Salmon Restoration, 101

Spotlight on Research

Northwest Fisheries Science Center

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Striding over slick cobbles and skirting downed nurse logs, Northwest Fisheries Science Center stream ecologist Peter Kiffney looks like just another fly fisherman cast for a scene in "A River Runs Through It."

But Kiffney casts no gently arching fishing line into this slow-moving water. Instead, his line spits out of an orange contraption about the size of a Viewmaster clipped to his waist; the line tracks the distance he travels as he gets to know one of the streams in the Cedar River watershed up close and personal.

On a satellite map, the Cedar River watershed gleams like an emerald green oasis amid the asphalt and concrete of the bustling greater Seattle area.

The watershed is home to 83 species of wildlife and fish, including the endangered -- spotted owls and chubby, neckless marbled murrelets -- and lies within the range of threatened chinook salmon. The 90,500 acres from which the city draws two-thirds of its drinking water for 1.25 million people are closed to development, hiking, camping and logging and are about as close as you get to pristine potential salmon habitat.

Soon, the potential will turn to actual: Nearly a century after the city built a dam that diverts drinking water but bans salmon from entering the watershed, they will build a fish ladder for steelhead trout, chinook and coho salmon to return.

The city is guardedly optimistic. Aiding salmon recovery is one of its goals.

But the transformation that will occur at the Cedar River watershed has no precedent elsewhere in the region. Exactly what happens when salmon return to a habitat after a 90-year-long absence? What happens when that Rip Van Winkle habitat awakens to a fertile supply of nutrients for bugs, bacteria, algae, fish, plants and trees? How do salmon colonize new waters? What happens to salmon diversity? And, city water managers wonder nervously, what happens to the purity of drinking water that meets or exceeds federal standards when you add spawned-out salmon carcasses to the mix?

"There's this real concern about what salmon might do to water quality. How many salmon can they let up there before they actually have some kind of material impact on the quality of the water? And what's that going to do in terms of what they have to do in terms of treatment?" said Bob Bilby, former Northwest Fisheries Science Center watershed processes program manager. "There's a potential downside they're fairly concerned with."

That's why a small band of NWFSC scientists -- clothed in waders, slathered with sunscreen and bug dope, outfitted with clipboards and waterproof GPS monitors -- have fanned through the Cedar River watershed this summer. They're measuring before and after water chemistry. They're making predictions of the places returning salmon might like best. They're running before and after isotopic analysis to pinpoint how the nutrients salmon deliver are gobbled up by a nutrient-starved ecosystem.

The scientists fill a dusty Jeep with a clump of waders, fleece, hiking boots and PVC pipe, like giant Pixi sticks, marked at intervals with black tape. They negotiate a series of locked gates and wind along narrow dirt roads that cut through old-growth and second-growth stands of Douglas fir, Western hemlock, Western red cedar and Sitka spruce. A polka dot flag dangles from

The Cedar River watershed provides two-thirds of Seattle's drinking water.

a branch to mark where they finished up the previous day.

Kiffney predicts Rock Creek, the subject of the morning's mapping effort, will be the object of coho adoration.

"They like smaller streams. And they love to rear in this marshy, slow-water habitat," he said. "We're predicting coho are going to get up there and like what they see."

The sky is gray and ambivalent, neither sighing with showers nor smiling with sun. Shaggy moss clings to exposed rocks. Fungi of improbable sizes and colors juts from downed alders. Kiffney creeps down from road level to stream level, cutting through fox glove and salmonberry underbrush.

Just as no two faces are alike, no two streams are the same. Kiffney keeps a keen eye to note and record the specific characteristics of this stream, stopping at a pool, a puddle of slow-moving water with a noticeable depression. Lunging under a downed alder, he flips the marked PVC pole end over end to measure P1's length and dunks the pole in to measure P1's maximum depth.

Same for R, or riffle, a place where water's flow has sped, dancing to create a frothy turbulence.

And the same for side channels, which are separated from the main bar by gravel, masses of tree roots or wood jams, and which slow the water to nearly stagnant.

No woody debris is complete without a "small," "medium" or "large" characterization. And there are no mere "rocks." A rock smaller than a baseball is gravel. Bigger than a baseball yet smaller than a basketball makes it a cobble. Too big for Michael Jordan to palm? Call that rock a boulder. Some rocks look pocked with acne. It's just caddisflies, aquatic insect grazers that are a sign of a healthy stream.

From previous research, the scientists have a hint what to expect when salmon negotiate the 17 miles of habitat made off limits by the Landsburg diversion dam.

Salmon returning in the fall and winter to spawn and die provide pulses of nitrogen and phosphorus, essential nutrients for the stream and for the ecosystem. The nutrients are gobbled up -- used immediately or hoarded for the future -- at every level of the food web.

"The salmon are the cornerstone of the ecosystem," Kiffney said.

Add salmon and, at the base of the food chain, the community of primary producers like algae increase in number. That triggers increases in abundance of invertebrates -- the scrapers, the grazers and herbivores that eat those plants. Insect populations boom. Predators, primarily salmon, are fueled by that increased insect productivity, Kiffney said.

Using the specialized fingerprint that marine salmon carry -- a unique ratio of heavier nitrogen atoms to lighter nitrogen atoms -- the researchers hope to trace the various places where salmon nutrients are used by the ecosystem. Water. Insects. Resident fish. Bushes. Trees. Isotopic analysis can be done at every level of the food web.

It's not clear how many nutrient deposits the watershed would need to experience to create the hospitable habitat that would nurture fat, healthy juvenile salmon.

"That system has been without those nutrients for 90 years," Kiffney said. "So the early fish, they're not going to have too much trouble once they're up there. Because they're basically up there to spawn. It's probably those next generations following that that may have some difficulty, just because of the nature of how those nutrients have been lost."

The simplest solution would be to tip the scales, priming the pump by adding spawned-out salmon carcasses. The city will not allow it on a wide scale but has given the go-ahead for small experiments that would track water chemistry and other changes in a few experimental channels.

"You can make these little experimental troughs -- basically -- that simulate a stream. You can add carcasses to these troughs and see how those carcasses influence the community, including juvenile salmon," Kiffney said.

The trough, based on past research, should become a salmon-eat-salmon world.

In research of fish behavior along Washington's southwest coast, Bilby and co-authors found that adding spawned-out adult salmon carcasses in a stream attracts a flood of juvenile salmon. And they're not there as innocent bystanders.

photo: Bob Bilby, NWFSC

Spawned-out salmon carcasses deliver nutrients that fuel ecosystem growth – among trees, shrubs, aquatic insects, even juvenile salmon.

"Anywhere from 60 to 90 percent of the material that we recovered from their stomachs was either carcass flesh or salmon eggs. So, they were feeding fairly heavily on the carcasses," said Bilby, lead author of the article published in the "Canadian Journal of Fisheries and Aquatic Sciences."

And, the bigger the younger salmon are, the better their chances of surviving when they hit the saltwater stage of their life, Bilby said.

"The difference is very, very significant. Relatively small increases in body size translate into large increases in survival in the ocean."

-- Diedtra Henderson

Next: Sniffing Out Salmon Risk From Pesticides

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