Look at the Salt River where it slices through Tempe, just north of the Arizona State University campus. It is a dried-up carcass of a waterway by this point of its meandering route, inhabited by gravel and sand. Only blocks away, researchers at ASU’s Center for Environmental Studies are spreading a simple message: It doesn’t have to be this way!

**BY DIANE BOUDREAU**

### What To Do About Those Dammed Rivers

Pat Shafroth below the Alamo Dam, a riparian area cut off from its natural flood cycle. Compare the site with the Nature Conservancy’s preserve along the Hassayampa River.
Consider that the Glen Canyon dam is only one of 431 dams built on rivers and streams throughout Arizona. Water is a precious commodity in the arid Southwest. As a result, people stockpile it for crop irrigation, electric power, and even recreation. There also is demand for water downstream from the dams. Plants and animals depend on the rivers for survival. If they don’t get enough water, they will die. It does not have to be this way.

Mimicking Mother Nature

“There’s more than enough water to go around,” claims Juliet Stromberg, an associate research professor at ASU’s Center for Environmental Studies, and an affiliated member of the botany department. “Let’s just allocate it in such a way that we don’t destroy natural areas that we appreciate.”

Stromberg studies the ecosystems of rivers. Riverside habitats are known as riparian ecosystems. The ASU scientist studies how the flow patterns of a river affect the plant life that grows on its shores. With such information in hand, she can provide valuable suggestions to water management professionals who are working to restore riparian habitats throughout Arizona.

There’s been a lot of emphasis on restoration in general lately. Lots of people want to do something to protect declining habitats, she explains. For a few years there was a big push to plant trees. That was called restoration.

Then came the realization that planting trees was not enough. Underlying questions needed answers. Where are all of the trees? Where have they gone? Why are the trees not establishing themselves along streams as they once did?

Arizona’s Hassayampa River flows through central Arizona near Wickenburg, about 50 miles northwest of downtown Phoenix. Cottonwoods, willows, and mesquite trees thrive along its banks. It is here that Stromberg is finding some answers.

Stromberg observes Mother Nature at work along the Hassayampa. Part of a Nature Conservancy preserve, the river is one of the few protected waterways in the Southwest today.

By studying the river’s flow patterns, Stromberg and her colleagues hope to gain a better understanding of exactly what riparian systems need in order to thrive. In turn, such information will help water management officials to better use dams to imitate natural water flows.

“We can’t go back to normal flows anymore [on dammed rivers],” Stromberg explains. “But we can mimic some of the elements of the natural flow that are important for the riparian plants and other organisms.”

Controlled Floods

Earlier this spring, the U.S. Bureau of Reclamation tried to do just that on the Colorado River. A week-long controlled flood released from the Glen Canyon Dam gushed into the Grand Canyon at a rate of 45,000 cubic feet per second. Duncan Patten, an ASU professor emeritus and founding CES director, served as senior scientist on the project.

“Unfortunately, we didn’t get as much of a flood as we’d have liked,” Patten says, noting a natural flood in 1983 that released 92,000 cubic feet per second. However, the controlled flood did succeed in some of its goals, the primary goal being the deposition of new sediment along the shore.
“T”HE RIVERS where I come from are very different from the Southwest,” says Joelle Dondeville, as she leads me along the edge of the empty Salt River basin just north of Arizona State University.

A Missouri native, Dondeville left the abundance of the Mississippi to come to ASU, where she is pursuing a master’s degree in education. Dondeville studies Southwestern river ecosystems. She hopes one day to share her fascination with the environment with high school biology students.

Dondeville was awestruck by the desert landscape upon arriving in Arizona. She set out to learn as much as she could.

“I just picked up all these little brochures and pamphlets about (Arizona) plant life. That’s how I started, I was so amazed, it was such a new experience,” she says.

“Then I encountered some ASU students. They clued me in to the Center for Environmental Studies,” she continues.

Dondeville is participating in a research project that will help the Arizona Department of Transportation (ADOT) revegetate the Salt River area in Tempe. The study is part of ADOT’s mitigation program, designed to make up for damage caused to the river area by freeway construction.

Dondeville points out a lone cottonwood tree, sole survivor from the days before the highway. Everything around it was bulldozed to make way for the Route 202. Much was already dead. Dams upstream along the Salt River effectively wiped out everything around it in Tempe.

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Now, ADOT, the City of Tempe, and the Southwestern Center for Education and the Natural Environment are trying to reconstruct the riparian ecosystem along drip lines that follow the riverbed.

“Creating a riparian ecosystem is much more difficult than preserving an existing area, according to Dondeville. For example, new seedlings do not have the cover of larger plants to protect them from the elements. They do in natural systems.

“The dynamics of the system are completely different,” she says. “Some of the plants don’t adjust as well. They’re not used to the full, direct sunlight.”

Despite these difficulties, Dondeville and her colleagues are not alone in their efforts. The ecosystem itself lends a hand. As we walked along the canal that flows beside the river, Ron Tiller, a doctoral candidate in the botany department, called out to us.

“Look at this!” he yelled, pointing down at the canal banks. There, a tiny forest of baby mesquite trees was pushing up through the gravel. These trees were not planted by human volunteers. They were volunteers donated by Mother Nature herself. In eco-speak, volunteers are plants that grow naturally without human instigation.

Dondeville’s job is to find out why some plants, like the tiny mesquite trees, survive, while others do not. To do this, she spends a great deal of time monitoring the plots, taking measurements from every angle. She measures diameter, height, canopy area, and stem density, to name a few.

She also looks at the leaf area index, which measures the canopy area and the amount of light that penetrates through it. Data in hand, she makes recommendations to the City of Tempe that will help increase plant survival.

Her recommendations might involve the need to provide more water from the drip lines or to relocate certain species.

There are certain plants that Dondeville does not want to survive, however. These are exotics, plants not native to this area and plants that, in many cases, kill the native species.

The most common exotic is salt cedar, an aggressive immigrant that was brought to Arizona from Eurasia.

“I asked Dondeville to point out a salt cedar to me. She swept her arm out towards a large collection of familiar-looking trees, trees that I had always taken for Arizona natives.

“You see it so often, it becomes part of what you think is supposed to be there, and it’s really not,” she says.

Dondeville hopes to educate her future students about what is supposed to be there. She also wants to teach them how to protect it.

“Future generations are going to be the stewards of the land. If I can incorporate some of my fascination and pass off the knowledge that I’ve acquired so that the decisions they make will be informed, conscientious decisions, that will be wonderful,” she says with a smile.

“Plus, biology is the study of life. How can you go wrong with that?” — DIANE BOUDEAU

Along undammed rivers, sediment is deposited regularly with the spring floods. Along the Colorado, however, the small, sudden releases used to generate hydroelectric power actually eroded sand from the banks into the river channel. The radical water level fluctuations also exposed and dried out plants living on the river bottom. This in turn depleted an important food source for the fish in the river.

The experimental flood redeposited sediment on the riverbanks. It also created backwaters, channels of water that tend to stay warmer than the main river waters. Backwaters also serve as excellent habitats for young fish. Even the river rafting industry benefited by the rise of beaches suitable for camping.

Further south, another river may soon get a dousing as well. Pat Shafroth is a doctoral student in botany at ASU and a National Biological Service employee. He studies the ecology of the Bill Williams River, which is obstructed by the Alamo Dam.

A large portion of the land below the dam is managed by the Bureau of Land Management and the Fish and Wildlife Service, both of which strive to promote healthy wildlife habitats. Two years ago, a technical committee drafted baseline recommendations for changing water release patterns from the Alamo Dam in order to promote better fish and wildlife habitats downstream.

“What we’re trying to do is refine those recommendations and fill in some of the gaps,” Shafroth says.

Putting Together the Pieces Shafroth’s work is much like building a puzzle with hundreds of interlocking pieces. A variety of factors contribute to an ecosystem’s health and welfare. In desert riparian areas, one of the most important pieces is flooding, which occurs periodically in Nature. In order to mimic a flood by releasing dammed-up water, several variables must be taken into account. These include:

Timing of floods: Some species, like the cottonwood and willow, require flooding to create the right conditions for their seeds to germinate. Therefore, the floods must be timed to occur before seed dispersal to provide the optimum environment for the young trees.
Environmental scientists use tree ring cores to derive climate history. Arizona's widely varying conditions and the hard life of southwest species like mesquite result in irregular growth that makes it difficult to obtain a reliable core. Instead, researchers study slabs (left). Other information is obtained by physical measurement (below left) and population studies of the species in a given area. The reeds below were collected into a reference herbarium to assist in identifying plants at the study sites. (Right) A typical winter flood along the Hassayampa River.

**Magnitude of floods:** The amount of water that is released also changes the growing conditions of a riparian area.

**Rate of decline after a flood:** When water is released from a dam to produce hydroelectric power, it often stops as suddenly as it starts. The more gradual decline found in natural systems ensures the tiny roots of seedlings do not dry out.

**Base flow:** Plants need more than just a periodic flood to keep them going. The base flow maintains the underground water table at appropriate depths for plant growth and survival.

So how do researchers study the effects of these variables? After all, they cannot ask a tree how it is feeling today. Instead, they piece together clues that tell them how flood patterns affect vegetation. For example, scientists take samples of tree cores using a tool called an increment bore.

Researchers drill into a tree and pull out small cross-sections of the trunk without harming the tree. Using the sections, they can then study the plant’s history by looking at its rings. Tree ring data often is used to determine the age of a tree and how it is feeling today. Instead, they piece together clues that tell them how flood patterns affect growth.

Some trees are scarred during periods of extreme flooding. Scars appear as indentations in rings on the upstream side of the tree. They occur when debris slams into the tree as it surges downstream during a flood.

**Balancing Act**

Shafroth uses these clues and others to determine the best release patterns for a healthy riparian system. Once he gathers enough information, he will make recommendations to the U.S. Army Corps of Engineers, which manages the Alamo Dam.

Alamo Dam provides a perfect work site for Shafroth. Because the dam is used primarily for flood control, the water is not allocated for other purposes such as irrigation. As a result, managers may be able to release water from the dam in the quantity and frequency that most benefit the downstream ecosystem. This is not the case in other areas.

“Most dams are operated for purposes which limit the flexibility of their operation,” Shafroth explains. “There may be dams operated to generate hydroelectric power, or dams which impound water that is diverted for agriculture. That water is all paid for and people have rights to it.”

According to Patten, trying to appease everyone involved is a balancing act. At the Glen Canyon Dam, the electric generators can handle 32,000 cubic feet of water per second, meaning that any additional water released will have to bypass the generators.

“Anything that doesn’t go through the generators is considered wasted water by the electric company,” Patten says. “This makes it difficult to convince dam management that they should release enough water to simulate a natural flood.”

Shafroth believes that dam managers are more likely to make changes that have a minimal impact on their operations.

“There may be an opportunity for some of the important (floodings factors) to be incorporated into dam operations. It would be on a case-by-case basis, and it might have to be opportunistic,” he adds.

Why so much effort to restore a river? The answers are many. The benefits extend to people as well as wildlife. One obvious reason is that rivers provide pleasant places for people to relax and enjoy themselves.

Many of the people fighting to protect the San Pedro River (in southern Arizona) are from the big cities,” Stromberg says. “They want to have a nice place to go. We’ve already ruined the Salt River in Phoenix and the Santa Cruz River in Tucson.”

But human effects on rivers go beyond aesthetics. For example, agriculture, cattle grazing, and damming have led to a rise in the population of salt cedar, a non-native plant imported from Eurasia. Salt cedar makes the soil more saline, which impedes the growth of many native plants. In addition, salt cedar is highly flammable, making it hazardous to have around during seasonal Arizona wildfires.

Many dollars have been spent in search of means to eliminate salt cedar. One fact is known for certain: salt cedar grows better along dammed rivers than on free-flowing waterways.

Salt cedar is a new piece of the puzzle. It does not fit well into our riparian picture. As Stromberg and other scientists learn more about what should exist in a natural system, they may find even more benefits in preserving existing systems and repairing those that have been altered.

“A riparian area is there because the river functioned naturally (at one time),” Patten adds. “Simulating natural processes helps us try to maintain what was there.”

For more information about riparian research or other projects at ASU’s Center for Environmental Studies, contact Juliet Stromberg, Ph.D., 602.965.2975.