediately become 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 as shown below, a body-wide space between them.

4. Once past the turbines, the salmon must get past some predatory wildlife. The predators, who have moved from the reservoir area to the area below the turbine, must catch the salmon **with both hands**—tagging isn't enough. Dead salmon are escorted by the predator to become part of the fish ladder. Later, the salmon who survive life in the open ocean will use the structure of the fish ladder—by passing through it—to return to the spawning ground. NOTE: Both the predatory wildlife in the last downstream area and the people fishing in the open ocean must take dead salmon to the fish ladder site. This gets the predators and fishing boats off the field regularly, helping to provide a more realistic survival ratio.

5. 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. For purposes of this simulation, the impact of this limiting factor creates a more realistic survival ratio on the population before the salmon begin the return migration upstream.

6. 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.**

7. 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 breadth 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.
NOTE: When playing indoors, the broad jump waterfall may be changed into a stepping stone jump defined by masking tape squares for safety on hard floors.

8. 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 students they caught to become part of the structure of the fish ladder.

9. The activity ends when all the salmon are gone before the spawning ground is reached—or when all surviving salmon reach the spawning ground.

10. Next engage the students in a discussion. Explore topics such as:

- the apparent survival-mortality ratio of salmon
- the students' feelings throughout the activity
- the role of the barriers
- the role of the predatory wildlife and the people fishing
- where the losses were greatest
- where the losses were least
- what the consequences would be if **all** the eggs deposited made the journey successfully
- what seemed realistic about this simulation and what did not

11. Ask the students to summarize what they have learned about the life cycle of salmon, the salmon's migration and limiting factors that affect salmon. Make sure the students have a clear working definition of limiting factors. Encourage the students to make the generalization that all animals—not just Pacific salmon—are affected by limiting factors. Ask the students to give examples. They might mention availability of suitable food, water, shelter and space; disease; weather; predation; and changes in land use as well as other human activities.

VARIATION: ATLANTIC SALMON

This activity can easily be adapted to feature Atlantic, rather than Pacific, salmon. The most significant difference between Pacific and Atlantic salmon is that the Atlantic salmon can spawn more than once. Many Atlantic salmon make their complete migratory journey and spawn two or more times. All Pacific salmon die after spawning only once. To adapt this activity for Atlantic salmon, students are to make as many complete migratory trips as possible. After the activity is finished, ask students to report how many times they successfully completed the migratory cycle. Graph the data. Have the students explain how age influences mortality rates and susceptibility to limiting factors.

EXTENSIONS

1. Write a report on the life history of one of the species of salmon (e.g., chinook or king, chum or dog, pink or humpback, coho or silver, sockeye or red, Atlantic). Create a mural showing the life cycle of this salmon.
2. Research and illustrate the life cycle of any local fish. If possible, look for one that migrates.
3. Compare how the life cycle of a Pacific salmon is similar and different to the life cycle of one or more local fish.
4. Investigate similarities and differences in the migration and life cycles of Atlantic and Pacific salmon. Investigate the life cycle of salmon in the Great Lakes ecosystem.
5. Visit fish hatcheries that work with migratory species and investigate how they function.
6. Explore ways that dams can be modified to let fish safely pass downstream and upstream. Design the "perfect" fish ladder.
7. Investigate and discuss **commercial** fishing for salmon. Investigate and discuss **personal**, including recreational, fishing for salmon.
8. Find out about laws protecting migratory species, including fish.

9. Consider this and try the activity again:
In the last 100 years, salmon have experienced many new, human-caused limiting factors. Dams, commercial fishing, timber harvest and road construction have had tremendous impact on salmon populations. In 1991, the Snake River sockeye salmon was placed on the federal endangered species list. In the past, tens of thousands of sockeyes would make the 900-mile return trip from the sea to Idaho's mountain streams and lakes. There they would spawn and die. Their offspring would hatch and begin their early development in freshwater. The actual migration to the Pacific Ocean could be completed in as few as nine days. Today that trip takes over 60 days. In 1991, only four Snake River sockeye salmon returned to their spawning grounds.
To simulate these increases in salmon limiting factors, play several rounds of "Hooks and Ladders." Allow each round to represent the passage of 25 years. Start in 1850. In that year do not include dams or commercial fishing operations in the scenario. As time passes, add the human commercial fishing operations. Build dams (jumpropes) as the scenario progresses into the 20th century.

Describe some of the possible effects on salmon from increased limiting factors as a result of human activities. Discuss possible positive and negative effects on both people and salmon from these increases in limiting factors affecting salmon. When the activity reaches "the present," predict what might happen to salmon in the future. Approaching this as a complex dilemma, discuss possible actions, if any, that might be taken to benefit both people and salmon.
10. Substitute striped bass for salmon. The striped bass is more widely distributed along the United States' coastlines than either the Atlantic or Pacific Salmon. Like the salmon, striped bass reproduce in freshwater and migrate to and mature in saltwater. They also must face the limiting factors outlined in this activity.
11. Find out if salmon exist in your state. If so are they native or were they introduced?

EVALUATION

1. List, describe, and illustrate the major stages in a Pacific salmon's life cycle.
2. Identify and describe some of the factors that affect salmon as they complete their life cycle.
3. Identify and describe some limiting factors that might affect other animal populations.