Managing for Scarcity

Carlos Paes

By Michele Taylor

We're spoiled. Most of us—even people in the arid West—expect that each time we turn on our faucets, we'll be rewarded with a rush of water. But how many of us think about the origins of this luxury, the aquifers or lakes or watersheds where our faucet water originates? How many of us really know exactly where the water is coming from?

U.S. Forest Service hydrologists know, and they're worried. National forest lands are the single largest source of potable water in the United States, providing fresh water to approximately 60 million people. According to Jim Vose, project leader at the Southern Research Station's Coweeta Hydrologic Laboratory in North Carolina, forested watersheds will be increasingly relied upon to offset or mitigate the impacts of population growth, while land use change and climate variability will make it increasingly difficult to keep up with demand. The pressure is on for Forest Service hydrologists to find a solution.

They are in for a rough ride. During the past fifty years, the withdrawal of surface water has risen from nearly 150 billion gallons per day to 250 billion gallons per day. The International Water Resources Association predicts that water withdrawal in 2040 will reach 440 billion gallons per day—more than enough water to fill the Empire State Building 1,500 times daily. More and more, people are looking to the Forest Service to meet water demands.

ON THE GROUND

The Forest Service must balance water demands with other environmental needs. But whether it can manage public lands to increase streamflow and enhance clean water supplies while protecting wildlife, providing recreation opportunities and managing timber resources is a complicated question.

Some answers have come from the longest continuous environmental study in North America. Since 1934, hydrologists at Coweeta have been recording climate and streamflow in sixteen watersheds in the Nantahala National Forest. Their 2,158-hectare laboratory consists of two adjacent, east-facing, bowl-shaped basins: the Coweeta Basin and the Dryman Fork Basin. Some areas of these basins have been managed, while others, particularly those in the Dryman Fork Basin, have remained undisturbed. The elevation and ecology of the areas varies—some grow largely pine, some are forested by hardwoods—and their variety allows researchers to experiment with a wide range of forest conditions.

Hydrologists have used each of these ecosystems as single study units to measure nutrient, carbon and water cycles

to understand the basic concepts of watershed dynamics. Long-term studies show that rain, snow, fog and condensation increase streamflow; transpiration, evaporation and interception reduce it. Further, scientists know that logging generally increases streamflow by reducing transpiration and interception. Pine forests have lower streamflows than hardwood forests due to their higher evapo-transpiration and interception rates. Vose warns that neither large-scale logging nor replacing pine forests with hardwood forests are sustainable management options to enhance watershed yield at levels needed to satisfy increased societal demands.

As a solution to the water supply issue, logging presents three major problems: high sedimentation levels will compromise water quality; the magnitude and frequency of logging will likely be unacceptable to society; and regrowth prevents increased flows from lasting more than ten to fifteen years. The species-change option isn't feasible, either—the Forest Service would be hard-pressed justify planting slow-growing hardwood stands instead of fast-growing pine stands that provide renewable lumber and paper resources. "There are only two ways to increase streamflow," Vose says. "Reduce the amount that leaves [the stream] or change vegetation composition to more water use–efficient species. From a forest management standpoint, that's about it."

Larry Schmidt, a retired program manager at the Rocky Mountain Research Station's Stream Systems Technology Center, says that managing drier landscapes in the West and Southwest for water "will be like squeezing water from turnips." Low precipitation, shallow soils and replacement vegetation prevent pinyon–juniper and sagebrush environments from producing water. Arizona's mixed conifer forests that grow at higher elevations with higher rainfalls also grow on terrain that's often too steep to log. Ponderosa pine forests have the potential to enhance streamflow, he says, "but the greatest yield increase comes from opening up the stands a great deal more than what most people would be comfortable with."

QUALITY, NOT QUANTITY

Studies conducted in the Pacific Northwest have also concluded that cutting trees to enhance streamflow is not viable. Sherri Johnson, lead scientist at the H.J. Andrews Experimental Forest in Oregon's Willamette National Forest, says that logging studies within Andrews's 6,000 hectares generally showed short-term increases in annual water yield. In some basins these were quickly followed by years with decreased yield.

Although logging can increase yield, it also increases water temperature and sedimentation to unacceptable levels.

By the Numbers

Number of Americans who rely on a water source that originates on national forest land: 60 million

Number of cities that rely on national forest watersheds: More than 900, including Denver, Oakland, Helena, Salt Lake City, Little Rock and Portland, Oregon

Number of public drinking water systems located in watersheds containing national forest land: 3,400

Estimated annual value of water from national forest land: $3.7 billion

Average annual value of timber cut on national forest land since 1991: $330 million

Percentage of our nation's outdoor recreation areas within half a mile of streams or other bodies of water: 75

Number of designated Wild and Scenic Rivers on national forest land: 96 (of 150)

Percentage of respondents to a 2000 U.S. Forest Service survey who cited protecting streams and other sources of clean water as the most important reason for national forests to be well managed: 95

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Sources: National Forest Foundation, U.S. Forest Service

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Moreover, it delivers peak flows during winter, when less water is needed. Land managers are shying away from this strategy, Johnson says, because watershed responses are too complex. She says that land managers have a better shot at maintaining and enhancing water quality than increasing quantity.

One of the hallmarks of high-quality water is low nutrient levels, particularly nitrogen. As nitrogen levels rise, Vose explains, streams can become eutrophic—hotbeds of "green slime." In agricultural settings, high nitrate levels in streams can cause toxicity. The Forest Service has some ability to keep nitrates in soils and vegetation—and out of streams—by establishing riparian buffers during timber harvests and controlling invasive species and wildfires. The biggest threat to drinking water, Vose says, is development, not forestry.

Surface water's most common pollutant—sediment—mostly comes from traffic on old, unpaved logging roads. Some roads were badly engineered when they were built, so now there's a backlog of roads to be fixed. The agency's management practices mandate improved road design and riparian buffers to lessen sediment in watersheds. Vose believes that through these practices, logging companies can maintain watershed quality. "It's the law of the land that loggers use [best management practices]," Vose says. "Fortunately, they are generally compliant in the Southeast."

Sediment from old logging roads also plagues western watersheds. But hydrologists there are more concerned with soil erosion after catastrophic wildfires. The headwaters of most western reservoirs reside in forested watersheds; the enormous amount of sediment from landscapes laid bare by wildfires has the potential to plug them. The current drought and decades of fire suppression have heightened the frequency and magnitude of wildfires. According to Schmidt, timber harvest and prescribed fire are the two most important things the Forest Service is doing to increase water quantity and protect water quality.

At the H.J. Andrews forest, the Northwest Forest Plan guides best water management practices. It requires up to two tree lengths of riparian buffer zone separating streams from logging activities. Johnson says that buffers have improved water quality in most landscapes by keeping stream temperatures down, eliminating disturbances that increase sediment levels and filtering nutrients. But people disagree about how wide the buffers need to be and whether or not they can be thinned, Johnson says. "With two tree lengths, you can't harvest very much timber."

Degraded logging roads have created the Pacific Northwest's most significant water quality problems. In the 1960s and 1970s, they were built on fill. Today, they are prone to landslides and need to be re-engineered. But there are no funds for expensive improvements, Johnson says. "There is not much timber harvest to pay for the upgrades." She adds that the Forest Service is replacing broken culverts and designing more-stable logging roads to prevent future landslides. "The fact is that we do have good water coming off of the forest," she says. "We are doing the right things in terms of water quality."

USE AND REGULATION

The Forest Service can maintain and enhance water quality by implementing best management practices that control nitrogen levels, sedimentation and wildfires. The agency cannot generate extra water or lessen the most significant threats to healthy watersheds: higher consumption rates by increasing populations and property development.

Most hydrologists agree that the more realistic way to mitigate water scarcity is to regulate society's use. Schmidt points to low-flow showerheads and toilets, drip irrigation systems, xeriscaping and graywater recycling as practical water conservation strategies. Curbing urban growth is a large part of regulating water use, Schmidt says, but instigating any common sense approaches in doing that is outside the agency's purview.

"If you look at Las Vegas, it doesn't have any water to speak of except what it is pumping out of the Colorado," Schmidt says. "What's the long-term picture, once all of the groundwater has been mined out of adjacent basins? When you talk about wise limitations on urban growth, well… that's a way to get yourself shot."