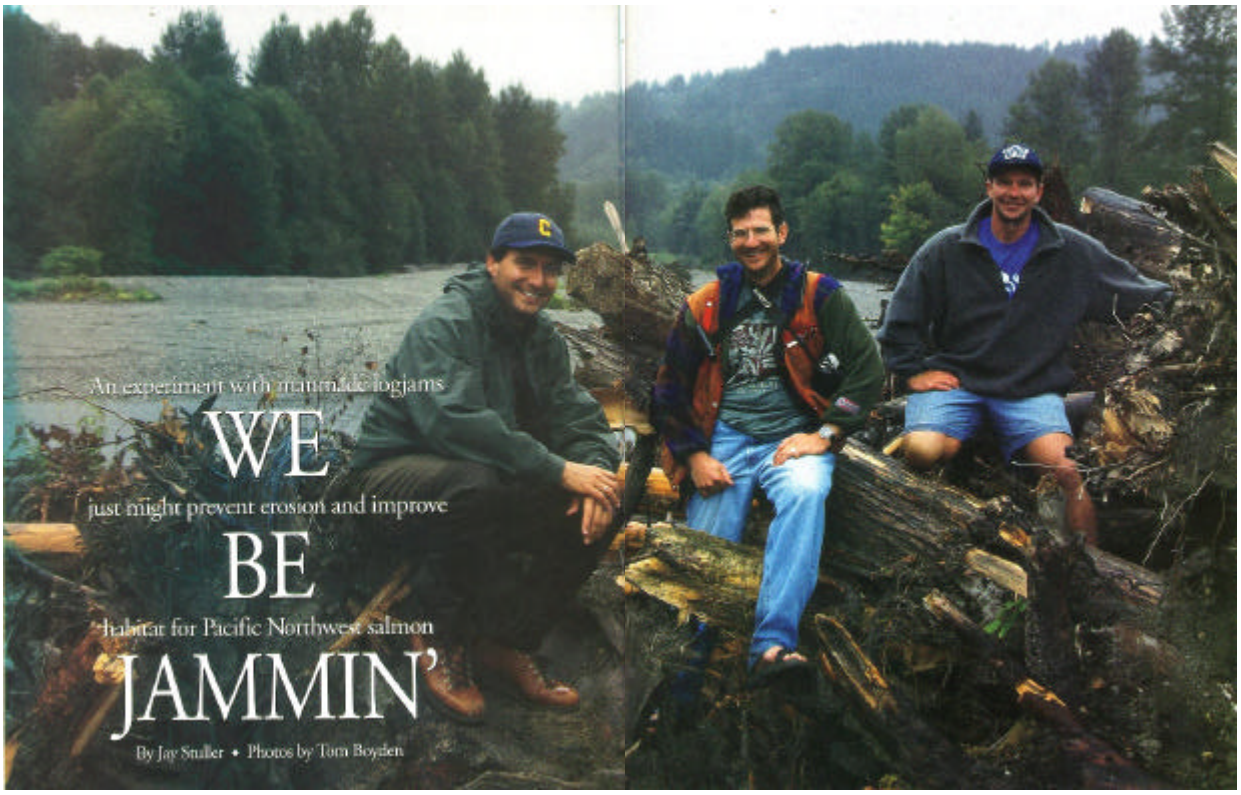


A team of scientists (top) are engineering logjams on Washington state's Stillaguamish River to simulate nature and improve salmon spawning sites (bottom right). During the early 1900s, the logging industry cut much of the tall timber in the region, reducing the number of natural jams. Sometimes, the huge cut logs would form jams (bottom left), but these were dispersed as quickly as possible to get the wood downstream to market.

NOTE: Reprinted from WILDLIFE CONSERVATION®, published by the WILDLIFE CONSERVATION SOCIETY, author Jay Stuller, and photographer Tom Boyden. The article has been modified slightly from it's layout in Wildlife Conservation, Mar/Apr 1999, Vol 102, No. 2, pages 44-51. The USDA, Natural Resources Conservation Service (NRCS) has not directly been involved in the design and construction of engineered log jams referenced in this article. However, the NRCS's Watershed Science Institute (WSSI) has actively supported Tim Abbe's intellectual work. This support will result in a forthcoming ***Guidance Manual for the Planning and Design of Engineered Log Jams in Large Rivers***. Please contact Carolyn Adams, Director of the WSSI at: caradams@u.washington.edu for more information.

PEERING THROUGH gold-rimmed spectacles dotted with drops from a light September rain, Tim Abbe leans over the railing of the C-Post Bridge and admires a large tangle of spruce, cedar, and cottonwood. The jumbled pile sits along the North Fork of the Stillaguamish River about 60 miles from Seattle and a stone's throw upstream from the small span, apparent testimony to the hydrodynamic power of floods. Below, in a shallow channel that cuts through alluvial gravel, a weary and moribund Chinook salmon flops about in a redd, or nest, depositing eggs and fulfilling her obligation to the anadromous cycle.

Most folks would drink in this view from the bridge and appreciate the splendor for what it is. The 36-year-old Abbe, a geomorphologist in the University of Washington's Geological Sciences Department, cannot help but envision the river and its surroundings as it was and will be. Abbe is one of a few scientists studying the ecological impact of wood debris in rivers and estuaries --his geomorphic specialty -- which in part explains his peculiar fascination with logjams.

"See that big spruce," says Abbe, pointing to an evergreen leaning perilously over an eroding bank about 50 yards upriver. "The next high water will probably take it down. It could float into an existing jam, or its root wad might anchor and start a new one. Once formed, a jam can evolve into an island covered with live trees and split the single channel into two."

Moreover, logjams can generate flow patterns that scour the river bottom in a way that creates deep pool habitats favored by salmon and trout.

Thus, Abbe and several of his colleagues aren't waiting for the elements to take their course. The nearby mound of tree trunks looks like the work of flood-borne chaos, but it actually is one of five engineered log jams, ELJs, built during the summer of 1998 along a half-mile stretch of the Stillaguamish. Part of a $400,000 experiment ostensibly about erosion control -- the money coming mostly from federal and local grants -- the jams are in reality a novel approach to habitat restoration.

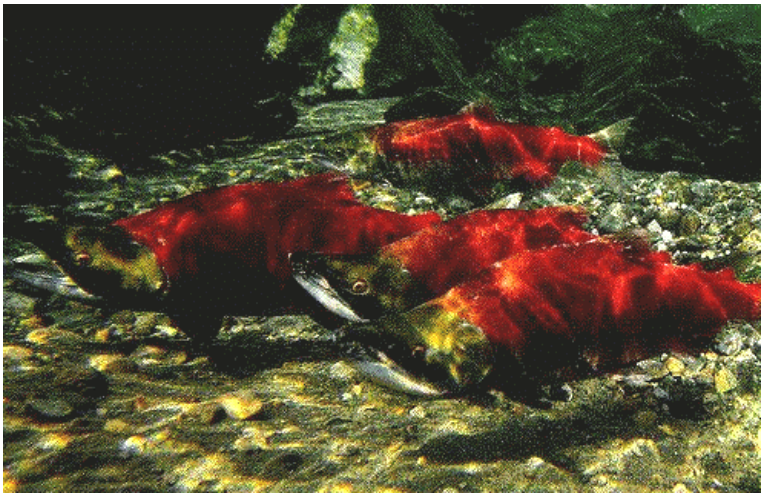
"For the big jam, we dug a hole and set some logs nearly ten feet deep, which gives it an awfully stable base," explains Abbe. "There are a hundred and twenty trees and several thousand tons of wood there. It's the world's largest accumulation of wood debris intentionally placed within a stream. Will it catch and keep debris from hanging up on this bridge, hold together and do what we expect to the channel?"

Abbe squints through the mist as he scans the contours of the narrow valley, the river's curves, and mentally fast-forwards through future scenarios. Yes, he's confident the experiment will work. "But after a big flood," Abbe allows, "nature is the final judge."

Over the past few hundred years in Europe and North America, folks living along rivers have pretty much judged wood debris a nuisance, if not a hazard that demands removal. A large log floating down the Danube or the Mississippi is nothing less than a timber torpedo, capable of sinking skiffs and steamers. Big jams that break loose during floods send forth a lethal swarm of floating battering rams, which can mangle bridge supports, stress dams, and plow through inundated houses. Where water flows swiftly, logjams have a nasty tendency to suck boaters and swimmers to their deaths. In this sense, wood isn't particularly good.

These are some of the reasons snag removal has grown into a gospel of river engineering and management. Yet another article of faith in this profession is that to control erosion and protect settlements, engineers must line banks with rock riprap. Such practices create clean and tidy channels. Alas, they're also hard on the environment and habitats of fish, a bounty that in part drew humans to streambanks in the first place.

Consequently, the chance to investigate the relationships between woody debris and fish populations has drawn Abbe and his fellow scientists to the Stillaguamish. A relatively small river, it has two forks, north and south, which tumble out of the Cascades and join into a main stem at the town of Arlington. From there, it meanders down its eponymous valley for about 15 miles due west, spilling into Puget Sound near Stanwood.



Salmon (right) need cold, deep pool in which to lay their eggs. After spawning, the fish die. Watershed ecologist George Pess (left) holds a dead Chinook, which provides food for eagles, bears, and other animals.

The ELJs are held together with glue (left). Civil engineering graduate student Tracy Drury (right) inspects one of the jams. He analyzes fluid mechanics and calculates the scouring patterns that the team believes will create pools beneficial to fish.

Neither mighty like the Columbia nor fabled as the Fraser, the Stilly is in many ways an unremarkable stream. From the geomorphic perspective, it is a sublime study of how humans have changed riparian habitat.

"Before settlers arrived in the 1880s, we're pretty sure the entire floor of the valley was covered by forest," says George Pess. A 33-year-old watershed ecologist, Pess works for the Tulalip Tribes, a band of Native Americans with a reservation about ten miles south of the river. He's sitting in Arlington's venerable Blue Bird Cafe with Tim Abbe and Tracy Drury, a 36-year-old graduate student in the University of Washington's Department of Civil Engineering. Although they've had help from advising professors, the state's Department of Ecology and, among others, officials and workers from Snohomish County, this trio is at the core of the river's ELJ project.

Pess's assessment of forest is confirmed by documents from the region's earliest European settlers. Elizabeth Wilson Mose, for example, arrived here in July 1889 at the age of four, with her widowed mother and two sisters, headed for a relative's homestead on the North Fork just a few miles from Arlington. In a journal account written before her death in 1974, she described how Stillaguamish Indians poled canoes to transport the family up the stream. "The river was much different then than it is now," she wrote. "It (had) huge trees lining the banks on either side."

What the pioneer didn't say was whether the trees were growing upright or were logs scattered like matchsticks along the bank. Most likely she observed both.

"Historical accounts suggest the Stillaguamish was full of enormous logjams, some more than a mile long, which is a natural condition for wild rivers running through old-growth forests," says Abbe. "As a result, the lower valley would flood up to ten times a year, often with several feet of water. Today, the same volume wouldn't come near to spilling over the banks. The logs took up that much space in the channel, pushing flood waters up and out."

The jams also facilitated a constant and dynamic migration of the river channel across the valley, which on the main stem averages three to five miles wide. "Settlers cleared trees from the valley floor and removed the logjams and beaver dams, which gave them great farmland on which to make a living," says Pess. "That stabilized the river's course and stopped much of the flooding. But it also cut off about eighty percent of the side channels and sloughs on the main stem, which before then were spawning grounds for a lot of fish."

Like most rivers in the Pacific Northwest before the turn of the century, the Stillaguamish had formidable salmon runs, with numbers that make the start of the New York Marathon look like a sparsely attended event. At times, Chinook, coho, pinks, chum, sockeye, Dolly Varden, sea-run cutthroat, and steelhead schooled upriver virtually gill-to-gill. From late September into October, one could almost see the stench of rotting fish hanging over the valley, as spawned-out salmon covered the river-banks.

"One estimate has it that an annual average of 50,000 Chinooks came up the Stilly at the turn of the century," says Pess. "I think that's conservative. But today we get less than a thousand."

The loss of side-channel habitat is just one factor in the decline. Logging of the upper valley and then Cascade headwater forests led to a tremendous increase in the number of landslides and sediment in the river. The volume of water during peak flows also increased; gauged since 1932, the river has had 11 of its 15 largest flows in just the past 20 years. Such floods in the fall and winter, says Pess, can scour eggs out of redds before they hatch.

Overharvesting in the Pacific and in Puget Sound, as well as an increase in sport-fishing, have also contributed to the Stilly's decline. In turn, Snohomish County sport-fishermen often place blame on Native Americans, who have the right to net salmon. "Ironically, they aren't taking quality fish and haven't for a decade," says Pess. "But the public sees their nets and assumes the worst."

In fact, the Stillaguamish Tribe nets about 100 Chinook each year for its hatchery and releases some 200,000 fingerlings each spring. "We'll

take about ten fish a couple times a year, mainly for ceremonial purposes such as a funeral," says the tribe's Pat Stevenson. "When people see the nets, it's for the hatchery or we're catching chum, a species no one else seems to want.

"Poaching is a much bigger problem," interjects Tracy Drury, stabbing at a generous portion of Blue Bird Cafe breakfast sausage. "I spent much of last summer living up at the ELJ site, and I saw a lot of people taking fish out of season. But the thing is, on top of all these other factors you've got a natural ocean cycle that seems to influence the fish population. We can do all kinds of habitat restoration and if the cycle doesn't cooperate, there won't be many fish.

"Or when the fish do come back," he adds with a wry grin, "we can take credit. There's just a lot of things we don't understand."

The logjam builders do have a solid grasp on the role of wood debris in rivers, how it interacts with water flow and can create habitat suited to fish. "I think more scientists are starting to believe that wood is geomorphically significant," says Abbe. "Geologists have long discounted biological factors in how surface features develop. But if you look at the different ways wood accumulates in rivers, it is often a foundation for solid structures."

In fact, when covered by silt and gravel, water-logged wood can last for several thousand years. And in river valleys such as the Stillilguamish, islands in the middle of the stream -- or even mysterious, tree-covered high spots in flat areas of the valley floor -- frequently are the remains of a long-buried logjam. Abbe has even developed terminology for different types of structures and describes the kinds of gravel bars and pools that form from different scour patterns.

Both Abbe and Drury are prone to drawing intricate graphs on napkins, showing how flow patterns of water accelerate away from the smooth and hard surfaces of rock groins. Wood debris presents a "softer" and more complex surface. Get past the basics, however, and both men will veer into incomprehensible details of sediment grain sizes, shear stress values, and other minutiae of their profession.

The two are scientists, with the sincere, goofy, and likable qualities found among the best. They also have retained their youthful exuberance, which you would expect of adults who build artificial logjams. Give a kid access to a small creek or a rain-filled gutter, and the urge to block or redirect the water is a drive almost as instinctive and powerful as that compelling salmon to spawn.

"It's true," concedes Abbe. "I spent a part of my preteen years living near Bethesda, Maryland, and there was a creek behind our house, full of crayfish. I used to play in it until some idiots filled it in for a housing development. That experience turned me into an environmentalist."

Before moving to Seattle to concentrate on geomorphology and wood debris, Abbe worked in the San Francisco Bay Area on sedimentation and erosion. He has designed small ELJs for erosion control on other Washington rivers, but the Stillaguamish project is by far his largest, most ambitious, and far-reaching. During a hectic four weeks in the summer of 1998, crews of county workers with heavy equipment helped install more than 400 logs, some of them up to 52 inches in diameter.

Call them tinker toys writ large.

A Washington native, Tracy Drury has long wanted to work in river management. But he believes that conventional engineering of streams does more harm than good, and he means to prove the utility of using wood and ELJs instead of rock and concrete. "My main role on the jams is the analytical work of fluid mechanics, predicting scour depths and such," he explains. "But I'll admit it's been fun to dig channels and redirect the river, and snorkel under a jam and count fish."

Make no mistake about whether this is an earnest endeavor for Drury. A return to graduate school for engineering studies cost him a marriage and left him broke. He shrugs in resignation. "It's not often that you get to work on a multi-disciplinary project that combines engineering with applied science and research," he explains.

Pess, a New Yorker who previously worked on fishery issues in San Francisco Bay, is the habitat expert. At the site of the five ELJs on the North Fork of the Stilly, he shows a visitor some of the problems the project is intended to remedy, which aregraphically evident. It's been an incredibly dry summer and the water volume is the second lowest ever recorded -- 152 cubic feet per second. The average flow at this time of year is 550 cubic feet.

"The average depth on this stretch of the river is only about two feet," says Pess, pointing to a channel that runs about 100 yards. "That means the water is relatively warm. Salmon like things colder and deeper, but in this stretch there's only one little spot that's maybe three or four feet deep. The fish have to compete for that resting space, and it tends to cut their fecundity."

One effect of the jams -- if Drury's calculations are correct -- is that they will generate scouring patterns that will create a large, deep pool under the face of each jam, which would provide cover for the fish and allow them to spread out. "The jams have been in place for only a couple of months," says Drury. "But I've snorkeled down there and seen it getting deeper. I was also swimming with some pretty big Chinooks."

The ELJ designers have little to fear should the river change course near the jams. "We secured a conservation easement on both sides of the river," explains Pess, "so we could observe natural dynamics without worrying that the property owners would lose their land and feel forced to intervene."

The designers do worry about what might happen if logs get loose and slam into a boat or a bridge, so each log is tagged. "I don't think it will happen," says Abbe, whose ELJ designs are modeled after the most stable logjams he has observed on wild rivers on Washington state's Olympic Peninsula. "But since everything we've put in is marked, we'll either get the blame or be in the clear."

There is plenty of blame to go around for the decline of the Stillaguamish fishery, although it's awfully judgmental to label the valley's early settlers as villains, when in fact they were devout Scandinavian Lutherans just trying to carve out a place to live in a damp and gray Pacific Northwest. And while the river can never be returned to its nineteenth-century log-jammed self -- because too many people live within the floodplain -- folks in the valley are increasingly conscious of the need to improve fish habitat.

Today, it's illegal for even private property owners to remove woody debris from the river and its tributaries. And down on the main stem of the Stilly, near the town of Silvana, Snohomish County's Surface Water Management group has spent $50,000 to restore the natural course of a winding, backwater creek, which farmers had straightened into a diked ditch nearly 100 years ago. The hope is that the stream will attract smolts (young salmon). Still, the five engineered logjams are no guarantee that Stillaguamish salmon will get their groove back. It's an experiment in which nature will be the final judge. Resting in a cool, deep pool and gathering strength before laying her eggs and swimming for the piscatorial bright light, a female Chinook just might think, if she's capable of thought, that Tim Abbe and his jam-building buddies are her kind of guys.

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Jay Stuller wrote about wildlife pathologists in our October1997 issue.

Editors' note: In late December, Tim Abbe reported that the five ELJs on the North Fork of the Stillaguamish had lived up to the scientists' great expectations. All five were intact, despite the fact that they had been submerged by at least four floods. Four of the logjams collected additional debris, but no debris accumulated at the bridge downstream of the ELJs.