Aravaipa Creek, June 2019. Photo: WRRC

ENVIRONMENTAL FLOWS

Policy Guide

March 2021

Introduction

INTRODUCTION

Water is a precious and finite resource in Arizona, the Lower Colorado River Basin, and other semi-arid regions of the world. It is critical for healthy human communities, and thriving natural areas that support the vast majority of wildlife and a diversity of plants in these semi-arid environments. Sky Island Alliance and University of Arizona Water Resources Research Center have worked together since 2016 to promote dialogue, understanding, and innovation among water managers, natural resources managers, and community groups toward securing environmental flows for water-dependent natural areas. Two critical threats to healthy ecosystems are the lack of policy tools necessary to protect water at its source, and the lack of effective mechanisms for reinvesting water saved through conservation and efficiency back into natural areas. To develop these tools and mechanisms, we must effectively link regional discussions about water management with conservation and strategies to protect water dependent ecosystems and watersheds.

Planning and management strategies for safeguarding water for natural areas are often limited by social, political, and economic constraints. Even as the public consistently ranks the environment and water as a top concern for local policy and quality of life, there are significant challenges in implementing on-the-ground solutions to provide water for flowing rivers for healthy human and ecological communities. This policy guide outlines available planning and management options for ensuring environmental flows by exploring the status of policies and regulations, highlighting successful examples of environmental flows projects, showcasing available tools for local decision making, and identifying future pathways available to include natural areas alongside human uses in water management.

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Environmental Flows in the Colorado River Basin

The Colorado River flows through seven states in the U.S. and two states in Mexico. The 1,450-mile-long river has its headwaters in the central Rocky Mountains, then flows southwest through the Colorado Plateau and through the Grand Canyon before reaching Lake Mead on the Arizona-Nevada border, where it finally turns south toward the U.S.-Mexico border.

Source: Elia Tapia

This guide focuses on the Lower Colorado River Basin, particularly on the state of Arizona, highlighting the Sky Islands Region.

State of Environmental Flows

Environmental flows are defined as the amount of water necessary to maintain the health, integrity, and productivity of riparian and aquatic species. Environmental flows also provide ecosystem services such as water supply, water purification, waste treatment, drought mitigation, nutrient delivery, biodiversity conservation, and religious, cultural, or recreational opportunities. As population growth and economic activity increase demands upon surface and groundwater, the quantity, quality, and timing of the environmental flows that support these benefits are impacted. This situation is particularly acute in the arid borderlands of the Lower Colorado River Basin (LCRB) in the U.S. and Mexico, which are impacted by land use changes, climate uncertainty, and water management decisions.

In order to protect riverine ecosystem diversity and maintain essential ecosystem services it is necessary to understand the characteristics of flow components. Magnitude, frequency, periodicity, duration, and rate of change of flow events are some of the variables that need to be considered when trying to allocate water for the environment. While numerous studies document methodologies to quantify environmental flows, there is a lack of data on species or system specific water needs, methods for community engagement around environmental flows, and policies to protect the environment. This pausity of data can hinder attempts to translate methodology into practice.

The University of Arizona Water Resources Research Center (WRRC) has collaborated with various partners for over a decade to provide greater understanding of environmental flows throughout the desert watersheds of the U.S. and Mexico. In addition to a 2016 study analyzing flow needs and responses, WRRC created the Desert Flows Database of available peer-reviewed articles and agency reports, the Desert Flows Assessment for the State of Arizona, the Arizona Environmental Water Needs Methodology Guidebook, and the Desert Flows Methodology Guidebook. These studies, along with 2014 The Roadmap for Considering Water for Arizona's Natural Areas, contain overview of available paths forward for including natural areas alongside human uses in water management, as well as a record of the state of knowledge to connect water and land data to improve decision-making. These works also identify widespread interest in understanding and prescribing environmental flows for the wellbeing of riparian and aquatic species. This interest rarely, however, translates into actual implementation projects, as evidenced by the handful of peer-reviewed articles and agency reports that describe instances where water was delivered to the environment. Far fewer articles examine environmental flows as part of a flow experiment, pulse flow, or controlled floods from regulatory or non-regulatory programs. To a much greater extent, articles and reports describe how to quantify flows.

This guide draws from case studies that prescribe management strategies to allocate environmental flows and tools to secure water for the environment. The goal of this work is to direct land and water managers to a set of tools that can be applied under different physical, temporal, and budgetary constraints and assist them in choosing those approaches that help take environmental flows from idea to reality. We accomplish this by analyzing current regulations, successful study cases, main strategies, engagement mechanisms, and barriers for the development of environmental projects in the Lower Colorado River Basin. This geography is well positioned to provide broadly applicable lessons for the development of future environmental projects because of the diversity of strategies implemented and barriers overcome by a variety of partnerships.

This work builds upon previous efforts of the WRRC and partners to provide information on water needs and responses of different aquatic and riparian species. Information in this guide is adapted from work by Elia Tapia Villaseñor to analyze foundational elements of success for environmental flows projects in the LCRB, as well as strategies and mechanisms to ensure environmental flows in the LCRB and an evaluation of successful practices as tools for the development of future environmental flow projects. Additional information is provided from developing efforts in the Santa Cruz Watershed, as part of the WRRC's partnership with Sky Island Alliance.

Peterson Pond, Huachuca Mountains (Source: Sky Island Alliance)

Existing Policies and Regulations

The environment is often the "forgotten sector" when talking about regulatory mechanisms to secure environmental flows in the state of Arizona (Megdal 2011). Despite this diminutive standing, understanding the regulatory framework surrounding the environmental flows is essential to successful implementation of environmental flows projects. This section describes existing regulations and how they have been or could be used to allocate environmental flows in both U.S. and Mexico.

United States and Arizona

Federal and state regulations that contribute to environmental flow preservation in Arizona include:

- Prior Appropriation Doctrine: Prior Appropriation Doctrine dominates surface water right models in the Western U.S. It is the core of the Arizona Public Water Code. Based on the "first in time, first in right" approach, those who are first to make use of water for a beneficial purpose have a right that is senior to subsequent users. Beneficial uses include domestic, municipal, irrigation, stock watering, water power, recreation, wildlife, including fish, mining uses, and nonrecoverable water storage. The key requirement of this doctrine is that a surface water right can be forfeited if the water right is note used for its designated beneficial use at least once every five years. The real-life implication is that water right holders will use water even when it is unnecessary in order to preserve their right, thereby needlessly depleting instream flows. This doctrine is built upon economic development as highest priority for water use, which often translates into a loss for the environment.

- Public Trust Doctrine: One of the longest lasting and most important doctrines to promote wildlife conservation, it states that navigable streambeds in the U.S. should be held in trust for the public to access for fishing, navigation, and commerce. However, it comes with a complex history and has never been applied to protect the environment in Arizona.

- Federal Reserved Water Rights: Applies to federal lands through setting aside unappropriated water to achieve the purpose of the reservation, i.e., agriculture on Indian Reservations or domestic water supply for Forest Service ranger stations. These rights are backdated to the date the federal government reserved the land, and can only be filed to meet the primary purpose of the reservation. Despite the importance of these resources to many federal lands, most water rights for environmental flows are though state-based systems due to limitations of the rights.

- Arizona 1980 Groundwater Management Code: Representing one of the most expansive groundwater frameworks in the U.S., the Code was enacted by the 1980 Groundwater Management Act (GMA). The Code does not acknowledge the connection between surface and groundwater despite its other innovations. Implemented by the Arizona Department of Water Resources (ADWR) for the designated Active Management Areas (AMAs), the Code requires a system of groundwater rights and permits for users, management plans, and an assured water supply program for the AMAs. While the connection between surface and groundwater is lacking, the ADWR's implementation strategies presumably indirectly benefit surface water flows in Arizona's perennial streams.

- Instream Flow Rights: Recognized officially through the 1991 Executive Order that authorized ADWR to develop rules that would allow instream flow applications to be filed, facilitating the protection of the state´s riparian ecosystems. While state-based instream flow rights are an option for environmental flows, the requirements for data collection prior to filing an application, time-frame for receiving a certificated right, and junior status of these rights to most users make them a relatively ineffectual tool for protecting environmental flows.

Other federal acts that indirectly contribute to the protection of environmental flows within the study area include:

- Clean Water Act (CWA): CWA regulates the quality standards of surface waters within the U.S. through pollution control programs that are implemented by the Environmental Protection Agency (EPA).

- Endangered Species Act (ESA): ESA protects threatened and endangered plants, animals, and the habitats in which they are found measures. Since the ESA protects the ecosystems upon which these endangered species depend on, it indirectly contributes to the protection of environmental flows if endangered species dependent on riparian areas are affected.

- The National Wild and Scenic Rivers Act (WSRA) of 1968: WSRA states that certain rivers that have remarkable scenic, recreational, geologic, historic, cultural, fish and wildlife, or other similar values, should be preserved in a free-flowing condition and their immediate environments should be protected for present and future generations. In order to designate a river as wild, scenic, or recreational, an act of Congress or the Secretary of Interior is needed, followed by state protections. WSRA is set up protect instream flows, but ambiguities related to water rights can cause controversy between water users. Once a river is

A CRITICAL TIME FOR FLOWS

The Colorado River Basin has been experiencing one of the worst droughts on record, starting in the year 2000 to present. Future climate projections for the area indicate that droughts will be more frequent, intense, and prolonged, resulting in water deficits that will affect humans and their environment.

designated, the amount of flows necessary to sustain its value must be quantified and a management plan drafted. Quantification of flows for Verde River and Fossil Creek in Arizona are ongoing at the time of this report.

Balancing bureaucratic processes with stakeholder engagement represents a major challenge for the protection of environmental flows. For this reason, conservation practitioners are beginning to seek other opportunities, such as voluntary agreements to protect riparian and aquatic ecosystems. Short-term water lease agreements are a type of voluntary agreement that are more common in the Pacific Northwest. These leases are beginning to be used in Arizona, providing farmers and ranchers with monetary compensation for keeping water in a stream. Conservation easements, mutual covenants, management agreements, and the purchase of development rights are also some voluntary land protection methods that can indirectly benefit the perennial streams within the LCRB and Arizona.

In Arizona, the largest barrier for the implementation of environmental flow projects is the regulatory framework that does not easily allow for the permanent protection of flows and voluntary short-term agreements represent a good starting point towards the protection of environmental flows.

Environmental Flows in Mexico

In Mexico, the National Water Law was enacted in 1992, with the main objective of conserving and protecting water resources as a matter of national security. The system of water rights developed in the National Water Law provides security and stability for the use and management of this resource. According to Mexican legislation, surface and groundwater are considered to be the nation's property, only to be used through a state concession. This is the equivalent of a water right permit in the U.S. The primary agency regulating the country's water resources is CONAGUA, created in 1989 to preserve the inherent public goods and manage sustainable use of these resources.

Among its many responsibilities, CONAGUA divided Mexico into 731 hydrologic basins. The surface water availability for each basin is defined according to the Official Mexican Norm NOM-011-CONAGUA-2000, published in 2000 and modified in 2014. This availability is defined in terms of the average runoff and water imports from other basins minus evapotranspiration and permitted water uses. According to NOM-CONAGUA-2000, annual extracted volumes should include water concessions (permit rights), pending concessions, and volumes associated to water reserves, environmental flows, and regulated areas. However, over-allocation of water resources often produces a water deficit, negatively impacting the environment.

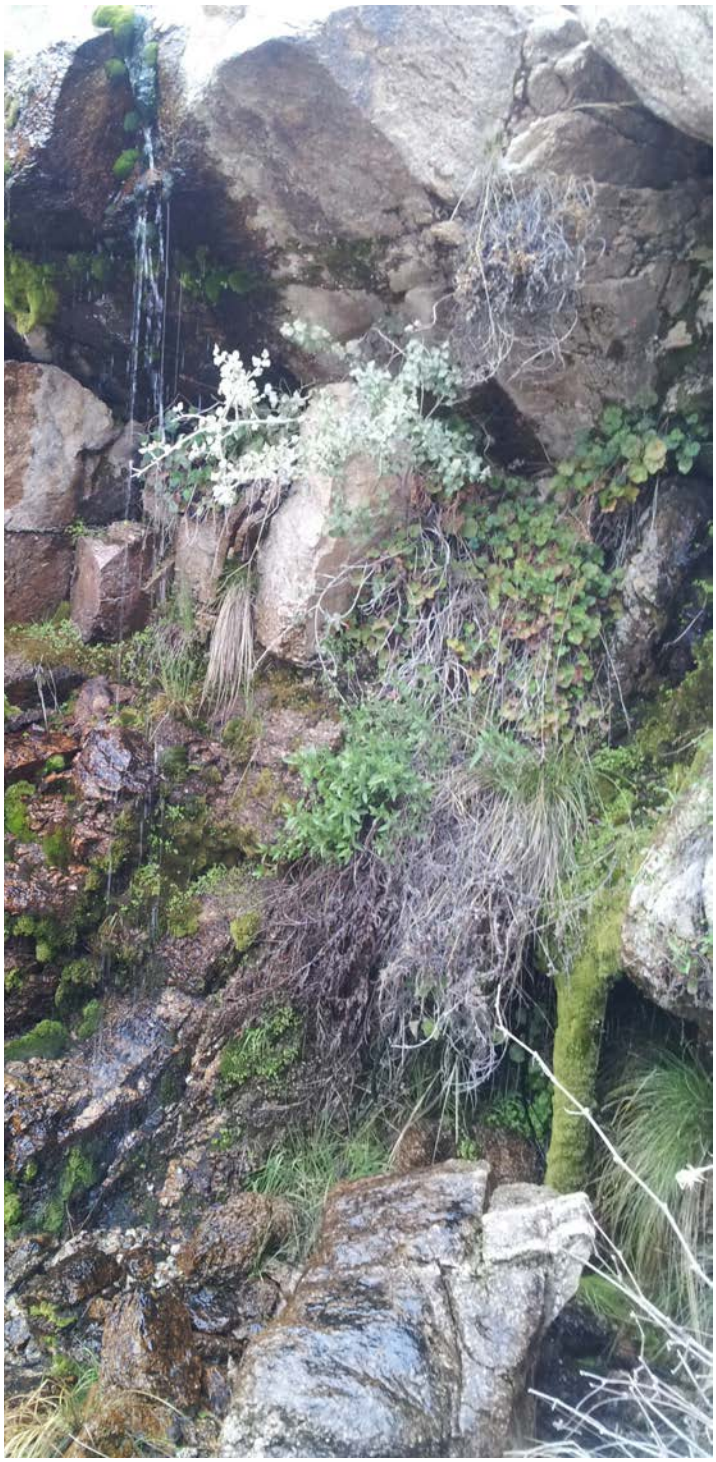
In 2012, due to pressure from different environmental groups, NMX-AA-159-SCFI-2012 was published with procedures for environmental flows determination in hydrologic basins. These are not mandated standards however. In contrast with the NOMs, the NMXs are established to improve the quality of products and services, and their application is not obligatory. The norm NMX-AA-159-SCFI-2012 classifies Mexican basins as a function of their relative ecologic importance and the volume their users demand, which forms the basis of its environmental objectives.

The existence of NMX-AA-159-SCFI-2012 represents a step towards the understanding of environmental flows in Mexico and can lead to the future consideration of the environmental sector in the water budget calculations that are used as the base for the designation of water permits (concessions) within the different basins of the country. The only problem is that a NMX is not an obligatory rule. At this point, environmental flow requirements are just an option to land and water managers. Another barrier that could hinder any attempt to allocate water for the environment is the same as in most arid regions of the country; water rights have already been distributed through the different users, leaving the environment out of the equation. Introducing the environment as a water user would mean to reduce the water right of another entity, an option that requires strong stakeholder engagement and outreach efforts to convince communities and individual landowners about the benefits of healthy ecosystems.

Borderlands of the Colorado River Basin

The border region of U.S.-Mexico is regulated by treaties overseen by the International Boundary and Water Commission (IBWC), an international body that applies the treaties as related to boundary demarcation, national ownership of waters, sanitation, water quality, and flood control. The IBWC is composed of two sections: 1) the U.S. Section of the IBWC is a federal government agency with headquarters in El Paso, Texas, and 2) the Mexican section is operated by the Mexican Ministry of Foreign Affairs in Ciudad Juarez, Chihuahua. Both sections are overseen by a commissioner who upholds the 1944 Water Treaty regarding the "Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande" (1944 Treaty), which is the main water-allocating mechanism for the two nations. To solve any issue that is not directly addressed by the 1944 Treaty, the IBWC works with different institutions on a case-by-case basis. Any decision that is made by the IBWC is recorded as a Minute, and it must be approved and signed by the two commissioners. A Minute can be defined as an interpretation of or amendment to the 1944 Water Treaty. To date, there are approximately 324 different Minutes acting as binding obligations between the U.S. and Mexico. This relationship has garnered attention for the efforts to secure water for the Colorado River Delta, specifically IBWC Minute 306, Minute 318, Minute 319, and Minute 323.

Minute 306 discusses a conceptual framework for cooperation through the development of studies and recommendations for conserving the riparian and estuarine species of the Colorado River Delta. In April 2010, the Mexicali conveyance system was damaged by an earthquake and Minute 318 allowed Mexico to temporarily store water in U.S. reservoirs. In addition to the adjustments to delivery schedules for Mexico, Minute 318 also discusses a series of steps to provide water for the delta. Minute 319 consist of an agreement to extend Minute 318. It focuses on sediment and trash problems in the Tijuana River Basin and also on the pilot program on water for the environment for the Colorado River Delta. Through Minute 319, it was agreed that a volume of water would be delivered to the environment between 2013 and 2017. Minute 323, an "Extension of Cooperative Measures and Adoption of a Binational Water Scarcity Contingency Plan in the Colorado River Basin", noted the interest of both governments in continuing cooperation in issues related to the protection of riparian and aquatic ecology within the delta. The agreements between both the U.S. and Mexico toward the protection of water resources for the environment led to the pulse flow of 2014. Barriers to the success of these Minutes include the availability of funding to acquire water rights for environmental purposes.



Hanging gardens in Catalina Mountains (Source: Sky Island Alliance)

Case Studies

This section highlights five distinct regions and projects that have successfully provided water to the environment in the LCRB:

- Bill Williams River
- Colorado River in Glen Canyon
- Colorado River Delta in the U.S.-Mexico borderlands
- Various Pima County streams and reaches
- Upper Gila River and the San Pedro River (Arizona Land and Water Trust)

Water allocation or delivery to a natural waterway is the primary criteria for the selection of these case studies. While many restoration projects have indirectly benefited natural areas and environmental flows, they are not discussed here. An example of such efforts is the Cienega Creek riparian habitat restoration project in Arizona. The following section describes regulatory context, foundational project elements, management strategies, key players, and allocated volumes.

Bill Williams River

The environmental flow releases from Alamo Dam on the Bill Williams River were based on an extensive study spanning multiple years and disciplines. This project was bolstered by the regulatory framework, engagement of diverse stakeholders in crafting and implementing the environmental flow prescriptions, and data collection and monitoring before and after releases.

The dam is managed by the U.S. Army Corps of Engineers, and was authorized under the Flow Control Act of 1944 for flood control, hydropower generation, water conservation and supply, and recreation purposes (Public Law 78-534). In 1996, the Water Resources Development Act added fish and wildlife as an authorized purpose and it was agreed afterward that base flows between 20-50 cubic feet per second (cfs) would be released to sustain ecosystem services if the water surface elevation of the reservoir is less than 1,125 feet. If the elevation exceeds 342.9 m, the dam releases a 7000 cfs flood also for environmental flows.

The design and development of the flow release program was characterized by a strong collaboration among scientists, water managers, and stakeholders. In 2002, Alamo Dam was included in the Sustainable Rivers Program, a partnership between The Nature Conservancy (TNC) and the U.S. Army Corps of Engineers. Engaging additional federal and state agencies, this effort focused on improving dam operations to enhance downstream habitat conditions.

Several of TNC's reservoir management recommendations improved water quality problems that emerged from the highly turbid water after flood releases. The Water Control Manual for Alamo Dam also provides options that consider water quality issues in the Colorado River. This project's emphasis on data collection and monitoring was important for the continued success of this project and conveying lessons learned.

Glen Canyon

Glen Canyon Dam was authorized in 1956 as part of the Colorado River Storage Project Act and completed in 1963 by the Bureau of Reclamation. The Grand Canyon Protection Act of 1992 established that Glen Canyon should be managed in a way that "protect[s], mitigate[s] adverse impacts to and improve[s] the values for which Grand Canyon National Park and Glen Canyon National Recreation Area" (Public Law 102-575). In 1996, the Secretary of the Interior signed a formal decision authorized experimental flow releases from the dam, and established the Glen Canyon Dam Adaptive Management Program. Hydropower revenues from the dam remain the source of funds for the program.

High Flow Experiments were part of Glen Canyon Adaptive Management Program and improved the understanding of sediment transport, water movement, and ecosystem processes. Results of these releases included the burial of non-native vegetation, improvement in habitat conditions for native fish, and expansion of sandbars and backwater habitat (Wesley, 2017, Korman et al. 2010). Steady low flows in 2000, and 2008-2012 resulted in water temperature increases, stabilization of sandbars, and benefits for native fish.

Key players to this effort include members of federal agencies, power generators, recreational users, environmental organizations, and Native American tribes. However, it was recognized that trying to satisfy all stakeholder demands ended up being complicated, and planning processes were slow and difficult (Susskind et al. 2010).

City of Tucson and Pima County

The City of Tucson and Pima County have led several efforts to enhance ecosystem restoration in urban and rural areas over the last two decades. These projects, built upon collaborative partnerships among local governments, take a holistic view of conservation and interconnected natural areas. The broad-based efforts are possible thanks to the commitment of water users, NGOs, the City of Tucson, environmentalists, and land owners. These projects include:

- Bingham Cienega focus on the restoration of natural ecological processes and to prevent floodplain development
- Cortaro Mesquite Bosque which has the goal of increasing vegetation structure and biological diversity and provide wildlife habitat for birds
- Kino Environmental Restoration Project focused on restoring wetland and riparian vegetative communities
- Marana High Plains with Oxbow Channel, which recharges treated effluent into the local groundwater aquifer supporting wildlife habitats
- Oro Valley Big Wash for restoring native vegetation
- Pantano Jungle Revegetation Phase I and Phase II to reestablish mesquite bosque and sacaton grassland habitat
- Parque de Santa Cruz for recreation purposes and flood control
- Simpson Farm to revegetate with native species
- Swan Wetlands and Rillito Riparian to restore a self-sustained ecosystem
- Old West Branch to irrigate native vegetation

Colorado River Delta

The Colorado River Delta "pulse flow" of 2014, along with the base flow distributed the years of 2012 to 2017, are the result of negotiations between the U.S., Mexico, and NGOs to protect the environment. The "pulse flow" of 130 MCM, which represents two-thirds of the agreed upon prescriptions of Minute 319, was provided by the federal governments of the U.S. and Mexico and released in 2014. Within the five years duration of Minute 319 (2012-2017), the remaining volume was released in the form of a "base flow" that was provided by non-governmental agencies via the Colorado River Delta Water Trust.

Through Minute 323, the U.S. and Mexican governments agreed to provide two-thirds of allocated water for the environment over the course of nine years, 2017-2026. The remaining third of water is provided by NGOs. It is important to note that the U.S.'s share of water for the environment is to be allocated through investment in water conservation projects in Mexico, invalidating this as an international water transfer for the environment. Even though the two governments agreed to provide with nine million dollars for scientific research and nine million dollars for restoration projects via Minute 323, barriers to this project include funding availability for monitoring and purchasing water rights. Particularly for NGOs, which are under significant pressure to acquire water rights to provide their agreed upon proportion for the Colorado River Delta.

Upper Gila River and the San Pedro River

Arizona Land and Water Trust (ALWT) has been working in Southern Arizona, particularly in the San Pedro River and the Upper Gila River, for over 40 years. The Trust implements projects with different landowners, farmers, and ranchers in short-term water transactions that allow the use of water for environmental purposes. Twelve successful transactions have been completed by 2019. ALWT has contributed with 3,000 acre-feet for the environmental sector since the beginning of their operations, proving that voluntary agreements are also an effective way to allocate water resources to the forgotten sector. Community engagement is key to the development of this program, as well as the interaction between landowners (ALWT, personal communication, 2019). Workshops on water rights and conservation opportunities from the ALWT Desert Rivers Program improved landowner understanding of available options when trying to secure water for the environment. The strength of this program is based on community collaboration, with landowners ultimately spreading the message about the benefits of short-term water transactions.

Rudy Ronquillo Spring, Pajaritos (Source: Sky Island Alliance)

EVALUATING SUCCESS

In evaluation of the case studies, several elements of success were identified and compared among the projects: the diversity of key players involved, funding availability, the type of agreement secured (e.g. mandatory, voluntary), the volume of water delivered to the environment, and duration of the water allocation.

Among those categories, Glen Canyon Adaptive Management Program included several elements of success as an environmental flow program. The magnitude and duration of flows, which surpassed the 7,631 MCM during a 22-year period accounts for a major success of the Glen Canyon Adaptive Management Program in comparison to all the other case studies. The variety of stakeholders involved in the development of the flow experiments, the mandatory character of the program, and the funding available through the federal government were also essential components for the case study success.

The Colorado River Delta project had the support of a variety of stakeholders, NGOs, and governmental agencies from both the U.S. and Mexico, and is a strong example of diverse stakeholder participation. Even though the Minute 319 can be considered a mandatory agreement, there were also voluntary components through the work NGOs via the Colorado River Delta Water Trust. While this case study provide a good recipe for success, the short duration of the program was detrimental to the long-term benefits to the environment.

The Bill Williams River was another case of collaborative efforts between federal agencies and NGOs with the construction of Alamo Dam followed the Flow Control Act of 1944 and the environmental flow releases followed the changes in the 1996 Water Resources Development Act (WRDA). As mentioned previously, the Bill Williams River is part of the Sustainable Rivers Program from The Nature Conservancy, strengthened by including the NGOs component into the equation.

Compared to the large volumes of flow from Glen Canyon, the Colorado River Delta, and Bill William River, the Pima County and ALWT efforts are much smaller in scope and represent localized approaches to riparian restoration that provide water to the environment. Even though these restoration efforts do not provide natural areas with significant amounts of flow when compared to the rest of the projects, the duration and consistency of the Pima County flows and the voluntary character of the ALWT makes them unique efforts with results that can be actually seeing by local communities within Arizona.

In all, funding, data availability, education, regulations, and clear objectives were listed as some of the barriers that land and water managers face when using available data on environmental flows or participating in environmental flow projects. Both the U.S. and Mexico agreed that lack of verifiable observations, measurements, and data are the most common problems for determining environmental flows. Bilateral relations between water managers and academic institutions, community awareness, and stakeholder engagements are some of the engagement mechanisms that can help to reduce these barriers.

The case studies indicate flexibility is entertwined within the elements of success. Environmental flow projects have been completed based in voluntary agreements, regulatory agreements, and even a combination of the two. Key players include governmental agencies, NGOs, major water using groups, Tribes, conservation groups, and local governments. However, an environmental flows project is no less important if arranged directly with landowners and water users. Additionally, restoration funds are essential for a project to get off the ground, but the source of funding is not as crucial as the consistency of resources and formal commitment.

Showcasing Tools

Springs Prioritization Tool

Taking action to ensure environmental flows requires a broad focus on ecosystems in arid and semi-arid environments. While rivers and streams are highlighted in the previous case studies, springs are keystone ecosystems that exert disproportionate influence on surrounding landscapes and are known to be biodiversity hotspots. They have enormous effects on surrounding landscapes, biota, and economies and play a crucial role in providing refuge for migratory birds, reptiles and amphibians. Although they are abundant in this arid region, they are poorly documented and little studied. They also suffer from extensive human modification and are among the most threatened ecosystems. Lack of information on their location, management context, and biological, hydrological, and ecological characteristics hinders effective stewardship of these resources.

Sky Island Alliance is working to inventory springs ecosystems and to assess their current condition and potential for restoration. This data is critical to determine which springs can be protected and to prioritize sites for restoration.

As a localized approach to providing water to natural areas, the Springs Prioritization Tool translates data associated with springs into greater decision-making capacity of land managers and conservation practitioners in the Sky Island Region of southern Arizona. Using a standard template, users can better understand the physical, biological, and social context for springs in their region, aiding in the prioritization of conservation activities. Using geographic information systems (GIS), the tool transforms a spatially-explicit database, allowing for the integration of specific policy standards with the biophysical at-site conditions at spring sample sites. Understanding the spatial distribution of standards can assist in the prioritization of emerging spring system restoration and conservation efforts.

Released in 2019, the Spring Prioritization Tool 1.0 contains an Excel database of attributes for over 4,000 springs and calculated scores for comparing relative spring conservation value, threat, and isolation from other water sources. It was developed to help land managers and conservation practitioners in the northern Sky Island Region better understand the physical, biological, and social context for springs in their region and to aid the prioritization of conservation activities.

Users are able to access the following individual spreadsheets that comprise the database:

- Springs Data: Compiled original data on variables for all springs included in the project.
- Scoring Method: Description of how spring scores (conservation value, threat, and isolation) were calculated for all mapped springs and a subset of surveyed springs.
- Scaled Springs Data: Compiled springs data converted to a 0-10 scale which serve as inputs to spring score calculations.
- Weighting: Adjustable weighting to calculate spring scores from springs data.
- Spring Scores: Calculated scores for spring conservation value, threat, and isolation and other key attributes included to aid spring prioritization for conservation activities
- Key Findings: Prioritization analyses for all springs included in the region.
- Metadata: List of variable description, unit of measurement, scale of analysis, data source, date or version of data acquisition, hyperlink to data source, and notes on any data calculation conducted.

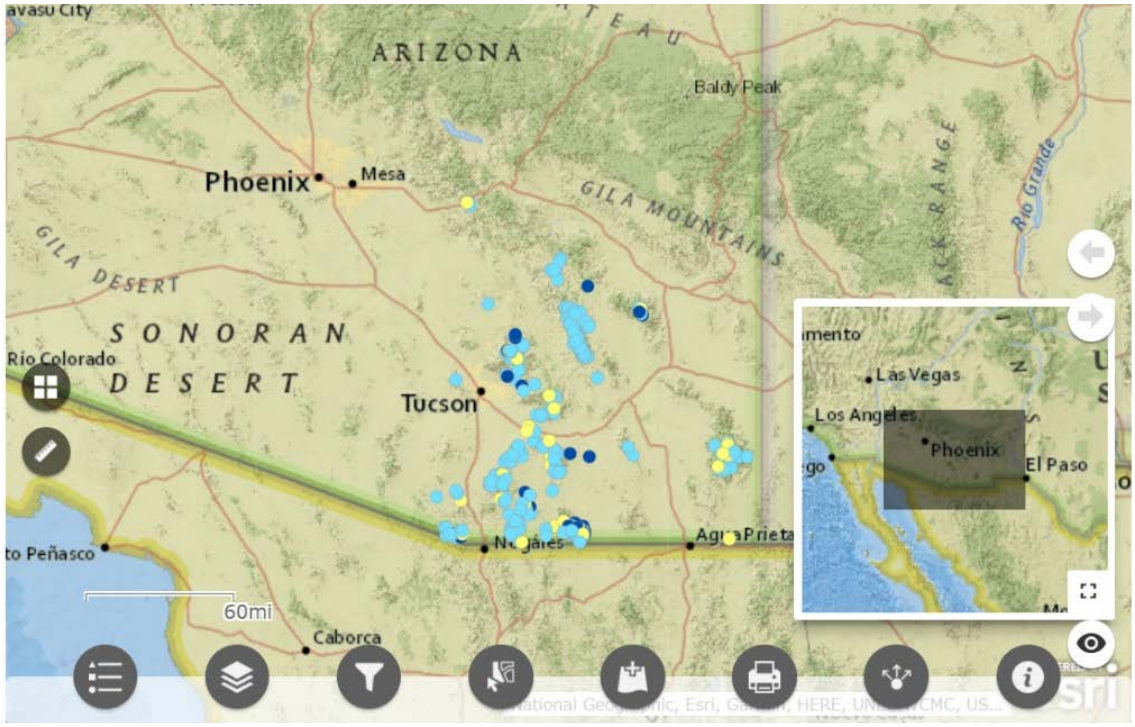
Explore the Spring Prioritization Tool:

https://skyislandalliance.org/our-work/water-program/springs-prioritization-tool/

McGrew Spring, Whetstones (Source: Sky Island Alliance)

Barfoot Spring, Chiricahua Mountains (Source: Sky Island Alliance)

The Spring Prioritization Tool allows users to explore an interactive map to compare the condition and risk of springs across public and private lands with best available data to guide the prioritization of springs for protection and restoration actions on the ground.



Conservation Value

All		Surveyed
33%	Critical Habitat	10%
33%	Winter Precipitation	10%
33%	Evapotranspiration Likelihood	10%
	Specific Conductance	5%
	Water Temperature	5%
	Water Presence	10%
	Water Flow	17.5%
	Habitat Patch Size	17.5%
	Soil Integrity	5%
	Habitat Integrity	10%

Threat

All		Surveyed
10%	Road Density	5%
10%	Road Proximity	5%
20%	Well Density	15%
20%	Burn Risk	20%
20%	Urban Proximity	12.5%
20%	Cropland Density	12.5%
	Grazing	20%
	Nonnative Plants	5%
	Nonnative Animals	5%

Isolation

minimum

Spring Proximity | Perennial Stream

Legend:
Resilience factors
Survey-derived factors

Variables used to calculate each score. Scores for all mapped springs are in the bold outlined boxes. Percentages reflect relative weights of variables used when calculating scores.

Desert Flows Database

The University of Arizona Water Resources Research Center led a systematic effort to compile, synthesize, and evaluate environmental flows studies to understand the available data and gaps related to desert rivers of the U.S. and Mexico. The researchers found that 62% of the rivers examined in the deserts of the U.S. and Mexico have had just one study over the past four decades and 67% of studies used qualitative methods. As part of the effort to assess available resources, the researchers also created the Desert Flows Database.

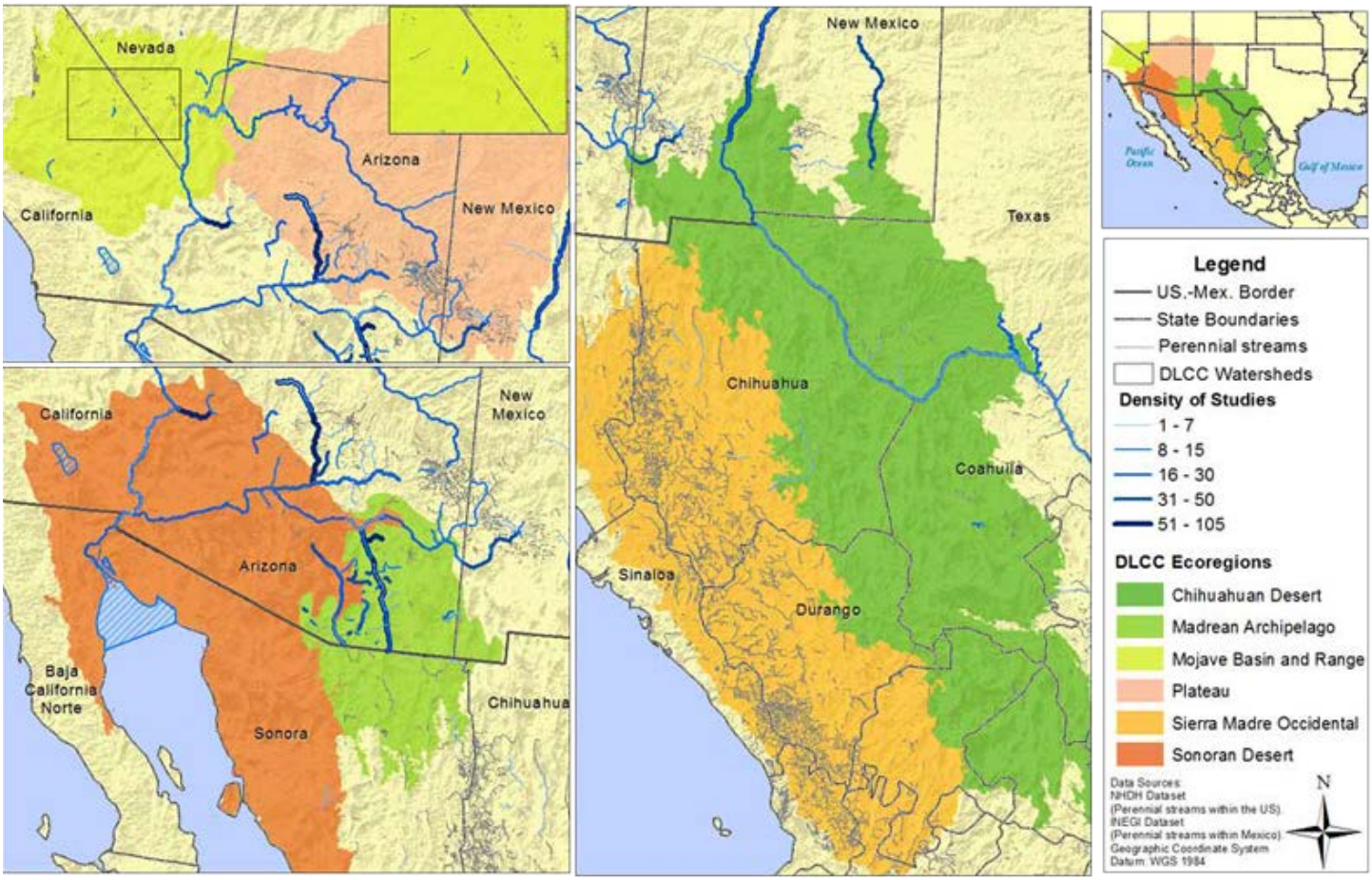
The Desert Flows Database is a compilation of over 400 peer-reviewed articles, reports, and book chapters from across the watersheds that touch the Sonoran, Chihuahua, and Mojave Deserts. Funding for this project was provided by the Desert Landscape Conservation Cooperative (LCC). Information about environmental water needs within the database come from many sources – studies done for the express purpose of answering questions about flow needs as well as studies performed for other purposes that have minimal reference to environmental water needs.

This database was employed to discover that only one-third of the 312 species catalogued in the geographic area have been studied more than once and only 5% have been considered five or more times. Additionally, the most common risks or stressors to riparian and aquatic species were engineered structures, invasive species, and altered flows. While 10% of studies included climate stressor, climate change impacts were infrequently examined. Ultimately, they found that although research has been conducted across the desert watersheds of the U.S. and Mexico, there are significant gaps in our knowledge of basic data such as the location and extent of perennial and intermittent streams, let alone studies of environmental flow needs.

As of January 2016, the Desert Flows Database contains data through June 2015. The database contains tabular data that can be linked to geospatial data on river segments studied. Users can download the database and a guide to using the database.

Learn more about the Desert Flows Database:

https://wrrc.arizona.edu/desertflowsdata



Studied streams documented in the Desert Flows Database (Source: Kelly Mott Lacroix)

Taking Action on Priorities

Local communities, water managers, and public land managers are the stewards of streams, springs and watersheds. For this reason, the **2014 Roadmap for Protecting Water for Arizona's Natural Areas** recommended localized approaches to securing water for the environment. A foundational element of this work is the ability to access and organize fragmented data to improve decision making capacity and implement on-the-ground projects. In turn, these projects can help to inform regional policy changes and allow managers, practitioners and the public to understand the larger context and see the tangible results of protection and restoration of water for the environment.

Antecedent social conditions for the implementation of environmental flow projects are a must and should include education, regulations, institutions, understanding of environmental flows, and conservation strategies. While there is an evident interest in environmental flow projects, the understanding of environmental flows is still in its infancy in many places in the Southwest U.S. and Mexico. Having communities recognize and protect the benefit of a flowing river is a challenge that can be overcome with the help of strong institutions, regulations, and conservation efforts.

Regional Mechanisms

Participation of established institutions and proper education about the benefits of environmental flows play an important role as building blocks for environmental flows efforts. The allocation of water for the environment is not an issue that can be solved with a single group of stakeholders. Allocating water for the environment should be considered by regional land and water management, engaging stakeholders in a transparent process and partnering academic institutions to define the quantity, need, and necessary pathways. The key to success in providing water to the environment includes a flexible approach and inclusion of different stakeholder groups such as governmental agencies, NGOs, academic institutions, tribal communities, land owners, water users, ranchers, and environmentalists.

It is a challenge to make room for the environmental sector in places where surface and groundwater is already allocated. Even if the regulatory framework from Arizona and Mexico promoted the development of environmental flow projects, serious issues with water right holders might arise at the time of allocating water for natural systems. If not in federal lands, basically any water right holder has the final word on what is going to happen with their properties and their water. For that reason, education is essential to promote environmental flow projects, starting with K12 and continuing into adulthood.

Local Mechanisms

Watershed partnerships are a valuable approach to collaboration among sectors and restoration efforts that span multiple jurisdictions. In southern Arizona, the Santa Cruz Watershed Collaborative (SCWC) is a watershed-based initiative with diverse participation among key players. Their mission is to collaboratively restore the hydrological and ecological function of the watershed. By fostering cooperation, SCWC enables watershed leaders to make well-informed management and policy decisions.

The Collaborative is an example of how to foster greater coordination and collaboration in the watershed in order to make partners' work more effective and achieve shared goals. The effort builds on existing work in the region, and focus on a comprehensive approach that considers the watershed as an integrated whole, but with a specific goal of restoring perennial and intermittent flow, native riparian habitat and associated ecosystem services of rivers and streams by managing watersheds holistically.

SCWC considers the watershed as an integrated whole with a specific goal of restoring perennial and intermittent flow, native riparian habitat and associated ecosystem services of rivers and streams. The aspiration for this diverse group of leaders is to create a pipeline for policy recommendations and needs from the local level to our state decisionmakers.

An example of an identified policy area of collaborative change relates to increasing instream recharge of recycled water in the Santa Cruz River and it's tributaries in the Tucson basin. Artificial recharge of groundwater occurs in two ways in Pima County: 1) in the channel of a natural stream (i.e., instream or managed recharge) or 2) in constructed infiltration basins (i.e., constructed recharge). Central Arizona Project (CAP) water is sourced from the Colorado River and accounts for most renewable water

Galiuros Springs Flow Monitoring (Source: Sky Island Alliance)

supplies that are recharged in the Tucson Active Management Area (AMA) – exclusively in constructed infiltration basins. Recycled municipal effluent is a growing water supply that is recharged both in constructed basins and in the channel of the Santa Cruz River.

Until 2019, there were two managed recharge projects in the Santa Cruz River downstream of the Tres Rios wastewater treatment facility (WRF) and Agua Nueva WRF, the two largest WRFs in Pima County. For decades, recycled water from these two facilities created about 30 miles of perennial, effluent-dependent flows in the Santa Cruz River in northwestern Pima County. The year-round effluent flows support lush riparian habitat that is scarce and ecologically invaluable in this arid region. In June 2019, Tucson Water added the Heritage Project, a managed recharge project in the Santa Cruz River in downtown Tucson.

Initially, putting recycled effluent in the river channel was a convenient and natural place for discharging recycled water. Interest shifted to recharging recycled water in constructed basins after the passage of the 1980 Groundwater Management Act and establishment of Long-Term Storage Credits (LTSCs) earned in the process of storing groundwater. Per state statute2, recharge of recycled water in constructed basins accrues 95% storage credit for the volume recharged, whereas instream recharge only accrues 50% credit. One way to conceptualize credit accrual as real-world water is to think of one gallon of water recharging the aquifer. Of that one gallon, 0.5 gallon of recycled water recharged instream counts as storage credit – compared to 0.95 gallon recharged in a constructed basin. The disparity in credit accrual creates an incentive for constructed recharge and a disincentive for the multi-benefits of instream recharge projects.

Instream recharge projects, in addition to replenishing groundwater, have many other benefits to human and wildlife communities. Effluent flows support riparian and wetland ecosystems, providing wildlife habitat, cooling urban areas, and enriching the community's recreational opportunities and quality of life. Additionally, the costs to the community of building, operating, and maintaining constructed basin projects are significantly more, not to mention that we forgo the economic and health benefits associated with flowing streams and riparian forest that are more ecologically rich.

In early 2019, Arizona legislators passed the Drought Contingency Plan and increased storage credit for recycled water in managed river projects from 50% to 95% in select cases in Arizona. This change affected two existing instream recharge projects in the Santa Cruz River plus a new project, Tucson Water's Heritage Project. The Santa Cruz Watershed Collaborative is invested in a change at the state-level to expand the 95% recharge credit for other projects recharging effluent instream. In turn, this change would incentivize future recharge projects that are more natural and beneficial to communities along rivers and streams.

The engagement strategies employed by SCWC could be applied elsewhere, including the establishment of working groups focused on localized issues, education campaigns that connect culture to water, workshops with experts and policy makers, creative outreach activities that bring stakeholders to natural areas, inclusion of Tribal communities, and training in market based trading.

Exchanging Lessons

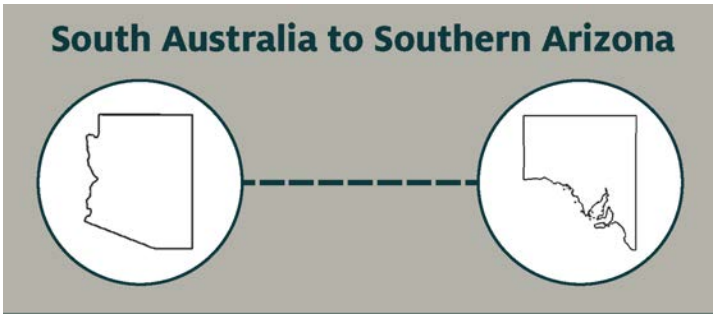
On April 2-3, 2019, the Desert Waters International Symposium offered exceptional opportunities to share water resource management experiences and perspectives from Arizona and South Australia. We appreciate your contribution to a thought-provoking discussion of actions to better connect water for natural areas to healthy, thriving communities and economies.

This symposium was an opportunity for us to share past and recent experiences in Arizona and South Australia in managing the water resources of their respective Colorado River and Murray-Darling Basins. We will be looking at these experiences through the Basins' respective governance and policy contexts, and the scientific understanding that underpins each Basin. From this overarching perspective, we will drill down into each of the three principles of integrated water resources management - social (cultural), economic (productive) and ecological (environmental). We will end the day by drawing together lessons from our respective experiences and present pathways to progress water management in each Basin, from overarching governance through to local implementation. This event is an important step in bridging contemporary lessons between Australia and Arizona and building on the long-term collaborative relationship between Australia and the US.

While the similarities between the Arizona and South Australian situations are striking, the institutions in these two settings are extremely different. The symposium presented lessons beyond environmental water rights that touch upon core human values, as well as trust and relationships among communities. The WRRC, Sky Island Alliance, and University of Adelaide worked together to synthesize and distill the major lessons and takeaways from our expert contributors.

The conversation and connection is recorded and available for continued dialog through an online platform available at:

wrrc.arizona.edu/desert-waters-international-connection



Future of Streams and Springs

Best practices and innovative collaborations are continually setting new standards for regional and localized approaches to securing water for the environment. This work requires spanning beyond political boundaries and environmental water rights, exchanging lessons that touch upon core human values, as well as trust and relationships among communities. The **Desert Waters International Connection** is a platform to exchange lessons and build upon past successes.

More work to be done

Reflecting upon the differing governance and policy contexts presented in this guide, and the scientific understanding that underpins ensuring environmental flows, we are required to look deeper. We must incorporate the three principles of integrated water resources management - social (cultural), economic (productive) and ecological (environmental).

Successful environmental flow projects have been completed based in voluntary agreements, regulatory agreements, and even a combination of the two. Data availability, funding, over allocation of water resources, and lack of a regulatory framework that specifically protects the environmental water needs represent the main barriers for providing water for the environment, while community engagement bilateral relations between the academic sector and land and water managers can help to overcome this issues. Key players for these efforts ended up including members of governmental agencies and non-governmental agencies, but also stakeholders that care for water resources, with their valuable ideas and contributions.

Frameworks for protecting environmental flows in the LCRB vary within the state and country of focus. In Arizona, limitations on the regulatory framework interfere with the development of restoration projects that seek to provide water for the environment. However, it is not the case of Glen Canyon Adaptive Management Program, the Bill Williams River, and the Colorado River Delta Efforts. Glen Canyon Adaptive Management Program allowed the release of high flow experiments, steady low flow experiments, and steady flow experiments that improved the habitat conditions for native fish with sand bar stabilization, burial of non-native vegetation, and expansion of backwater habitats. It received support from the federal government, through the Grand Canyon Protection Act of 1992 and the Department Interior of interior signature that allowed the program to operate, and it also had a variety of stakeholders involved. The Bill William River was also supported by a federal program, but incorporated The Nature Conservancy, an NGO, into their efforts towards the protection of the environmental sector. Through the agreements established on Minute 319 and 323, Mexico and the U.S. agree to collaborate in the protection of the Colorado River Delta, and none of these agreements would have been possible without the contribution of NGOs.

Voluntary contracts with stakeholders are another common strategy for ensuring environmental flows in the LCRB, with successful case studies like the ones implemented in the Gila River and the San Pedro River through the Arizona Land and Water Trust, where contracts with farmers and ranchers provide additional water for the ecosystems. The local efforts from Pima County have also proven that much can be done through community engagement.

In Mexico, the non-binding regulatory framework specifies the level of stress of each basin and the methodology that should be used to determine environmental water needs, but provides little to no help when talking about actual environmental water allocations.

While it is convenient to have a regulatory framework and the support from the federal government because it secures funding opportunities and research that does not mean that voluntary agreements are less important. Efforts from non-governmental agencies have promoted the development of projects for decades. They are also behind the development of some of the most important agreements for the preservation of riparian and aquatic ecology within the LCRB.

Information in this guide was adapted from various efforts housed at the WRRC, in particular the research of Elia Tapia Villaseñor, Kelly Mott Lacroix, and Ashley Hullinger, in coordination with the Sky Island Alliance and additional partners. We appreciate the opportunity to distill the richness of research and engagement around environmental flows in this summarized format, with the goal of reaching wider audiences and sharing lessons broadly.

SKY ISLAND ALLIANCE
Protecting our Mountain Islands and Desert Seas

COLLEGE OF AGRICULTURE & LIFE SCIENCES
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