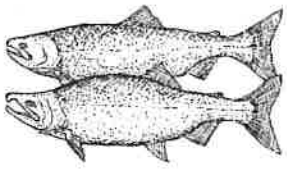
STUDENT HANDOUT 4A

THE JOURNEY OF WILD PACIFIC SALMON



ACTIVITIES:

- As you read, complete the chart in Student Handout 1B: *The Life Cycle of Wild Salmon.*
- As you read about each stage of a salmon's life, think about all the possible human and natural challenges a salmon might encounter. Use Student Handout 1C: *Challenges to Salmon*, to organize your thoughts and to develop a list of potential problems and challenges to salmon on their journey.
- Use Student Handout 1D: *My Life Cycle*, to compare the similar stages of your life with those of the salmon's.
- Use a dictionary or biology textbook to look up the definitions of words that are unclear. Words that are in **bold** are of particular importance to understanding salmon and are defined in the glossary.

For nearly 10,000 years, salmon have used the rivers and streams of the Pacific Northwest to travel from their birthing streams to the ocean and back. A century ago, between 10 and 16 million salmon returned from the ocean each year to spawn in Northwest rivers. Today less than a million return.

Nothing is more awe-inspiring and remarkable in nature, and nothing defines the character and beauty of the Northwest better than the migratory journey of salmon. It represents life as a cycle, the power of survival and endurance, and the promise of return.

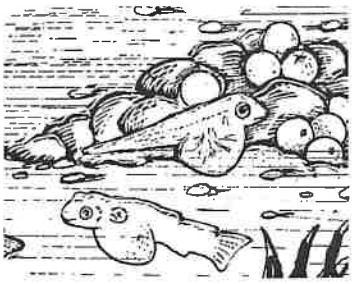
Pacific salmon are extremely important for several reasons. They have been a critical food source for the people of the region, and a significant food resource worldwide. Second, salmon are an **indicator species**. Because salmon migrate thousands of miles, moving from streams and rivers through estuaries to the ocean and back, they provide a valuable indication of environmental conditions in those habitats. Third, salmon play a central role in maintaining biologically diverse and productive ecosystems. For example, they are prey for a multitude of species, and their carcasses bring ocean-rich nutrients to relatively nutrient-poor freshwater environments. And finally, Northwest Native American cultures and spiritual beliefs are deeply connected with the great silver fish. In fact, the Chinook salmon takes its name from a Northwest tribe.

The salmon have evolved with incredibly strong instinctive patterns. Born in freshwater streams, **anadromous** or sea-run species like salmon are uniquely compelled to travel to the ocean. The vast ocean food chain supports a growth rate that freshwater members of the same species could never hope to achieve. However, travel to and from the ocean is a very risky venture. Travelling up to a thousand miles, migratory fish are inherently vulnerable to a variety of threats, both human and natural, along the way. Only the strongest, luckiest and most tenacious fish withstand the journey to reproduce. Of the 3,000 to 7,000 eggs in a nest, only one spawning pair will likely make it back to its original spawning habitat.

1. EGG STAGE

Salmon begin their lives in shallow gravel beds within the **substrate** of the freshwater streams and rivers in which their parents were born. The fertile, reddish-orange eggs develop in the safety of the gravel. Cold, clean **sediment**-free water must wash the eggs and bring them oxygen. Eggs lie in the gravel through the winter, as the embryos develop. **Incubation** may take 50 days or longer. For example, the colder the water, the longer the incubation period.

2. ALEVIN STAGE

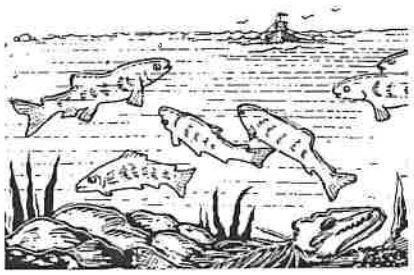


In late winter or spring, young translucent fish with large protruding eyes, called **alevins** (sometimes called yolk-sac fry), hatch and lie protected under the gravel. An orange **yolk sac** attached to the bellies of the tiny fish carry a food supply consisting of a balanced diet of protein, sugars, vitamins and minerals. As the fish grows, the yolk sac gets smaller. They will not leave the protection of the gravel until the yolk is used up, which can be twelve weeks or more. A flow of water is critical to alevin survival.

3. JUVENILE STAGE

In late spring and summer, with yolk sacs buttoned up, or absorbed, and eyes still protruding, small fish called **fry** emerge upward through the gravel and begin to forage for food. They are about the length of a fir needle and stay in shallow pools near the edge where the current is slow.

When the young fish reach about two inches in length, they are known as **parr** (sometimes called fingerlings) and become intense feeders on plankton, small insects, worms, mussels and snails. The parr growth phase is best recognized by the development of dark bars aligned vertically along each side of the fish. The parr phase is the most vulnerable time in a salmon's life, as they become the morsel of choice for sculpins, raccoons, kingfishers and large trout. **Juvenile** (fry and parr) salmon will remain in the river four months to two years depending on the species before moving downstream to the estuary.



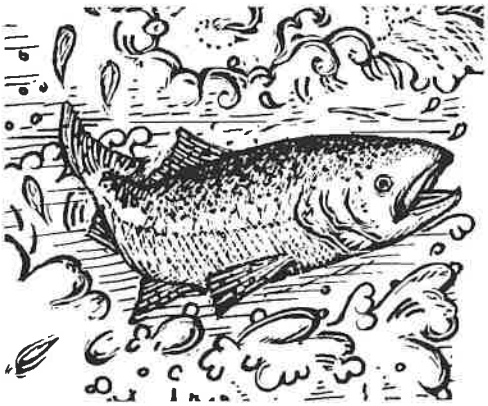
4. SMOLT STAGE

At four to six inches in length, salmon are known as **smolts**. As the parr marks disappear, most young salmon begin a physical change that triggers their downstream migration and adaptation to saltwater environment. Smolts let the current carry them downstream, tail first. Much of their travelling is done at night to avoid predators.

Estuaries occur where coastal rivers enter the ocean, creating a mix of fresh- and saltwater habitats. For salmon, the estuary represents the drastic transition from the river to the sea. Nutrient-rich sediment in estuaries produces nurseries for thousands of tiny organisms, upon which salmon feed. The inner waters of eelgrass beds and salt marshes provide habitat for the fish as they transition from fresh to salt water. This transformation involves amazingly complex body-chemistry changes. In addition, other physical changes occur during smolting: scales become larger, color turns silvery, and tails lengthen and become more deeply forked. Depending upon the species, salmon spend from a few days to a few months in an estuary.

Water flow is again a critical factor during downstream smolt migration. High flows mean higher survival rates. Decreased flows can increase the amount of time it takes smolts to reach the ocean and affect their ability to adjust to saltwater conditions. A delay can also increase their susceptibility to predators and disease.

5. OCEAN-FARING ADULT STAGE



Some theories suggest that salmon follow a life cycle of going to the ocean in order to overcome the limits of food and space in freshwater habitats. Upon entering the ocean, salmon will turn toward their **hereditary** feeding grounds. For some it is north to Alaska. Others will feed in the deeper waters off of the California coast. To avoid predators like seals they will remain in large numbers called schools. Their two-tone coloring helps conceal them from enemies. Seen from above, they blend with the dark ocean waters; from below, they blend with lighter sky. They feed heavily on such prey as crab larvae, barnacles, herrings, sand lance, rockfish, anchovies and squid. Time spent at sea varies according to species ranging from one to five years.

6. UPSTREAM MIGRATION STAGE

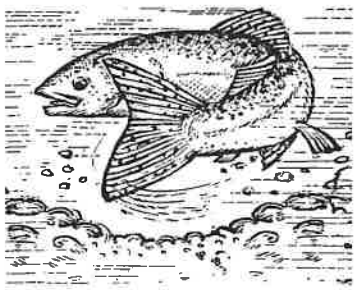
The salmon's return to the estuary is remarkable. For a fish to travel thousands of miles in the open ocean, up to thirty miles a day, and then locate and return to the estuary of its origin seems to defy all odds. This is called **homing**. Although still a mystery, scientists hypothesize that salmon navigate at sea with the aid of an inner magnetic map and a strong sense of day length, thus a salmon knows approximately where it is in relation to its home stream. As changing day length signals the advance of the season, the fish moves more or less directly toward the river mouth. As the salmon gets closer to the river the salmon's keen sense of smell comes into play, drawing it toward water smells encountered during the juvenile phases of life. Salmon can pick up the scent of their home river with noses so sensitive that they can detect dissolved substances in parts per 3,000,000,000,000,000,000! Arrival occurs during all seasons depending on the species.

A unique feature of the life cycle is that salmon migrate and spawn in mass groups called stocks or runs. The fish within each stock or run has a unique "map" with special genetic codes that instruct and direct the fish's behavior specifically to when and where to migrate and spawn. For example, the Sandy River Fall Chinook is a stock or run of salmon that migrate up the Sandy River in the fall to spawn.

The struggling, leaping salmon against the torrent of the stream is one of nature's most incredible feats. Upon re-entering fresh water to spawn, salmon lose their desire to eat and live off their accumulated fat reserves. In proceeding toward their spawning grounds, the fish move quickly upstream in groups. They make their way by stages upstream, pausing for days at a time to rest in **pools**, often waiting for improved water flows. They tend to move as long strands, hugging the deeper channels and shaded areas of the stream. At shallow **riffles**, where the river steps down a gravel ramp, running fish raise rooster tails of water as they speed over the rocks.

7. COURTSHIP STAGE

Once they come to their home gravel, females search for suitable egg-laying territories to build nests, called **redds**. As the sac around the eggs loosen, the urge to **spawn** quickens. Aggressive displays between the fish occur at this time. Males chase, bite and attack to ward off competitors. Females butt other females that appear to threaten their redd.

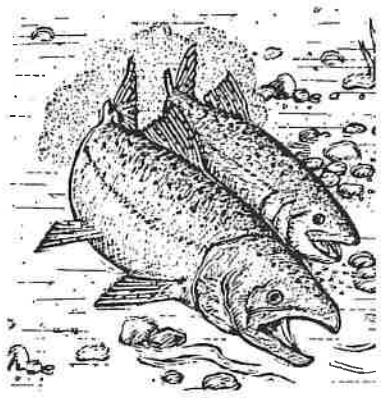


At this stage, the final days of the salmon are near, with many changes in color and body apparent. The males of some species get humped backs, hooked jaws, and sharp canine teeth. With muscles softening, skin thickening and body chemistry changing, white fungus may grow over sores or the eyes of the fish. The fins and tail fray from pounding against rocks and wounds from the journey may mark the body.

8. SPAWNING STAGE

Spawning is the process of reproduction for salmon. 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. Once the female has selected the general location for laying eggs, she turns on her side and uses sweeping or **undulating** movements of her tail to dig the nest in the gravel. Every so often she checks the depth of the nest by "**crouching**" or lowering herself into the nest. In time, she eventually produces a cone-shaped nest up to 16 inches deep. Within that site, she may dig several nests and deposit eggs in them over a period of several days.

The digging of redds attracts males. As a male manages to ward off competitors, he joins the female in the nest in a series of courting movements. Eventually, he will move alongside the female and move his body against hers slightly. Frequently he will open his mouth in a "**gape**." When the female is ready to deposit her eggs, she too will open her mouth to resist the current and help her lower herself deeper into the nest. Finally, as both rapidly vibrate their tails, the eggs and sperm, or **milt**, are released. A female may lay up to 7,000 in a series of redds.



9. KELT STAGE

As the female has released her eggs, she instinctively covers them by moving upstream slightly and repeating her digging motions. This lifts gravel just above the nest, so that the current carries it into the depression. Females will defend their redds until they die, which may be a few hours or a week. Males can spawn more than once and often will leave the female, in search of another that is preparing a nest. Salmon that have spawned are called **kelts**.

10. CARCASS STAGE

Most salmon spawn only once during their lifetime (**semelparous**), although some steelhead have the ability to spawn more than once (**iteroparous**) and can re-generate, return to the ocean, then return to spawn another season. Both the male and female salmon die within a week after spawning. Their **carcasses** float downstream, get caught in roots and limbs, line beaches and sink to the bottom of the river. Opportunists like bears, gulls, crows, and eagles dine on the dead salmon.

The death of the salmon also serves the next generation. As decaying salmon add nutrients to the rivers, they feed aquatic life that will in turn feed young salmon already growing in the gravel in the streambed. In Cascade streams, as much as 40 percent of the nitrogen and carbon in young fish and 20 percent of the nitrogen in streamside plants come from dead salmon.