

Rock Dentention Structures: Restoring Watersheds for Wildlife

Cuenca Los Ojos, Borderlands Restoration
Network, and the Biophilia Foundation

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Cuenca Los Ojos, Borderlands Restoration Network, and partner organizations have adapted and expanded the use of regionally-derived, low-tech methods to restore arid and semi-arid landscapes. By controlling erosion and encouraging sedimentation with rock detention structures, such as check dams and gabions, we have improved hydrological function and created habitat for a wide variety of species important to the Sky Islands biodiversity hotspot.

Lush Wetlands Once Thrived in this Arid Region

Only a few hundred years ago, the Sky Islands region was crossed with wide, shallow rivers and distinct alkaline wetlands known as *ciénegas*. The landscape provided food, water, and habitat to innumerable species that made a home in the arid region.

The desert rivers and wetlands were made possible by several forces working together: forested uplands that soaked up rainfall on mountains and hillslopes, beavers, whose dams kept the water table high, and a highly textured land surface that slowed the movement of rainfall over the land, enabling water to infiltrate the soil.

Wetlands Lost to a Cycle of Degradation

The land began to change with the arrival of Euro-Americans to the region. Decrease in groundcover, introduction of sheep and cattle at unsustainable levels, eradication of beavers for fur, destruction of beaver dams to drain land, and clear-cutting of forests for fuel for mining operations together transformed the region's hydrology.

Monsoon rains flowed with greater speed and energy over the land, cutting deep channels into the earth. The channels reduced infiltration of water into the surrounding soil and lowered water tables. In some cases, such as the San Bernardino Valley (sidebar, next page), newly incised waterways even drained the *ciénegas*.

Changes to hydrology rippled through the ecosystem. Less moisture in the soil caused a change in vegetation and in some places led to bare, exposed soil that was more vulnerable to erosion, harbored fewer microorganisms, and absorbed less precipitation. In this downward spiral, land degradation was self-perpetuating, and in a matter of decades, the landscape became less hospitable to the abundant wildlife that once lived there.



Historical photos document a much wetter landscape than we see today.

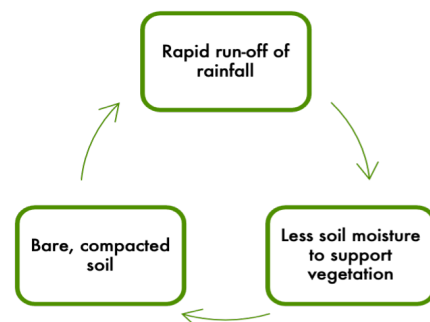


Figure 1. In fragile environments like deserts, land degradation can become a self-perpetuating cycle.

Protecting the Land Is Not Enough

In modern times, numerous private landowners, nonprofit organizations, tribes, and government agencies have worked to restore the land to a healthier condition. Organizations like Cuenca Los Ojos and Borderlands Restoration Network have found that simply protecting land from further threats is not enough; we must actively restore ecosystem function.

Loose Rock Structures Are a Simple Solution

In Arizona and Sonora, Cuenca Los Ojos and the Borderlands Restoration Network have adopted practices originally developed by the indigenous peoples of the region. Low tech, stacked rock structures, installed by the thousands across a watershed, can stop and even reverse the cycle of degradation.

The process is not always intuitive: what is the connection between loose rock structures and ecosystem restoration? The answer lies in the structures' ability to impact multiple biophysical systems, working with nature to initiate a virtuous cycle of restoration.



*Photos courtesy of
Ganesh Marin.*



Historical incision of the San Bernardino River

The San Bernardino valley was once the site of a regionally important *ciénega*, a marshy desert wetland supplied by freshwater springs. The *ciénega* provided water, food, and habitat for many resident and migratory species.

As the land degraded, it became more vulnerable to extreme weather events. The San Bernardino *Ciénega* was perhaps even drained by a single event. Heavy rainfall created a new channel, now known as the San Bernardino River. The incision depleted surface and ground water, altered habitats, and led to a decline in wildlife.

In recent decades, CLO A.C.'s restoration work on the San Bernardino River and Silver Creek, which flank the San Bernardino *Ciénega*, has nearly tripled the wetland's inundated area.

How Do Loose Rock Dams Restore Watersheds?

Inspired by the traditional knowledge of craftsmen from Sonora, the founders of Cuenca Los Ojos began experimenting with loose rock structures in Arizona's Chiricahua mountains over 40 years ago.

A variety of structures were used. High in the watershed, simple **one rock dams** slowed water and increased infiltration into the soil (Fig. 2A). In intermittent streams, **trincheras** (Fig. 2B), also known as check dams, caused sediments to accumulate, reversing historical incision of waterways. **Gabions**, which are loose rocks enclosed in wire frames (Fig. 2C), served the same purpose and were installed where water flows faster and with more force.

Although they are colloquially called dams, they do not stop the flow of water but rather slow it down. The structures are intentionally leaky and lower than the surrounding land surface.

During rain events, water flows over and through the structures, enabling fish and other aquatic species to travel upstream and downstream. As such, their impact is more similar to tree roots and natural debris than to conventional dams.

While a single rock detention structure can stop erosion at its location, it is only when structures are applied across an entire watershed that their ability to restore ecosystems becomes apparent. In Arizona and Sonora, Cuenca Los Ojos, Borderlands Restoration Network, and affiliated organizations have installed more than 60,000 rock detention structures and created a transformative effect on the entire ecosystem.

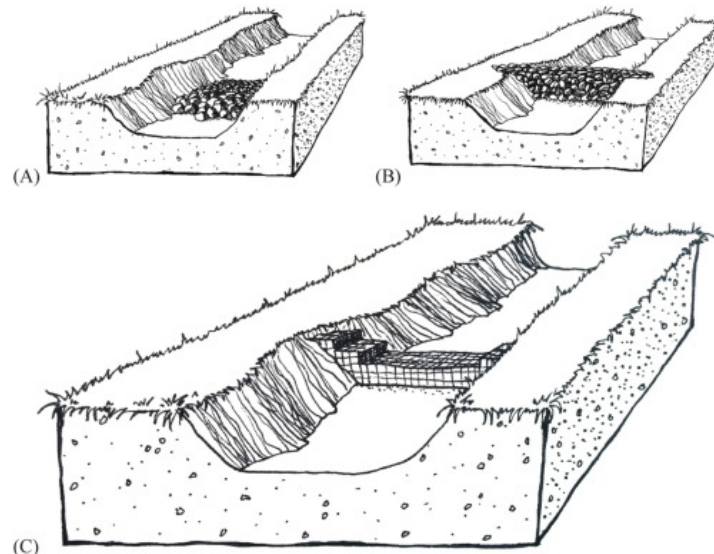


Figure 2. Sketches of rock-detention structures, including:
(A) one-rock dam, (B) trinchera, and (C) gabions.
(By Chloé Fandel, reprinted from Norman et al. 2017.)

Ecosystem Functions

Widespread installation of loose rock dams serves numerous functions in the ecosystem.



Reduces erosion and increases sedimentation: Immediately upon installation, rock detention structures begin accumulating sediments. (In highly erosive watersheds, small structures have even been known to fill up in a single rain event! But additional layers can be built atop older ones as needed.) Sediments can be several meters deep behind large gabions, reversing centuries of channel incision in a matter of decades.



Restores hydrological function: Watershed restoration with loose rock dams 'smooths out' the highs and lows of water channels' flows. By slowing heavy rainfall over the land and enabling soil infiltration, rock dams reduce peak flow during flood events. The absorbed water is then released slowly, extending the annual duration of water flow. In the most-studied watershed, Turkey Pen in the Chiricahua Mountains, annual flow volume increased 28% compared to an unrestored watershed. Field studies and modeling further suggests and increase in aquifer recharge of up to 10%.



Increases vegetation: Restored watersheds are significantly greener, with denser vegetation, greater water content in vegetation, and a larger percentage of perennial plants. The additional vegetation cools soil, creates conditions favorable to microorganisms, adds organic carbon and other nutrients to the ecosystem, and provides food and habitat for a multitude of species.



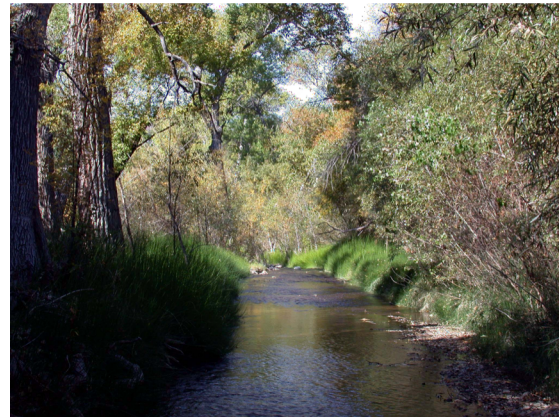
Supports biodiversity: Researchers have documented an increase in the number of grass species and aquatic species, including recolonization by rare native fish. Abundant new growth of trees and other vegetation supports populations of jaguar, ocelot, Mexican grey wolf, black bear, and other wide-ranging and migratory species, many of which are threatened or endangered in the Sky Islands.



Increases resilience: Because restored watersheds hold more water in the soil, restoration increases the landscape's resilience to drought. A 30-year study found that restored sites remained greener in seasons with low rainfall. By reducing peak water flows, restoration also increases resilience to flooding, protecting ecosystems and the people who depend on them. Landscapes that hold more moisture may also be more resilient to the hot-burning, catastrophic wildfires that have ravaged the West in recent years.

Advantages of Loose Rock Structures

- Low tech: One-rock dams and trincheras are simple structures that can be constructed from materials found on site. They require craftsmanship to build, but the work can easily be taught to volunteers and work crews.
- Low cost: Because they use found materials and require less advanced planning than some other riparian restoration methods, loose rock structures can be very cost-effective. A medium-sized trinchera can be built for less than \$100.
- Jobs: Loose rock structures require little investment in materials and equipment. Most of the installation cost goes to labor, which provides jobs that support a restoration economy.
- Indigenous technologies: Developed by indigenous peoples in Sonora and throughout the region, loose rock structures maintain a traditional practice uniquely suited to the Sky Islands region.
- Virtuous cycle: When installed throughout the watershed, loose rock structures can stop the cycle of degradation and initiate a new, self-perpetuating cycle of regeneration.
- Improves resilience: When installed across a watershed, loose rock structures increase the landscape's resilience to drought and floods. Benefits can accrue to downstream neighbors and communities, who see increased water flow during drought and a decrease in catastrophic flood events.
- Benefits for working lands: Restoration can increase the availability of surface water and forage in ranching operations, providing a tool to increase productivity and operate more sustainably.



The Cajon Bonito, before and after restoration. The Cajon, on the Cuenca Los Ojos reserve, has been recognized as one of the most important freshwater streams in North America for its populations of endemic fish. Restoration activities have created conditions that are more hospitable to native aquatic species.

Want to learn more? We can help.

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Cuenca Los Ojos, the Watershed of the Springs, is a 121,000-acre (49,000-ha) protected area in the Sky Islands of Sonora, Mexico. Located directly along the United States-Mexico border, CLO stewards the unique desert wetlands, open grasslands, and soaring mountains of the Madrean Archipelago. CLO is restoring and rewilding these once-degraded ranch lands by repairing waterways and reviving the natural processes of herbivory, predation, pollination, fire, carbon sequestration, and nutrient cycling. Today, CLO is home once again to jaguar, ocelot, black bears, beavers, and a host of other threatened and endangered species.

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Borderlands Restoration Network partners to grow a restorative economy by rebuilding healthy ecosystems, restoring habitat for plants and wildlife, and reconnecting our border communities to the land through shared learning. BRN works primarily in southern Arizona and northern Sonora. The tri-national borderlands region is one of the most ecologically diverse and socio-economically dynamic regions in the world. It presents a microcosm of issues including habitat degradation, aridification, racial injustice, income inequality, food injustice, climate change, and migration issues. BRN's activities include watershed restoration, education and outreach, and native plant and seed propagation.

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The Biophilia Foundation supports efforts that protect, restore, enhance, and preserve wildlife habitat for all species of native plants and animals. Biophilia sees watershed restoration as the foundation of landscape restoration in the arid and semi-arid West. To that end, the Biophilia Foundation has launched a program to develop a carbon credit mechanism for dryland riparian restoration. The Biophilia Foundation is currently studying the impact of loose rock dams on riparian carbon cycles and bringing together practitioners from across the West to scale up financing. Other areas of focus include rewilding, capacity building, private land conservation, and restoration in the Chesapeake Bay.

