The River Doctor

Dave Rosgen rides in rodeos, drives bulldozers, and has pioneered a widely used approach to restoring damaged rivers. But he's gotten a flood of criticism too

STOLLSTEIMER CREEK, COLORADO—"Don't be a pin-headed snarf. … Read the river!" Dave Rosgen booms as he sloshes through shin-deep water, a swaying surveying rod clutched in one hand and a toothpick in the other. Trailing in his wake are two dozen rapt students—including natural resource managers from all over the world—who have gathered on the banks of this small Rocky Mountain stream to learn, in Rosgen's words, "how to think like a river." The lesson on this searing morning: how to measure and map an abused waterway, the first step toward rescuing it from the snarfs—just one of the earthy epithets that Rosgen uses to describe anyone, from narrow-minded engineers to loggers, who has harmed rivers. "Remember," he says, tugging on the wide brim of his cowboy hat, "your job is to help the river be what it wants to be."

It's just another day at work for Rosgen, a 62-year-old former forest ranger who is arguably the world's most influential force in the burgeoning field of river restoration. Over the past few decades, the folksy jack-of-all-trades—equally at home talking hydrology, training horses, or driving a bulldozer—has pioneered an approach to "natural channel design" that is widely used by government agencies and nonprofit groups. He has personally reconstructed nearly 160 kilometers of small- and medium-sized rivers, using bulldozers, uprooted trees, and massive boulders to sculpt new channels that mimic nature's. And the 12,000-plus students he's trained have reengineered many more waterways. Rosgen is also the author of a best-selling textbook and one of the field's most widely cited technical papers—and he just recently earned a doctorate, some 40 years after graduating from college.

"Dave's indefatigable, and he's had a remarkable influence on the practice of river restoration," says Peggy Johnson, a civil engineer at Pennsylvania State University, University Park. "It's almost impossible to talk about the subject without his name coming up," adds David Montgomery, a geomorphologist at the University of Washington, Seattle.

But although many applaud Rosgen's work, he's also attracted a flood of criticism. Many academic researchers question the science underpinning his approach, saying it has led to oversimplified "cookbook" restoration projects that do as much harm as good. Rosgen-inspired projects have suffered spectacular and expensive failures, leaving behind eroded channels choked with silt and debris. "There are tremendous doubts about what's being done in Rosgen's name," says Peter Wilcock, a geomorphologist who specializes in river dynamics at Johns Hopkins University in Baltimore, Maryland. "But the people who hold the purse strings often require the use of his methods."

Class act. Dave Rosgen's system for classifying rivers is widely used in stream restoration—and detractors say commonly misused.

All sides agree that the debate is far from academic. At stake: billions of dollars that are expected to flow to tens of thousands of U.S. river restoration projects over the next few decades. Already, public and private groups have spent more than $10 billion on more than 30,000 U.S. projects, says Margaret Palmer, an ecologist at the University of Maryland, College Park, who is involved in a new effort to evaluate restoration efforts. "Before we go further, it would be nice to know what really works," she says, noting that such work can cost $100,000 a kilometer or more.

Going with the flow

Rosgen is a lifelong river rat. Raised on an Idaho ranch, he says a love of forests and fishing led him to study "all of the '-ologies' " as an undergraduate in the early 1960s. He then moved on to a job with the U.S. Forest Service as a watershed forester—working in the same Idaho mountains where he fished as a child. But things had changed. "The valleys I knew as a kid had been trashed by logging," he recalled recently. "My trout streams were filled with sand." Angry, Rosgen confronted his bosses: "But nothing I said changed anyone's mind; I didn't have the data."

Rosgen set out to change that, doggedly measuring water flows, soil types, and sediments in a bid to predict how logging and road building would affect streams. As he waded the icy waters, he began to have the first inklings of his current approach: "I realized that the response [to disturbance] varied by stream type: Some forms seemed resilient, others didn't."

In the late 1960s, Rosgen's curiosity led him to contact one of the giants of river science, Luna Leopold, a geomorphologist at the University of California, Berkeley, and a former head of the U.S. Geological Survey. Invited to visit Leopold, the young cowboy made the trek to what he still calls "Berzerkley," then in its hippie heyday. "Talk about culture shock," Rosgen says. The two men ended up poring over stream data into the wee hours.

By the early 1970s, the collaboration had put Rosgen on the path to what has become his signature accomplishment: Drawing on more than a century of research by Leopold and many others, he developed a system for lumping all rivers into a few categories based on eight fundamental characteristics, including the channel width, depth, slope, and sediment load (see graphic, p. 938). Land managers, he hoped, could use his system (there are many others) to easily classify a river and then predict how it might respond to changes, such as increased sediment. But "what started out as a

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description for management turned out to be so much more," says Rosgen.

In particular, he wondered how a "field guide to rivers" might help the nascent restoration movement. Frustrated by traditional engineering approaches to flood and erosion control—which typically called for converting biologically rich meandering

rivers to barren concrete channels or dumping tons of ugly rock "rip rap" on failing banks—river advocates were searching for alternatives. Rosgen's idea: Use the classification scheme to help identify naturally occurring, and often more aesthetically pleasing, channel shapes that could produce stable rivers—that is, a waterway that could carry floods and sediment without significantly shifting its channel. Then, build it.

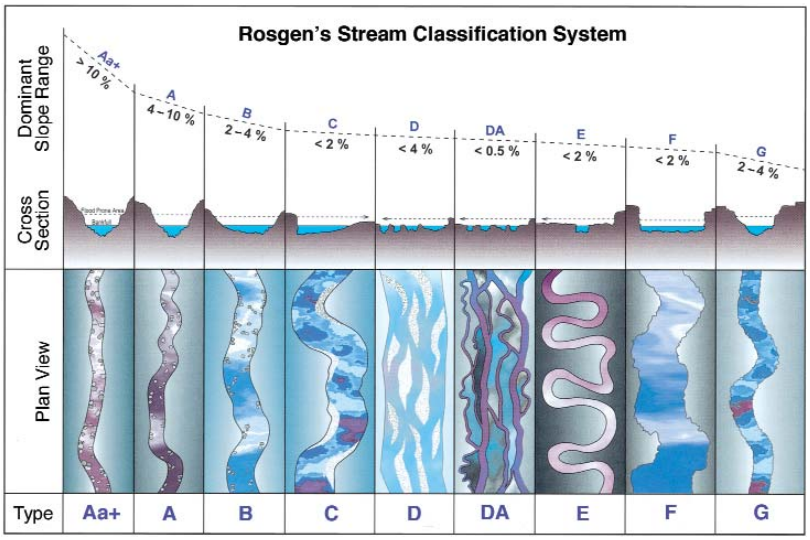
In 1985, after leaving the Forest Service in a dispute over a dam he opposed, Rosgen retreated to his Colorado ranch to train horses, refine his ideas—and put them into action. He founded a company—Wildland Hydrology—and began offering training. (Courses cost up to $2700 per person.) And he embarked on two restoration projects, on overgrazed and channelized reaches of the San Juan and Blanco rivers in southern Colorado, that became templates for what was to come.

After classifying the target reaches, Rosgen designed new "natural" channel geometries based on relatively undisturbed rivers, adding curves and boulder-strewn riffles to reduce erosion and improve fish habitat. He then carved the new beds, sometimes driving the earthmovers himself. Although many people were appalled by the idea of bulldozing a river to rescue it, the projects—funded by public and private groups—ultimately won wide acceptance, including a de facto endorsement in a 1992 National Research Council report on restoration.

Two years later, with Leopold's help, Rosgen won greater visibility by publishing his classification scheme in *Catena*, a prestigious peer-reviewed journal. Drawing on data he and others had collected from 450 rivers in the United States, Canada, and New Zealand, Rosgen divided streams into seven major types and dozens of subtypes, each denoted by a letter and a number. (Rosgen's current version has a total of 41 types.) Type "A" streams, for instance, are steep, narrow, rocky cascades; "E" channels are gentler, wider, more meandering waterways.

Although the 30-page manifesto contains numerous caveats, Rosgen's system held a powerful promise for restorationists. Using relatively straightforward field techniques—and avoiding what Rosgen calls "high puke-factor equations"—users could classify a river. Then, using an increasingly detailed four-step analysis, they could decide whether its channel was currently "stable" and forecast how it might alter its shape in response to changes, such as increased sediment from overgrazed banks. For instance, they could predict that a narrow, deep, meandering E stream with eroding banks would slowly degrade into a wide, shallow F river, then—if given enough time—restore itself back to an E. But more important, Rosgen's system held out hope of predictably speeding up the restoration process by reducing the sediment load and carving a new E channel, for instance.

The *Catena* paper—which became the basis for Rosgen's 1996 textbook, *Applied River Morphology*—distilled "decades of field observations into a practical tool," says Rosgen. At last, he had data. And people were listening—and flocking to his talks and classes. "It was an absolute revelation listening to Dave back then," recalls James Gracie of Brightwater Inc., a Maryland-based restoration firm, who met Rosgen in 1985. "He revolutionized river restoration."



A field guide to rivers. Drawing on data from more than 1000 waterways, Rosgen grouped streams into nine major types.

Rough waters

Not everyone has joined the revolution, however. Indeed, as Rosgen's reputation has grown, so have doubts about his classification system—and complaints about how it is being used in practice.

Much of the criticism comes from academic researchers. Rosgen's classification scheme provides a useful shorthand for describing river segments, many concede. But civil engineers fault Rosgen for relying on nonquantitative "geomagic," says Richard Hey, a river engineer and Rosgen business associate at the University of East Anglia in the United Kingdom. And geomorphologists and hydrologists argue that his scheme oversimplifies complex, watershed-wide processes that govern river behavior over long time scales.

Last year, in one of the most recent critiques, Kyle Juracek and Faith Fitzpatrick of the U.S. Geological Survey concluded that Rosgen's Level II analysis—a commonly used second step in his process—failed to correctly assess stream stability or channel response in a Wisconsin river that had undergone extensive study. A competing analytical method did better, they reported in the June 2003 issue of the *Journal of the American Water Resources Association*. The result suggested that restorationists using Rosgen's form-based approach would have gotten off on the wrong foot. "It's a reminder that classification has lots of limitations," says Juracek, a hydrologist in Lawrence, Kansas.

Rosgen, however, says the paper "is a pretty poor piece of work … that doesn't correctly classify the streams. … It seems like they didn't even read my book." He also emphasizes that his Level III and IV analyses are designed to answer just the kinds of questions the researchers were asking. Still, he concedes that classification may be problematic on some kinds of rivers, particularly urban waterways where massive disturbance has made it nearly impossible to make key measurements.

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One particularly problematic variable, all sides agree, is "bankfull discharge," the point at which floodwaters begin to spill onto the floodplain. Such flows are believed to play a major role in determining channel form in many rivers.

Overall, Rosgen says he welcomes the critiques, although he gripes that "my most vocal critics are the ones who know the least about what I'm doing." And he recently fired back in a 9000-word essay he wrote for his doctorate, which he earned under Hey.

Rosgen's defenders, meanwhile, say the attacks are mostly sour grapes. "The academics were working in this obscure little field, fighting over three grants a year, and along came this cowboy who started getting millions of dollars for projects; there was a lot of resentment," says Gracie.

Errors on trial. Rosgen's ideas have inspired expensive failures, critics say, such as engineered meanders on California's Uvas Creek (*above*) that were soon destroyed by floods.

River revival?

The critics, however, say the real problem is that many of the people who use Rosgen's methods—and pay for them—aren't aware of its limits. "It's deceptively accessible; people come away from a week of training thinking they know more about rivers than they really do," says Matthew Kondolf, a geomorphologist at the University of California, Berkeley. Compounding the problem is that Rosgen can be a little too inspirational, adds Scott Gillilin, a restoration consultant in Bozeman, Montana. "Students come out of Dave's classes like they've been to a tent revival, their hands on the good book, proclaiming 'I believe!' "

The result, critics say, is a growing list of failed projects designed by "Rosgenauts." In several cases in California, for instance, they attempted to carve new meander bends reinforced with boulders or root wads into high-energy rivers—only to see them buried and abandoned by the next flood. In a much cited example, restorationists in 1995 bulldozed a healthy streamside forest along Deep Run in Maryland in order to install several curves—then watched the several-hundred-thousand-dollar project blow out, twice, in successive years. "It's the restoration that wrecked a river reach. … The cure was worse than the disease," says geomorphologist Sean Smith, a Johns Hopkins doctoral student who monitored the project.

Gracie, the Maryland consultant who designed the Deep Run restoration, blames the disaster on inexperience and miscalculating an important variable. "We undersized the channel," he says. But he says he learned from that mistake and hasn't had a similar failure in dozens of projects since. "This is an emerging profession; there is going to be trial and error," he says. Rosgen, meanwhile, concedes that overenthusiastic disciples have misused his ideas and notes that he's added courses to bolster training. But he says he's had only one "major" failure himself—on Wolf Creek in California—out of nearly 50 projects. "But there [are] some things I sure as hell won't do again," he adds.

What works?

Despite these black marks, critics note, a growing number of state and federal agencies are requiring Rosgen training for anyone they fund. "It's becoming a self-perpetuating machine; Dave is creating his own legion of pin-headed snarfs who are locked into a single approach," says Gillilin, who believes the requirement is stifling innovation. "An expanding market is being filled by folks with very limited experience in hydrology or geomorphology," adds J. Steven Kite, a geomorphologist at West Virginia University in Morgantown.

Kite has seen the trend firsthand: One of his graduate students was recently rejected for a restoration-related job because he lacked Rosgen training. "It seemed a bit odd that years of academic training wasn't considered on par with a few weeks of workshops," he says. The experience helped prompt Kite and other geomorphologists to draft a recent statement urging agencies to increase their training requirements and universities to get more involved (see www.geo.wvu.edu/~kite). "The bulldozers are in the water," says Kite. "We can't just sit back and criticize."

Improving training, however, is only one need, says the University of Maryland's Palmer. Another is improving the evaluation of new and existing projects. "Monitoring is woefully inadequate," she says. In a bid to improve the situation, a group led by Palmer and Emily Bernhardt of Duke University in Durham, North Carolina, has won funding from the National Science Foundation and others to undertake the first comprehensive national inventory and evaluation of restoration projects. Dubbed the National River Restoration Science Synthesis, it has already collected data on more than 35,000 projects. The next step: in-depth analysis of a handful of projects in order to make preliminary recommendations about what's working, what's not, and how success should be measured. A smaller study evaluating certain types of rock installations—including several championed by Rosgen—is also under way in North Carolina. "We're already finding a pretty horrendous failure rate," says Jerry Miller of Western Carolina University in Cullowhee, a co-author of one of the earliest critiques of Rosgen's *Catena* paper.

A National Research Council panel, meanwhile, is preparing to revisit the 1992 study that helped boost Rosgen's method. Many geomorphologists criticized that study for lacking any representatives from their field. But this time, they've been in on study talks from day one.

Whatever these studies conclude, both Rosgen's critics and supporters say his place in history is secure. "Dave's legacy is that he put river restoration squarely on the table in a very tangible and doable way," says Smith. "We wouldn't be having this discussion if he hadn't."

–DAVID MALAKOFF

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