Environmental Case Study

Why Trees Need Salmon

Ecologists have long known that salmon need clean, fast-moving streams to breed, and that clear streams need healthy forests. Surprising new evidence now indicates that some forests themselves need salmon to remain healthy, and that bears play an important intermediary role in this dynamic relationship.

The yearly return of salmon from the open Pacific Ocean to coastal waters of western North America is one of nature’s grand displays. Salmon (*Onchorhyncus* sp.) are anadromous: They hatch in freshwater lakes and streams, spend most of their lives at sea, then return to the stream where they were born, to breed and die. To reproduce successfully, these fish require clear, cold, shaded streams and clean gravel riverbeds. If forests are stripped from riverbanks and surrounding hillsides, sediment washes down into streams, clogging gravel beds and suffocating eggs. Open to the sunlight, the water warms, lowering its oxygen levels, and reducing survival rates of eggs and young fish.

Every year, as millions of fish return to spawn and die in rivers of the Pacific Northwest, they provide a bonanza for bears, eagles, and other species. Ecologist Tom Reimchen estimates that each bear fishing in British Columbia’s rivers catches about 700 fish during the 45-day spawn, and that 70 percent of the bear’s annual protein comes from salmon. After a quick bite on the head to kill the fish, the bears drag their prey back into the forest, where they can feed undisturbed. Some bears have been observed carrying fish as much as 800 m (0.5 mi) from the river before feeding on them.

Bears don’t eat everything they catch. They leave about half of each carcass to be scavenged by eagles, martens, crows, ravens and gulls. A diversity of insects, including flies and beetles, also feed on the leftovers. Within a week, all the soft tissue is consumed, leaving only a bony skeleton. Reimchen calculates that between the nutrients leeching directly from decomposing carcasses and the excreta from bears and other scavengers, the fish provide about 120 kg of nitrogen per hectare of forest along salmon-spawning rivers. This is comparable to the rate of fertilizer applied by industry to commercial forest plantations. Altogether, British Columbia’s 80,000 to 120,000 brown and black bears could be transferring 60 million kg of salmon tissue into the rainforest every year.

How do ecologists know that trees absorb nitrogen from salmon? Analyzing different kinds of nitrogen atoms, researchers can distinguish between marine-derived nitrogen (MDN) and that from terrestrial sources. Marine phytoplankton (tiny floating plant cells) have more of a rare, heavy form of nitrogen called 15N compared to most terrestrial vegetation, in which 14N, the more common, lighter form, predominates. Using a machine called a mass spectrometer, researchers can separate and measure the kinds and amounts of nitrogen in different tissues. We’ll discuss different forms of atoms (called isotopes) later in this chapter. Because salmon spend most of their lives feeding on dense clouds of plankton far out to sea, they have higher ratio of 15N/14N in their bodies than do most freshwater or terrestrial organisms. When the fish die and decompose, they contribute their nitrogen to the ecosystem. Bears and other scavengers distribute this nitrogen throughout the forest where they drop fish carcasses or defecate in the woods.

Robert Naiman and James Helfield from the University of Washington found that foliage of spruce trees growing in bear-impacted areas is significantly enriched with MDN relative to similar trees growing at comparable distances from streams with and without spawning salmon. These results suggest that in feeding on salmon, bears play an important role in transferring MDN from the stream to the riparian (streamside) forest. Nitrogen is often a limiting nutrient for rainforest vegetation. Tree ring studies show that when salmon are abundant, trees grow up to three times as fast as when salmon are scarce. For some streamside trees, researchers estimate that between one-quarter to one-half of all their nitrogen is derived from salmon. Not only do salmon replenish the forest, but they also vitalize the streams and lakes with carbon, nitrogen, phosphorous, and micronutrients. Nearly 50 percent of the nutrients that juvenile salmon consume comes from dead parents.

This research is important because salmon stocks are dwindling throughout the Pacific Northwest. In Washington, Oregon, and California, most salmon populations have fallen by 90 percent from their historic numbers, and some stocks are now extinct. Because of the close relationship of salmon and the trees, biologists argue, forest, wildlife, and fish management need to be integrated. Each population—rainforest trees, bears, hatchlings, and ocean-going fish—affects the stability of the others. Salmon need healthy forests and streams to reproduce successfully, and forests and bears need abundant salmon. Stream ecosystems need standing trees to retain soil and provide shade. So healthy streams depend on fish, just as the fish depend on the streams. As this case shows, the flow of nutrients and energy between organisms can be intricate and complex. Relationships between apparently separate environments, such as rivers and forests, can be equally complex and important.

Reading the case study to the left, complete the following

1) Illustrate a food web based on the case study above – include all animals mentioned in the case study.

2) Illustrate a food pyramid – include the biomass ratios using the 10% rule.

Pyramid

Mass Ratios per Level

3) Summarize the importance of the case study above

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Rebirth on the River: Washington's Elwha Flourishing After Big Dam Removals

Posted by Guest Blogger in Water Currents on August 29, 2013

By Jason Jaacks

The first signs of life are beginning to return to the Elwha River in Washington State, where the largest dam removal in U.S. history is nearly complete. The Elwha River begins in the heart of Olympic National Park and flows 45 miles (72 kilometers) to the Strait of Juan de Fuca. Historically, all five species of Pacific salmon lived in the river–a rare occurrence even in salmon country. Old photographs show smiling fishermen hefting 85-pound (39-kilogram) Chinook salmon caught in the Elwha. There were rumors of Chinook salmon that weighed over 100 pounds (45 kilograms).

I began photographing the Elwha River in 2010, a year before the dams were slated to be removed. The whole process has taken several years–each dam has been torn down bit by bit to allow the river to move as much sediment as possible downstream.

Source to Sea

Last year, I rafted and walked the Elwha from source to sea as a National Geographic Young Explorer. Over the course of several weeks, my team and I followed the river as it plunged through the mountains. While we explored the Elwha backcountry, I imagined how the river must have looked a century ago, surrounded by thick stands of old growth forest and running freely through the mountains. The only thing that was missing was salmon.

Once we reached the old reservoirs downstream, the landscape looked completely different. As the reservoirs drained, the river chiseled through plateaus of mud, sand, and silt. At the time of the expedition, in August 2012, Elwha Dam was completely gone and Glines Canyon Dam was about ⅔ gone. We left the river and crossed the emptied lake beds on foot. It felt like walking across a moonscape, everything was covered in ash-grey dust.

The most powerful part of our trek down the former reservoirs was finding stumps of giant trees that were logged before the dams were built, nearly a century ago. They had been perfectly preserved under the water and mud. We could even see where loggers had notched the trees to saw them down. At the time I found it hard to believe that a forest could ever reclaim the abandoned lake bed.

Returning to the River

A year later, I returned to the Elwha to see if the landscape had changed. My first stop was at the reservoir behind Elwha Dam. What I remembered from the expedition–a dusty moonscape interrupted only by a small ribbon of flowing water–had completely transformed. The river was beginning to meander, to take shape and re-carve its path across the former lakebed. The plateaus of dirt left high and dry were covered in sprouting grasses, shrubs, and alder bushes. The old growth stumps were still there, but they were surrounded by new flora.

As I walked, I saw tracks everywhere: deer, elk, river otter, birds. The landscape was awakening and the river was coming back to life. But I didn't see any redds in the river–the nests that spawning salmon make in the river bottom. Were the salmon returning?

After several days of documenting the former reservoirs, I connected with several fisheries biologists from the National Oceanic and Atmospheric Administration (NOAA). We spent the morning below the Elwha Dam site looking for Chinook salmon. The water was dark and murky; it was still carrying sediment down from the reservoirs.

In the span of a few hours, we caught, measured, and released 19 adult Chinook salmon. According to one of the biologists, it's only a matter of time before the fish move upstream. I've been going back up to the Elwha River for the last four years and I've watched the landscape transform. Officials from Olympic National Park expect Glines Canyon Dam to be completely removed by September 2014. I hope to continue witnessing this incredible restoration project beyond the dam removals. The story of the Elwha, to me, is a story about a river slowly coming back to life, one season at a time.

4) based on the article above – explain the impact urban development had on the ecosystem

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