



Teacher Background

The Cycle Continues

A female Pacific salmon produces between 1,500 and 7,000 eggs, an amount which varies with species. The eggs are deposited in a redd, a shallow gravel depression scooped out by the female. As they fall into the gravel, the eggs are fertilized by the male. After they are fertilized, the female nudges gravel over them for protection. The spawning pair will dig and fill several more redds, but within a few days both the male and female salmon will have completed their reproduction and died.

The eggs and young which hatch out of them are susceptible to many limiting factors, factors which limit the number of naturally spawning fish that survive to spawn the next time. We have already looked at some of these factors, such as fishing and water quality problems. In this lesson we will look at more, and at some efforts people are making to increase the chances for naturally spawning salmon.

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 these first two weeks, they begin their journey. If they are coho or chinook they will remain for a while in the fresh water stream. If they are sockeye, they will move to a lake for a period of time. Chum and pink salmon head directly to the sea.

From the time the eggs are deposited to their migration out to sea, the small salmon are confronted by many hazards. Earlier lessons have already discussed the effects upon salmon eggs and juveniles of siltation caused by road building, logging, or fires. Low water levels, an increasing problem around Puget Sound, can trap salmon offspring in isolated depressions where they soon die. Large numbers are killed if they are forced to pass through the turbines of power dams. And of course the eggs and the fry become the food of birds, mammals, and larger fish. Up to 90% of salmon that hatch never reach the sea. Those that do are called "smolts" when they reach the river mouth and move into salt water.

Once 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. And of course, humans fishing now harvest a major portion of the population as it returns to spawn.

In two to five years, depending on species, the Pacific salmon start the journey that will guide them back to the rivers and streams leading to their own hatching site. Salmon making the upstream migration from the ocean face a new series of

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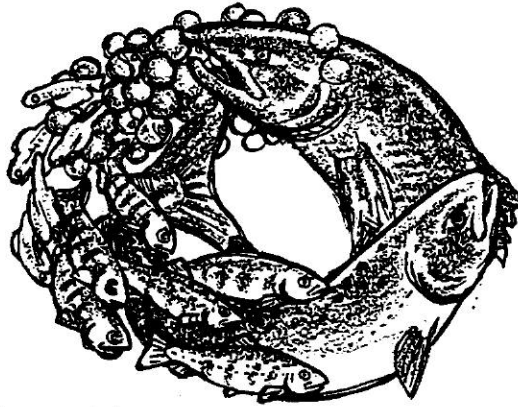
hazards. As we have seen, hydroelectric dams hinder their journey or block it completely when fish ladders are not present. Humans fishing and natural predators reduce their numbers on the way to the spawning ground. Sometimes landslides and log jams provide unexpected new barriers in addition to the natural waterfalls and rapids that the salmon must overcome.

Once back at the spawning ground, the life cycle of the Pacific salmon begins anew. In spite of the high mortalities salmon suffer during this cycle, the large number of eggs released offers some built-in protection. From each spawning pair, only two fish must themselves return to spawn for the Pacific salmon population to remain constant.

The lesson **THE CYCLE CONTINUES** includes a slide set for you to deliver, which illustrates the salmon life cycle. After watching the slides, your students will complete the narration of Hyak's story, describing her final actions and the new life in the river bottom.

Your students will also make salmon life cycle diagrams. They will include in these diagrams, names for parts of the salmon's life cycle and dangers or help which the salmon might encounter along the way. The information they will need is contained in the slide series.

An adaptation of the life cycle game, **HOOKS AND LADDERS**, developed by Project Wild, has been included to provide a physically active experience which reinforces concepts covered in this lesson.

**Lesson Plan**

The Cycle Continues

Student Objectives:

- Students will watch and discuss a slide show offering a visual glimpse into the remaining parts of the Pacific salmon's life cycle, reproduction and development.
- They will make a life cycle diagram for salmon which will place the stages in the salmon's life cycle in sequence.
- The students will discuss natural and human caused factors which interrupt the Pacific salmon's life cycle, and they will look at what some people are doing to give wild salmon a better chance at survival.

Materials:

- LIFE CYCLE slide set and text
- Projector and tray
- One copy per student, THE CYCLE CONTINUES
- Student activity, SALMON LIFE CYCLE
- Scissors and glue
- Large (12 x 18) sheets of paper, white or colored
- Accessory materials to add color and visual interest to the diagrams: additional colored paper, colored pencils, colored marking pens

Procedure:

1. Introduce the Life Cycle slide series. You can tell your students that salmon are quite wary of disturbance and usually spawn during the night. They seek out secluded streams, which for some species may be only a few inches deep. You might ask the students to consider how they would go about photographing salmon in the act of spawning.
2. Give your students the student text, THE CYCLE CONTINUES before beginning the slides. Point out to them that they will write the remainder of the narration themselves after watching the slides. This narration will include what the salmon does before, during, and after spawning, and what happens to the eggs in the stream. Suggest that they take notes during the slide show so they can include information from it in this work, and in a salmon life cycle diagram which they will also be making.

LESSON PLAN

3. You can take your time with the slides to introduce terms, ask questions, and generate discussion. A suggested narration begins on the page following this lesson plan.
4. After showing and discussing the slides, have the students finish the narration for **THE CYCLE CONTINUES**. (By going directly to this activity from the slide show this information will still be fresh in their minds. You may prefer a different sequence, however.)
5. Have your students use the student activity page, **SALMON LIFE CYCLE** or their own drawings to make a diagram which represents the life cycle of the salmon. This diagram should contain the following information:
 - The name and a picture of each phase of the salmon's life cycle
 - The habitat, or environment in which each life phase takes place
 - Some of the dangers -- or help -- which the salmon may encounter along the way

Student activity page, **SALMON LIFE CYCLE** is offered as a source of cut-out pictures to help them make their diagrams. You can decide whether to allow them to cut the pictures out and use them directly in their diagrams, or to have them draw pictures of their own, or you may give them that choice.

This is also a great project for two students to do cooperatively. To encourage quality of work and creativity, display finished work around the room.

Answer Key:

In their narratives, the students should include descriptions of digging a redd, spawning, covering the eggs, and the fact that a pair of salmon digs and fills several redds as part of the spawning process. They should include discussion of the eggs incubating beneath the gravel for several months, followed by hatching. The students should note that the little fish, now called alevins, remain under the gravel until their yolk sacs are absorbed. When the yolk is gone, they are known as fry and become free swimming fish.

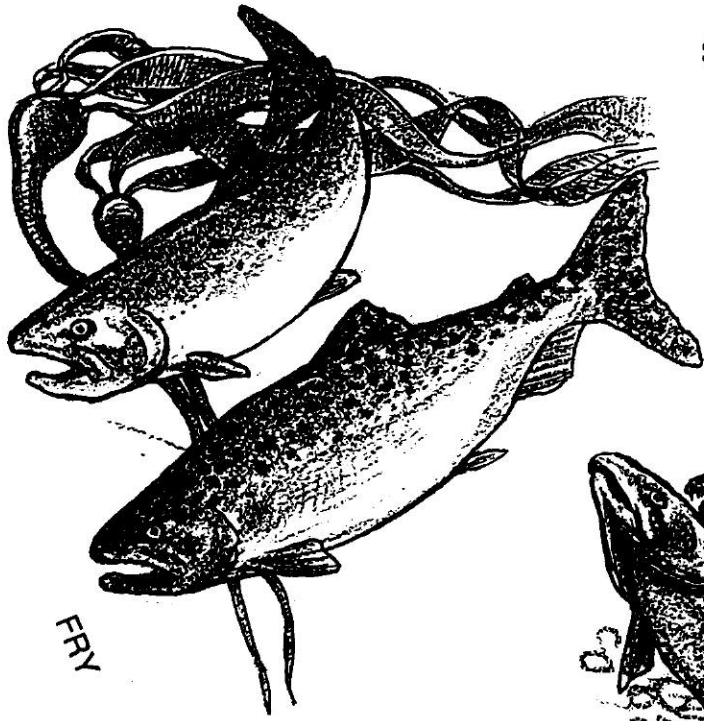
The students should also include the fact that Hyak, like all Pacific salmon, will die within a few days of spawning.

An excellent extension to this lesson would be a field trip to a salmon hatchery. Washington Department of Fisheries can provide you with a pamphlet about state hatcheries, and Northwest Indian Fisheries Commission has information on tribal hatcheries. Write to:

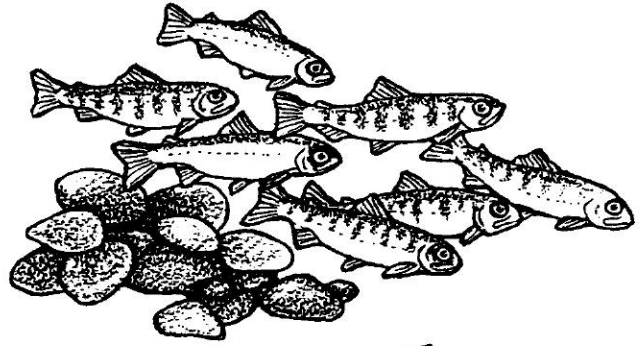
Washington State Department of Fisheries
Room 115, General Administration Building
Olympia, WA 98504.

Northwest Indian Fisheries Commission
670 Martin Way E.
Olympia, WA 98506

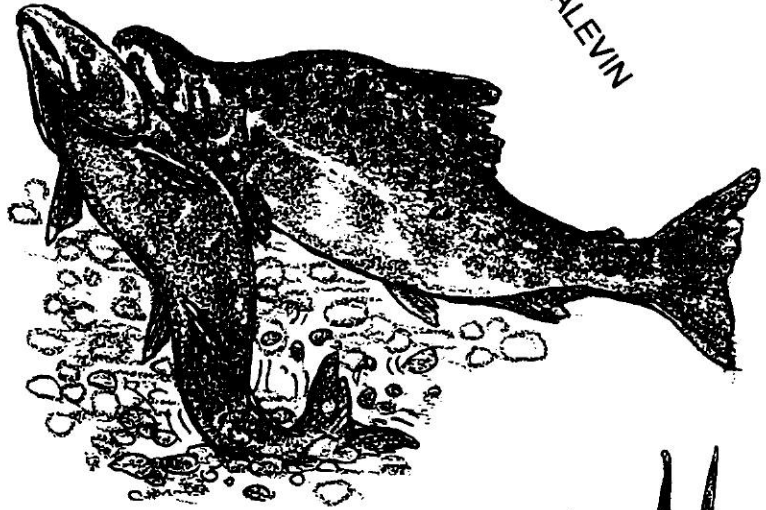
SPAWNERS - FRESH WATER



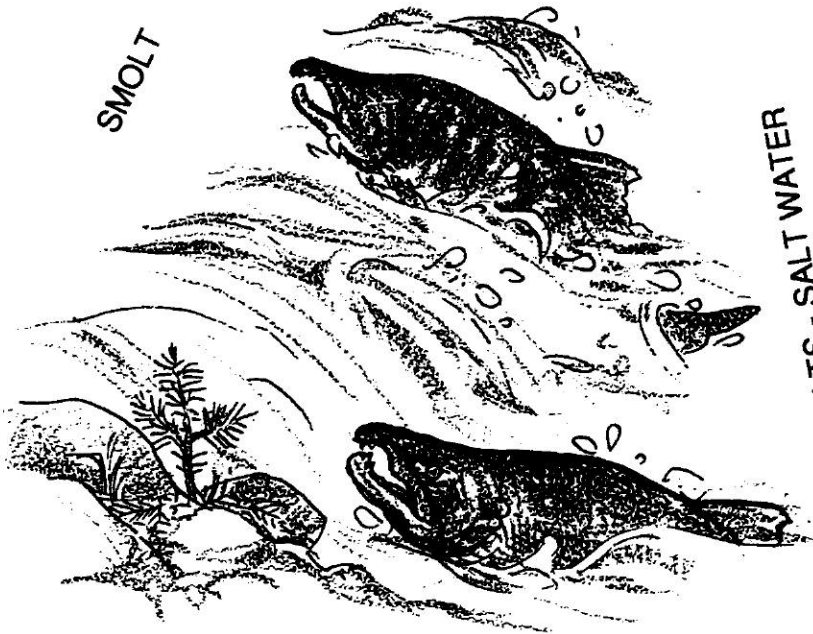
FRY



ALEVIN



SMOLT



ADULTS - SALT WATER



SPAWNING ADULTS

Slide Set

The Cycle Continues

Narration for Life Cycle Slide Set

1. Each year several million salmon return to Puget Sound.
2. They come in search of freshwater rivers and streams where they will attempt to spawn naturally as Pacific salmon have done on the West Coast for thousands of years.
3. Guided to place of their own birth by a powerful and persistent sense of smell, salmon may travel upstream hundreds of miles. (Before the Grand Coulee dam was placed on the Columbia River, salmon traveled up its length more 1000 miles!)
4. Although salmon are sleek and silvery in the ocean, once they enter fresh water their bodies undergo marked changes in shape and coloration. (Can you guess which species this is?) The salmon in this slide are sockeyes. During spawning their bodies turn a brilliant red and their heads an olive green.
5. A school of salmon moves up river in a series of short, furious bursts of effort as the fish fight to overcome obstacles in their way. They may pause to rest in areas of slack water.
6. Since salmon no longer feed once they enter fresh water, all the energy they use to make this fantastic migration is stored in their rich, oily flesh. By the time they reach their destination, their flesh is no longer oily and their muscles are already breaking down.
7. At one time all of Puget Sound's rivers had the conditions required by spawning salmon: cold, quickly flowing water with plenty of oxygen, and a clean, gravel-lined stream bed in which to bury the eggs. Today these places are becoming increasingly hard to find.

SLIDE SET NARRATION

- 8.** Once in the area they began life themselves, salmon instinctively select a location with the water depth and gravel size needed by their developing eggs.
- 9.** Before spawning, the female digs a redd, a special gravel nest where the eggs will be deposited. She turns on her side and vigorously moves the gravel with her tail.
- 10.** The male swims near her, undulating his body to help stimulate her nest building behavior. He may also make digging gestures himself, but his movements don't actually help in digging the redd.
- 11.** Eventually the redd will be a bowl-shaped depression between 1 and 6 square yards in area, depending on the species. The redd in this picture already contains eggs, suggesting the photo was taken part way through the spawning process.
- 12.** The two fish hover over the nest, their mouths open. The female deposits her eggs in the nest while the male releases a white cloud of milt, or sperm over them.
- 13.** The eggs are heavier than water and are covered with a sticky substance when they are first released. They quickly adhere to the gravel.
- 14.** The female then pushes gravel back over the nest with her tail, covering the eggs 6 to 18 inches deep. This behavior does two things. It covers her last redd and digs the next one, located just upstream from the previous one.
- 15.** She will eventually dig 5 or 6 redds, arranged one above the other in a line up the channel.
- 16.** Soon after spawning all adult salmon will die.
- 17.** But under the gravel, anywhere from 2,000 to 5,000 eggs are developing. These eggs will incubate beneath the gravel from 2 to 6 months, depending on species. Salmon eggs are especially sensitive to disturbance during their first weeks. After the eyes are visible the eggs can be handled and transported.
- 18.** The embryo begins to form on the surface of the egg. Food for the little fish is contained in the large yolk mass, which at the beginning is much larger than the tiny embryo.

- 19.** Gradually most of the yolk is absorbed by the developing embryo, and eventually, a tiny translucent fish emerges from each egg.
- 20.** These tiny fish, still carrying the remainder of their yolk sacs, are called alevins. Alevins stay hidden under the gravel until their yolk sacs are completely absorbed.
- 21.** Once their yolk sac is used up, the little fish push their way out of the gravel and swim up into the current. They are now on their own, and they must find their own source of food.
- 22.** When they emerge from the gravel and begin an independent life in the stream, they are known as fry.
- 23.** Meanwhile, the bodies of adult salmon which died soon after spawning have long ago decomposed. Some of these carcasses have broken down along stream-sides; others have been dragged deeper into the forests by scavengers.
- 24.** The rich nutrients from the sea, contained in the bodies of the adult salmon have been distributed throughout the watershed. Now they are fertilizing the land and enriching the forests.
- 25.** Directly or indirectly, the bodies of the adult salmon provide food for small aquatic animals throughout the watershed. Young salmon will then feed on these small animals, and later they will eat larger animals which fed upon these small animals.
- 26.** The fry of pink and chum salmon head downstream to saltwater almost immediately.
- 27.** Sockeye fry migrate into a fresh water lake for a year or more.
- 28.** Coho and chinook salmon may stay in the stream for up to a year.
- 29.** Wherever they live, young salmon become part of a food chain. They feed on tiny shrimp-like animals, insect larvae, and plankton.
- 30.** In turn, salmon eggs and fry are preyed upon by birds, larger fish, and amphibians. Only 10% of the eggs survive to reach the fry stage.

SLIDE SET NARRATION

- 31.** The young salmon which survive eventually leave fresh water and move into seawater. As they do, they undergo a process called smolting. Salmon smolts are young fish adjusting to their new life in salt water.
- 32.** As the little smolts leave fresh water behind, their parr-markings--the vertical stripes on their sides--fade, and they take on a silvery luster.
- 33.** For a period of weeks or months, the smolts may live along the boundary between fresh water and sea water, which is called an estuary. Estuaries are especially rich in food for the smolts, and here they pick up strength and body size before moving on to open water.
- 34.** Eventually the smolts will leave the estuary behind and begin their oceanic life stage. During this phase of their lives, they may complete a remarkable migration thousands of miles up the Pacific coast or far into the open ocean.
- 35.** Here they have the rich food resources of the North Pacific to draw from as they build the body size and power they will need to make their strenuous migration back to their spawning streams.
- 36.** In all parts of this life cycle, predators and natural hazards limit the numbers of fish which survive.
- 37.** In fresh water and estuaries they are eaten by birds and larger fish, while in Puget Sound or off the Pacific coast they are preyed upon by sea lions . .
- 38.** . . .and by orca whales.
- 39.** Today the chief predator on salmon is man himself.
- 40.** Since each pair of spawning salmon releases several thousand eggs, the species is somewhat "prepared" to overcome natural hazards.
- 41.** But over the last century, changes in our uses of the land around Puget Sound have posed some new and far more serious threats to the survival of wild salmon than any which have existed previously.
- 42.** Today's salmon passing in and out of the Strait of Juan de Fuca are now forced to share Puget Sound and its watersheds with us, . . .

- 43.** and they are strongly affected by the ways we use this environment.
- 44.** Frequently the needs of salmon are in direct conflict with economic goals of the region. For example, the harvesting of valuable timber through clearcutting can have a major impact on salmon spawning habitat in the watershed.
- 45.** Logging practices and the cutting of access roads in mountainous parts of our watersheds can cause for serious erosion problems which leaves streams and rivers clogged with silt.
- 46.** For years people in the northwest have enjoyed the inexpensive power generated by hydroelectric dams to run their industries and heat their homes. But these same dams block salmon from reaching large parts of Washington's watersheds.
- 47.** Other uses of our watersheds affect the quality of the water in which the fish must live. Pesticides and fertilizers can upset the delicate balance in a stream, as can organic wastes from farm animals and poorly maintained septic systems.
- 48.** Today, even in the rainy Northwest, our cities, industries and agriculture place an enormous demand on our fresh water supply. The water salmon require to complete their life cycle may simply not be in the stream when they need it.
- 49.** Record growth around all parts of Puget Sound is putting people, their homes and their businesses in places where there was once wilderness, and habitat for salmon and other wild species is rapidly shrinking.
- 50.** Yet despite this depressing picture, there are also some signs of hope. Many people around the Sound have taken an important step toward improving the survival chances of wild salmon by "adopting" neighborhood streams.
- 51.** One stream was adopted by a nearby school. The students and teachers wondered why fish no longer came up this stream which had once been used by a large salmon run. In order to find out what was wrong, they walked the length of the stream and checked all the conditions which could be important to salmon.
- 52.** They found places where the fish were blocked by trash and fallen logs. They removed all the trash and made the stream passable to fish.

SLIDE SET NARRATION

- 53.** The students and their teachers also discovered that the stream was used to carry away large amounts of storm water which drained from the city's streets, roofs, and parking lots.
- 54.** Since this water carries in it everything people dump on the ground, the students decided they needed the help of other people in town to keep harmful substances out of the storm water. They put out information brochures explaining how to take care of the stream, and they wrote articles which were printed in the local newspaper.
- 55.** There were places along the stream where no vegetation shaded the water, so the students decided to plant trees along the streams banks.
- 56.** They knew that in a few years, when salmon began returning to the stream, the trees would already be providing some shade.
- 57.** Since the salmon which once lived in this stream had died out years ago, the teachers talked to the Washington Department of Fisheries about obtaining some fish to release. The teachers were given salmon eggs from a nearby hatchery to raise in an aquarium at school. The eggs hatched in the classroom, and later they were released into the stream as fry.
- 58.** Other groups have learned how to help when a few salmon are still running in a stream but their numbers are badly depleted. They have learned to build egg boxes, in which eggs removed from the few fish in the stream are incubated.
- 59.** Egg boxes sit beside the stream and use water directly from the stream, but but they protect the eggs from predators and unstable stream conditions. Up to 90% of these eggs will survive to become fry.
- 60.** Stories like these have taken place in many watersheds of Puget Sound. Bigger steps than these will still need to be taken in order to keep salmon spawning naturally in this region. Yet these efforts do offer hope that people of Washington are willing to save a place for wild salmon in the future of Puget Sound.



The Cycle Continues

Near river mile 7 in a sheltered bend on the Skokomish South Fork, a small group of salmon are nearing the end of their thousand mile journey. You take the story from here.

First, draw the final leg of Hyak's route on your Skokomish Watershed Map.

Then, in the space below, you finish the story. Be sure to include a description of how the salmon prepare the river bottom before spawning. How are the eggs protected after being deposited? Describe where and how the eggs develop up through the point the little salmon emerge from the gravel river bed. Include the names for the life stages they pass through during this period. What must inevitably happen to Hyak and all other spawning adult salmon?