# Desert Waters

We regard Earth as a blue planet, and water is the key to its life. But the water on which we all depend makes up a mere sliver of the planet's total – only 2.5 percent of Earth's water is freshwater. Most of that is locked in ice and snow, leaving less than 1% accessible to grow crops, cool power plants, supply drinking water, provide habitat, and slake the thirst of our world's biodiversity.

Nowhere is water more precious than in the desert. Drought and aridity are near constant drivers that force species' adaptation to survive in an arid land. Here in the Sonoran Desert, winter and summer rainy seasons provide a relative bounty of moisture and support diverse plant and animal communities. Where water collects and percolates into the soil this diversity reaches its greatest expression. The ecosystems associated with seasonal **runoff** and near-surface **groundwater** are called **riparian communities**.

Riparian communities have taller, denser vegetation, more moisture, and more life than their surrounding lands. They vary depending on how much water they contain. A **dry desert wash** that runs only a few hours a year collects water from a large area and provides

Dry desert wash west of Blythe, California. Photo credit: Mark Dimmitt

more moisture than the adjacent desert. In very arid parts of the Sonoran Desert, species like ironwoods, mesquite, blue palo verde, and desert willow only exist along these drainages. **Intermittent streams** that carry water seasonally during periods of high rainfall or snowmelt in their higher elevation headwaters support tree species like cottonwoods and willows in lower elevations, and sycamore and ash in the uplands. **Perennial streams** support the same species in denser profusion. And where the **water table** is at the land surface, springs and marshy areas called **ciénegas** appear, supporting trees at their edge and sedges and aquatic plants in their waters.

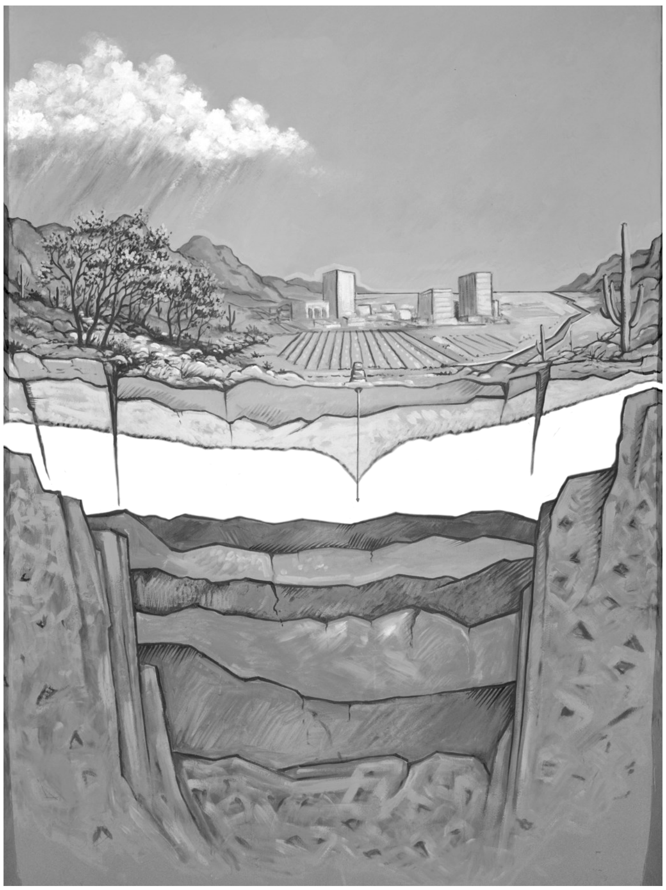
Perennial stream, Aravaipa Canyon. Photo credit: Robin Kropp

Riparian areas are our desert's lifeblood. These green arteries traverse the surrounding arid land and provide habitat and corridors for many species. Nearly 80% of Arizona's wildlife species depend on riparian areas for food, water, shelter, or migration during some part of their lives. Birds such as bald eagles, black hawks, and summer tanagers nest along them. Mammals like beavers, raccoons, otters, and many others rely on their food, shelter, and water. Leopard frogs, garter snakes, dragon flies, and human beings all depend on these desert waters.

Yet most of our riparian areas have been degraded or destroyed. Where dams have restricted or eliminated water flow downstream, or groundwater pumping has caused the water table to drop deep below the surface, vegetation communities have disappeared, along with their animal inhabitants. Now, as we begin to understand the importance of intact riparian ecosystems, people are working to protect and restore what remains while meeting the needs of an evergrowing human population. Tucson's water story illustrates the complexity of water issues in a thirsty land.

## Water in Tucson

Tucson is like a large bathtub: the mountains that surround it are its rim, and the deep layers of gravel, sediments, and rock beneath form its basin. The Santa Cruz River is its drain, the lowest point toward which surface and subsurface waters flow in the basin.



The aquifer under the Tucson Basin filled with groundwater over millennia.

Tucson exists because, over millennia, storm runoff from throughout the Santa Cruz **watershed** percolated into the **aquifer** and filled the basin. This fossil groundwater—dated at 4500 years old—was at or near the surface in drainages like the Santa Cruz River, Rillito Creek, and Pantano Wash. Recent archaeological excavations near Sentinel Peak or "A" Mountain have revealed that Tucson has been continuously inhabited for at least 4,000 years, making it one of the oldest settlements in the U.S. Why? At this spot, the mountain's bedrock pushed groundwater to the surface in the Santa Cruz River, providing perennial flow that supported a lush riparian woodland where native people subsisted off wild foods and used the river's water to cultivate corn, beans, squash, and cotton. The Santa Cruz's permanent water was imperative for human life to thrive, and Tucson's name is derived from where it flowed—the Tohono O'odham words *Chuk Shon* mean "black base," which refers to the foot of "A" Mountain. Today at this spot, the Santa Cruz River is a dry, channelized ditch that only flows after rain storms.

A Mountain near dry Santa Cruz River bed. Photo credit: Jesús García

What happened?

Tucson's first inhabitants used the Santa Cruz's water by scooping it out or directing small canals to irrigate crops – the first irrigation canals appeared around 1200 B.C. When the Spanish arrived in the late 1600's they continued to utilize water in much the same way. They watered their crops through a communal system of ditches or *acequias* that took water from the river upstream, let it flow through fields, and reenter the channel downstream. They also dug shallow wells for municipal use. In the mid-1800s, water was delivered by wagon. The population remained small – around 250 people – and put little strain on the water supply. What they used was replaced by rainfall and snowmelt along the watershed.

But more and more people came and needed more water. In the 1880's, railroad and steam technology arrived, and people began to pump water from deeper wells and made bigger canals. The first irrigated farms appeared, undermining the old *acequia* system. In the late 1800s, a series of drought years were followed by heavy floods that scoured river banks destabilized by overgrazing and canal building and deeply eroded the river bottom. The newly incised channel left canal intakes high and dry. This, combined with unregulated groundwater pumping, led the Santa Cruz's surface waters to disappear completely by the late 1940s.

Human demand for water in the basin continued to far exceed that **recharged** by precipitation. Until the last two decades, groundwater pumped from wells throughout the community was the sole source of water for residential delivery. Tucson was the largest municipality in the U.S. that relied solely on groundwater.

By the latter part of the 20th century, the impacts of this dependence were clear. In Tucson's central wellfield the water table had dropped 200 feet. Cottonwood and mesquite groves in the Tanque Verde wash were dying. Midtown houses formed large cracks as the ground subsided. In the most affected areas, some wells had to be shut down.

Arizona passed the Groundwater Management Act in 1980 which requires that municipal water recharge must exceed pumping by 2025. Tucson Water, the city's main water provider, currently delivers water to approximately 709,000 customers out of a county population of nearly a million people. With the population projected to double in fifty years, the utility faces a great challenge. To address it, Tucson Water is pursuing a variety of efforts to safeguard our water supply: 1) recharging groundwater with Colorado River water, 2) promoting conservation, and 3) using **reclaimed** water.

## Colorado River and the Central Arizona Project

The Colorado River drains seven U.S. and two Mexican states in the arid West. It is the most dammed and diverted river in the world, serving some 30 million people and thousands of acres of farmland throughout its watershed. It is so overdrawn by its consumers it no longer reaches its outflow in the Sea of Cortez.

Tucson receives Colorado River water pumped here along a 336-mile long canal called the **Central Arizona Project** (CAP.) CAP brings about 1.5 million acre-feet (enough water to cover an acre of land with one foot of water, about 320,600 gallons) of Colorado River water per year to Pima, Pinal, and Maricopa Counties. This system of aqueducts, tunnels, pumping plants, and pipelines begins at Lake Havasu, near Parker, and ends at the southern boundary of the San Xavier Indian Reservation southwest of Tucson.


CAP Map from: http://www.cap-az.com/aboutus/systemmap.aspx

CAP waters are allocated roughly to the following uses/users:

- 35% municipal and industrial
- 25% agriculture
- 10% Indian communities
- 30% banked underground for future use.

Tucson's CAP allotment is 144,000 acre feet. Tucson Water has been banking Colorado River water underground at its recharge facility west of Tucson in Avra Valley since 1996. This helps mitigate times when demand along the Colorado River outstrips supply due to drought years or increasing numbers of users. The water is recharged into groundwater storage basins by allowing water to percolate down through the soil to replenish underground aquifers. Recharge basins are selected for their permeability, proximity to customers and delivery systems, and lack of contaminants in the soils. The recharged water blends with existing groundwater, and it is delivered to customers through the utility's water supply infrastructure.

## Reclaimed Water

Tucson Water has also operated a Reclaimed Water production, storage, and delivery system since the mid -1980s. Wastewater from the Pima County sewage treatment facility is further filtered and disinfected for use in irrigation and other non-potable applications at golf courses, parks, schools, and homes. In 2011, approximately 15% of all of Tucson Water's deliveries were reclaimed water.

## Water Conservation

Because our water supply is limited, and our population continues to grow, it is imperative that we use water wisely. There are many things that we can do use water more efficiently, starting at home:

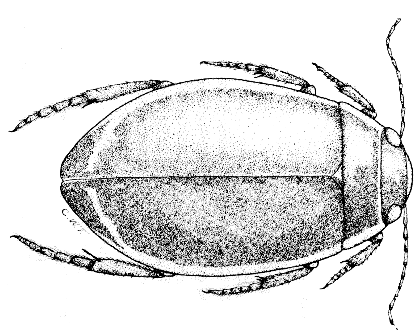
- Fix water leaks in toilets and sinks.
- Use water efficient fixtures and appliances that replace older, water-wasting ones.
- Take shorter showers.
- Turn off the tap when we brush our teeth.
- Run the dishwasher only when it is full. This can save from 10-20 gallons/day/household.
- Plant native plants for landscaping. Desert landscaping can reduce outdoor water use by 50% - it requires about 15 gallons of water per square foot per year while grass and non-native plantings need about 27 gallons.
- Capture **gray water** from clothes washers, bathroom sinks, and showers to water landscape plants.
- Harvest rainwater in cisterns or catchment basins that capture flow off roofs or driveways and direct it to landscape plants.

Desert landscaping planted in a midtown Tucson front yard. Photo: Robin Kropp

Tucson Water promotes a host of WaterSmart water conservation tips through classes, workshops, and free publications. They have rebate programs for homes and business customers who install gray water systems, rainwater harvesting infrastructure, high efficiency toilets and urinals, and more. These save money and water that can be put toward ecosystem restoration projects.

## Riparian Ecosystem Restoration and Protection

Healthy riparian ecosystems improve quality of life for all residents. We can use water conserved by wise use practices and recharged treated wastewater to restore riparian ecosystems that have been lost or degraded. Two examples, Sweetwater Wetlands and North Simpson Farm and Martin Farm, are bringing new life to the Santa Cruz River.



The Sweetwater Wetlands is part of Tucson Water's Reclaimed Water facility. Treated wastewater filters into recharge basins at the site in the Santa Cruz riverbed. As the water infiltrates it is further cleaned by the soil sediments. Wells beneath these recharge basins capture this cleaned water and distribute it through the reclaimed water delivery system. The wetlands provide habitat for urban wildlife including residential and migratory birds, raccoons, and bobcats, and the park is a wonderful outdoor classroom or relaxing space to enjoy nature.

Sweetwater Wetlands from: From : http://cms3.tucsonaz.gov/water/sweetwater

North Simpson Farm and Martin Farm are riparian restoration projects of Tucson Audubon Society and the City of Tucson in Marana. Treated effluent from Tucson sewage treatment facilities flows in the Santa Cruz riverbed for several miles before sinking underground. Riparian species have again returned along its banks. At these sites, project personnel have planted and seeded riparian area species, built erosion control features, and fought invasive plant species to restore a healthy riparian ecosystem. Bird surveys have shown that many species, some of which are threatened by loss of habitat in their range, now utilize these sites.

Pima County has protected riparian areas within its limits such as Cienega Creek, Tanque Verde Wash, the San Pedro River, and Sabino-Bear Canyon. As part of the county's Sonoran Desert Conservation Plan, a long-term plan for protecting our region's heritage and natural resources, additional critical riparian habitats have been identified that merit protection. County bond money and private donations have been used to purchase and protect these lands for wildlife and plants, maintain recreational trails, promote groundwater recharge, protect water quality, and attenuate flooding.

**Water for our Future**

Animals, plants, and native people here all adapted to our desert's scarcity of water by getting by with very little. When newcomers came to the area, we didn't follow this example very well. Much has been lost.

Human populations are expected to double in the West in the next 50 years. And the drought-stricken Colorado River may only recover about 85% of its historic flows. These demands require conservation on a whole new scale. If we employ the conservation and restoration efforts highlighted above, we have a powerful tool kit to protect what is left and create abundance that meets the needs of all of our residents—human, plant, and wildlife alike.

Cienega Creek southeast of Tucson. Photo: Carroll Hemingway

The following two case studies illustrate the complexity of water use issues in the Colorado River Basin.

## Case Study 1: The Colorado River


Most of the northern Sonoran Desert Region drains into the Colorado River watershed. For 1,450 miles, the Colorado River flows through seven U.S. and two Mexican states from its headwaters in the Rocky Mountains to the Gulf of California. It is the most dammed and diverted river in the world. Agriculture, ranching, industry, urban development, hydroelectric power generation, mining, and recreation throughout this arid region depend on its waters, the "lifeblood of the West." The river is "over-allocated" – more water has been divided among its users than flows there in an average year. Some states do not use all of their allocations, but already more water is extracted from the river system than snowmelt and rainfall replenish annually.

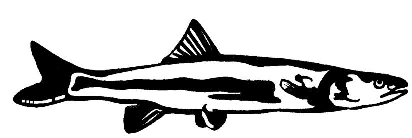
Ecosystems along the river and the northern Gulf of California have been impacted as dams and diversions have changed river flows, resulting in extinction of native species and loss of biodiversity. Today the Colorado no longer reaches the sea. The vast Colorado River Delta, which once provided 3,000 square miles of rich wetland habitat, has all but disappeared.

Demand already exceeds supply, and this problem will only intensify as the region's population is predicted to reach 50 million, and as flows may further be reduced by drought and climate change. We recognize that human health and economic well-being in the region depend on a healthy river. The challenge will be to balance protection and restoration of healthy flows with our water needs now and in the future.

## Case Study 2: The Colorado Pikeminnow

The Colorado pikeminnow is North America's largest minnow. A hundred years ago, these fish were found all along the Colorado River and in large rivers that join it. It was not uncommon for people to catch a six-foot long pikeminnow that weighed almost 100 pounds! There were so many that farmers caught them in their irrigation ditches with pitchforks and used them to fertilize their fields. Today the Colorado pikeminnow is almost extinct in Arizona, and it is rare to find a big adult fish anymore. What happened?

The main reason is that people changed the fishes' habitat. Dams were built along the Colorado River to generate electricity, provide water for use in farms and cities, and to control spring floods. The dams changed the flow and temperature of the water. Before the dams, pikeminnows produced their eggs in late spring and early summer. As spring floods ended, the river water level would drop, and the sun would warm up the water. This warmer, shallower water told the pikeminnows that it was time to lay their eggs. But once dams were built, people controlled water flow into the river below the dams. The water stayed higher and cooler in the spring and summer. The pikeminnows stopped producing their eggs like before.
Their numbers dropped because fewer young were born.



Also, people added different fish to the river to have new fish to catch. One kind, largemouth bass, came from the Eastern U.S. Largemouth bass did well in the "new" habitat along the Colorado River. They began to compete with pikeminnows for food and living space. They even ate Colorado pikeminnow eggs and young, causing their populations to drop even more.

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