To Save The Salmon

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11/97

Corps Efforts to Save the Salmon

Here's a bit of history and highlights of the Corps' work to assure salmon survival and restoration.

1805-1900s: Lewis and Clark see "multitudes" of migrating fish in the Columbia River. By 1850, settlements bring agriculture, commercial fishing to the area.

1888: A Corps report warns Congress of "an enormous reduction in the numbers of spawning fish..." in the Columbia River.

1900s-1930s: Overfishing, pollution, non-federal dams, unscreened irrigation ditches and ruined spawning grounds destroy fish runs. Early hatchery operations impact habitat or close the Clackamas, Salmon and Grande Ronde rivers to salmon migration. Congress directs the Corps to draft plans for a hydroelectric, navigation and flood control system in the Columbia River Basin.

1929: Regional Corps officials advise that Corps-built dams should provide for "the passage upstream of fish, especially salmon migrating to breeding places."

1934: Biologists from the Bureau of Fisheries work with the Corps and a Corps-assembled team of outside experts to design the fish passage system for Bonneville Dam. System design and construction costs neared $7 million—about 15 percent of the original project costs.

1938: Bonneville Dam opens. As constructed, its fish collection and bypass system included three fish ladders, two pairs of fish lifts and four special bypasses to help fish pass the dam.

1941: The first resident biologist begins work at Bonneville Dam.

1950s-1970s: Multi-use dam construction continues: (in service) McNary, 1953; The Dalles, 1957; John Day, 1968; and on the Snake River, Ice Harbor, 1961; Lower Monumental, 1969; Little Goose, 1970; and Lower Granite, 1975. Agriculture diverts more water from the river, and industry uses more of the hydropower produced.

1951: The Corps embarks on a new research program focusing on designs for more effective adult fishways.

1955: A fisheries field unit was established at Bonneville Dam. There, biologists and technicians work to better understand and improve fish passage conditions on the river system.

1960s: Experimental diversion screens at Ice Harbor Dam guide some juveniles away from the turbine units, and lead to a major effort to develop juvenile bypass systems using screens for other dams.

1968: The Corps funds a National Marine Fisheries Service (NMFS) experiment at Ice Harbor Dam using tanker trucks to transport smolts past the dams. Initial results were successful enough to convince the two agencies to begin a major collection and transport operation from Little Goose, Lower Granite and McNary dams in 1971. Fish barges, with their larger capacity, were added to the fleet of transport trucks. Lower Monumental Dam was added as a collector dam in 1992. The Corps continues the juvenile fish transportation program today.

1970s-1980s: Evolving Corps policy emphasizes that "environmental values will be given full consideration along with economic, social and technical factors" in planning and constructing water resource development projects. The Corps' fishery research programs develop five technologies to combat fish losses: spillway deflectors, screened turbine intakes, collection and transport of smolts past the dams, improved fishway designs, and flow pattern changes at main-stem dams. "El Nino" (ocean warming) and drought conditions add to the problems of the threatened fish runs. As research and knowledge grow, the Corps adjusts and improves fish passage facilities and operations.

1972: Tests focus on reducing spill-created gas supersaturation, which gives the fish a condition similar to 'bends' in humans. The Corps and NMFS also begin a major study using radio tracking and electronic monitoring areas to determine causes of adult fish delays at dams.

1979: The Corps expands the use of sonar monitoring to determine when significant numbers of juveniles are present above selected dams to maximize benefits of spilling water to divert young fish through spillways and away from powerhouses.

1980s-1990s: Computer models and actual scale models of the dams and river are used by the Corps to study juvenile migration problems and find possible solutions.

1991-1995: Snake River sockeye, plus Snake River spring/summer and fall chinook salmon, are listed as threatened or endangered under terms of the Endangered Species Act (ESA). Under provisions of the ESA, the NMFS provides recommendations for the Corps and the Bureau of Reclamation to consider in operating the Federal Columbia River Power System so that the continued existence of listed salmon species is not jeopardized.

1997: Two Columbia Basin steelhead populations are listed as endangered.

Today: *Research and work are underway on virtually every part of the juvenile and adult bypass systems. Improved turbines, spillway deflectors to decrease gas supersaturation, surface bypass systems, and relocated bypass systems are all on the table. There are no "one-size-fits-all" solutions because each dam, and the river conditions surrounding it, is different.*

Dams and Salmon

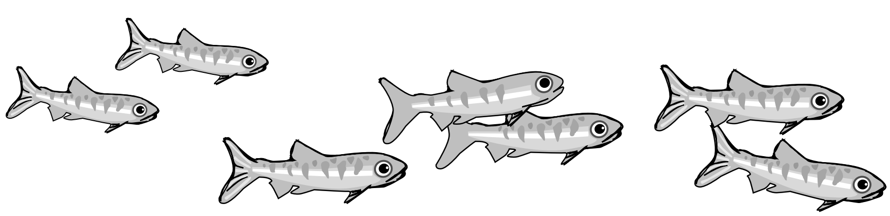
Dams of the Columbia River Basin do many valuable things for the people of the Northwest. They provide a dependable water supply for farms, industry and cities, prevent flooding, power homes and industries, and provide water recreation opportunities. Their locks enable commercial navigation from Portland, Ore., to Lewiston, Idaho, 465 miles from the Pacific Ocean.

However beneficial to humankind, the system of dams in the Columbia River Basin is widely believed to be a major factor in the decline in numbers of wild salmon stocks. The eight lower Snake and Columbia river dams are of particular concern. They make passage more difficult for anadromous fish on a vital stretch of their downstream migration route as juveniles, and are the major obstacles encountered when the fish return upstream as adults. Their reservoirs also change water velocities and temperatures and create favorable conditions for predators that prey on young salmon.

Of course, dams are not the only problem affecting salmon stocks in the basin. Settlement contributes to the decline with logging, mining, cattle grazing and agricultural and industrial pollution in spawning and rearing habitat. Predators, drought, poor ocean conditions, overharvesting and even competition for food and exposure to disease from hatchery stocks also take their toll on wild salmon.

Factors contributing to the decrease in wild salmon stocks can be categorized into what fisheries experts call the "Four H's:" **Hydropower, Harvest, Habitat** and **Hatcheries.**

As the construction and operating agency of eight lower Snake and Columbia river dams, the U. S. Army Corps of Engineers accepts the responsibility for its part of the **Hydropower** "H" and brings with it a long record of interest in salmon survival in the basin.



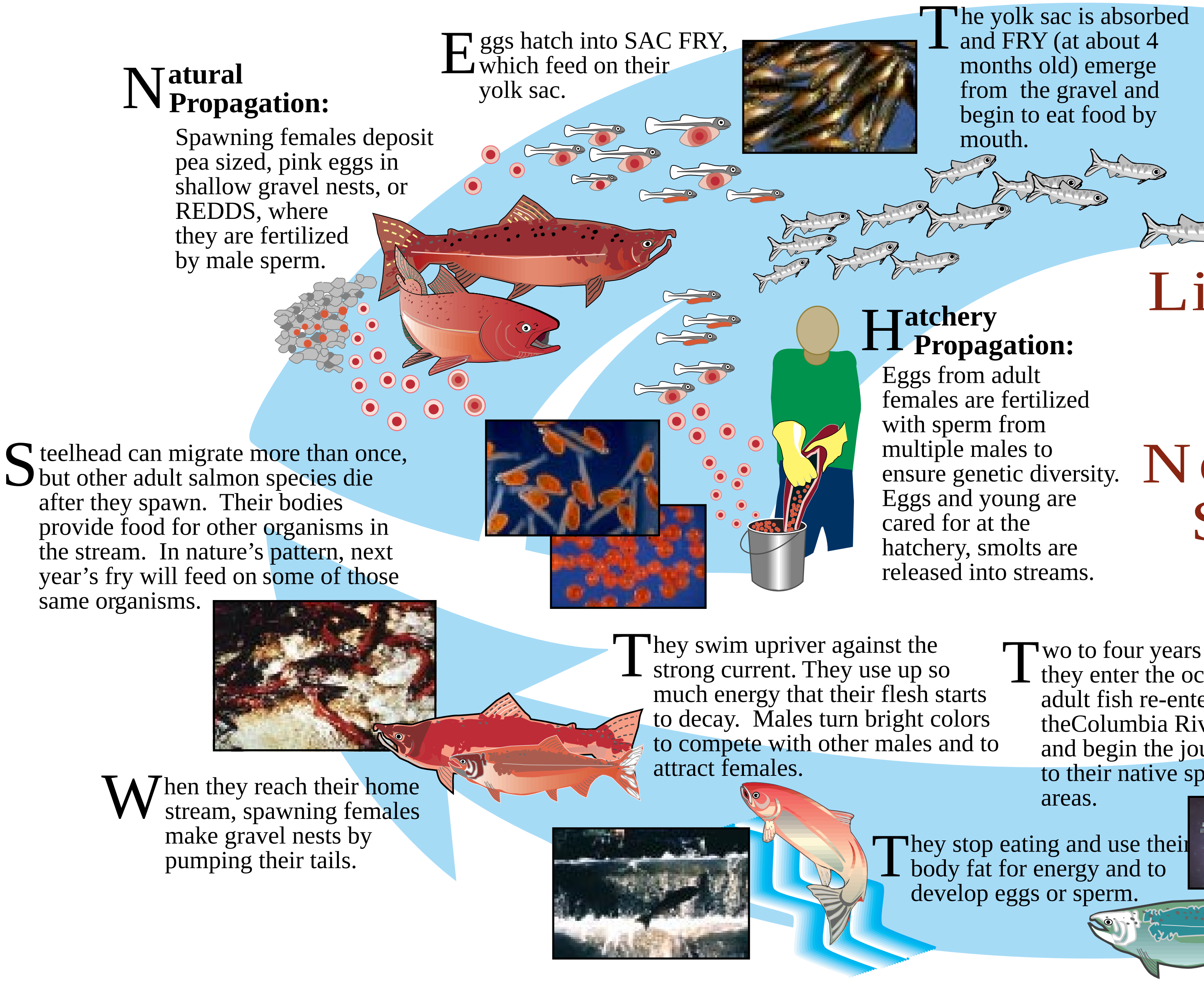
Unraveling the Mysteries

Salmon are *anadromous* fish. The Greek word ‘anadromous’ means ‘running upriver’ and refers to the salmon’s migratory journey to and from the ocean. The Columbia River and upstream tributaries such as the Snake River produce six species of salmon—chinook, coho, chum, sockeye, pink and steelhead. Shad, smelt and lamprey are also anadromous fish.

Since the discovery of the Columbia in 1792 by Robert Gray, who named it after his ship, the river, along with its legendary salmon, has been one of the region’s most romanticized treasures. The salmon’s incredible journey from the Pacific to spawning streams and lakes—some as far inland as 1,000 miles—is an inspiration and wonder to all who learn of this remarkable feat.

Northwest Native Americans not only enjoyed salmon as an important food source, the fish also were the focus of religious ceremonies and rituals for many tribes. The importance of salmon to the economy and culture of Columbia Basin tribes in Oregon, Washington, and Idaho was recognized in the many treaties negotiated, first with territorial governors, and, later, with the United States. These treaties guaranteed the tribes’ rights to fish at usual and accustomed places and remain in force today.

Today, knowledge about salmon behavior is increasing, yet there is much still to be discovered. When baby salmon hatch, their parents are no longer around. For them, there is no such thing as ‘learned behavior.’ Though their desire to head downstream and the road maps they follow to the ocean and back to their



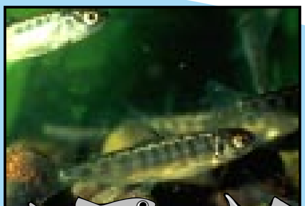
native streams are part of their romance and mystery, this behavior is likely genetically inspired. Some believe that smolts migrating downstream imprint on the sequence of odors they encounter. When they return, the fish follow the reverse sequence.

During their return trip adult salmon are doggedly determined. If the salmon encounter an insurmountable obstacle blocking the way to their destination stream, they usually will die attempting to overcome it. The Corps uses this natural determination to improve adult fish passage systems at the dams. Attraction flows are provided at the dams to guide the salmon to the fish ladders. Otherwise, a salmon may waste days, weeks or its remaining lifetime trying to find a way through or around the dams.

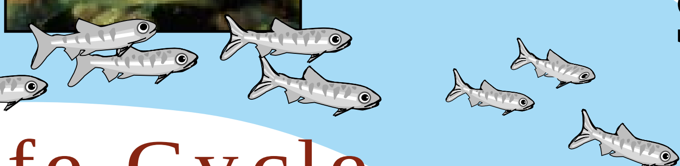
For downstream migrants, scientists have observed that where water currents suddenly get stronger, young salmon will flip around and go-with-the-flow tail-first. Their strong tail fin helps them hold their direction and maintain control in the water column. They do this near dams or within turbine intakes and bypass systems because flows speed up in those places.

Knowing this, Corps biologists and engineers design fishways that maintain a constant and reasonably swift water velocity so that the fish will just “ride” the current as they would in a natural river’s rapids and waterfalls.

Learning about salmon and finding ways to help them migrate safely through dams and other obstacles is essential to their continued survival. The Corps has invested over $1 billion in research, and works cooperatively with state and federal agencies, regional commissions and tribes in search of answers.

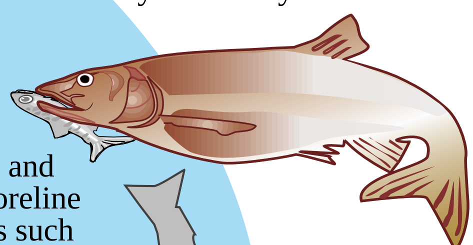


FRY feed and grow in home streams, then begin "smoltification" as their bodies change to get ready for life in sea water.

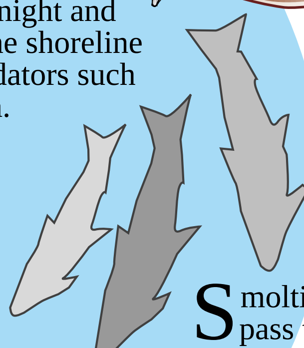


SMOLTS, young fish ready to migrate downstream, "imprint" or store information about the streams and river, so they can find their way when they return as adults.

fe Cycle of Pacific orthwest Salmon



SMOLTS migrate primarily at night and swim near the shoreline to avoid predators such as squawfish.



Smoltification ends when they pass through the estuary where the fresh river water begins mixing with salty ocean water.

Most Northwest salmon swim north to feeding grounds off the coast of British Columbia, Alaska, or the Bering Sea.

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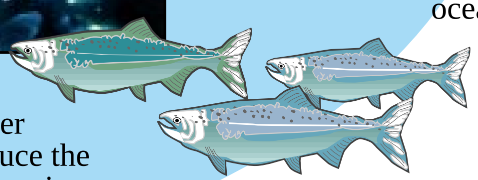
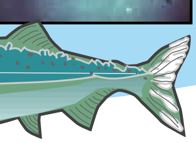
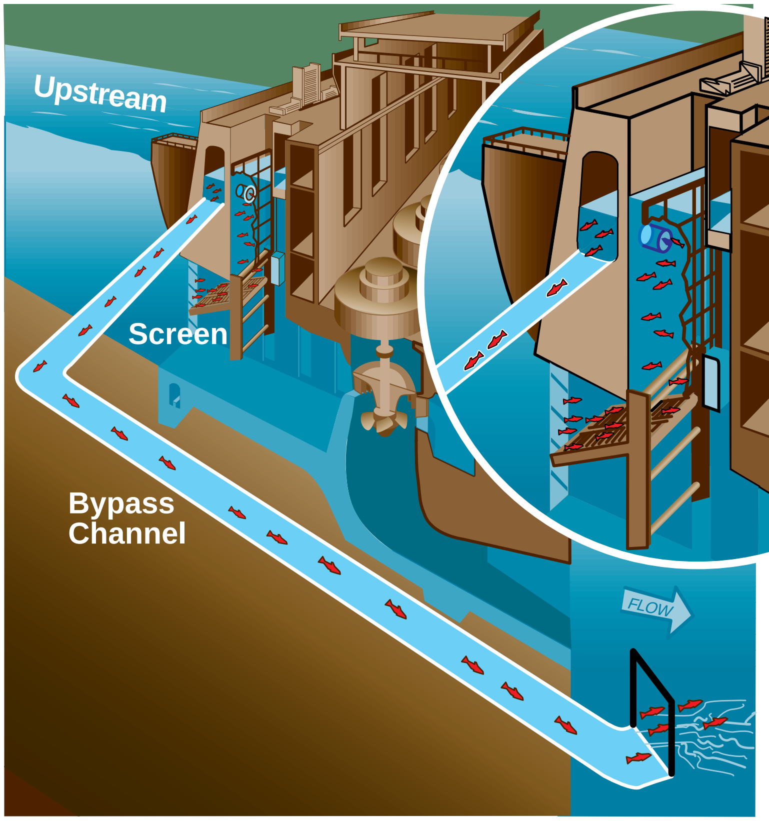
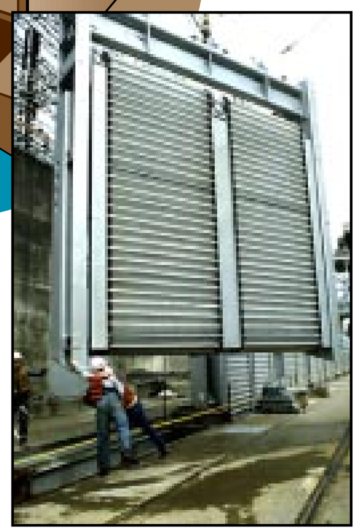


Ocean and river harvests reduce the numbers of returning salmon.



IDEAS IN ACTION...
To Save the Salmon





JUVENILE BYPASS

Water moving through turbines creates current—a flow of water that attracts juvenile fish toward the powerhouse. At most of the Columbia-Snake dams, the Corps has placed large underwater screens in front of the turbine intakes or entrances. As fish follow the current toward the turbine intakes, the screens direct them upward into a bypass channel that runs the length of the powerhouse.

Fish in the bypass channel safely re-enter the river on the downstream side of the dam to continue their journey. At some dams, they also can be diverted to collection raceways or ponds and transferred to barges or trucks which transport them the rest of the way down the river.

Depending on the species of fish, length of the guidance screens and other factors, anywhere from 30 to 90 percent of the juvenile salmon are guided into the bypass channel. The remaining fish pass through the turbines, over the spillway or, at some dams, through a special channel called an ice and trash sluiceway.

The Corps is testing and installing longer screens that extend deeper into the river. Initial research shows that extended screens increase the percentage of the fish guided into the bypass channel.

SPILLWAYS

Juvenile fish can travel past the dam through spillways, a row of adjustable water gates built into the dams.

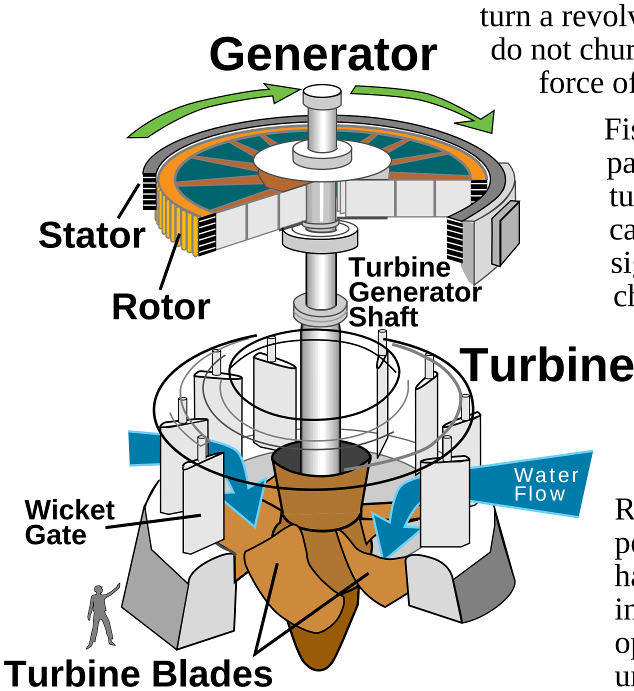
When young fish are approaching the dam, the spillway gates can be opened to let water—and fish—flow through. With regional input, the National Marine Fisheries Service and the Corps develop annual operating plans which often give priority to passing as many juveniles as possible through the spillways rather than through bypass systems. Water that is diverted from the powerhouses to be spilled does not produce electric power.

Some dams may spill 24 hours a day during peak migration periods. Many juveniles travel at night, however, and nighttime spilling is often as beneficial and conserves water when river flows are low. Spilling at night has less affect on adult fish, which prefer to pass the dams during the day.

High spill volumes often create supersaturation of total dissolved gasses, which can cause both juvenile and adult fish to become sick or die from a condition much like "bends" in human divers. Special instruments are used to monitor gas levels so that spill volumes can be adjusted accordingly.

TURBINE PASSAGE

The energy of falling water is converted into electricity as it flows down through the turbines from the upstream side of the dam. Moving water turns the turbine blades much like people turn a revolving door as they walk through. The blades do not churn the water, but instead are moved by the force of the water.



Fish that are not bypassed, transported, or passed through spillways go through the turbines. Several conditions inside a turbine can injure or kill migrating juveniles. The most significant of these are the extreme pressure changes and, to a lesser extent, blade strike. The majority of fish survive turbine passage. Many, however, become disoriented and are less able to avoid predators that are often waiting for them when they re-enter the river.

Research has shown that turbines operating at peak efficiency are safest for fish. The Corps has installed computer controls on all turbines in the Columbia/Snake river system to optimize their efficiency. Research is also underway to improve other aspects of the environment inside turbines to benefit migrating juvenile fish.

COLLECTION AND TRANSPORT FACILITIES

One way to get young salmon downstream through slow-moving reservoirs, avoid problems with dam passage, hungry predators and the perils of gas-supersaturation, is to give them a ride.

That’s why many juvenile salmon are given a lift downriver. These fish are collected at Lower Granite, Little Goose, Lower Monumental and McNary dams. Most travel in specially equipped barges, while a smaller number are transported in tanker trucks. The transported fish are released back into the river below Bonneville Dam.

Each transport barge and tanker truck is custom made to make the trip as safe and comfortable as possible. As the barge travels downriver, fresh river water is constantly circulated, making a complete water change several times an hour. This not only keeps the water fresh and healthy for the young fish, but also helps them ‘get to know’ or 'taste' the river just as they would if they were still swimming in it. If the barge encounters poor water conditions such as chemical pollution or high levels of gas, circulation pumps can be turned off until good water is found.

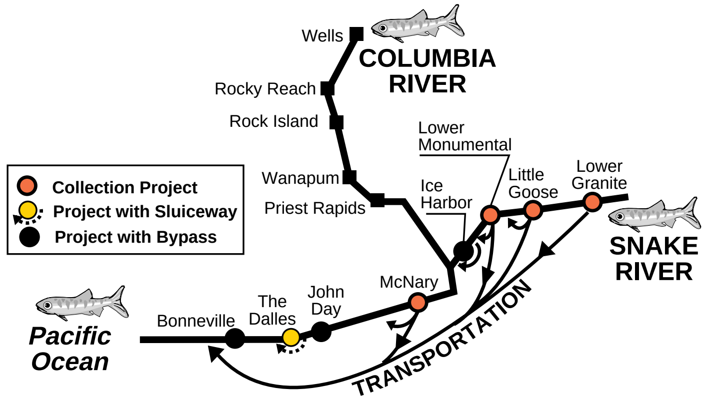
Even though the trucks don’t travel on the river, their fish tanks also contain river water which is kept at ideal temperatures and properly aerated for the fish.

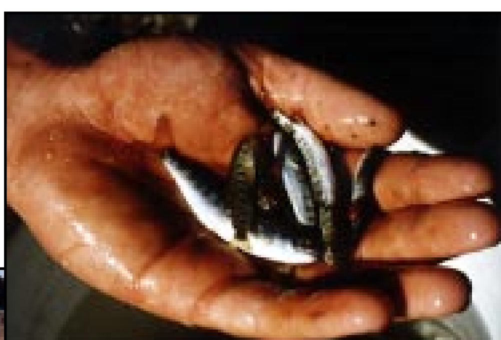
There is an active debate about the benefits of transportation - especially for spring/summer chinook salmon. The Corps, along with state and federal fishery agencies, the National Marine Fisheries Service, and several universities and independent researchers are currently conducting research to enable the region to reach consensus on this issue. The simple question is a results-oriented one. Do transported salmon return as adults at a higher ratio than fish left in the river, and in sufficient numbers to help rebuild the runs?

While many difficult decisions have yet to be made, juvenile salmon transportation remains an option along with other downstream passage measures available to agencies charged with restoration of salmon populations.

Columbia/Snake River System

Juvenile Fish Passage Routes





Corps of Engineers' dams
Dams owned by others
Adult fish passage blocked
Canada
U.S.
WA
OR
ID
MT
Mica
Revelstoke
Arrow Lakes
Duncan
Kootenay Lake
Keenleyside
Libby
Hungry Horse
Chief Joseph
Grand Coulee
Wells
Rocky Reach
Rock Island
Wanapum
Priest Rapids
Columbia R.
Albeni Falls
Pend Oreille Lake
Noxon
Flathead Lake
Kerr
Seattle
Lower Monumental
Little Goose
Lower Granite
Dworshak
Ice Harbor
The Dalles
McNary
John Day
Bonneville
Portland
Willamette R.
Oxbow
Hells Canyon
Brownlee
Boise Projects
Jackson Lake
Snake R.
American Falls
Minidoka

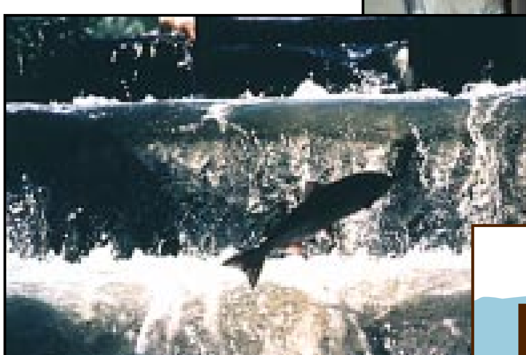
ADULT FISH PASSAGE

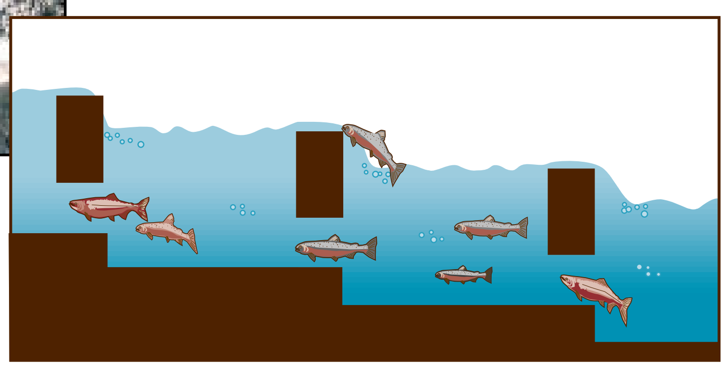
Ladders and Counters

A fish ladder is like a stairway that forms an artificial set of rapids. Adult fish can jump from one 'step' to the next. Usually, however, they swim through openings at the bottom of each step in the ladder. The success rate for adults negotiating the fish ladders is about 95 percent.

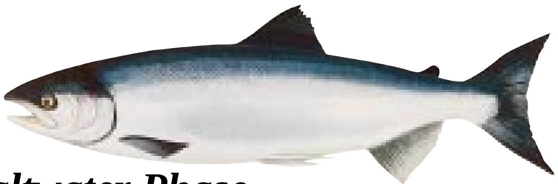
Fish counters record the number of adult fish, by species, as they move past underwater windows. This data is used by agencies to manage the fishery. Records date back to the opening of each dam. Visitors also may watch through underwater windows in visitor centers at the dams as fish move through the ladders.

Numbers of returning adult salmon have varied each year since counting began at Bonneville Dam in 1938. The lowest yearly total at Bonneville was in 1944 when less than 400 thousand were counted. In 1985 and 1986, total runs topped one million fish. In recent years the runs are at about one-half million. At Lower Granite, where counting began in 1975, the lowest yearly total was 37,777 in 1979, the highest 177,558 in 1986. The1995 and 1996 runs tallied close to 100,000 fish. The ratio of wild fish to hatchery fish has also changed. Today, only about 20 percent of the upriver migration is wild fish.

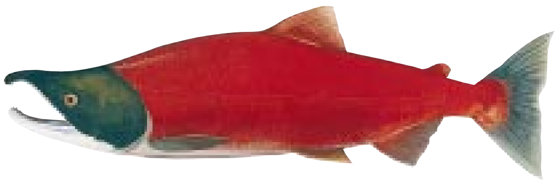




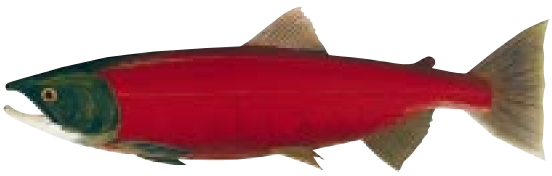
Sockeye



Saltwater Phase

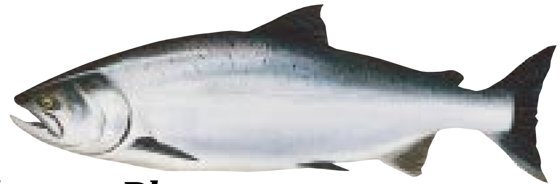


Male - Freshwater Phase



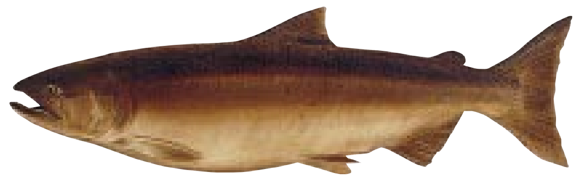
Female - Freshwater Phase

Chinook



Saltwater Phase

Male - Freshwater Phase

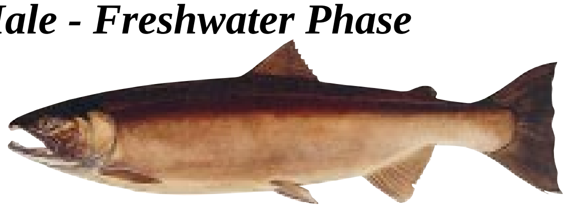


Female - Freshwater Phase

Coho

Saltwater Phase

Male - Freshwater Phase

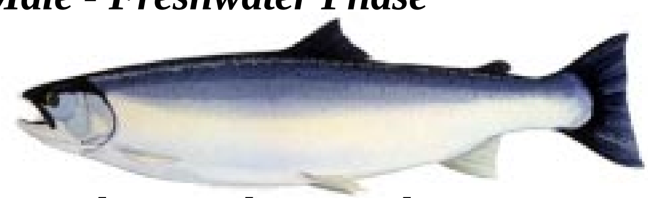


Female - Freshwater Phase

Steelhead

Saltwater Phase

Male - Freshwater Phase



Female - Freshwater Phase