

From *Earthscapes In Time: The SEE-THROUGH Satellite Atlas*

Earthscapes in Time: The See-Through Satellite Atlas displays natural fluctuations in the Earth and human-made changes over two decades, using satellite images from NASA, Landsat, NOAA and the CIA. Fully annotated images of the same area, taken decades apart, demonstrate the many transformations that have occurred from deforestation and forest recovery, urbanization, the ozone hole and ground water usage. As with all CD titles in the Small Blue Planet series, users can access a highly detailed Hammond relief map covering the region onscreen. Another module, *Civilizations Out of Time*, parallels the rise and fall of historical cultures and then compares them to modern situations. Now What Software, San Francisco, CA

To know the salmon is to know the indomitable energy of life itself. —John Daniel

Part plumbing, half-machine. The Columbia has become a robo-river, a cyborg of sorts. —Richard White

In spring, summer, and fall, adult salmon convene in the Pacific Ocean at the mouth of the Columbia River to begin a journey to their birth streams. Each fish swims upstream in a specific river (and its tributaries) to a particular spot where it spawns and dies, closing a cycle that began with its parents' identical journeys. For five million years, an estimated 16 million salmon have spawned yearly in the Columbia River watershed. Today, Columbia River salmon and steelhead trout returning to the watershed number about 300,000, a decline mostly attributed to the construction of some 50 hydroelectric dams since 1933.

To understand the incompatibility of dams and salmon runs, it helps understand something of the salmon's biological imperative. Five salmon species and the steelhead trout, having reached maturity in one to five years, migrate from the ocean to the inland streams of their birth. Columbia River salmon literally climb mountains upstream, some as far as 1,200 miles (1,900 km) inland, racing against the clock and evading predators. If they make it past various obstacles to the spawning grounds, females dig nests with their tails and deposit as many as 4,000 eggs, while males spread their milt. Both parents die and decompose, contributing nutrients to the inland ecosystem.

About an eighth of the eggs will make it to the fry stage (about an inch long) where more than 90% die or are eaten. The remainder, now called fingerlings, feed on lake plankton and insect larvae for a few months before being pushed downstream by cold, fast-moving runoff. During this interval, normally 20 to 30 days, smoltification, the process by which salmon become acclimated to saltwater, occurs. An estimated one percent of the eggs laid become smolts.

Human activities are hazardous to this process. Clear-cutting trees close to the river's edge removes the rich source of nutrients that decomposing leaves contribute and the essential, water-cooling shade of overhead branches. Logging roads are also problematic; of the Forest Service's 340,000 miles of logging roads, 30% are in the Pacific Northwest. These roads change runoff patterns, washing silt into rivers which covers gravel essential for spawning. Bundles of logs floating downstream scour the gravel out of river bottoms.

If the lack of habitat does not get the small salmon, there is the added challenge of contamination in the water itself. Paper mills dump toxic waste into the rivers. The Columbia River basin is host to 43 Superfund sites (sites identified as so toxic they merit federal cleanup funds) outside the abandoned Hanford Nuclear reservation, as well as 1,400 other, separately identified pollution sites inside the reservation itself. Runoff from nearby farms introduces fertilizers and pesticides into streams. Mines leach heavy metals that poison fish populations. In spite of all this, the salmon have endured.

THE SALMON: CANNED

Human occupation on the banks of the Columbia began approximately 11,000 years ago. When the Europeans began exploring the Pacific Northwest in the late 18th century, the salmon were so abundant they were thought to be limitless. In the early 19th century, French Canadian trappers discovered the Columbia's headwaters in Canada, and in 1805 Lewis and Clark were the first whites to paddle down the Columbia from the interior to the Pacific Ocean.

Native American contact with Europeans resulted in both cooperation and violent conflict. Indians acted as guides, shared food, married, lived with, and traded with whites, and played integral roles in the constantly shifting presence and claim of the region by the English, Americans, Spanish and Canadians. Disease killed many more natives than settlers' violence. An estimated 90% of the Chinook tribe died of European diseases by 1834.

White occupation of the region became more and more profitable. Trapping, trading, and export were practiced by the Canadian North West and Hudson Bay companies, with fur shipping going as far as China. Control of the region was settled with the creation of the international border between Canada and the United States in 1846. Also in 1846, the Oregon Territory was established, followed in 1853 by the creation of a separate territory north of the Columbia River, called the Washington Territory.

Three entrepreneurs from Maine successfully canned and exported the first salmon from the region in 1866. (In 1807, Nicolas Appert, a confectionery shop owner in Paris, claimed the 12,000 Franc prize for inventing canning as a food preservation method for Napoleon's armies.) Within twenty years, fifty-five canneries operated on the Columbia, most in the city of Astoria. (see the Landsat image pairs, at the river's mouth). As fishing technologies improved (from half-mile long nets pulled by draft horses in the river's mouth to the gasoline engine trollers of the 1920's, and beyond) and the fleet expanded, the salmon declined. Production of canned chinook, the largest salmonid species, peaked at 43 million pounds in 1883, followed in 1911 by a peak of 46 million pounds of several species of salmon. Half of the Columbia River salmon populations were fished out before a single dam was built.

SALMON: UP AGAINST THE WALL

"The only obstacle the salmon have not been able to overcome," says Idaho governor Cecil Andrus, "was the pouring of concrete across their rivers."

Some 25 million years ago, the Columbia Basin was formed by flows of basalt magma. Coulees (from the French verb couler, "to flow") were gouged out by great Ice Age floods about 16 million years ago. The term is now used to describe a dry riverbed. The largest was Grand Coulee, the site of the third great water reclamation project built on the Columbia. The big hydroelectric dams on the Columbia were intended to make its waters useful for agriculture, create cheap electricity, bring work to communities during the Depression; and, in the words of President Roosevelt during a visit to the work camps of the Bonneville and Grand Coulee dams in 1933, "not only develop the well-being of the Far West and the Coast but...also give an opportunity to many individuals and families in the older, settled parts of the nation to come here and distribute some of the burdens which fall on them more heavily than in the West."

Cheap power brought industry to the new region. Today Pacific Northwest regional consumers pay far less for power than most of the rest of the U.S.; aluminum smelters on the Columbia pay even less, about one-third the national average for industrial users. The bombing of Pearl Harbor silenced skeptics who questioned the Depression-era need for Grand Coulee Dam's electricity. Aluminum mining and smelting became a force in the region's economy and the war effort; Columbia River electricity powered Boeing's production of 10,000 bombers; and the production, in Vancouver and Portland, of 27% of the ships built for U.S forces in WWII. Today the Columbia River powers ten of the nation's twenty-three aluminum smelters.

From the beginning, salmon populations were expected to decline as a result of dam building, a result accepted in the expectation of the benefits of clean, cheap power, mostly received by local industry. "Recent studies estimate 90% or more of human-inflicted mortality (of salmon) comes from the dams and reservoirs behind them," says Joel Bourne. Dams block the upstream passage of salmon returning to spawn. They create warm, still lakes behind — the antithesis of the cold, fast moving gravel streams that salmon require for spawning. Dam spillways change siltation patterns, causing silt buildup over gravel beds that would normally be washed clean by stream runoff. Thousands of young salmon washing downstream are ground to mush by dam turbines. Smoltification, the process by which young salmon become saltwater fish, is altered as the downstream journey is extended from some twenty days to as long as three months.

DNA, LADDERS AND DECLINE

Engineers and biologists hoped that fish ladders (pools of water arranged like a staircase that go up and over the front of a dam) would help adult salmon return to spawning streams. But not all dams are equipped with fish ladders. "Grand Coulee, too tall for fish ladders, eliminated the most fabulous run of all; the chinook called 'June Hogs,' fish that grew to five feet long and 125 pounds and used that bulk to fuel their epic journey into the Columbia headwaters in British Columbia," says John Daniel. "The returning June Hogs of 1941 milled in (front) of the new dam, waiting weeks for the obstruction to clear, until they could wait no longer and spawned where they were. Their population held on below the dam until the mid-1950's, when it disappeared forever."

Efforts to truck juvenile salmon around the dams have been costly and mostly unsuccessful. This practice on the Snake River, the Columbia's largest tributary, has not saved the sockeye. Trucking batters the fish and promotes the spread of disease.

Congress passed the Mitchell Act to fund the building of hatcheries to produce salmon to replace those lost by the destruction of habitat. Hatchery fish are bred for maximum numbers, not for genetic diversity. They are raised in concrete tanks and are therefore subject to increased disease transmission. They are hand-fed (fisheries biologists report that the shadow of a hand over the tank doesn't scare the fish as it would wild salmon, but draws them together, expectant for food) and are unaccustomed to avoiding predators. When released into the streams with wild salmon, hatchery-bred fish bring along their genetic inferiority and susceptibility to disease, and, in their sheer numbers, compete for food and space, making life even tougher for wild salmon.

Wild salmon populations are disappearing. This loss affects the Pacific Northwest ecosystem since salmon are at the center of an ecosystem of insects, bears, raptors, humans, orcas, seals and birds. Their yearly migration constitutes a uniquely beneficial transfer of energy from the ocean to the inland environment.

The impact of dam construction on white and Indian fishery communities can't be overstated. "Native Americans lived on the Columbia for at least eleven thousand years before European discovery. When it was inundated by the Dalles Dam in 1957, the Indian fishing community at Celilo Falls which is 250 miles upstream, dated back eight millennia (8,000 years) and was the oldest continuously inhabited community on the continent," says William Dietrich.

1983 was recorded as the year of the smallest Columbia River salmon catch in history. In 1990, after decades of conflict between whites and Indians over fishery quotas, the Shoshone-Bannock tribe (the tribe of Sacajawea, who accompanied Lewis and Clark on their passage) petitioned successfully to place the Snake River sockeye on the endangered species list. Similar proposals to list Snake River chinook and coho salmon on the Pacific Coast have been filed. Fishermen, long reluctant to invoke the Endangered Species Act because it would limit their access to fish runs, have nothing left to lose.

In 1994, the Northwest Power Planning Council, created by Congress, adopted a plan to address declines in salmon populations. At the center of the controversial plan is a recommendation for drawing down the reservoir levels of four federal dams on the lower Snake River to provide sufficient water to flush juvenile salmon out to sea. Federal agencies, such as the Army Corps of Engineers (responsible for nine dams on the Columbia and Snake Rivers), are required by law to comply with the council's recommendations. Opponents of the plan say that the council has underestimated the costs to the region to interrupt power production and barge activities. As of August 1995, the Army Corps of Engineers was investigating the costs and impacts of such a plan.

Such measures, while seen by some as drastic, may be too little too late. In 1991, the American Fisheries Society judged more than half of the stocks of Pacific Northwest salmon are at risk of extinction. Asked what she thought should be done to save the salmon, a woman working in the gift shop of the Columbia River Maritime Museum replied, "Well, they say the life expectancy of concrete is only 100 years."

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