

Plan to thin trees in Apache-Sitgreaves forest could increase streamflow in short term

BY MELANIE LENART

As the Apache-Sitgreaves National Forest launches its stewardship project to thin about 15,000 acres of Ponderosa pine forest a year over the next decade, the question arises: Will the reduction of trees in these forests mean an increase in streamflow for the communities that border them?

The consensus of researchers who have tackled this issue is a qualified “yes.” Thinning some of the trees in these admittedly dense stands of pines should lead to an increase in runoff for the streams that flow through the thinned areas—but only for a few years, and perhaps only noticeably so during years of high precipitation.

“I can’t see any reason why it wouldn’t have the benefit of providing additional water,” University of Arizona Natural Resources Professor Peter Ffolliott said of the planned Apache-Sitgreaves thinning project. “The question is does that (benefit) persist, and of course it doesn’t because the site recovers after awhile.”

Typically, the increase in streamflow, a.k.a. water yield, that a thinning project promotes drops off after about five years, he noted. But if the thinning project stretches across 10 years, as planned for the stewardship project, the increase in water yield could continue for more than a dozen years, albeit it with the benefits turning up in different streams within the White Mountains watershed.

The forest stands targeted for thinning as part of

the stewardship project drain variously into three major rivers: the Little Colorado, the Gila, and the Salt rivers, noted Robert Dyson, who handles public affairs for the Apache-Sitgreaves National Forest. Some of the local tributaries that stand to benefit in the near future include San Francisco, Mineral, Show Low, Silver, and Chevelon creeks.

A research project on the White Mountains’ Thomas Creek headed by one of Ffolliott’s then-graduate students, Gerald Gottfried, found that streamflow increased measurably in the eight years following a 1978–79 tree harvest that reduced the ground coverage of trees by about a third.

Gottfried, who now works as a research forester for the Rocky Mountain Research Station, used streamflow measurements to estimate an average increase in annual runoff of about 1 to 1½ inches based on measurements from when the logging ended in 1979 to when the study ended in 1986 (Figure 1). Runoff is the amount of water that makes it to streams after trees and soils get their fill. Like precipitation, runoff is a point measurement often reported in inches.

The water yield increase came mainly from winter precipitation (Oct. 1 through May 30 in his analysis), especially from March through May, Gottfried indicated. Apparently snow piled up in cleared openings, thus leaving less surface area susceptible to evaporative processes. However, the difference was driven mainly by wet years, he noted. Annual precipitation on the Thomas Creek watershed averaged about 30



Salt cedar: Villain or scapegoat when it comes to water use?

BY MELANIE LENART

Salt cedar’s reputation as a high water user has made it the bane of water agencies for many decades. When the drought slowed the flow of many southwestern rivers down to a trickle in 2002, its presence along New Mexican waterways even made it a target of then-gubernatorial candidate Bill Richardson.

Upon his election, Richardson followed through with his plan to eradicate salt cedar stands lining the state’s riverbeds. In 2003, the state spent \$4 million to spray the herbicide Arsenal from helicopters onto stands of salt cedar, also known as tamarisk because of its scientific name (*Tamarix* species, mainly *ramosissima*). About 25,000 acres of salt cedar had been so treated by spring of this year, according to an April 1 op-ed piece in the *Albuquerque Journal* by Assistant Secretary of the Interior Rebecca Watson, who touted the eradication effort as an outstanding example of water conservation in the West.

Yet there are some who consider salt cedar to be a scapegoat. One of these skeptics is Edward Glenn, a senior research scientist with the University of Arizona’s Environmental Research Laboratory. Glenn mentored then-graduate student Pam Nagler in research estimating water use of salt cedar compared to other species based on their leaf area indices and other remotely sensed data for a roughly 200-mile stretch of the Lower Colorado River.

“Particularly, salt cedar doesn’t seem to be the big hog, the biggest water user, that people have given it credit for,” Glenn said. “For years and years, people

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inches a year between 1964 and 1986, but ranged from about 20 to 44 inches.

“In high-precipitation years, it seemed there was more water in the ground than the trees could use, but this would not work in a dry year,” he explained during a recent telephone conversation. “In the middle of drought—and this is not just in Arizona but throughout the U.S.—you’re not going to create more water.”

David Goodrich, a hydraulic engineer with the U.S. Department of Agriculture Research Service unit, concurred. Measurable water yield increases are difficult to detect in dry years or dry areas, he said, noting that a research project he worked on that involved removing woody vegetation on 10 acres near Tombstone found no difference in water yield after the treatment. The research site receives an average of about 13.8 inches in annual precipitation.

“The conclusion was that the variability or some of the uncertainty in rainfall was enough to mask the potential change in water yield,” Goodrich explained.

In the case of the Apache-Sitgreaves stewardship project, any water yield increases would be seen as a fringe benefit to the main intention: to reduce fire risk in the forest stands near communities, which foresters call the wildland-urban interface.

Another potential fringe benefit, although more speculative, might be increased resistance to bark beetle outbreaks among the remaining trees in the stand. Drought stress makes it more difficult for trees to repel these invasive insects with their sap, so the thinking goes that reducing the competition for water among trees can only help boost a stand’s resistance to bark beetle.

For that matter, the millions of trees killed in recent years by beetles and by fire in southwestern forests have also

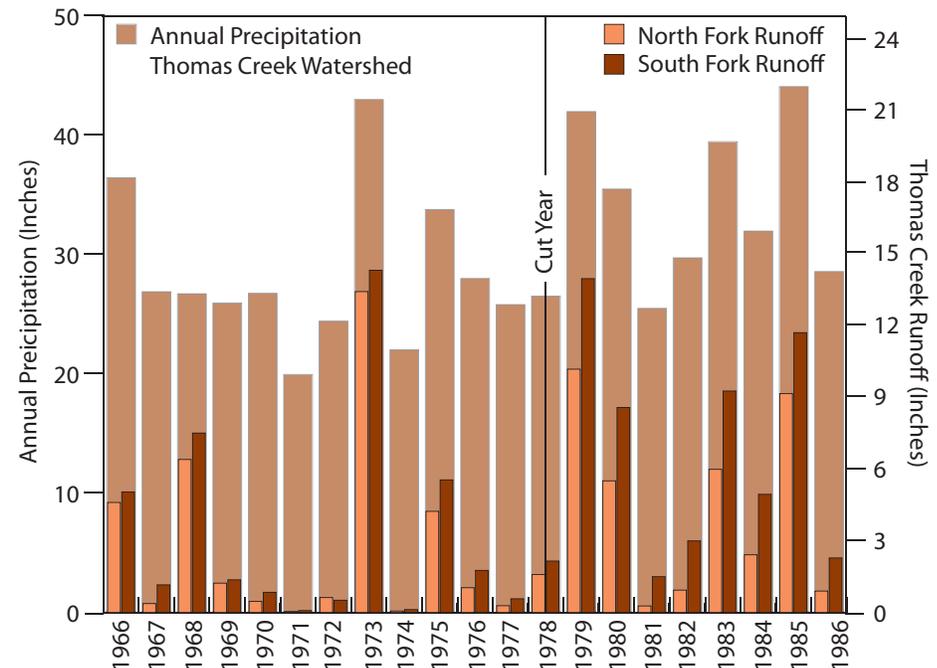


Figure 1. The South Fork of Thomas Creek in the White Mountains had a slight tendency to produce more “runoff,” or water yield from overland flow, before a logging treatment that was completed on the South Fork of the watershed in 1978. After the treatment, this tendency was more pronounced, as the above graphic illustrates. However, the main difference occurred in years of high precipitation. On the graphic, the scale for precipitation for the Thomas Creek watershed is on the left, while the scale for runoff values is given on the right. Data from 1989 University of Arizona dissertation of Gerald Gottfried, School of Natural Resources.

stopped drawing water for sustenance (although their remains may still increase surface area and therefore evaporation rates). All living plants use water for tissue construction as they photosynthesize, and for nutrient transport as they transpire, with the latter describing the process of transporting water from their roots to their leaves for eventual evaporation.

It’s comforting to know that there’s a silver lining to the clouds of smoke and flying insects that have ravaged southwestern forests in recent years. But the increase in water yield from beetle kill and particularly from fire poses other problems—namely floods and erosion.

It’s ironic that drought can actually increase the risk of floods, albeit indirectly, because it increases the risk of severe fires and insect attacks, commented Daniel Evans, a hydrologist with the U.S. Geological Survey’s Tucson office. Severe fires in particular can increase flood risk by searing the soil, changing its structure so that it repels water.

This, in turn, reduces the rate at which water can infiltrate soil and so increases the runoff rate, i.e. the rate at which water will flow over the land and reach streams. (For more details, see “Flooding after Fire” from the May 2003 packet at: http://www.ispe.arizona.edu/climas/forecasts/archive/may2003/may2003figs/19_Floods.html)

Like the White Mountain logging treatment, the 2003 Aspen fire on Tucson’s Mount Lemmon caused peak streamflow increases when severely burned watersheds were exposed to monsoonal rains, reported Evans, who helped monitor streamflow within the Sabino Canyon and Canyon del Oro drainages. After making adjustments for precipitation differences, he estimated streamflow highs on some creeks draining the burn area were more than five times greater than they had been before the fire.

Unfortunately, the excessive streamflow turned into a wall of water that careened through the town of Oracle in August of

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2003, sweeping 60-year-old newspaper publisher Jim Huntington to his death.

Peak streamflow increases also occurred on watersheds draining forests affected by the Rodeo-Chediski fire. For instance, concerns over potential floods led officials to evacuate the town of Carrizo three times, Evans said. But no deaths related to fire-caused floods were reported.

The Rodeo-Chediski fire of 2002 set the Arizona record for fire severity in the past century, with about 460,000 acres burned to varying degrees. So perhaps it's not surprising that the highest measured increase in streamflow peaks occurred within that burn area, in Ffolliott's estimation.

Ffolliott was watching the televised account of the fire in action when he noticed that it was spreading to an area that he and others had worked on in the 1970s. Although they had finished the project in 1977, they had left the flume and some other measuring devices in place—and were able to relocate them within a week after the Rodeo-Chediski's devastating passage through the area.

"It was a tragic event, but it was a unique research opportunity," Ffolliott said of the fire. He and U.S. Forest Service project leader Daniel Neary used a high water mark to estimate that, at one point during monsoonal rains a few weeks after the fire, streamflow through the plume peaked at 232 feet per second—about 2,300 greater than the peak of 0.1 feet per second they measured during the 1972–77 experiment on the same creek.

The arrival of the monsoon season near the tail end of the southwestern fire season contributes to peak streamflow and erosion extremes that—along with drought—help define the semi-arid lands of the Southwest. Particularly in

the case of severe fire, higher erosion rates tend to accompany the dramatic increase in streamflow peaks, with soil often seared and formerly protective vegetation shriveled or dying.

On the severely burned watershed of the Rodeo-Chediski fire, Ffolliott and Neary measured post-fire sediment yield rates of about 25 tons per acre. This is about five times higher than the baseline rates of 4 to 5 tons per acre they calculated for the 1972–77 time frame.

Similarly, Evans noted that the July Nuttall Complex wildfire on Mount Graham led to erosion that dumped at least 30 feet of sediment into the Frye Mesa Reservoir. But, as in the case of streamflow and water yield, he estimated that it generally takes about five years or less for a mountainside to stop shedding topsoil at unusually high rates.

Streamflow peaks on the creeks Ffolliott is monitoring at the Rodeo-Chediski site are already coming back to normal, at least at the larger scale of the watershed, he indicated.

"Actually, peak flow declined quite rapidly down to pre-fire conditions. I think we still have some elevated flows coming through, but it's nothing like in that first year," he said. "During our first trip out there, it was during the monsoon and thunderstorms started. You felt a little uneasy. Literally, we were the only living things out there. Now it's getting green again, which is kind of nice."

Nature has a track record of rebounding from disturbance, whether it's from fire, insect invasion or tree cutting. Assuming topsoil remains, vegetation will find a way to respond with a fresh flush of growth to the inherent productivity of a site—which is based on the input of sunshine, snow and rain. As it does, the transient benefit of increased water yield will fade away—like a far-away cloud drifting across the horizon.

Salt Cedar, continued

would quote these figures that they were using 3 to 4 meters of water a year, but they didn't have good methods for measuring it."

More recent techniques using sophisticated technology have found that salt cedar trees were using comparable amounts of water as the native cottonwood and willow trees they are seen as replacing.

"They (researchers) found that it actually uses less water than Bermuda grass. So your back lawn is actually using more water than salt cedar," Glenn said. Nagler, Glenn and others reported in a 2004 paper in *Agricultural and Forest Meteorology* that salt cedar actually appeared to consume less water than cottonwood, based on leaf area indices.

A year-long study conducted by Steve Hansen, an assistant area manager for the Albuquerque office of the U.S. Bureau of Reclamation (USBR), and colleagues found that salt cedar at the site they measured in the late 1990s used about 4 feet of water a year. This is about one third of the 4 meters it had been accused of consuming, although values would vary somewhat by site. Salt cedar used about the same amount of water as alfalfa, and roughly 20 percent more water than cottonwood, Hansen's research indicated.

Glenn credited Juliet Stromberg, an associate professor at Arizona State University, with launching the effort to examine the salt cedar issue objectively.

Stromberg explained by telephone that she falls into the camp of researchers who suspect salt cedar has proliferated because of changes in streamflow patterns, livestock grazing, water availability, and water quality. Given sufficiently high water tables and natural flood regimes (which reduce soil salinity) and protection from grazing, cottonwood

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Salt Cedar, continued

and willow will grow taller than salt cedar and therefore maintain dominance in stands, her research indicates.

“There is an assumption that salt cedar has contributed to changes in stream hydrology and geomorphology that has, in turn, reduced the ability of cottonwood and willow to survive,” she explained.

However, seeds from both native species are distributed and nourished by a natural flood regime, which typically is lacking in the dam-regulated environment of western rivers. In addition to salt cedar, houses tend to line the rivers, and it’s doubtful many residents would welcome annual floods. Also, the ongoing water use by the growing population of people and by long-time farmers may be lowering the water table beyond the tolerance of cottonwood and willow.

“If salt cedar is not the cause—if it’s just sort of a symptom—then if you clear the salt cedar you haven’t addressed the root cause of vegetation change,” she added. Rather than native vegetation, salt cedar is likely to return, unless changes occur in the management of rivers and floodplain lands.

New Mexico planners have not yet moved fully into the stage of re-establishing native vegetation to replace the Arsenal-killed salt cedar stands. Although thousands of salt cedars lining the Middle Rio Grande River are “deader than a hammer,” many of them remain standing on the landscape while officials confirm their demise, Hansen said. State officials are trying to figure out what to do with all the dead wood, which can act as a fuel source in case of fire, or transform into dangerous woody debris in case of floods. Until then, little can be done to re-establish native species, he indicated.

Streamflow in river stretches in which salt cedar was killed are not showing clear signs of an increase in water yield since eradication, said Hansen, who at-

tributed this to an inability to measure water levels accurately enough to detect a difference. He compared the concept of measuring a difference to trying to detect how much water a person has consumed based on a change in their weight. Instead, he suggested it is more accurate to measure the actual amount of water the person consumed, as with studies like his that document how much water a salt cedar tree consumes.

Given the relatively small portion of the water allotment consumed by “phreatophytes” like salt cedar, cottonwood, and willow—which the USBR estimates at about 7 percent of its total water budget along the lower Colorado River from Hoover Dam to Mexico—it’s even more understandable that a difference would be difficult to detect. Based on the 7 percent proportion, even if salt cedar represented all the phreatophytes and was completely replaced with cottonwood stands that used 20 percent less water, the best the Bureau could hope for would be about a 1.4 percent increase in total available water along this stretch.

Still, in the Middle Rio Grande, the savings estimated from the approximately 60,000 acres covered by salt cedar in 2002 potentially would amount to about 40,000 acre-feet of water, Hansen noted. However, if riverside trees follow water use patterns similar to mountaintop trees, the water yield increase may be more obvious during wet years than dry ones. (See related story in this issue.)

Also, it’s a bit more complicated than a one-to-one replacement of salt cedar with native vegetation because cottonwood and willow trees won’t necessarily be able to survive in the same places occupied by salt cedar, noted Fred Nibling, a research botanist for the USBR’s Denver office.

“The difference is the footprint on the terrain that salt cedar is capable of occu-



U.S. Bureau of Reclamation scientists work on methods for revegetation that can be used once they eradicate the salt cedar lining the banks of Pecos River near Carlsbad, New Mexico. Although most salt cedar eradication efforts in New Mexico involve using chemical control, the area above is about five miles from a Pecos River site where scientists are trying biological control by introducing a beetle that kills salt cedar. Photo by Fred Nibling.

pying is much greater than that of cottonwood and willow,” he elaborated. So the eradication program could help the USBR in its mission to deliver the allotted water to its clientele, which includes farmers near New Mexico’s Elephant Butte Reservoir who have not received their full allotment for several years.

Salt cedar is considered an invasive species by most ecologists. It was introduced to the West from Asia, in part to help control erosion. Its ability to live along relatively dry channels that do not support other riparian species does help prevent erosion, but salt cedar is also accused of making the soil more saline via leaf fall, and of contributing to flood risk by narrowing channels.

Nibling acknowledged that the situation posed an environmental challenge, with the goal of controlling invasive plants (salt cedar) competing with the goal to protect endangered species (including the willow flycatcher, which does well in salt cedar stands).

“It’s an interesting quandary,” Nibling said. “It’s really a challenge to our scientific skills to make it work for both groups.”

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