Is Woody Riparian Vegetation Declining in the Southwest?

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Scientists and the media often quote a statistic that Arizona has lost 90 percent of its riparian vegetation. The original source of the number is hard to trace, but more difficult is determining how much riparian vegetation was in the state at any specific time in the past, let alone quantifying how much there is now.

Vegetation loss: the Santa Cruz River from Martinez Hill near Tucson, Arizona, June 1942 (top) and Nov. 25, 2002 (bottom). (Stake 937 from the Desert Laboratory Repeat Photography Collection. 1942 photo by Arizona Game and Fish; 2002 photo by R.M. Turner.)

Vegetation gains: the Virgin River at Littlefield, Arizona, June 4, 1942 (top) and Oct. 30, 2000 (bottom). (1942 photo by John A. Baumgartner for the USGS Arizona District. 2000 photo by Dominic Oldershaw, stake 1729b, from the Desert Laboratory Repeat Photography Collection.)

Robert Webb, a hydrologist with the U.S. Geological Survey in Tucson, is using photographs to study changes in woody riparian vegetation in the Southwest since the 1860s, when the area was first photographed. By revisiting locations photographed earlier and taking new pictures, he has accumulated the largest library of "repeat" photography in the world. His study area includes the Colorado Plateau in Utah, all of Arizona, and the Mojave Desert area of southeastern California. He has matched photos from 5,925 sites covering more than 20 rivers in the Southwest.

Using more than 3,000 of the matched photographs, Webb mapped the gains and losses of species of woody riparian vegetation in the Southwest over the past century and saw a correlation between the location of species losses and surface and groundwater management projects such as reservoirs, diversions, and extensive groundwater pumping. Examples of reaches that have lost riparian species include the Mojave River in southern California, the lower Gila and Salt rivers near Phoenix, and lakes Powell and Mead on the Colorado River.

Gains in vegetation abundance have occurred in many reaches, including major tributaries of the Colorado River in Utah; the Virgin River in Utah and Arizona (see photos); and in Arizona, the Bill Williams, San Pedro, Verde, and upper Gila rivers, and tributaries and upper parts of the Santa Cruz River.

Natural and Human Factors at Work

Webb attributed the vegetation changes he observed to several factors, including climate variability, natural geomorphic processes, and human intervention. Two wet periods occurred in the 20th century—one early and one late—characterized by increased winter rainfall and floods, conditions beneficial to woody riparian vegetation. Winter and nighttime temperatures have increased since the 1960s, extending the growth period. This warming is particularly beneficial in riparian environments because water generally is available to support increased evapotranspiration.

While increases in riparian vegetation are widespread, locations of decreases that coincide with large-scale water management activities indicate such activities can override favorable growth conditions. Although groundwater pumping is a well-documented cause of reductions in riparian vegetation in many locations such as the Santa Cruz River in Tucson (see photos), some areas of pumping contain thriving riparian systems. "A little perching goes a long way," says

Webb; riparian systems can thrive on perched or alluvial aquifers unconnected to the regional aquifer where the pumping occurs. Some riparian vegetation also can adapt to lowering of the water table (within limits; about 30 feet for cottonwood) if the reduction occurs slowly enough for the roots to keep up.

Webb's photos document a period of rapid arroyo downcutting in the Southwest from the late 1800s to the early 1900s, which he attributes primarily to large floods, with livestock grazing contributing only locally. However, old photographs, scientific reports, and anecdotal evidence do not indicate that arroyo downcutting and large floods removed significant amounts of riparian vegetation, with the exceptions of the Gila River upstream from the Salt-Gila confluence and the Little Colorado River between Holbrook and Winslow.

100 Percent Change

So has Arizona in fact lost 90 percent of its riparian vegetation? According to Webb, the evidence neither supports nor disproves the premise. But he will say that nearly 100 percent of the woody riparian vegetation in the Southwest has changed, with and without human intervention.

Webb's results raise an interesting question: if riparian systems constantly change, whether or not humans are involved, how do groups working on riparian restoration projects decide what conditions to restore to? Geologic and historic data indicate that flows to the Colorado River Delta, currently a hotbed of restoration efforts, may have been naturally diverted into the Salton Sink for as much as three-fourths of the past 1,700 years, preventing large flood flows from reaching the delta. Webb says he has deleted all mention of "restoration" from his forthcoming book precisely because of the questions the term raises.

Bob Webb is the lead author of The Ribbon of Green: Long-Term Change in Woody Riparian Vegetation in the Southwest*, coauthored by Stanley A. Leake and Raymond M. Turner, to be published by the University of Arizona Press next year.*

River Restoration Efforts Compared Among Four Corners States

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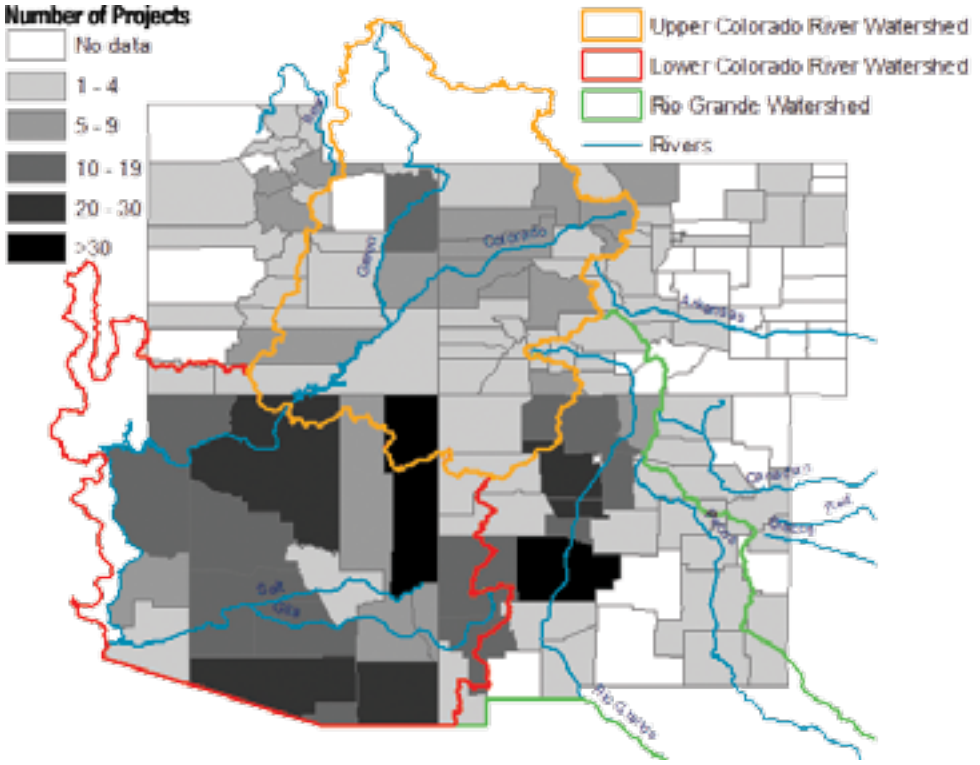
This article is the second of a 3-part series.

In the last issue of *Southwest Hydrology*, we reported that roughly $1 billion has been spent on restoration projects throughout the Four Corners states. Here we compare the differences in the distribution, costs, and goals of restoration between these states according to 576 project records in the National River Restoration Science Synthesis Southwestern Database (NRRSS-SW).

The NRRSS-SW includes records from national and regional sources for projects in Arizona (193), New Mexico (179), Colorado (112), and Utah (101). Results are based on dataset availability and do



Number of river and riparian restoration projects in the NRRSS-SW database by county. Data collection focused on obtaining records from the upper and lower Colorado River and Rio Grande watersheds.

not include individual restoration projects within large-scale species recovery or ecosystem adaptive management programs (AMPs). AMPs are "adaptive" because their plans are modified based on the results of monitoring efforts that track population and ecosystem level response to program actions.

habitat improvement projects. The highest percentage of floodplain reconnection projects is in New Mexico, which also has a high percentage of miscellaneous projects such as riparian fuels reduction, endangered species recovery, and unspecified habitat restoration. Utah has the highest percentage of in-stream species

State	Number of Projects	Cost			Percent of records for which data were available	
		Total (in millions)	Project Mean (in thousands)	Project Median (in thousands)	Cost Data	Monitoring Data
AZ	193	$187	$967	$84	76	24
CO	112	$8	$67	$73	48	46
NM	179	$109	$608	$52	85	29
UT	101	$9	$83	$46	78	16

Summary data from NRRSS-SW, by state. Note: 12 projects span more than one state. Project count excludes those associated with adaptive management programs.

Some 78 percent of the 140 counties in the four southwestern states are represented by records within the NRRSS-SW (see map). Half of these counties contain one to four projects, while only five percent of counties have 20 or more. Apache County in northeastern Arizona has the most projects, with 35. Regionally, the highest concentration of projects is in the lower Colorado River watershed. Project densities are likely underestimated for counties in the upper Colorado River watershed where several AMPs are underway.

Median costs of individual projects range from $46,380 in Utah to $84,679 in Arizona (see table). These figures are conservative as they do not include AMP projects. Project costs in the Southwest are higher relative to national estimates, for which median costs are less than $45,000.

Riparian management, water quality management, in-stream habitat improvement, and flow modification are the most common types of projects across the Southwest. Arizona has the highest percentage of water quality, flow modification, land acquisition, and fish passage projects. Colorado has the highest percentage of bank stabilization, channel reconfiguration, and in-stream management and riparian management projects. None of the states are well-represented by dam removal/retrofit or stormwater management projects.

Flow modification, in-stream species management, and fish passage projects are likely underrepresented by the Arizona and Colorado data, as these are focus areas of the Glen Canyon Dam AMP, San Juan River Basin Recovery and Implementation Program, and the Upper Colorado River Endangered Fish Recovery Program, not represented in the NRRSS-SW. Similarly, water quality management would be more prominent in Colorado data if individual project activity associated with the Upper Animas Abandoned Mine Land Program were included.

The most common restoration goals in the Southwest mirror those throughout the nation with the exception of flow modification. The dominance of flow modification in the Southwest is a byproduct of river regulation necessitated by regional water scarcity. Flow modification is being used as a tool to protect populations of threatened or endangered fish and promote the regeneration of native plant communities, while providing water resources for growing human populations.

Monitoring activity is more common in the Southwest than in the nation as a whole (28 percent versus 10 percent of project records). It is most common in Colorado and least common in Utah (46 percent and 16 percent of project records, respectively). These differences may be related partly to funding requirements of entities that fund and track restoration activities.

The NRRSS-SW represents the most comprehensive dataset of restoration projects in the Southwest to date. The database was created to assess the ecological efficacy of restoration practices. Efficacy is still difficult to ascertain given the paucity of information contained within most datasets included in the NRRSS-SW. This fact, together with existing NRRSS-SW database deficiencies resulting from missing information pertaining to all restoration efforts, underscores the great need for increased pre- and post-project monitoring, better reporting of restoration results, and coordinated tracking of restoration projects within relational databases at regional or national scales.

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A listing of datasets used to populate the NRRSS-SW database can be found at nrrss.umd.edu.

More information on national trends can be found in Bernhardt, E.S., et al., 2005. Restoration of U.S. rivers: A national synthesis, Science, 308:636-637.