

by Joanna Nadeau

*In early 2011, the University of Arizona Water Resources Research Center (WRRRC) released its **Arizona Environmental Water Needs Assessment (AzEWNA) Report and Methodology Guidebook** (Nadeau and Megdal 2011). These documents represent a synthesis and analysis of studies that quantify the water requirements of Arizona's springs, riparian areas, and aquatic ecosystems.*

In 2010, the WRRRC set out to answer the following question: *How much water does Arizona's environment need?* We found that choosing an answer to that question depends heavily on one's perspective. Ecology and hydrology experts pointed out that all rivers were committed to various functions before humans began withdrawing water from the system. Arizona's native animals and plants are adapted to flow patterns present for hundreds of years. According to this historical perspective, the environment can use all of the water. However, under a more pragmatic approach, established human uses of water cannot simply be eliminated, but should be balanced with what can be the competing demands of the environment.

Assuredly, river systems need at least some water, for after all, fish need water to live. Many human uses of water temporarily (e.g. water diverted and returned to a stream) or permanently (e.g. water quality degradation) make water unavailable for wildlife, fish and plants to use. Groundwater pumping and instream diversions can reduce flows. Reduced flows directly affect species diversity, abundance, and reproductive success. Water resource managers shoulder the task of reconciling the current way of life with desires for healthy ecosystems and flowing streams. On the one hand, they must to respond to immediate crises (such as drought) and clear legal authorities (such as prior appropriation). On the other hand, recognition of social and economic values of water left in the environment has led to support for the consideration of environmental water needs.

In some cases, human and environmental uses coincide. Water traveling through a river to farming or domestic uses downstream can support riparian (streamside) and aquatic ecosystems along the way. Arrangements that benefit multiple water users represent important opportunities for meeting



competing needs. As competition for water supplies tightens, these innovative and collaborative approaches to water management will be critical.

Beyond small water management changes, the people of Arizona face some tough choices: are there uses of water that they will reduce in order to preserve environments they treasure? Local and regional discussions about the future of our shared water will have to consider the environment, Arizona's communities, and the state's economy. There may not be an easy answer but these discussions are a necessary next step.

The science of environmental flows is even more complex, but can inform water planning. Researchers addressing the question of environmental needs not only define flow requirements of aquatic and riparian species, but they also work to understand how species, and ecosystems, respond to changes in flow. Flow response methods provide information about tradeoffs between various flow scenarios that can be used in decision making. By all assessments, the answer to the amount of flow necessary is methodology- and values-based and will differ considerably depending on where it is asked.

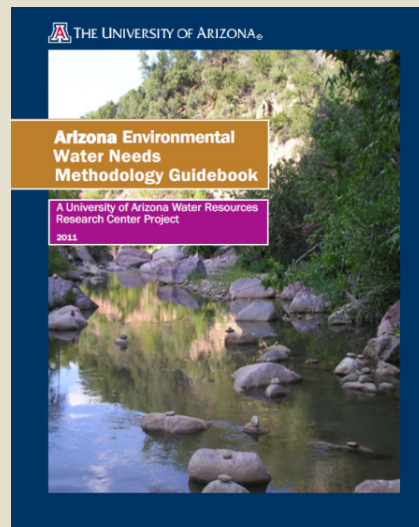
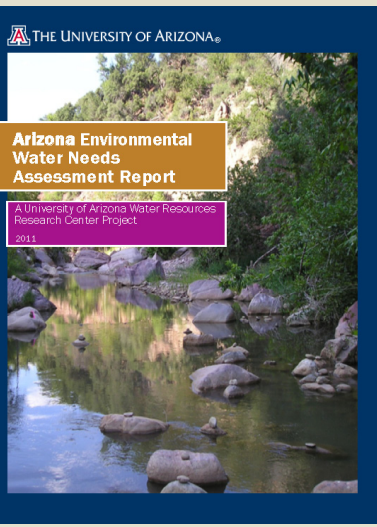
Partners Involved

This project was funded by the Nina Mason Pulliam Charitable Trust, U.S. Bureau of Reclamation, and the University of Arizona Technology & Research Initiative Fund (TRIF), Water Sustainability Program, through the Water Resources Research Center. The following organizations also served as partners for AzEWNA: **Arizona Game and Fish Department, Arizona Land and Water Trust, Arizona State University, Ecosystem Economics, Audubon Arizona, Sierra Club, Squire Sanders, The Nature Conservancy, and U.S. Fish and Wildlife Service.**

Background

Arizona's riparian ecosystems have been susceptible to degradation because state water laws do not consider environmental water needs. This lack of legal authority led to water being diverted from desert waterways through surface water and groundwater withdrawals. The fact that Arizona surface water and groundwater are regulated as separate entities only exacerbates this problem (Megdal et al. 2011).

The purpose of the *Arizona Environmental Water Needs Assessment (AzEWNA)* was to increase public awareness of environmental flow (e-flow) needs, help policy makers understand the science behind e-flow studies, and identify information gaps in understanding environmental water needs. The primary resource for quantifying Arizona's water demands is the Arizona Department of Water Resources' Water Atlas. However, the Water Atlas provides limited information on environmental water needs. *AzEWNA* set out to identify some of this missing information and in doing so, bring the environment to the table when it comes to water policy decisions. This was accomplished by conducting a technical and spatial assessment of almost 100 studies on environmental flow needs and responses (e-flow studies).

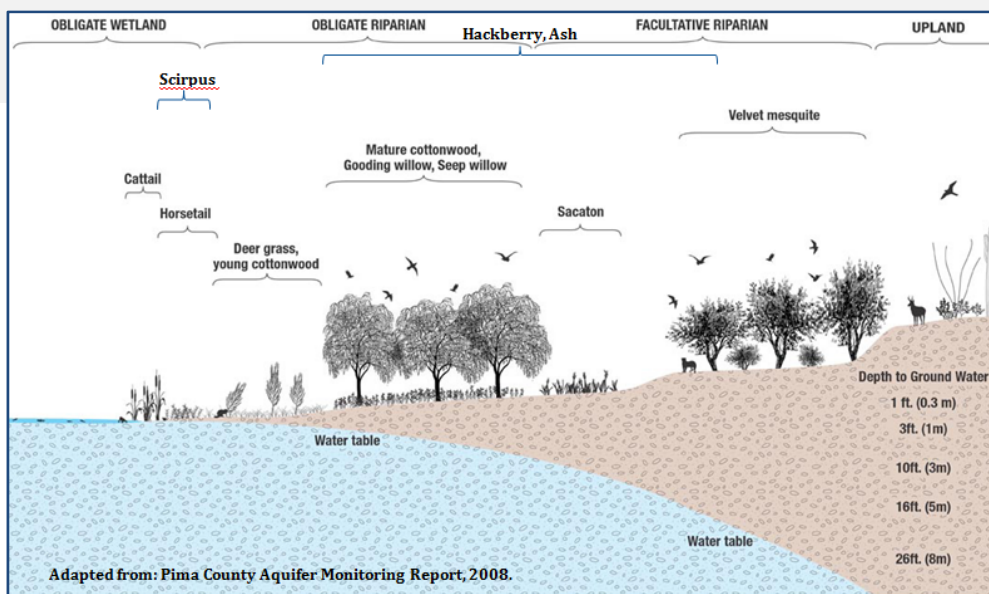


AzEWNA Report and Methodology Guidebook Covers

Assessment Results

All studies demonstrated a connection between water availability and ecological health of rivers and riparian areas. Findings range from broadly cataloguing the number of studies done in each basin by taxonomic group to defining the specific flow velocities needed to sustain certain fish species. Additional findings include:

- Those studies that document ecological flow responses provide the most insight into how an ecosystem functions. Ecosystem alterations, such as changing groundwater depth and diminished surface flows, were shown to directly influence species diversity, abundance, and reproductive success.
- Most Arizona studies on environmental water needs look at plants. The amount of water needed to sustain a species was described by eighty-nine (89) of the 93 studies: 64 for riparian elements, 12 for aquatic, 13 for both riparian and aquatic.
- The environmental water needs of many river basins in Arizona are not well understood—rivers like the Lower Gila, Salt, Middle Gila, Upper Colorado, and Little Colorado are associated with fewer than 5 studies each. Seventy-five (75) of the 93 studies focused on environmental water needs of a single river basin with only eighteen (18) looking at multiple rivers. This presents a major barrier to developing a picture of *statewide* flow needs.



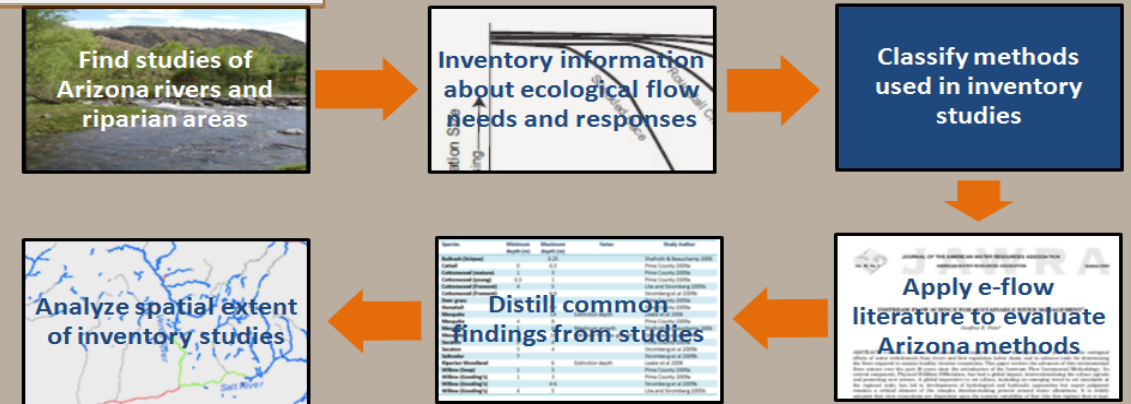
Quantitative Findings

Quantitative results compiled in the *AzEWNA Report* describe the necessary depth to groundwater for riparian plant survival (see figure at left) as well as evapotranspiration rates of riparian plants by species.

Initial Findings:

- Depth to groundwater required to sustain cottonwood and willow trees is one to three meters, with mortality at six meters**
- Frequency of flood events needed for riparian vegetation is 5-15 years**
- Native fish prefer flow velocities between 0.1 and 0.4 m/s**

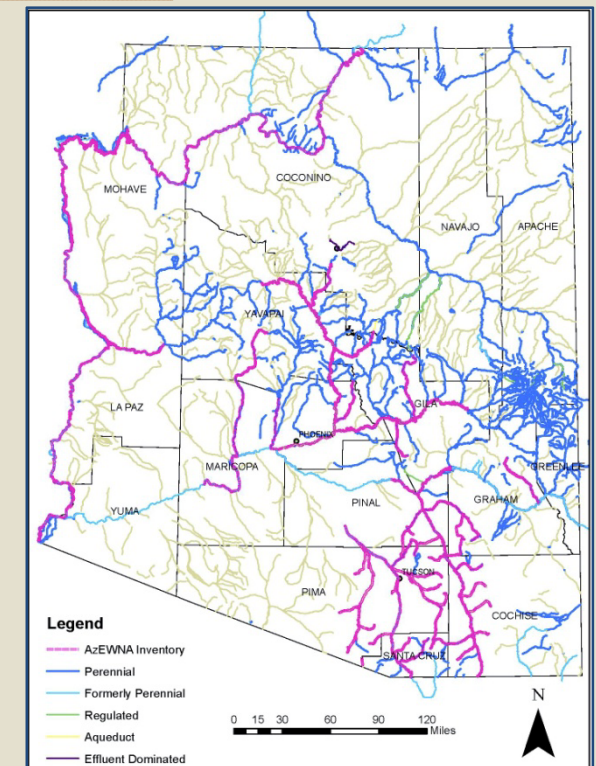
Assessment Approach



New Resources Produced

The *Arizona Environmental Water Needs Assessment (AzEWNA) Methodology Guidebook and Assessment Report* are intended to assist in ongoing efforts to quantify Arizona's environmental water needs. The documents also include resources to inform water management and planning, including a decision tree for selecting appropriate study strategies in a given environment and GIS maps of study information. The *Report and Methodology Guidebook* contain:

- A compilation of 93 Arizona e-flow studies including information about:
 - Study method
 - Location of studies (see figure at right)
 - Taxa (groups of species) observed
 - Study findings
 - Information gaps
- Evaluation of e-flow methods used in Arizona including suggested applications of uses of the 23 methodologies used by Arizona researchers
- A decision tree to help identify appropriate methods for future e-flow studies, with guiding questions such as:
 - What is the hydrological context?
 - What are the management goals?
 - Do you need quantitative or qualitative information?
 - What resources are available to the study?
- Recommendations for future research and analysis



Research Recommendations

Water-related ecological objectives need to be quantitatively, consistently defined so they can be integrated with water management objectives.

Future studies are needed on underrepresented streams and on poorly studied taxa, mainly aquatic species.

- These studies should use holistic methods that reflect the fact that riparian and aquatic species rely on multiple components of the flow regime for survival.
- Identifying acceptable mechanisms for transferring findings across river basins may reduce the need for intensive study.

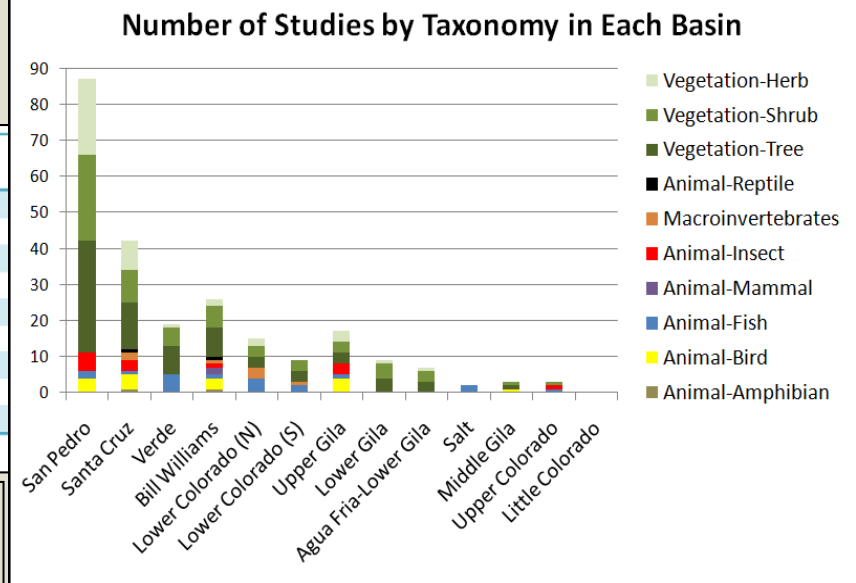
Additional AzEWNA Findings

Plant Community	Annual ET Range (mm/yr)	Study Author
Cottonwood-Willow	410-2000	ADWR 2005/Springer et al 1999
Grassland	643*	Scott et al 2008a
Mesquite Forest	380-1046	Williams 2009/Nagler et al 2005
Mesquite Shrub	157-486	Williams 2009/Scott et al 2008
Mixed Forest	410-727	ADWR 2005/Scott et al 2008
Saltcedar	375-750	ADWR 2005/Nagler et al 2005
Saltcedar/Native Trees	640*	Nagler et al 2005
Scrub/Mixed Deciduous	335*	ADWR 2005
Shrubland	661*	Scott et al 2008

*Only one value reported

Left: Evapotranspiration Rates for Plant Communities in the San Pedro Basin

Right: Number of Studies by Taxonomic Group, by River Basin.



References

Megdal, S.B.; J. Nadeau; T. Tom. (2011). "The Forgotten Sector: Arizona Water Law and the Environment." *Arizona Journal of Environmental Law and Policy*. 1(2): 243-293.

Nadeau, J; S.B. Megdal. (2011). "Arizona Environmental Water Needs Assessment Report and Methodology Guidebook."

Looking Forward

The *Arizona Environmental Water Needs Assessment Report and Guidebook* systematically assembled technical information about the environment's water needs that can be used in water planning and policymaking statewide. Efforts like that of the Water Resources Development Commission (WRDC) to look at water demands statewide provide opportunities for introducing the environment's water needs into a dialogue with all water sectors. Ultimately, the hope is that by explaining the state of knowledge about Arizona's environmental water needs, AzEWNA will support the work of those seeking to conserve desert rivers and streams.

The *Assessment Report* identified several challenges and opportunities:

Challenges –

- Location and species-specific information on needed flow volumes or average annual riparian vegetation water use for native ecosystems is available, but applying findings across the region is difficult. Because environmental water needs information is patchy, some areas are at a distinct disadvantage when trying to considering the environment in water planning because of limited data.
- Ecosystem-level flow requirements are not well understood. Defining water needs for a few taxa may not represent water needed for system-wide health and for conditions necessary to long-term survival of all native species.

Opportunities –

- Findings about depth to groundwater or flow velocity requirements of certain species may be transferable across river systems in the state. This information may be particularly useful in those basins that lack information about environmental water needs.
- Arizona researchers have depth of knowledge about a wide variety of methodologies that can be used to study environmental water needs.

The *AzEWNA Report and Guidebook*, *The Forgotten Sector* paper, and information about related efforts such as the Conserve to Enhance program are available on our website: <http://cals.arizona.edu/azwater>.

For hard copies of the AzEWNA products or other questions, contact the WRRC at 520-621-9591.