Strategies for Managing Water and the Environment in an Arid Land

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Water Resources Research Center

The University of Arizona

WRRC Mission

The University of Arizona Water Resources Research Center (WRRC) promotes understanding of critical state and regional water management and policy issues through applied research, community outreach and public education.

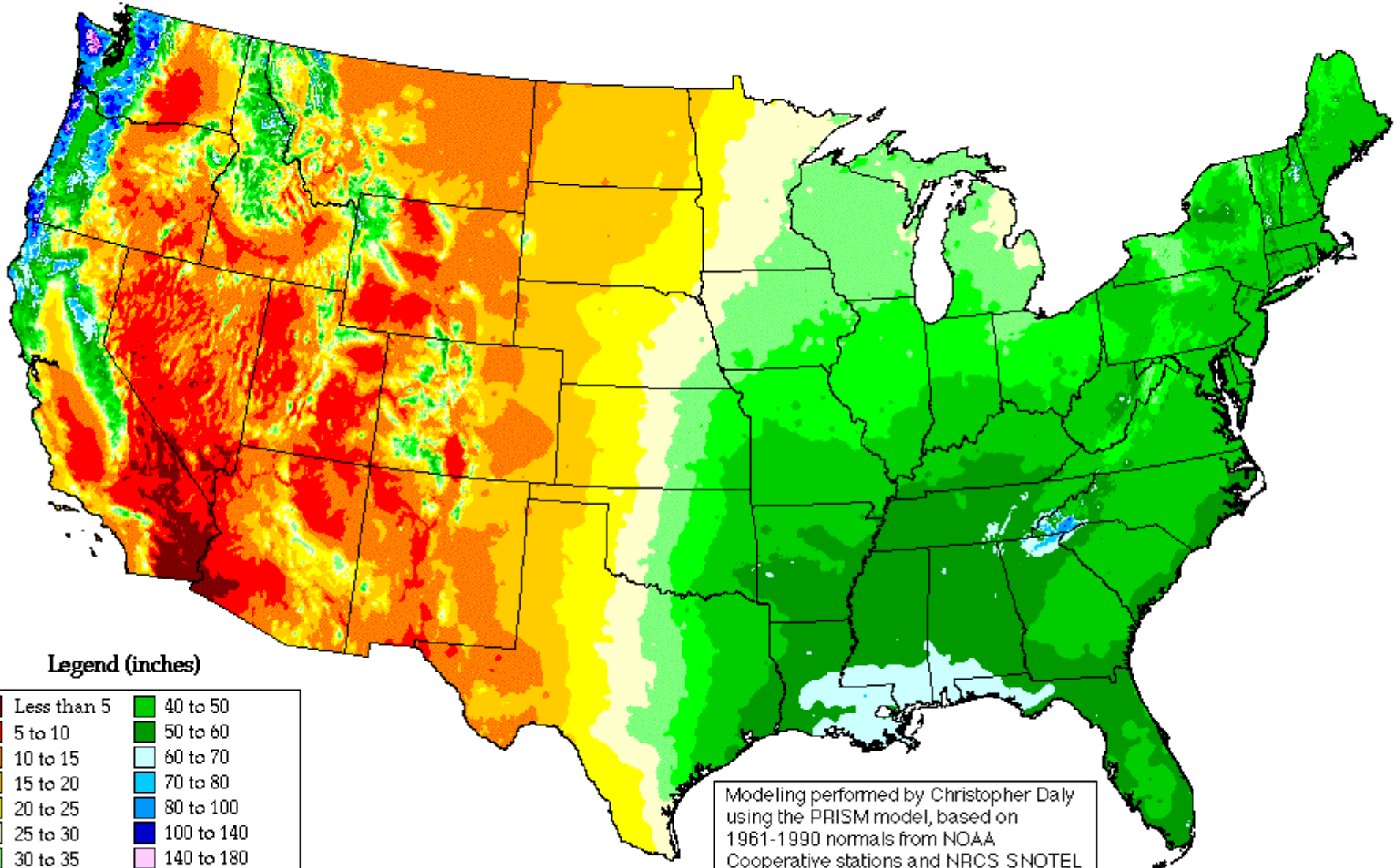
The WRRC is committed to:

- **assisting communities in water management and policy;**
- **educating teachers, students and the public about water; and**
- **encouraging scientific research on state and regional water issues.**

Web site: wrrc.arizona.edu

Annual Average Precipitation

United States of America



Legend (inches)

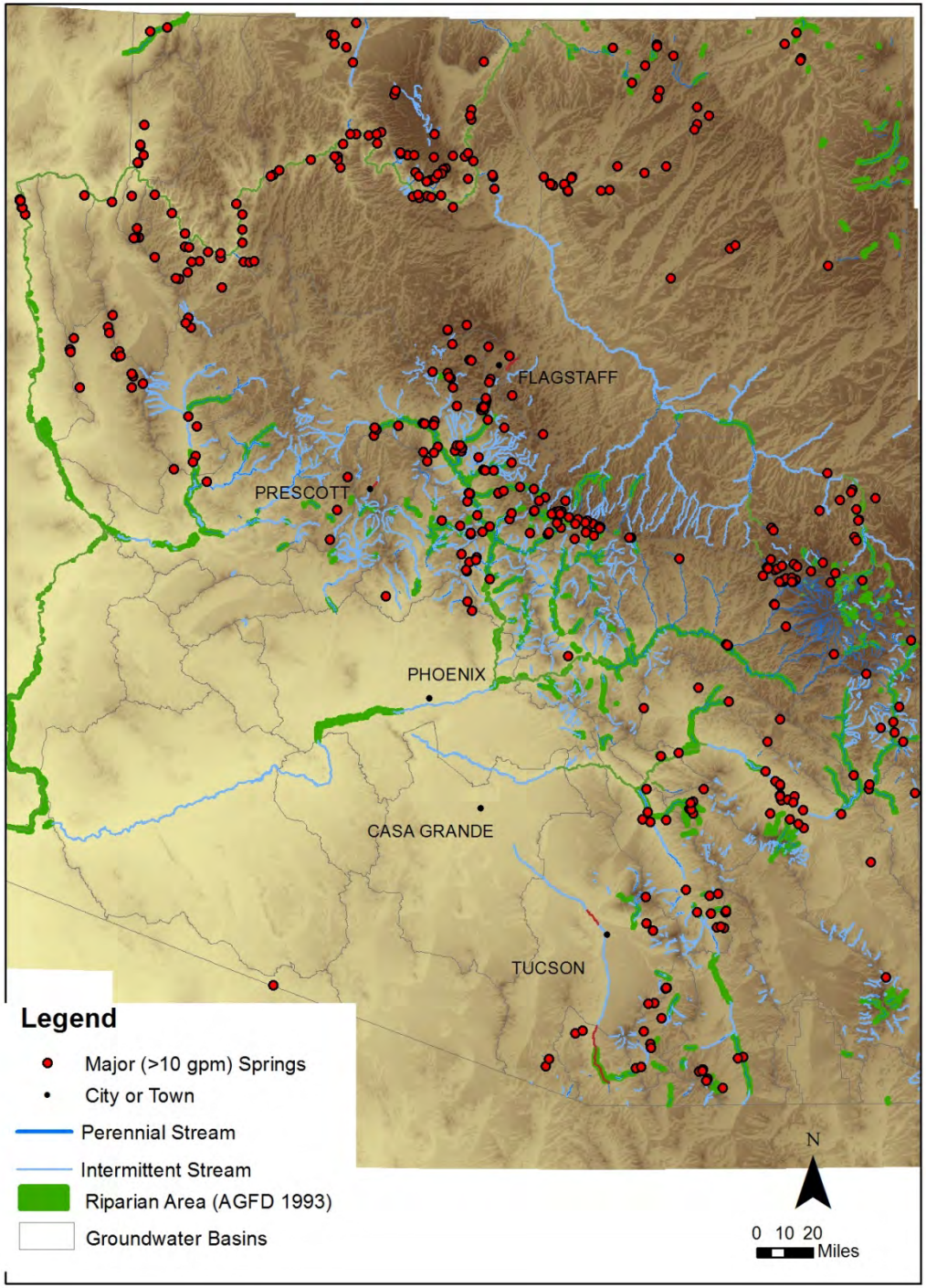
Less than 5	40 to 50
5 to 10	50 to 60
10 to 15	60 to 70
15 to 20	70 to 80
20 to 25	80 to 100
25 to 30	100 to 140
30 to 35	140 to 180
35 to 40	More than 180

Period: 1961-1990

Modeling performed by Christopher Daly using the PRISM model, based on 1961-1990 normals from NOAA Cooperative stations and NRCS SNOTEL sites. Sponsored by USDA-NRCS Water and Climate Center, Portland, Oregon.

Oregon Climate Service
George Taylor, State Climatologist
(541) 737-5705

Streams of Arizona



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Riverine Species of Arizona

Cattail
Horsetail
Scirpus

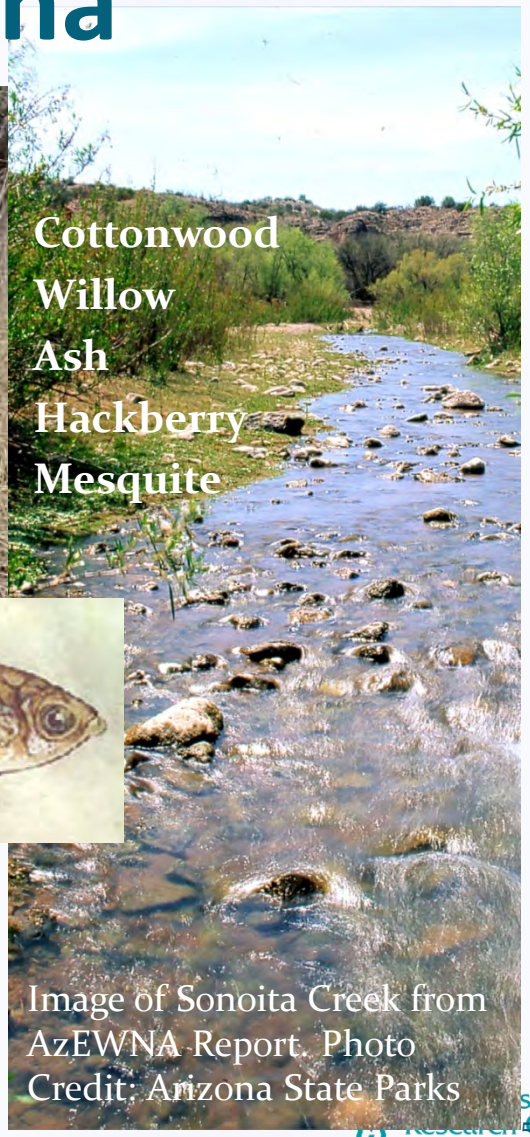
Grasses

- Deer grass
- Sacaton

Saltbush

Fish

- Gila topminnow
- Mosquito fish
- Sonoran topminnow



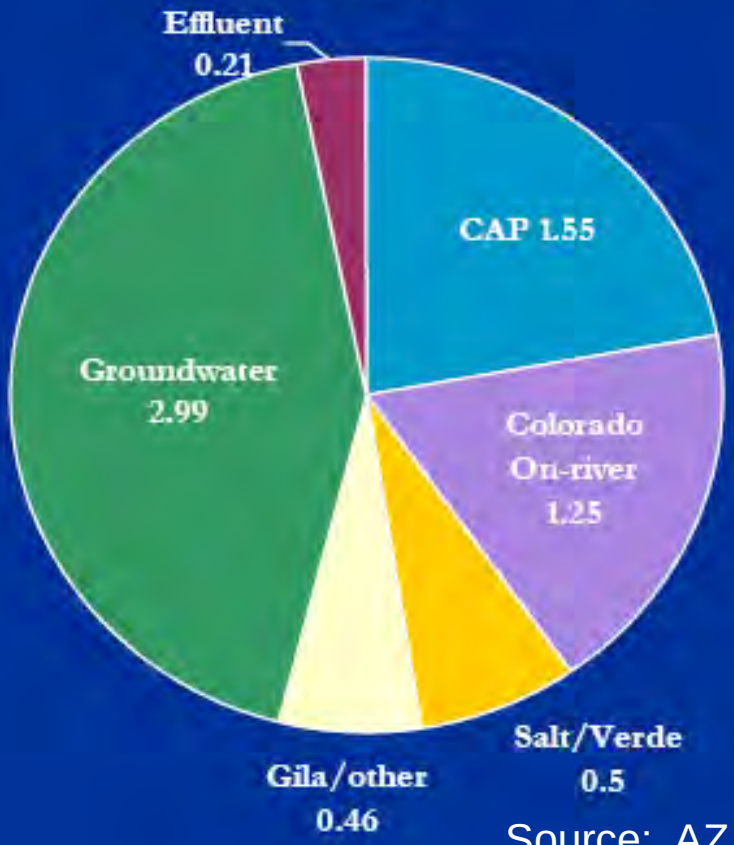
Cottonwood
Willow
Ash
Hackberry
Mesquite

Image of Sonoita Creek from AzEWNA Report. Photo Credit: Arizona State Parks

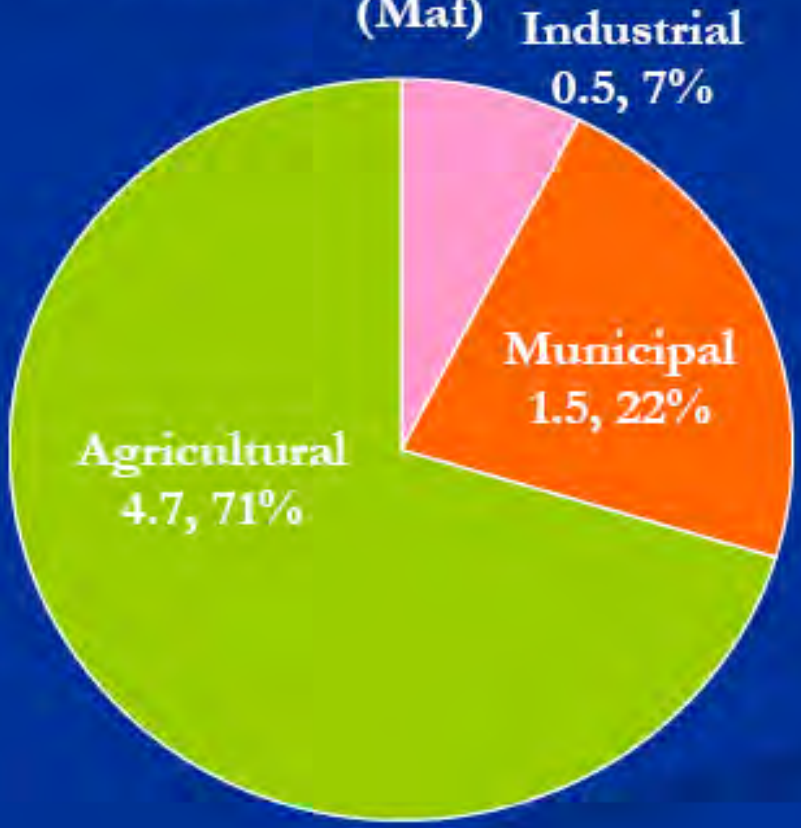
Arizona Water Supply & Demand

Colorado River on-river diversions are 2.046 Maf of which 0.75 Maf is returned to the system for other use.
Assumes all well pumpage is groundwater, except for accounting surface wells along the Colorado River.
Demand does not include CAP long-term storage and system losses (approximately 0.3 Maf) or environmental demands on the Colorado River (approximately 0.02 Maf)

WATER SUPPLIES 2001-2005 (Maf)

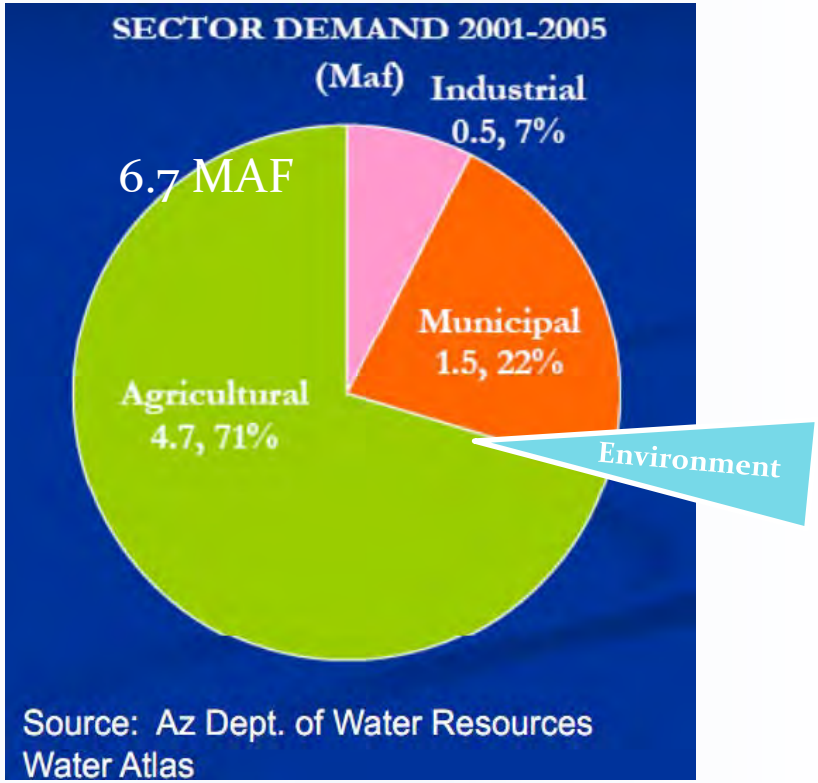


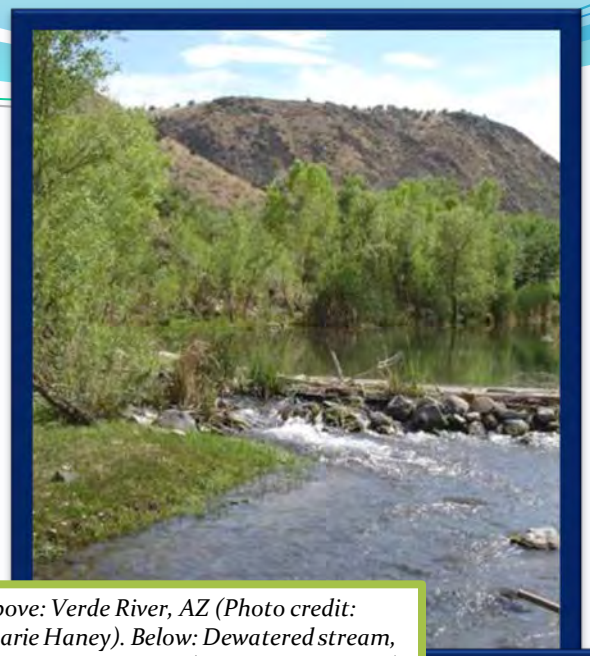
SECTOR DEMAND 2001-2005 (Maf)

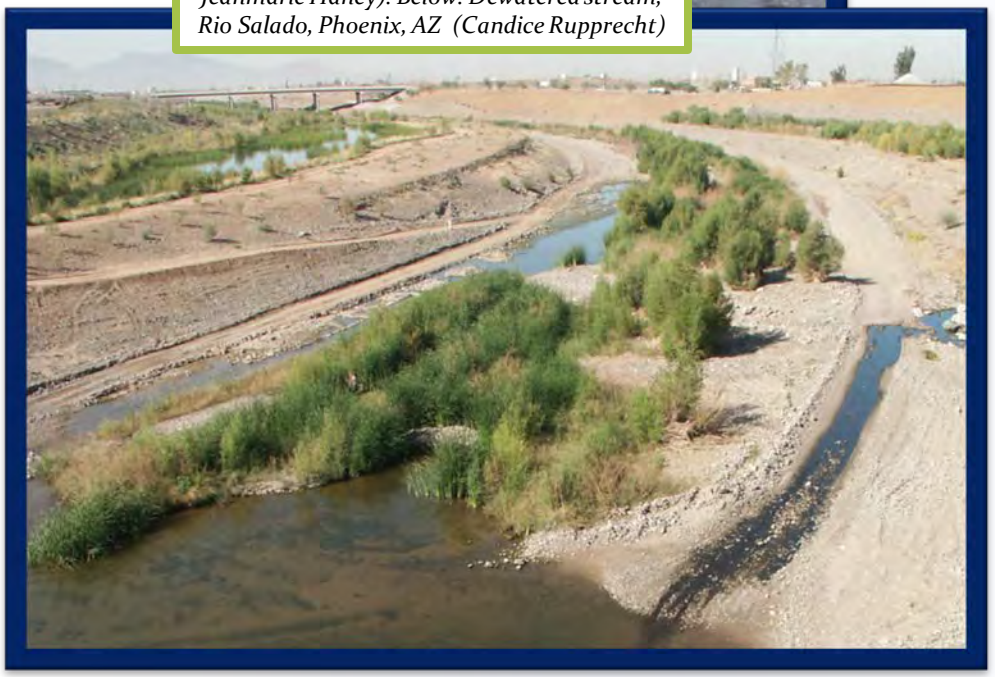


Source: AZ Dept. of Water Resources
Water Atlas, www.azwater.gov

The Forgotten Sector







Above: Verde River, AZ (Photo credit: Jeanmarie Haney). Below: Dewatered stream, Rio Salado, Phoenix, AZ (Candice Rupprecht)

Arizona's Environmental Issues

- Lack of legal protections
- Attitudes vary – public, policymakers
- Institutional capacity

Water Policy Framework in the Colorado Basin

- The "Law of the River" governs allocations of water between the 7 basin states
  - Allocates more water than we expect to have available
- State policy framework: (Megdal et al 2011; Garrick et al 2011)
  - Prior appropriation, with ongoing adjudication
  - Surface water and groundwater managed separately
  - No clear process to transfer conserved water to environment
  - Price signals generally absent

Opportunities for the Environment within the Legal Context

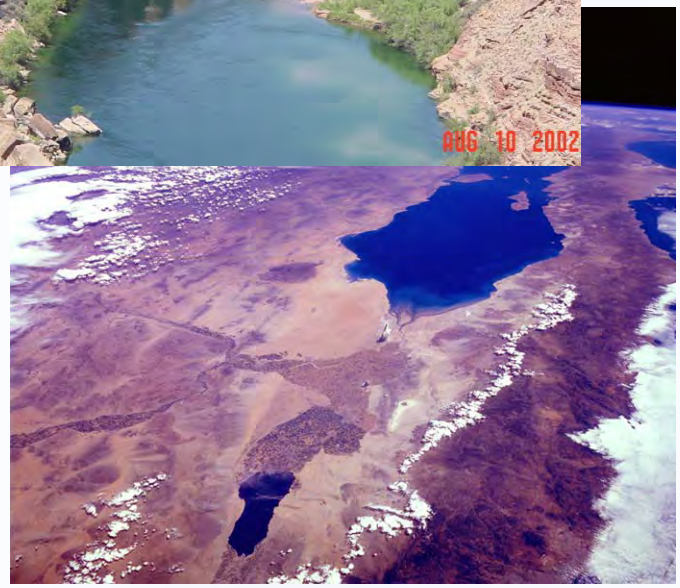
- Use federal regulations that already exist
  - Federal Reserved Water Rights
  - Clean Water Act
  - Endangered Species Act
  - Wild and Scenic Rivers Act
- Encourage voluntary arrangements
  - Develop new preservation, restoration, and enhancement projects
  - Instream flow permits to protect existing flows
  - Water planning

Arizona's Water Planning & the Environment… the Past

- Since 1964 – 5 Arizona Town Halls on water
  - Environment not mentioned until 1997; not meaningfully until 2004
  - "Comprehensive, multi-use watershed planning is essential to maintaining a healthy natural environment"
- 1980 - Groundwater Management Act
- 2001 - GWMC recommendations for riparian protection had no major effects
- 2011 - Resistance to strong environmental language in Water Resources Development Commission report

Creating A New History: Recognizing the Environment

- Driven by litigation:
  - Colorado Delta restoration
  - Colorado River basin study
- Endangered Species Act
  - Lower Colorado MSCP
- Arizona We Want survey:
  - People value environment
- WRDC Environmental Report



Institutional Capacity

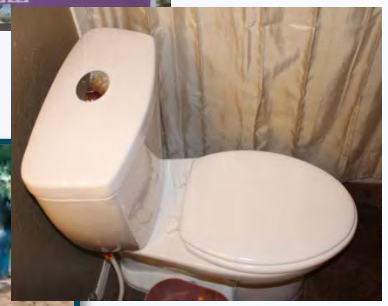
- Lack of statewide data on environmental needs
- Transfers between uses difficult
- Standards for instream flow permits changing
- Declining funding for state agencies
- Lack of expertise integrating environment

WRRC Areas of Focus

- Goal: Establish tools to improve water management
- Strategies
  - Assess legal framework for opportunities
  - Develop innovative voluntary mechanisms
  - Help people rethink environment, realize its worth
  - Define environmental water needs quantitatively
  - Create tools to use in water planning

Traditional Conservation Program Challenges

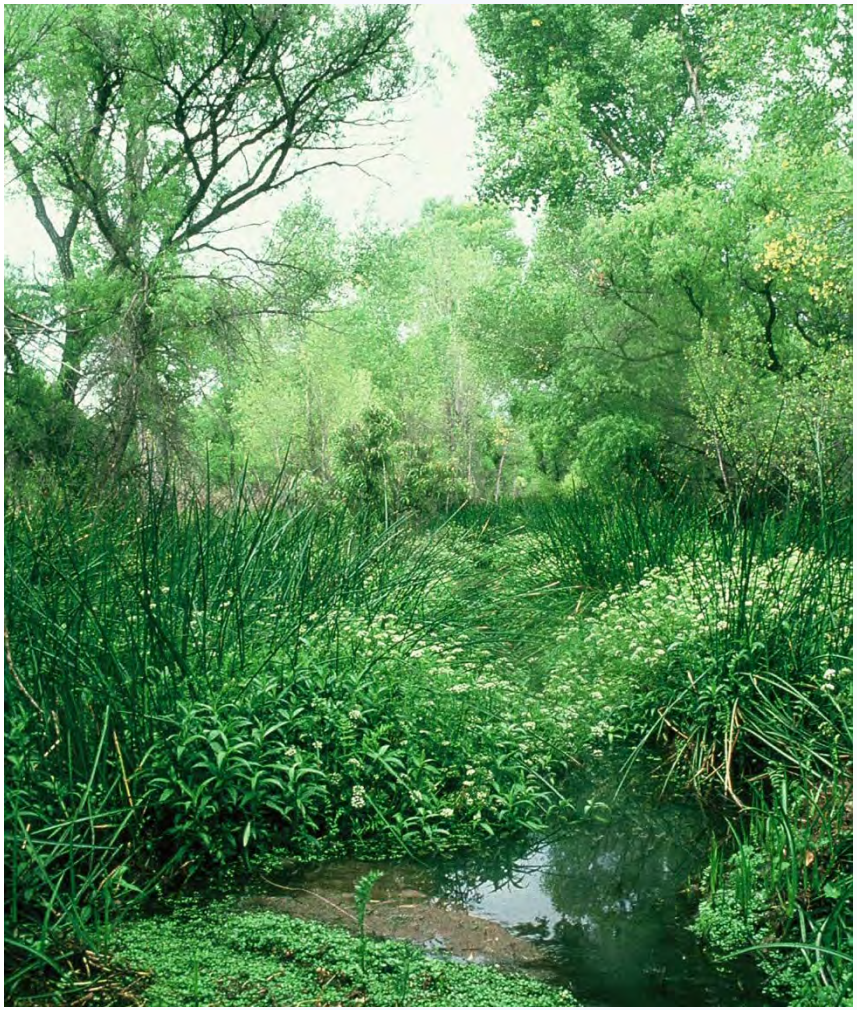
- Ordinances & rate structures *are effective*
- Rebates, water audits, and other voluntary programs go the next step, *but are less effective*
  - Limited participation without much personal motivation



Motivation to Conserve Water

- Why should I save water?
- How do I save water?
- How are these things connected?

The environment can be a significant motivator that makes these connections.



Cienega Creek,, Arizona. Photo Credit: Candice Rupprecht

Conserve to Enhance

Water saved through water conservation

C2E conserve to enhance

Water delivered to river enhancement sites

Watershed Management Group

Watershed Management Group

An Innovative Voluntary Mechanism

How C2E Works

1. Water is conserved (at homes & businesses)
2. Money saved through water conservation
3. Money donated to a C2E fund
4. Money used to implement environmental enhancement projects

Program development funded by the U.S. Bureau of Reclamation. Current funding includes Walton Family Foundation.

Program Benefits: Water Conservation

- Program results in measurable water conservation that would not have occurred otherwise
  - Extends water supplies
  - Lower infrastructure costs
- Water is becoming more scarce – conservation is no longer an option

Program Benefits: Environmental Enhancement

- Wide range of projects that program can support
- Instream flows, green infrastructure, stream restoration – whatever the community values

Beaver Creek, AZ. Photo credit: Brittany Choate

- But maintain a connection to water!

Program Benefits: Education

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C2E conserve to enhance

Water Resources Research Center

User Contribution Programs

Tucson C2E Pilot Program

- To test the C2E concept, Tucson became home to the first C2E Pilot
  - 60 participants began their 2 year enrollment January 2011
- Tucson Water provides water use information
  - Historic (2008-2010) water use establishes baseline
  - Current monthly water use determines conservation
- Each quarter participants receive a survey and a donation request

2011 Tucson C2E Pilot Results

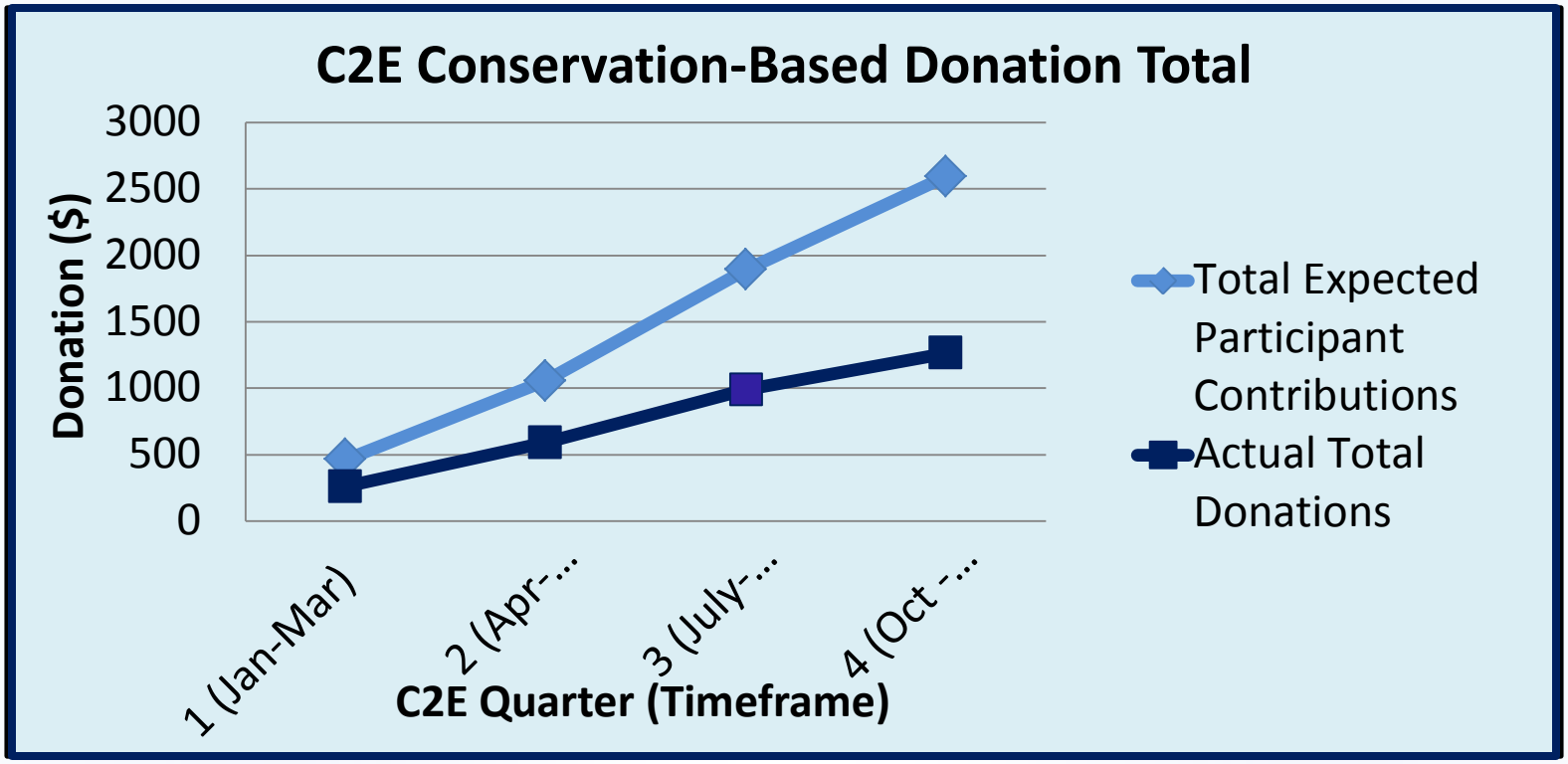
Actual donations for 2011: **$1,262**

- **$3.62** household/month

Total Water Conserved: **1.1 million gallons**

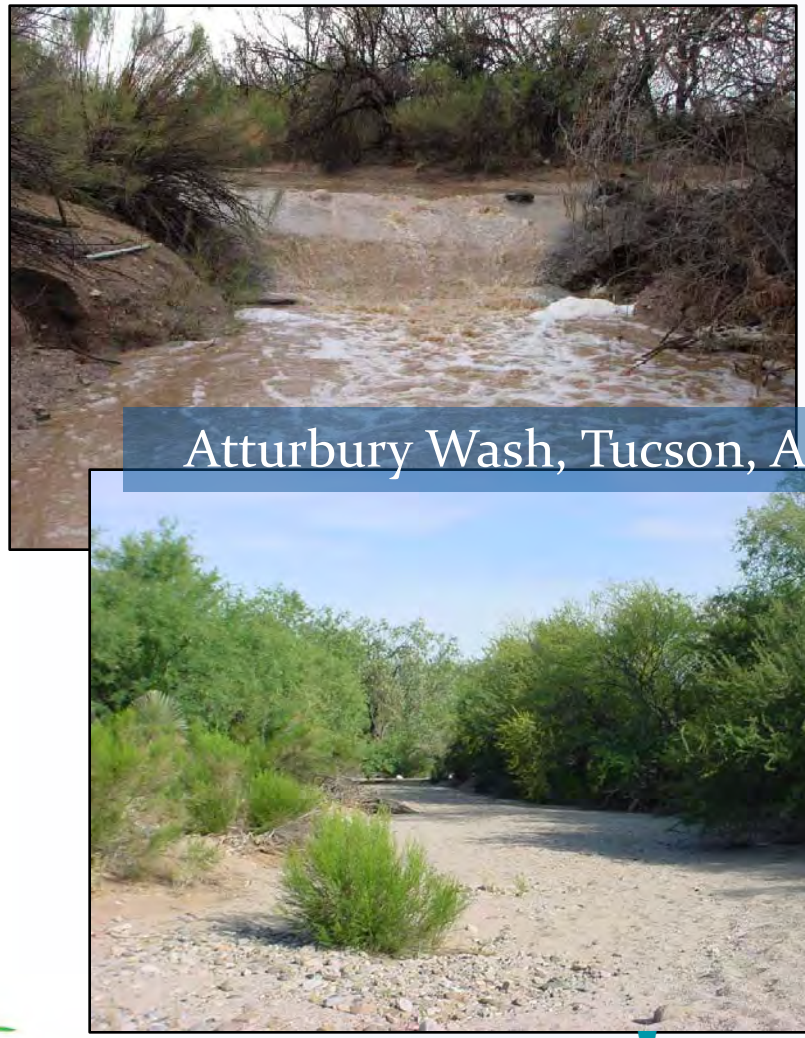
- 500,000 gal with overages

C2E
conserve to enhance



Tucson Pilot Results: Looking Forward

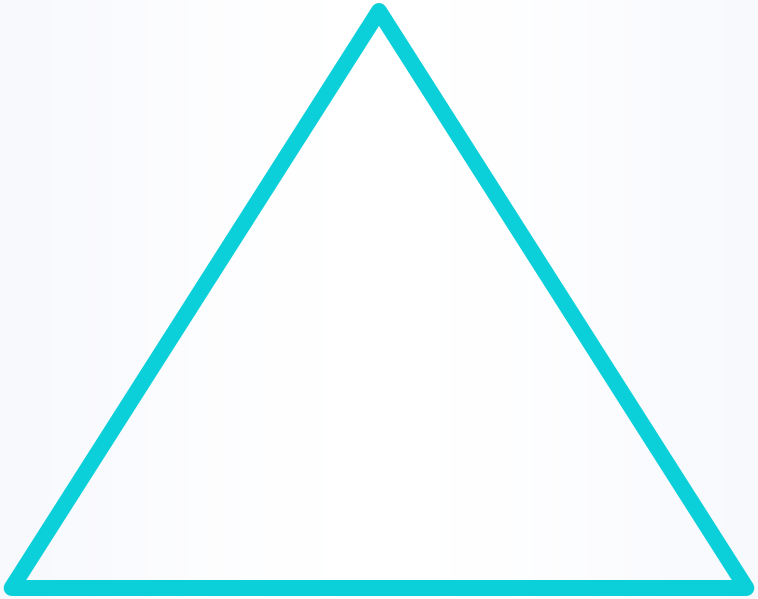
- If C2E is scaled up to entire Tucson Water service area…
  - 12,500 participant estimate (~5% TW customers)
  - 850 + acre/feet of water conservation
  - $500,000/year for local environmental enhancement



Atturbury Wash, Tucson, AZ

Getting Going: Program Partners

Water Providers and Corporations



Community Members and Local Government

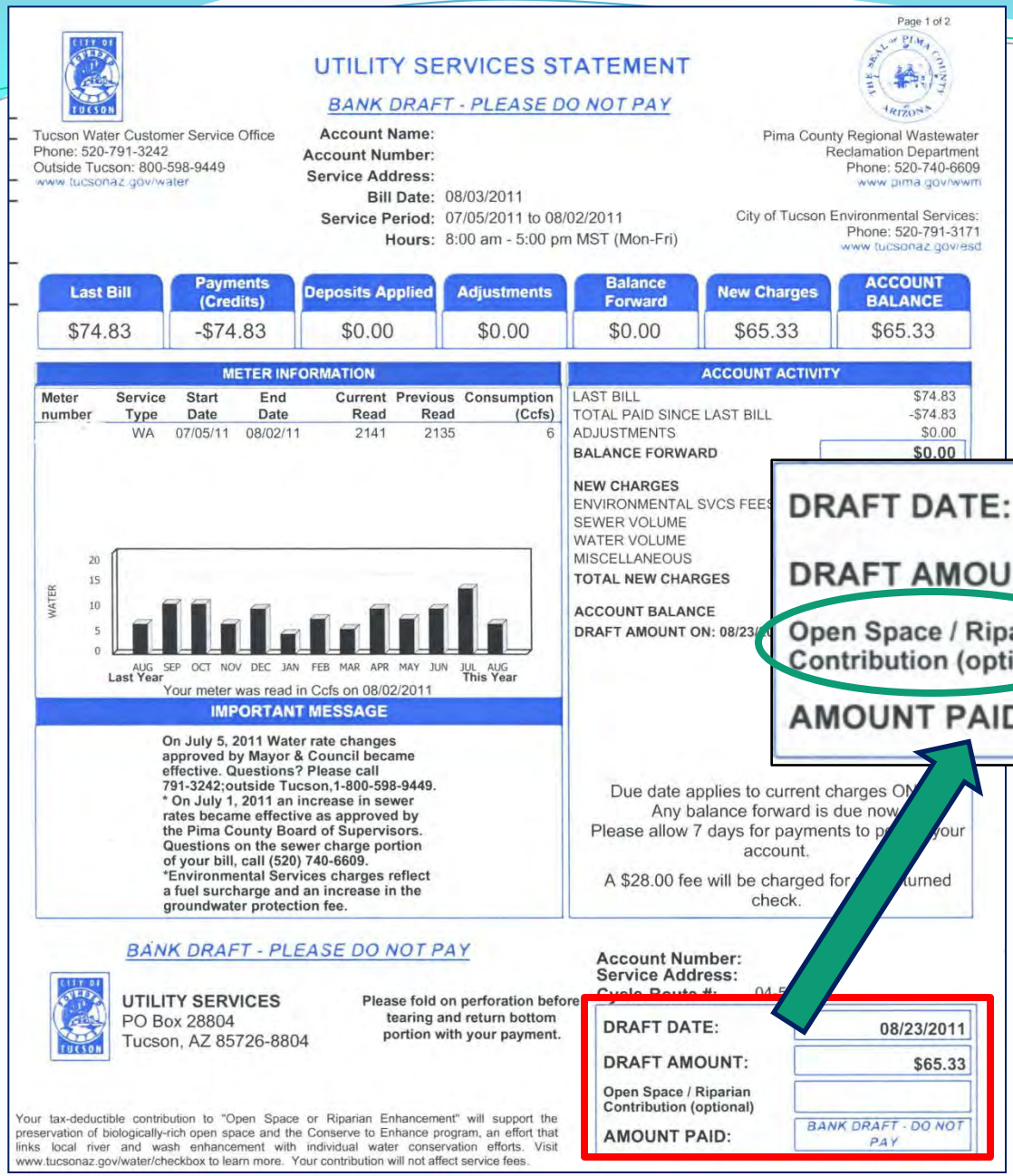
Conservation Organizations, Agencies

Getting Going: Environmental Enhancement Priorities

Getting Going: Tracking Water Savings and Donations

- Need an accounting approach that fits your capacity.
  - For corporations, simply a matter of tracking change in water use and expenses
  - For water providers, need to track water use relative to each user's historic baseline and their donations
  - Many ways to achieve this accounting depending on sophistication of billing software, capacity, etc.

Tucson Water bill with Checkbox program highlighted



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UTILITY SERVICES STATEMENT

BANK DRAFT - PLEASE DO NOT PAY

Tucson Water Customer Service Office
Phone: 520-791-3242
Outside Tucson: 800-598-9449
www.tucsonaz.gov/water

Account Name:
Account Number:
Service Address:
Bill Date: 08/03/2011
Service Period: 07/05/2011 to 08/02/2011
Hours: 8:00 am - 5:00 pm MST (Mon-Fri)

Pima County Regional Wastewater Reclamation Department
Phone: 520-740-6609
www.pima.gov/wwm

City of Tucson Environmental Services:
Phone: 520-791-3171
www.tucsonaz.gov/esd

Last Bill	Payments (Credits)	Deposits Applied	Adjustments	Balance Forward	New Charges	ACCOUNT BALANCE
$74.83	-$74.83	$0.00	$0.00	$0.00	$65.33	$65.33

METER INFORMATION

Meter number	Service Type	Start Date	End Date	Current Read	Previous Read	Consumption (Ccfs)
	WA	07/05/11	08/02/11	2141	2135	6

WATER 20 15 10 5 0
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
Last Year This Year

Your meter was read in Ccfs on 08/02/2011

IMPORTANT MESSAGE

On July 5, 2011 Water rate changes approved by Mayor & Council became effective. Questions? Please call 791-3242;outside Tucson,1-800-598-9449.
* On July 1, 2011 an increase in sewer rates became effective as approved by the Pima County Board of Supervisors. Questions on the sewer charge portion of your bill, call (520) 740-6609.
*Environmental Services charges reflect a fuel surcharge and an increase in the groundwater protection fee.

ACCOUNT ACTIVITY

LAST BILL	$74.83
TOTAL PAID SINCE LAST BILL	-$74.83
ADJUSTMENTS	$0.00
BALANCE FORWARD	$0.00
NEW CHARGES	
ENVIRONMENTAL SVCS FEES	
SEWER VOLUME	
WATER VOLUME	
MISCELLANEOUS	
TOTAL NEW CHARGES	
ACCOUNT BALANCE	
DRAFT AMOUNT ON: 08/23/	

Due date applies to current charges ON
Any balance forward is due now
Please allow 7 days for payments to p your account.

A $28.00 fee will be charged for turned check.

BANK DRAFT - PLEASE DO NOT PAY

UTILITY SERVICES
PO Box 28804
Tucson, AZ 85726-8804

Please fold on perforation before tearing and return bottom portion with your payment.

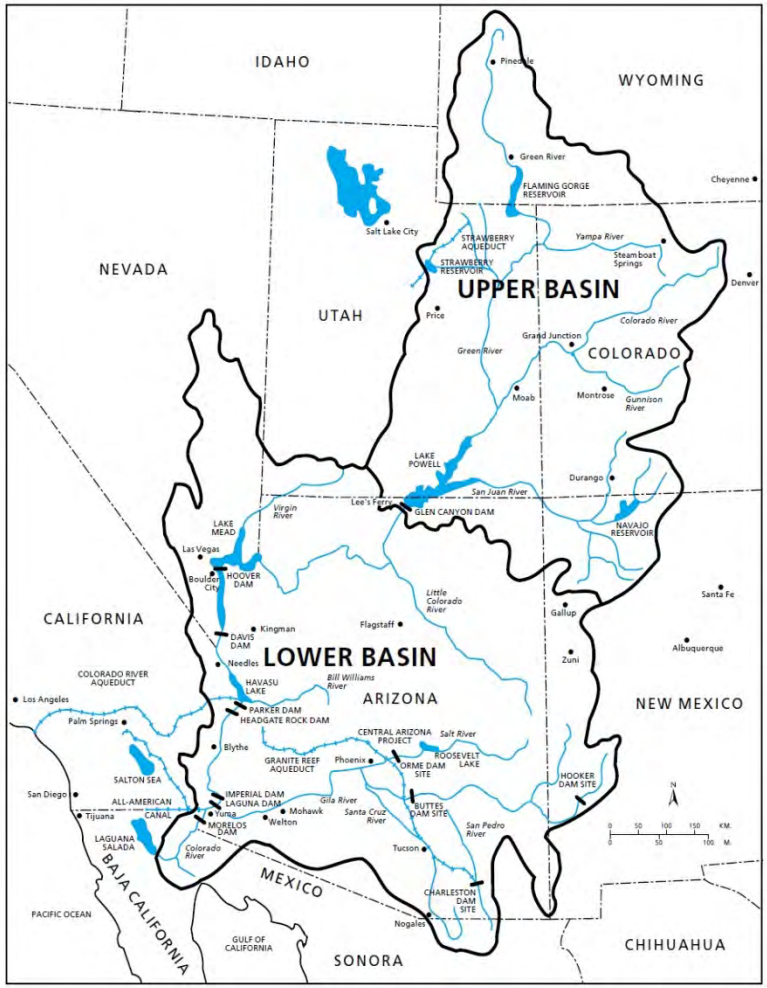
Account Number:
Service Address:
Cycle Route #: 04 5

DRAFT DATE:	08/23/2011
DRAFT AMOUNT:	$65.33
Open Space / Riparian Contribution (optional)	
AMOUNT PAID:	BANK DRAFT - DO NOT PAY

Your tax-deductible contribution to "Open Space or Riparian Enhancement" will support the preservation of biologically-rich open space and the Conserve to Enhance program, an effort that links local river and wash enhancement with individual water conservation efforts. Visit www.tucsonaz.gov/water/checkbox to learn more. Your contribution will not affect service fees.

DRAFT DATE:	08/23/2011
DRAFT AMOUNT:	$65.33
Open Space / Riparian Contribution (optional)	
AMOUNT PAID:	BANK DRAFT - DO NOT PAY

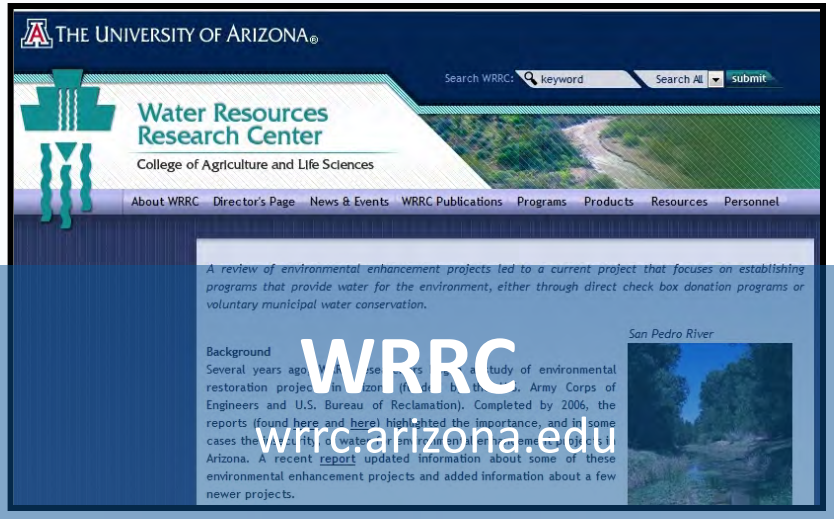
Supporting Pilot Development in New Communities



WRRC Role:

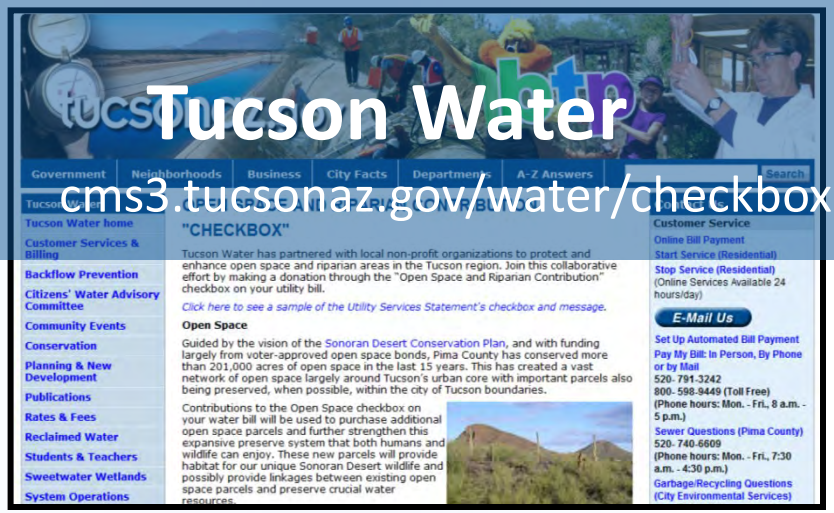
- Assistance Tailoring New C2E Programs to Meet Community Needs & Priorities
- C2E Program Design Guide & Guidance on Key Elements
- Integrated Program Development Support
- Active Stakeholder Engagement & Partner Development

C2E Program Websites:

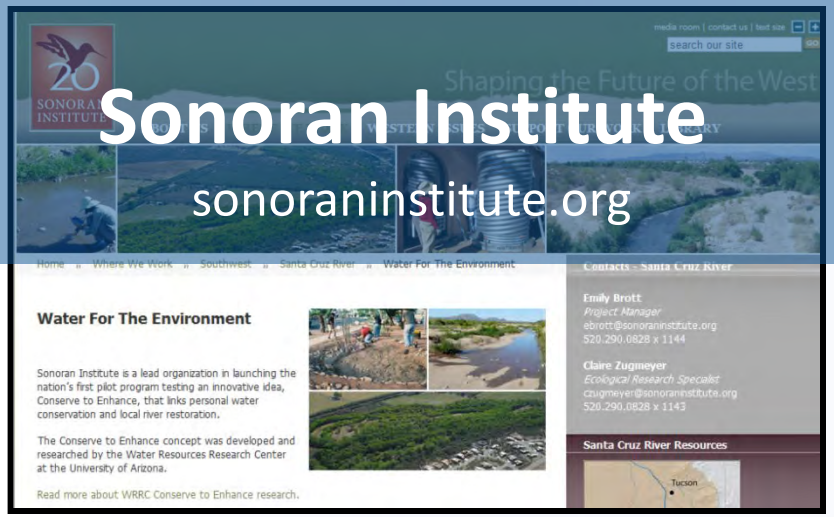


WRRC
wrrc.arizona.edu

Watershed Management Group
watershedmg.org/c2e



Tucson Water
cms3.tucsonaz.gov/water/checkbox



Sonoran Institute
sonoraninstitute.org

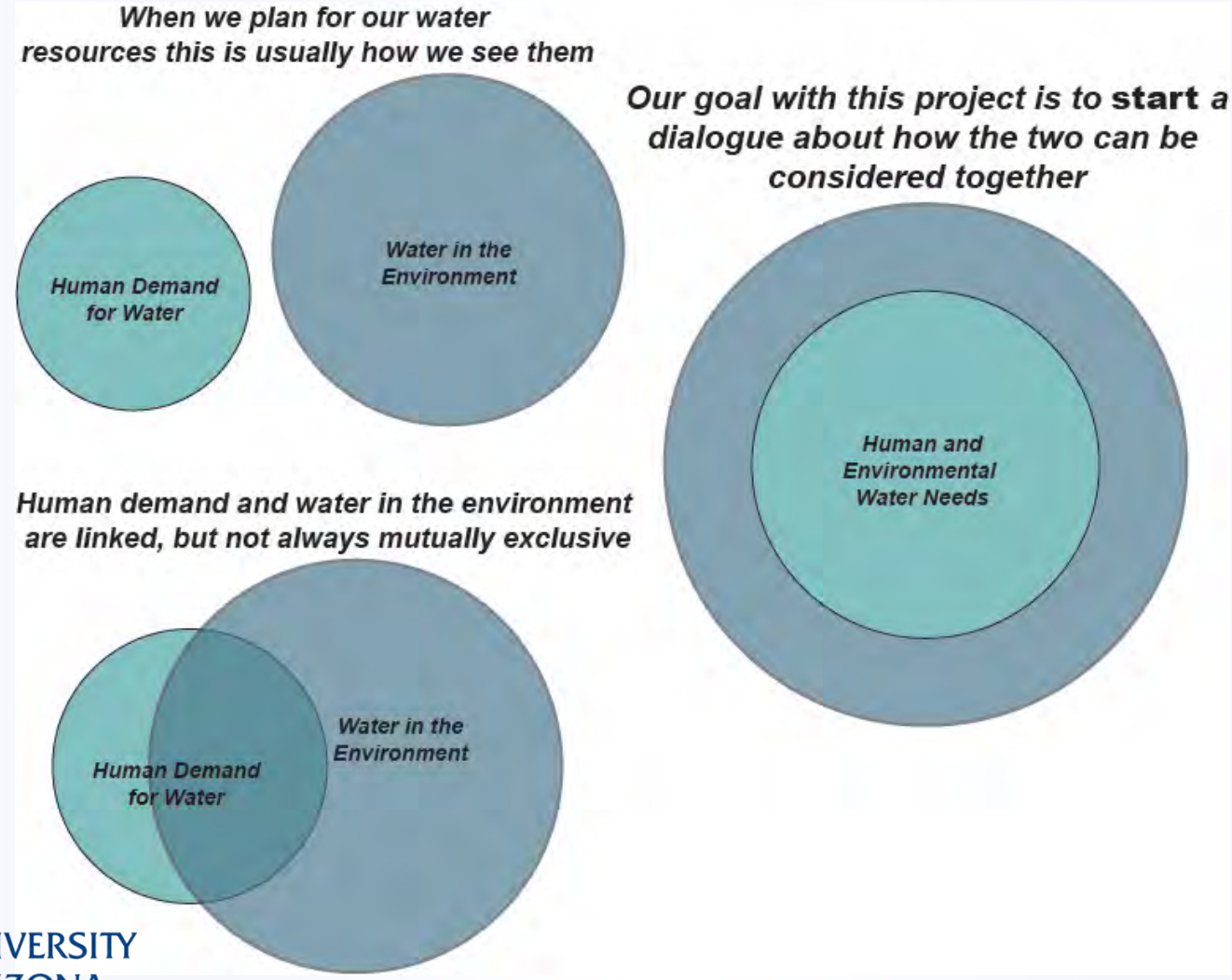
Arizona's Technical Challenges

- Need comprehensive regional flow management
  - Poff et al. 2010
- Lack of statewide data on environmental water needs
  - ADWR 2009
- Gaps in understanding about ephemeral rivers
  - Hughes 2005

Changing the Conversation: Defining All Water Sectors

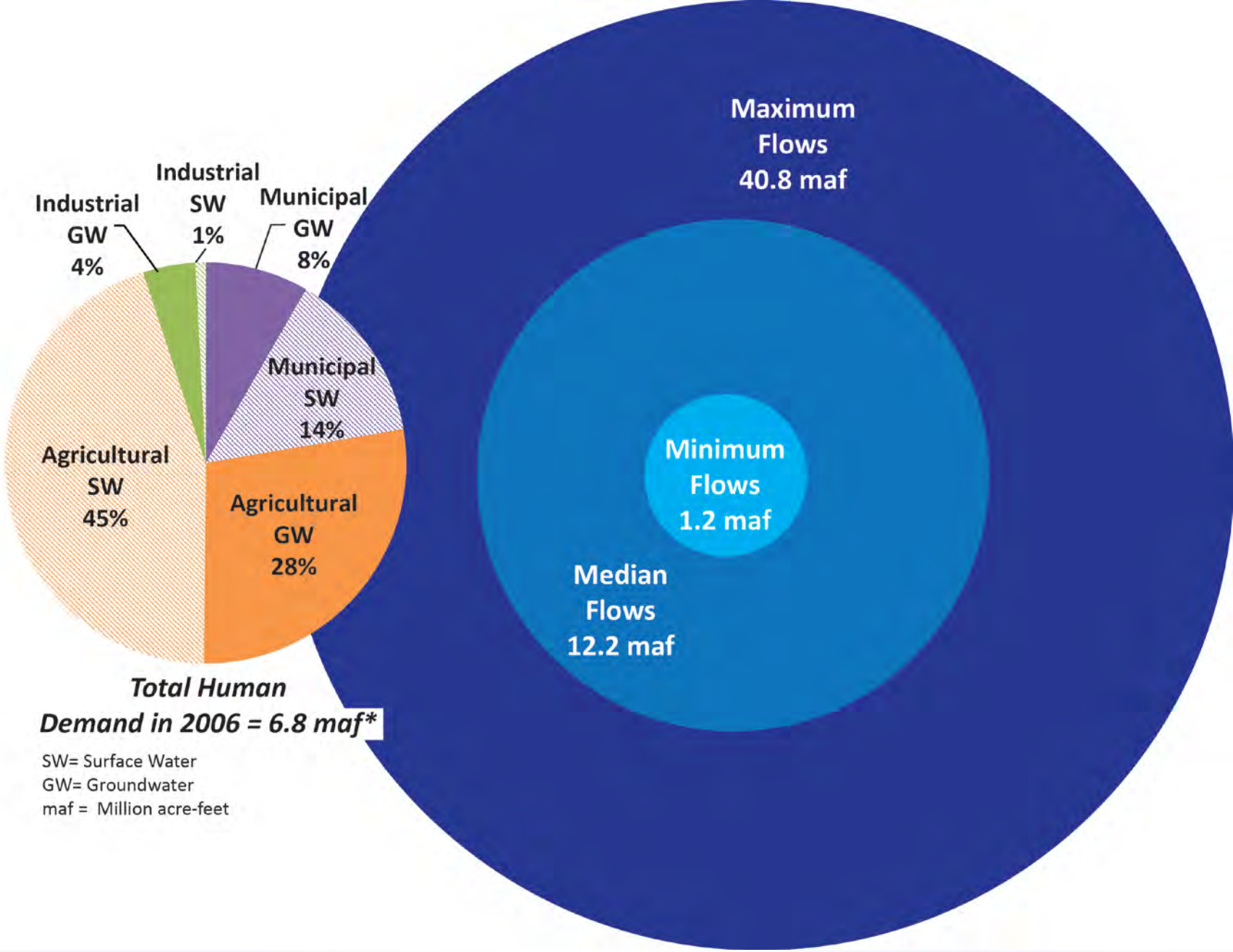
- Information comes from:
  - Arizona Water Atlas (ADWR)
  - Arizona Environmental Water Needs Assessment (AzEWNA) Report and Methodology Guidebook
  - Water Resources Development Commission (WRDC) Environmental and Supply & Demand Reports

Considering Water Demands



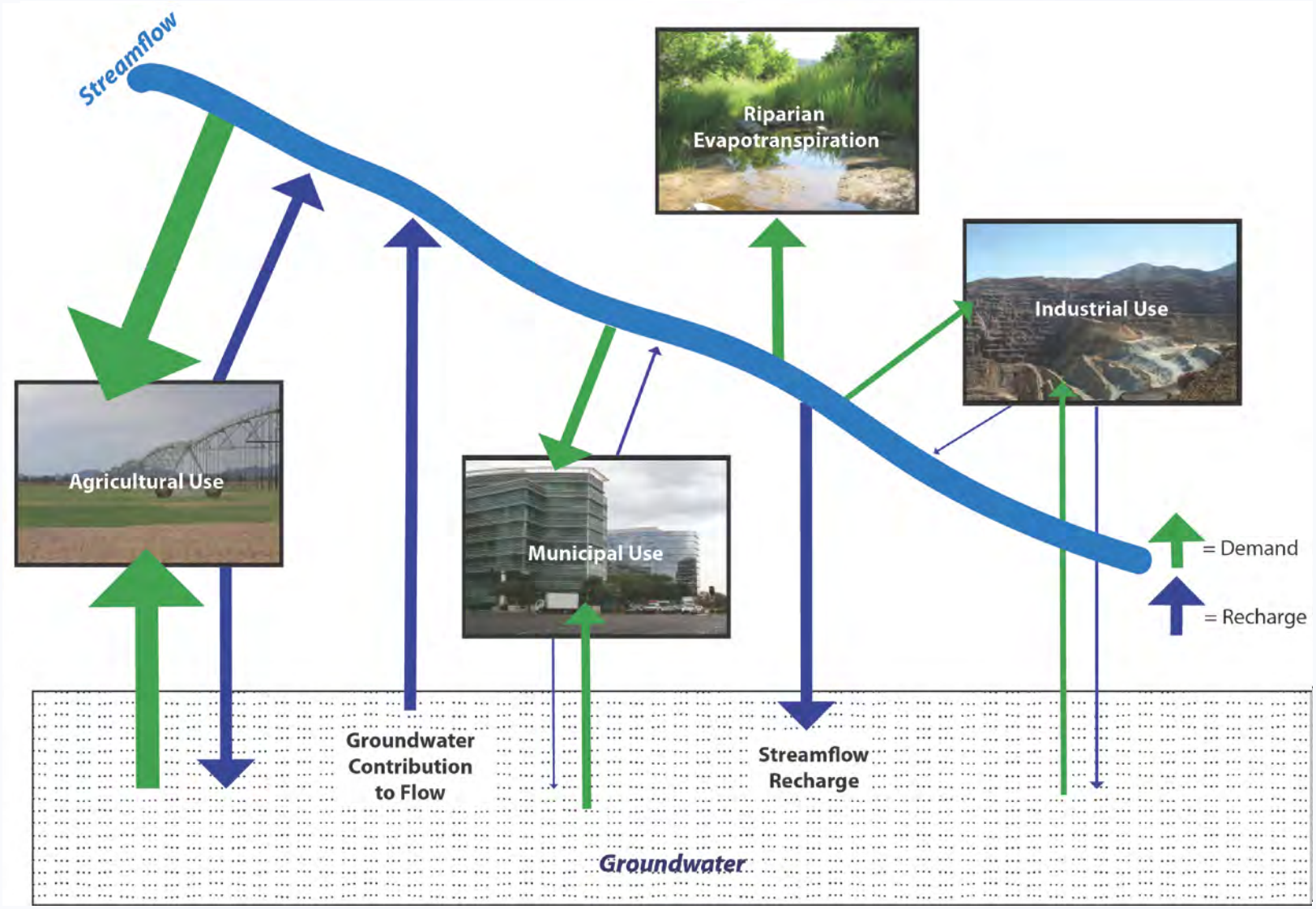
What is the Environment Worth?

- Economic studies
  - State revenues
  - Housing prices
- Social values
  - Preferences
  - Non-Use
- Ecosystem services



Data Source: ADWR 2010 (2001-2005 average demand)

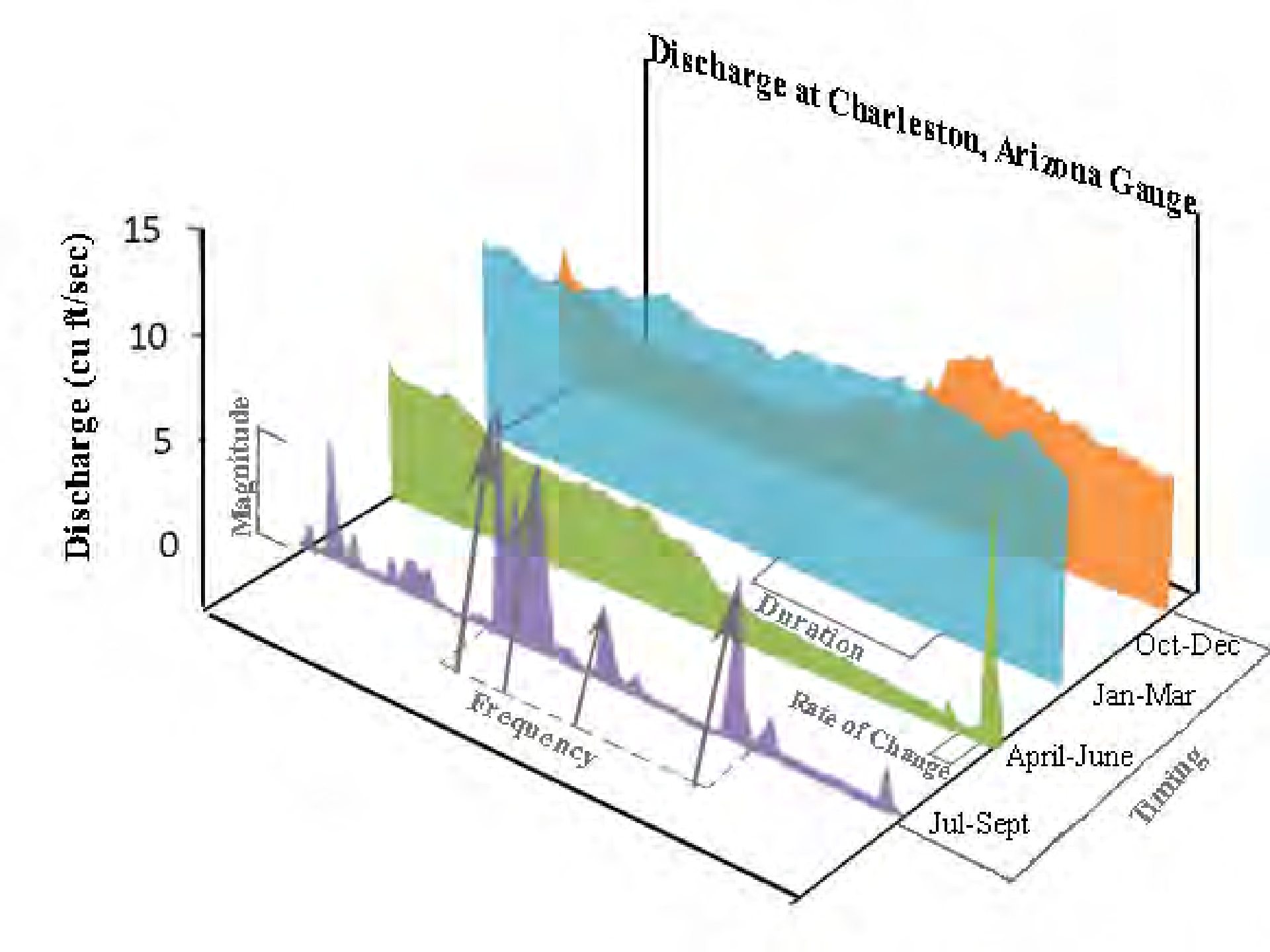
Arizona Water Demand and Use



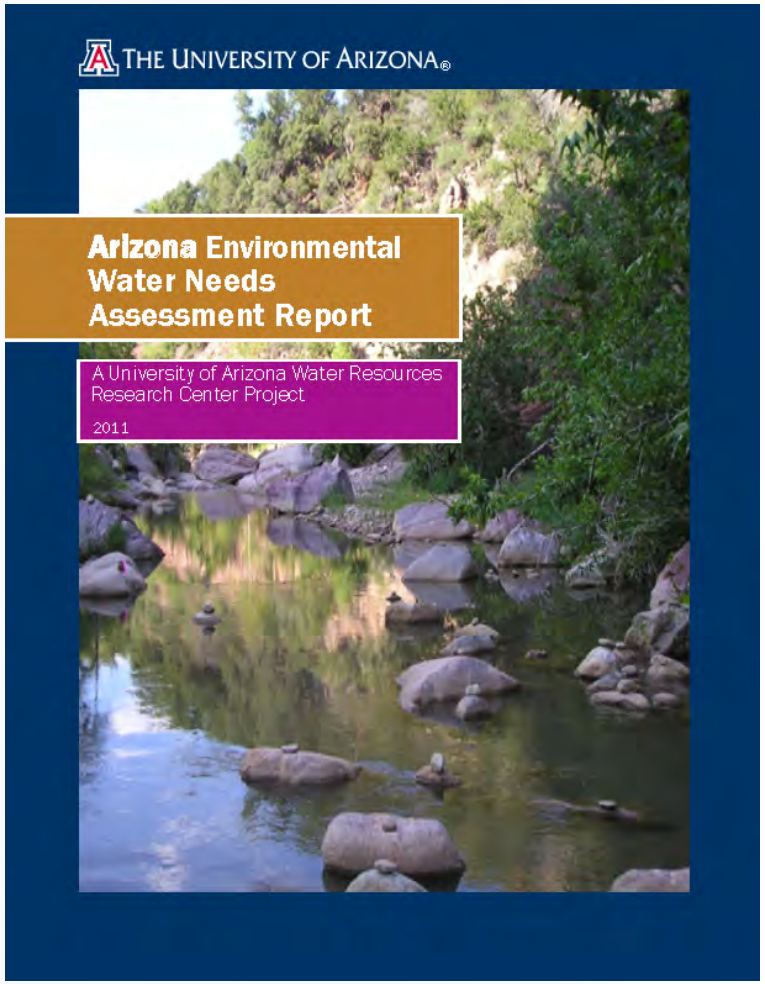
Quantified Streamflow or Environmental Demands?

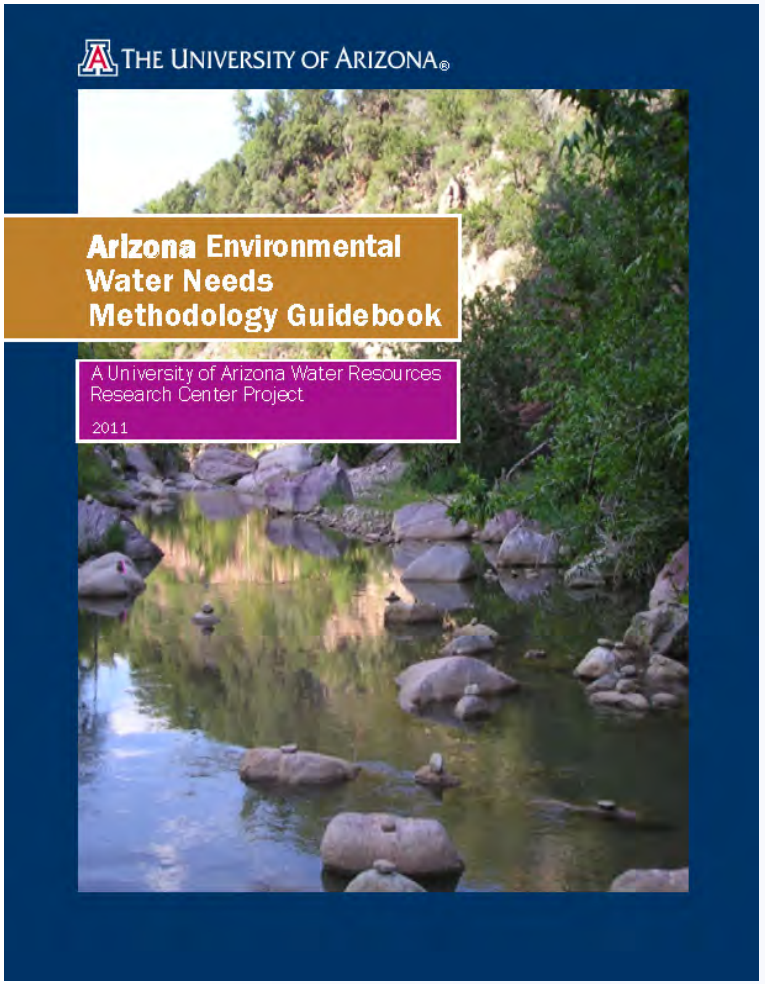
- Quantified Streamflow
  - Streamflow that supports the environment
    - Annual baseflow
    - Groundwater underflow
    - Riparian extent
    - Average annual evapo-transpiration (ET)

- Environmental Demands
  - The amount of water needed in a watercourse to sustain a healthy ecosystem
    - Magnitude (how much)
    - Frequency (how often)
    - Duration (how long)
    - Timing (how predictable)
    - Rate of Change (how variable)

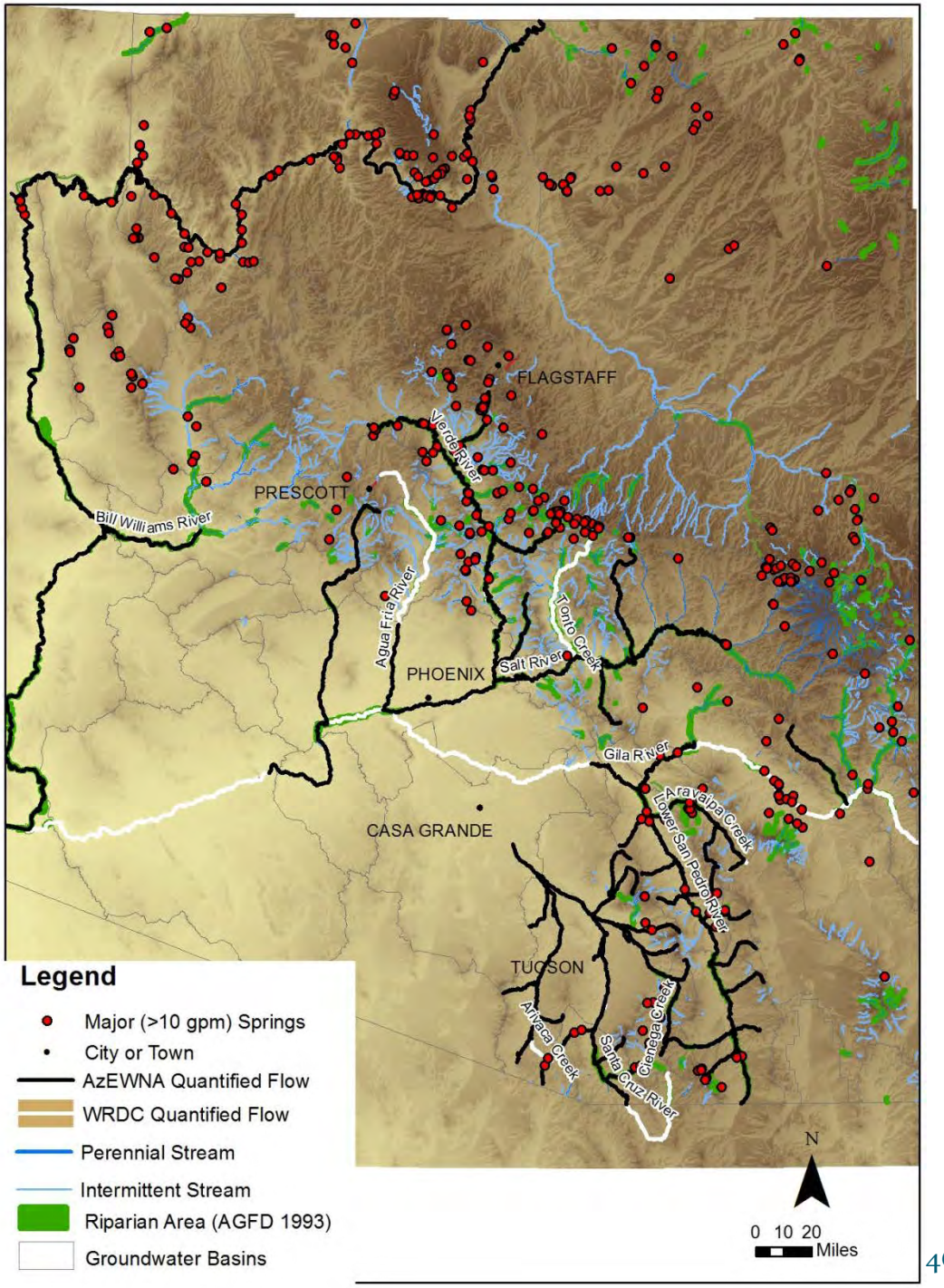

Discharge at Charleston, Arizona Gauge
Discharge (cu ft/sec)
15
10
5
0
Magnitude
Duration
Frequency
Rate of Change
Timing
Oct-Dec
Jan-Mar
April-June
Jul-Sept

Examining Environmental Flow Needs

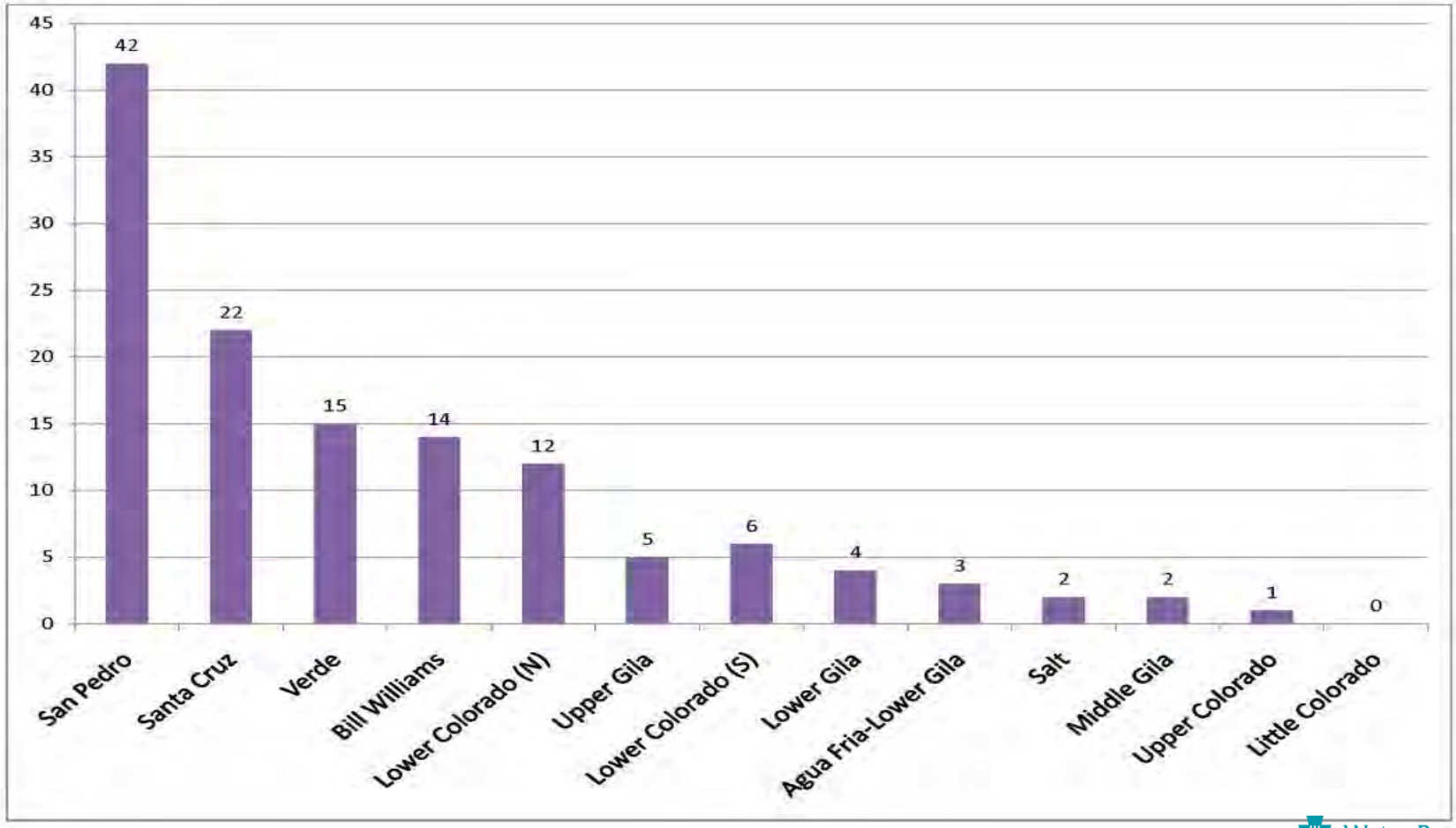




Extent of Quantified Flows



of Studies By Watershed



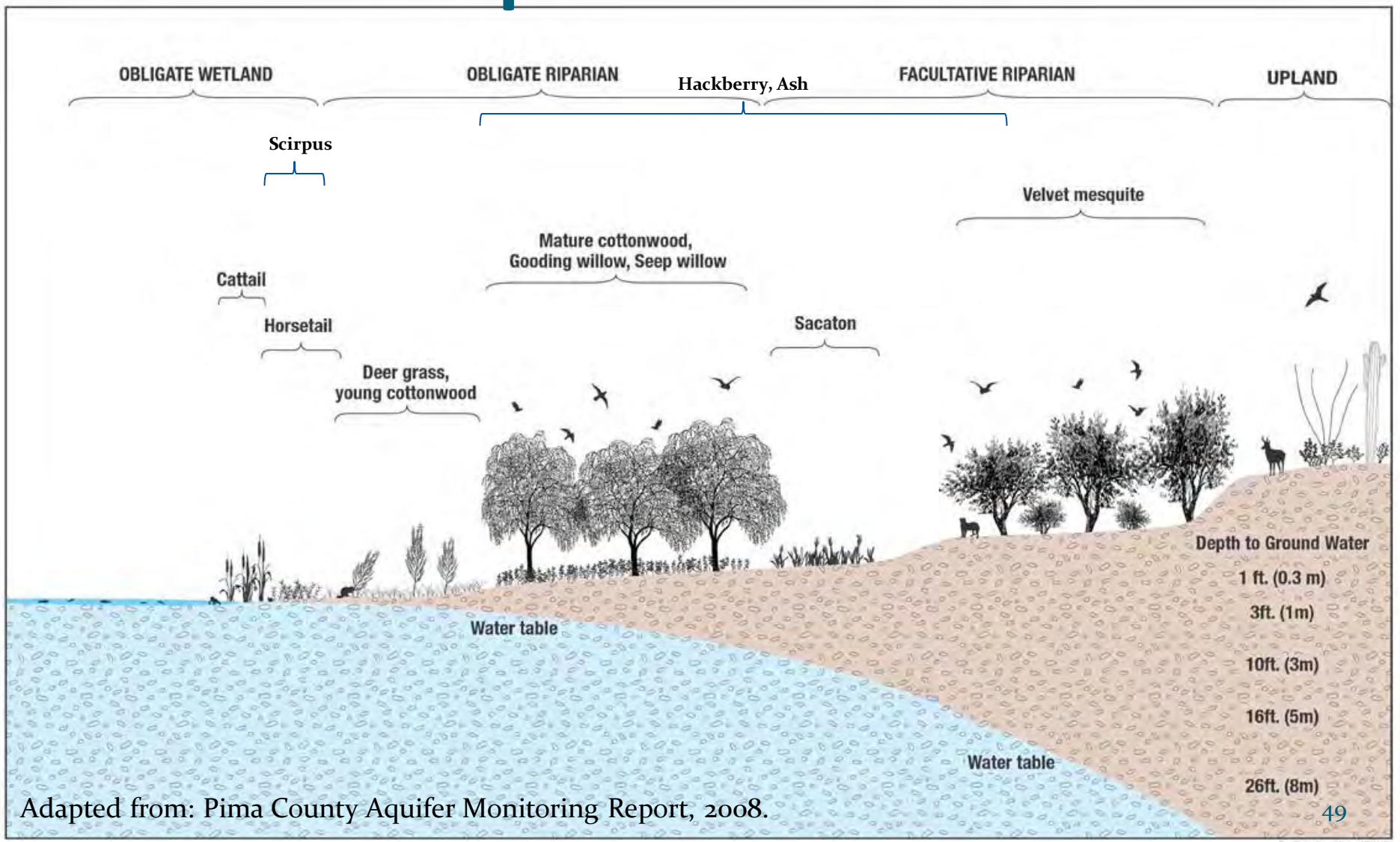
Summary of Studies - Statewide

93 studies in database

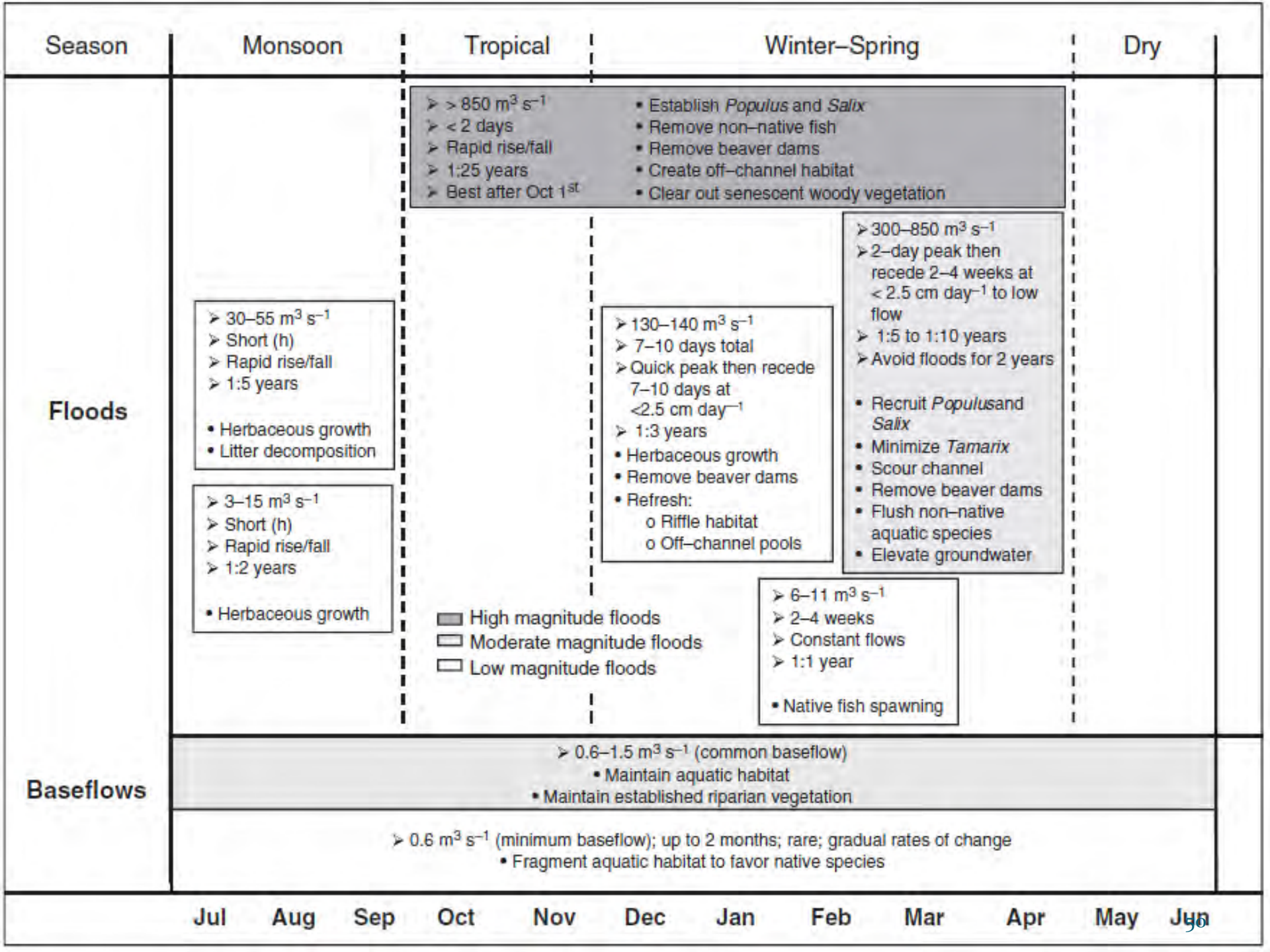
70 give quantitative information about ecological flow needs or ecological responses to flow alteration

	Aquatic Only	Riparian Only	Aquatic/ Riparian	TOTAL
Multiple Study Syntheses	5	12	8	**25**
Review of Multiple Studies	0	15	2	**17**
Single Study	7	41	3	**51**
TOTAL	**12**	**68**	**13**	**93**

Riparian Plants



Adapted from: Pima County Aquifer Monitoring Report, 2008.


Season
Monsoon
Tropical
Winter–Spring
Dry
Floods
➢ > 850 m3 s–1
➢ < 2 days
➢ Rapid rise/fall
➢ 1:25 years
➢ Best after Oct 1st
• Establish Populus and Salix
• Remove non–native fish
• Remove beaver dams
• Create off–channel habitat
• Clear out senescent woody vegetation
➢ 300–850 m3 s–1
➢ 2–day peak then recede 2–4 weeks at < 2.5 cm day–1 to low flow
➢ 1:5 to 1:10 years
➢ Avoid floods for 2 years
• Recruit Populusand Salix
• Minimize Tamarix
• Scour channel
• Remove beaver dams
• Flush non–native aquatic species
• Elevate groundwater
➢ 130–140 m3 s–1
➢ 7–10 days total
➢ Quick peak then recede 7–10 days at <2.5 cm day–1
➢ 1:3 years
• Herbaceous growth
• Remove beaver dams
• Refresh:
o Riffle habitat
o Off–channel pools
➢ 30–55 m3 s–1
➢ Short (h)
➢ Rapid rise/fall
➢ 1:5 years
• Herbaceous growth
• Litter decomposition
➢ 3–15 m3 s–1
➢ Short (h)
➢ Rapid rise/fall
➢ 1:2 years
• Herbaceous growth
High magnitude floods
Moderate magnitude floods
Low magnitude floods
➢ 6–11 m3 s–1
➢ 2–4 weeks
➢ Constant flows
➢ 1:1 year
• Native fish spawning
Baseflows
➢ 0.6–1.5 m3 s–1 (common baseflow)
• Maintain aquatic habitat
• Maintain established riparian vegetation
➢ 0.6 m3 s–1 (minimum baseflow); up to 2 months; rare; gradual rates of change
• Fragment aquatic habitat to favor native species
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun

Arizona Environmental Water Needs Assessment

Methodology Classification

Increasing complexity ←←←←

Qualitative Methods	
Distribution of flora and fauna associated with water sources Flow-ecology response curves Flow-ecology response relationship described	
Quantitative Methods	
Aquatic	*Riparian*
Hydrological index Hydraulic rating Habitat simulation Biological response to flow correlation	Hydrological event models Water budget/Evapotranspiration Water source Eco-flow response curves Biological event models
Holistic	

Needs Assessment: Conclusions

- Limited study information in some areas
  → Barrier to developing *statewide* flow needs
- Future studies needed on underrepresented streams and species
  - Should follow holistic approach
- Where information is available, water-related ecological objectives can be quantitatively defined

Connecting the Environment to Arizona Water Planning (EnWaP)

- Further understand water needs of the environment
- Build upon efforts to address increasing water demands of AZ
- Identify voluntary, stakeholder-driven options for addressing needs of water dependent natural resources

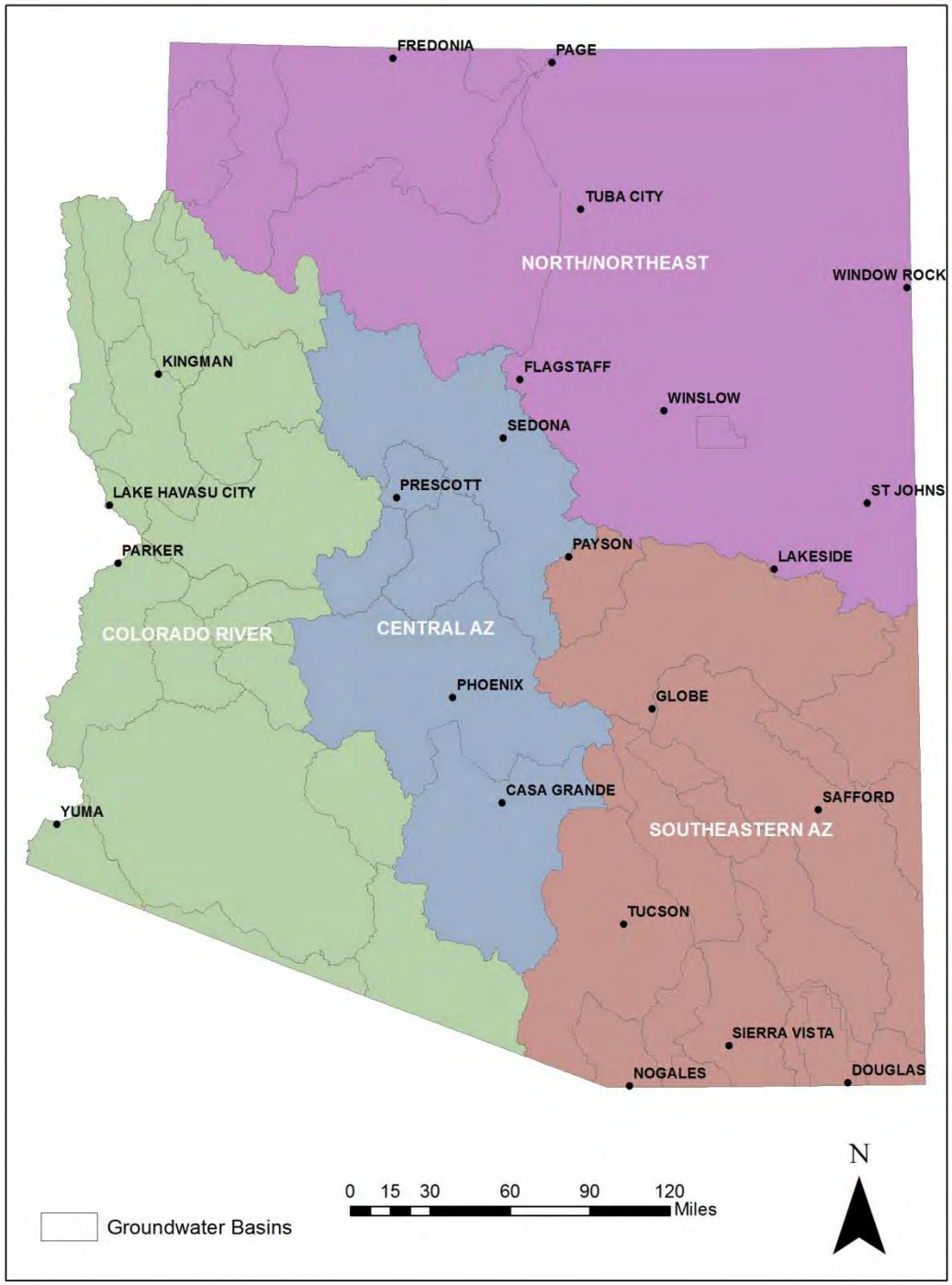
Aravaipa Creek
Photo credit: ADWR 2009

Regional Bulletins: Environmental Flows and Water Demands

Contains information on:

- Quantified Environmental Water Demands
- Regional Water Demand by Sector (incl. Environmental)
- Overview of Environmental Demand Aspects Studied
- Information Gaps
- Water Resources and Environmental Designations

Central Arizona, Southeastern Arizona, North/Northeast Arizona & Colorado River

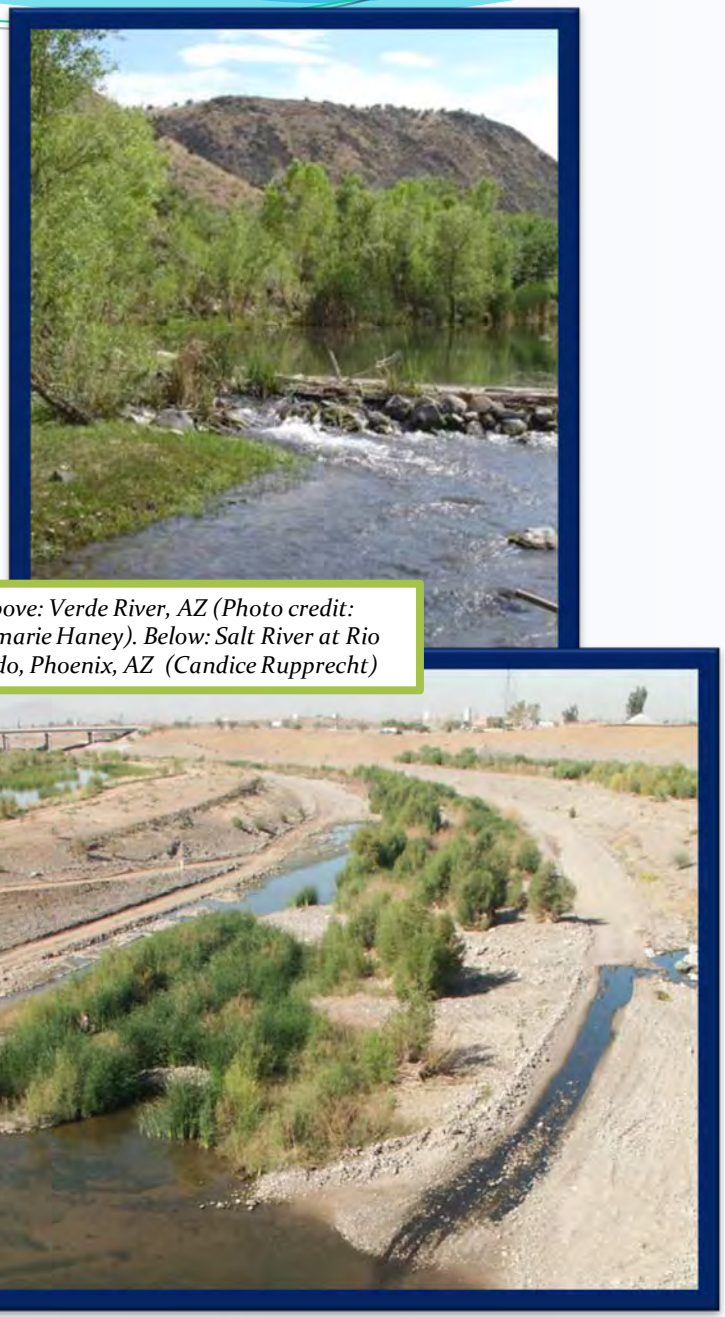


How you can apply this information

1. Determine how environmental flows interact with other demand sectors
2. Identify factors putting environmental flows at risk
3. Identify studies need to address key information gaps about environmental flows
4. Determine local priorities for ecosystems
5. Develop scenario analyses for water planning that incorporate the environment

EnWaP Next Steps

- Regional bulletins
- Reach all water sectors
- Start conversations
  - Outreach to watershed and water planning groups
  - Share environmental demand information
- **Is there room for the environment at the table and if so where and how?**



Above: Verde River, AZ (Photo credit: Jeanmarie Haney). Below: Salt River at Rio Salado, Phoenix, AZ (Candice Rupprecht)

Conclusions

Goal: Ensure a sustainable water future

- Strategies:
  - Public Education
  - Opportunities for Voluntary Action
  - Raise funds for environment
  - Increase institutional capacity for inclusive water planning

Innovative and practical solutions are possible!

Will it be enough? You decide!


Questions?

Contact Us

- Learn more:
  - wrrc.arizona.edu
  - Share your thoughts with us…

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