A photograph of a riparian ecosystem. In the foreground, there is a body of water reflecting the sky and the surrounding vegetation. The middle ground is filled with dense, tall grasses and shrubs in various shades of green and brown. The background shows more trees and a clear blue sky. The text is overlaid on the upper half of the image.

Riparian vegetation water needs:
stressor-response model for assessing
riparian ecosystem condition, case study
of the San Pedro River, Arizona

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Assessment Models

Uses

- Monitor changes in ecological condition

- Determine need and type of restoration

- Assess restoration success

Indicators

- Stream hydrology/geomorphology

- Biota

- Ecosystem functions

Objective

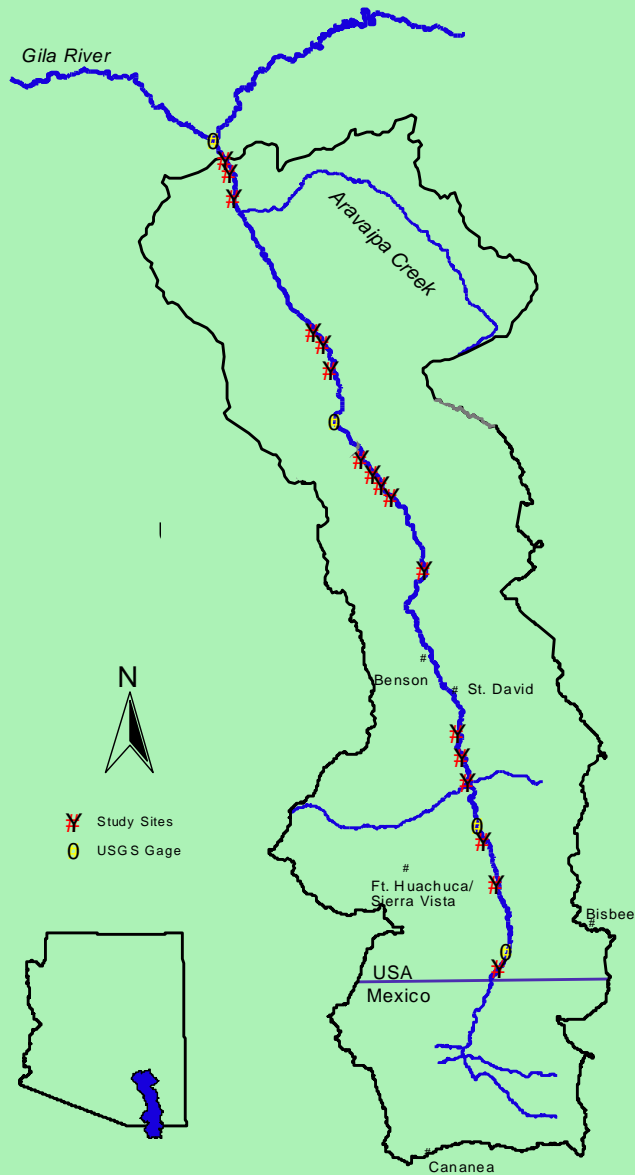
Develop assessment model for San Pedro River riparian vegetation

Follows dose-response approach of Index of Biological Integrity (Karr 1991)

Based on a suite of field-measured vegetation variables (bioindicators)

Methods

- Identify vegetation traits (bioindicators) that change in response to the stressors of stream and aquifer dewatering (*regression analysis*)
- Determine the set of biotic indicators that is most robust in modeling the hydrologic conditions at San Pedro River sites and place these indicators into assessment classes (*iterative ANOVA*)
- Internally validate the model (*using 10 San Pedro River sites not used in model development*)



- 17 sites spanning gradients of hydrology
- Measured vegetation traits (composition, structure, abundance, diversity)
- Measured stream hydrology (flow duration and depth to ground water)

Identification of Indicators: Variables Used for Single and Multiple Regression

Independent

Flow duration (measure of
intermittency)

Depth to ground water

Ground water fluctuation

Hydrologic rank

Dependent

Flood-plain physiognomy

Woody species abundances

Tree age structure

Woody biomass structure

Woody and herbaceous
diversity and richness

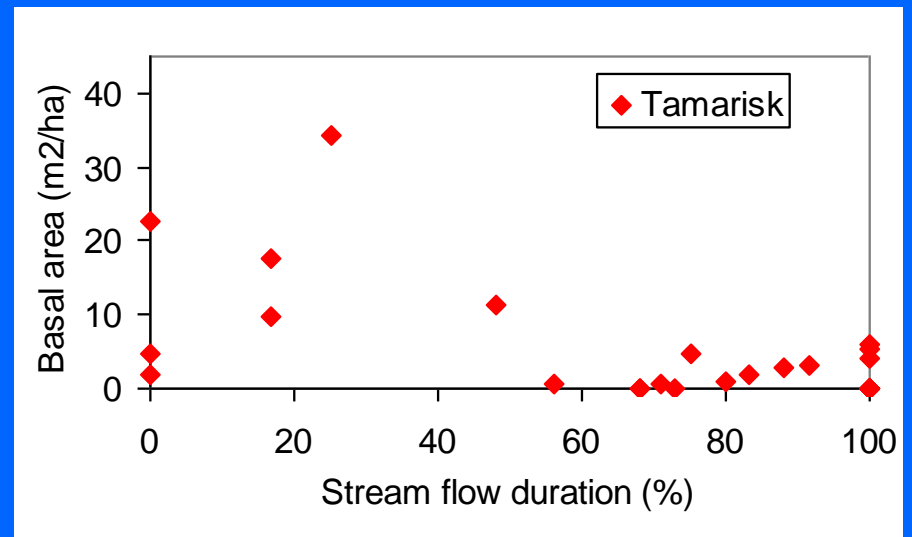
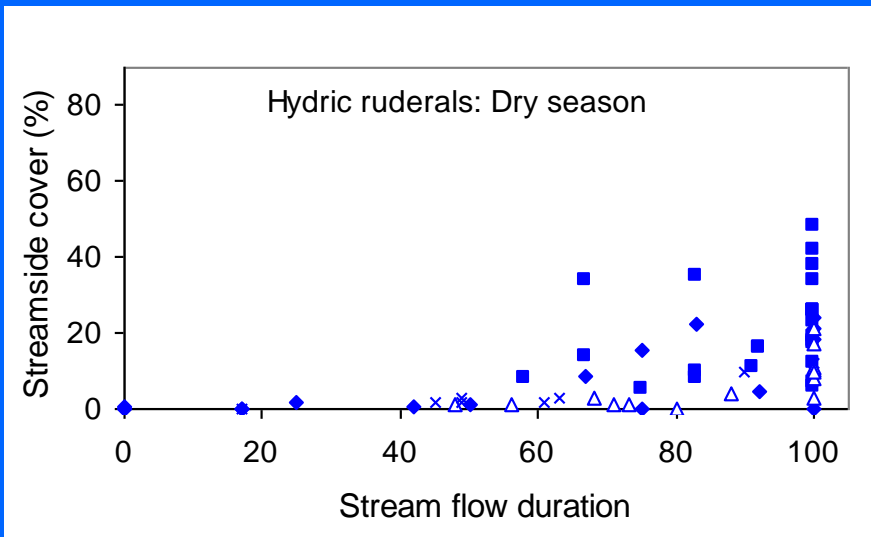
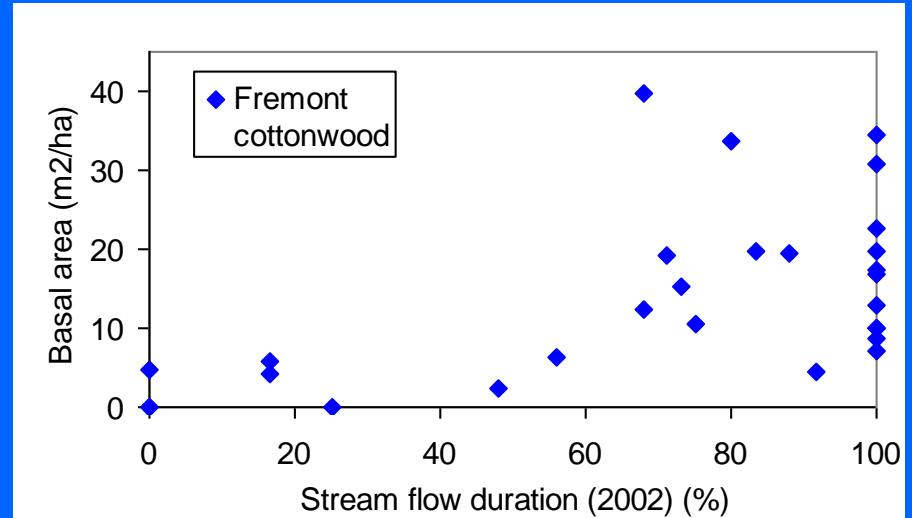
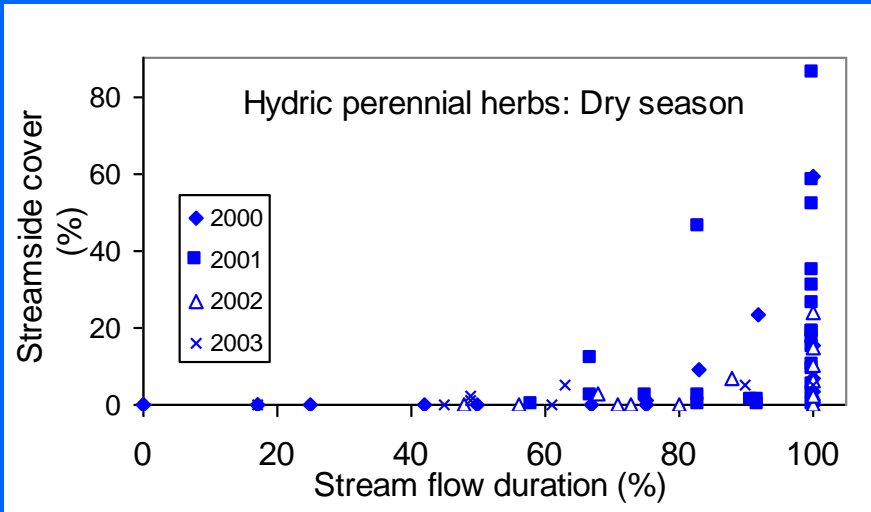
Woody and herbaceous
wetland indicator score

Herbaceous cover (total and
by functional group)

Potential bioindicators

Herbaceous vegetation

Woody vegetation



Variables Included in Model

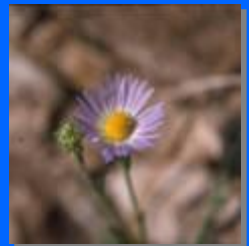
Woody vegetation

1. Size class diversity of hydric pioneer trees (i.e., cottonwood-willow)
2. Basal area of hydric pioneer trees
3. Relative basal area of hydric pioneer trees (relative to mesic species)
4. Maximum vegetation height
5. Percent of flood plain covered by shrublands

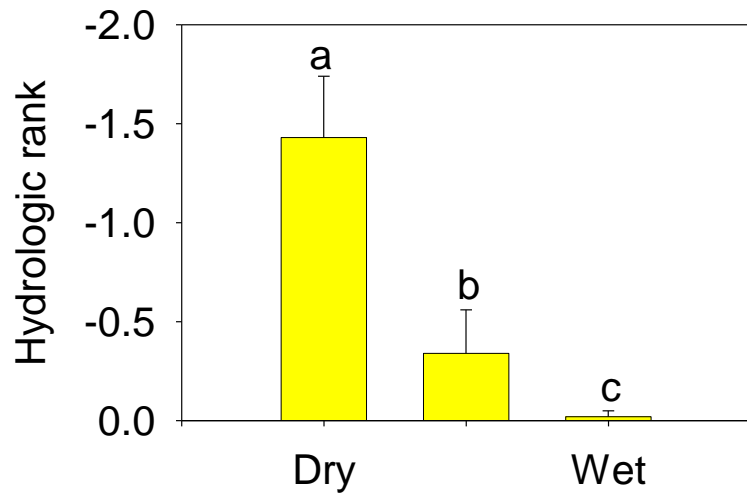
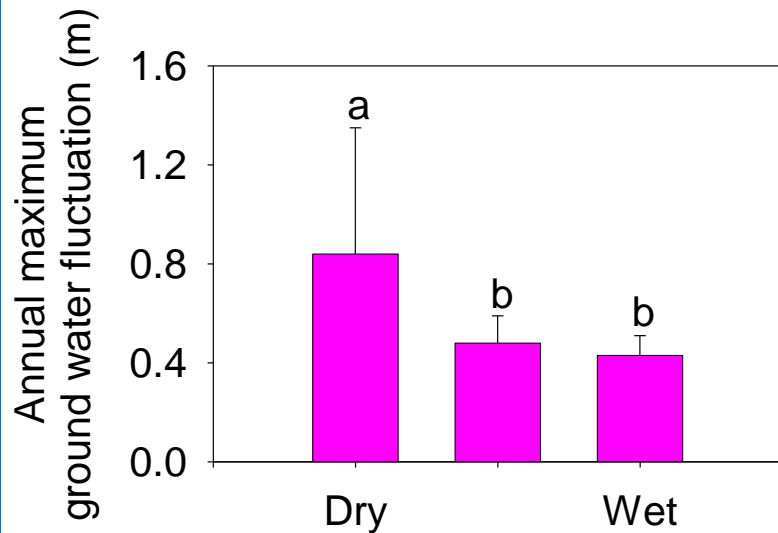
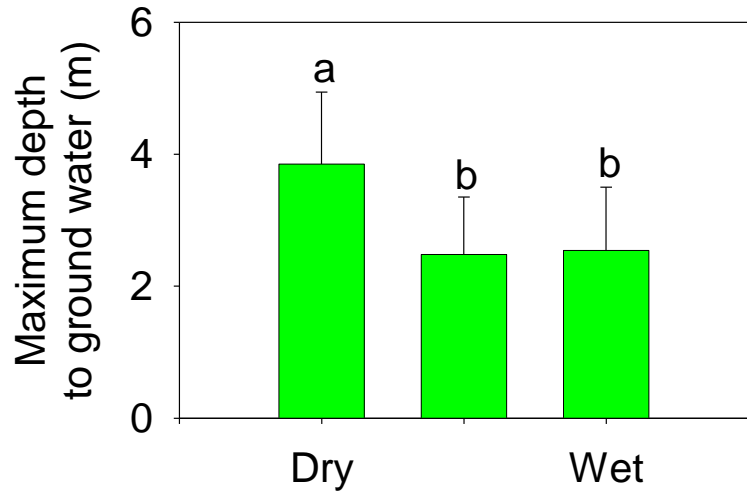
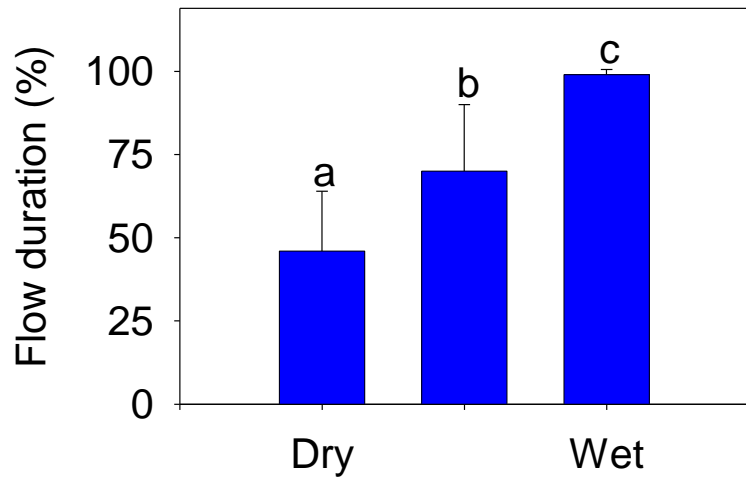


Herbaceous vegetation

6. Dry season cover of streamside hydric perennial herbs
7. Dry season relative cover of streamside hydric perennial herbs
8. Dry season absolute cover of streamside hydric herbs
9. Dry season relative cover of streamside hydric herbs

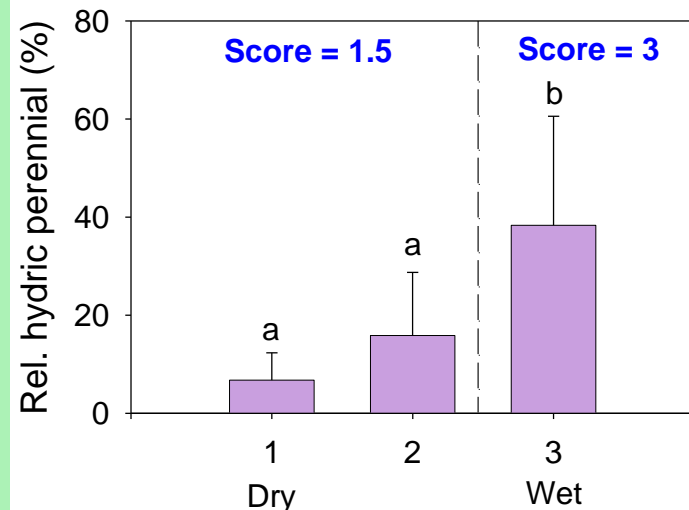
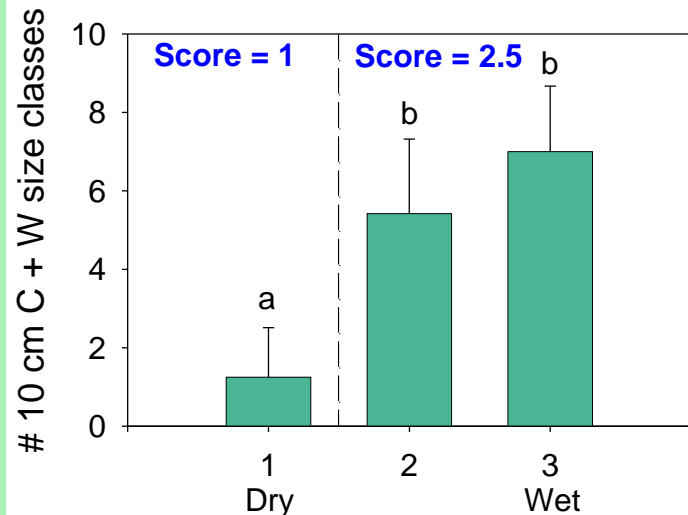


Determination of model assessment classes: Hydrologic Classes

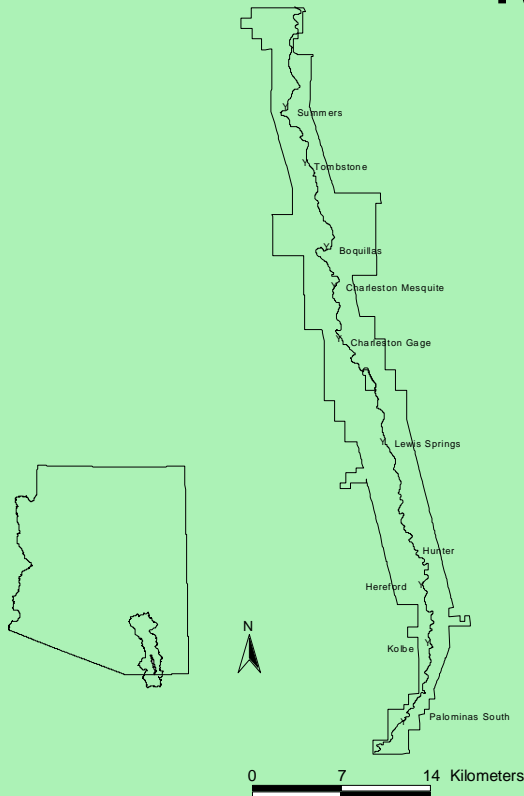


San Pedro River Scoring Values for Indicator Variables.

	Score			
	1	1.5	2.5	3
No. of 10 cm C +W classes	≤ 3		≥ 4	
C + W basal area (m ² ha ⁻¹)	≤ 4.7		≥ 4.8	
C + W relative basal area (%)	≤ 21		≥ 22	
Max. veg. height (m)	≤ 15		≥ 16	
% Shrublands	≥ 35		≤ 34	
Hydric perenn.herb cover (%)		≤ 5		≥ 6
Rel. hydric perenn.(%)		≤ 14		≥ 15
Hydric herb cover (%)		≤ 29		≥ 30
Rel. hydric.(%)		≤ 24		≥ 25



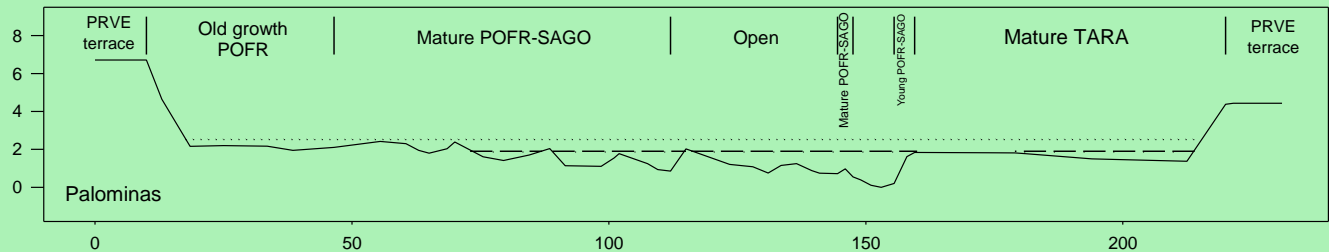
Model Validation



Six unburned and four burned Upper Basin sites
Hydrology and vegetation data collected at each site.

Assigned sites to hydrologic classes, then scored using the vegetation data.

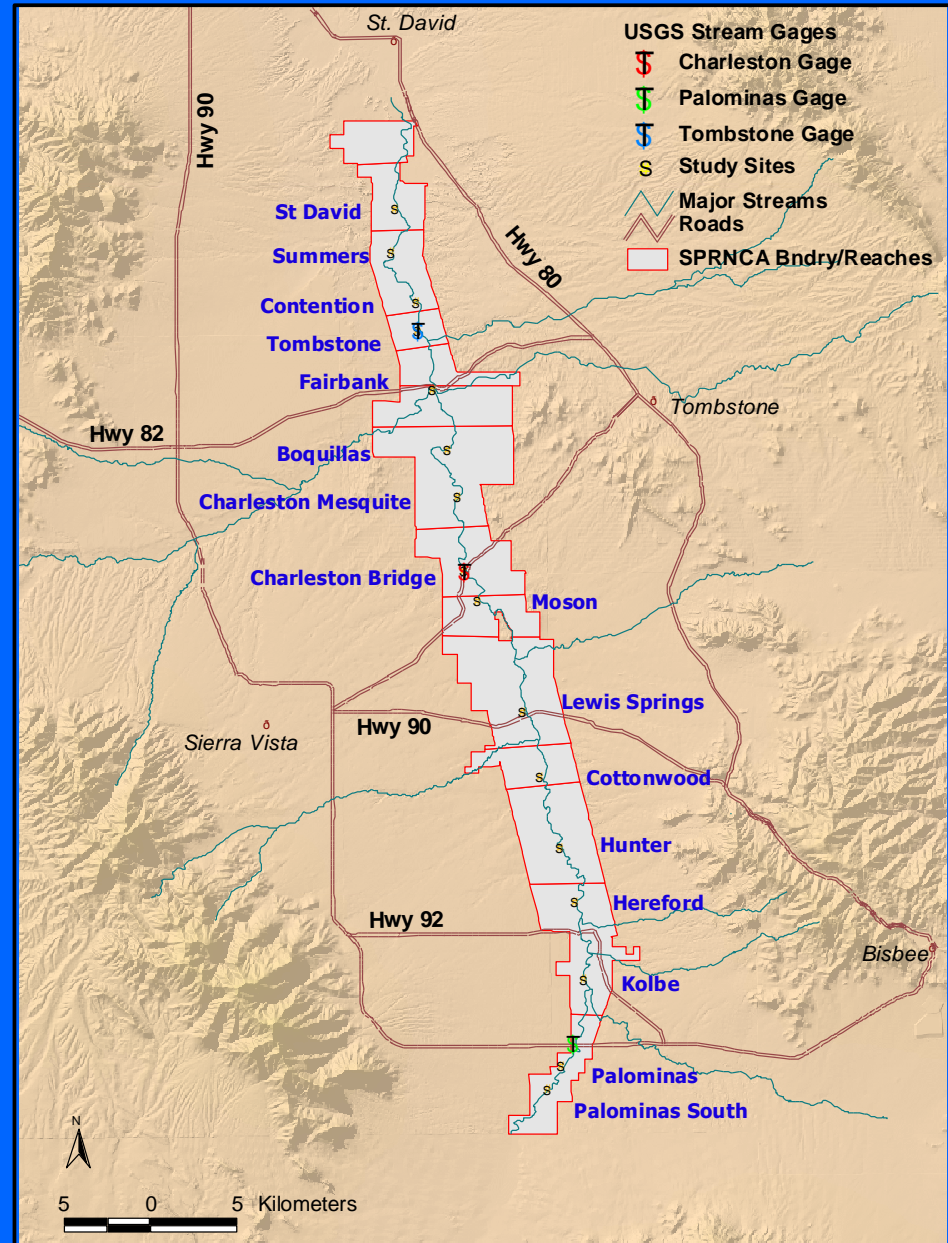
80% success rate



SPRNCA sites

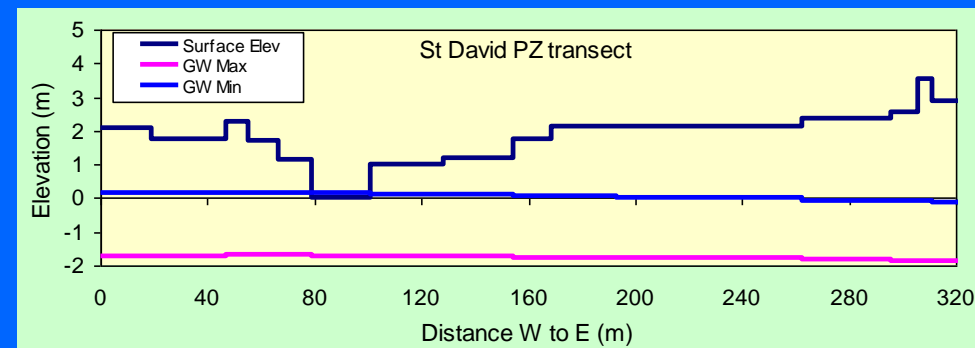
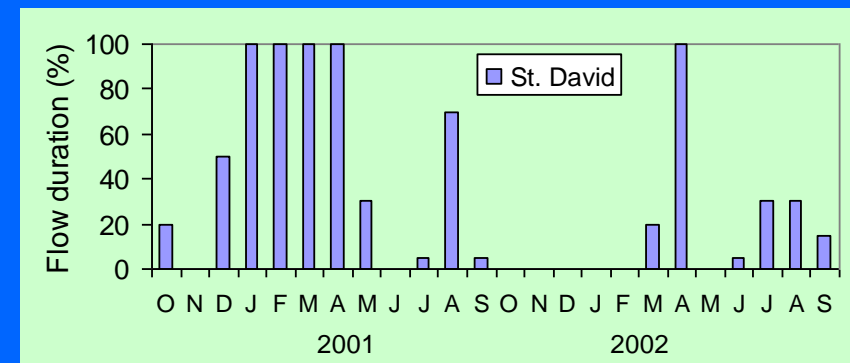


Collected data on bioindicators and hydrology in 14 SPRNCA reaches



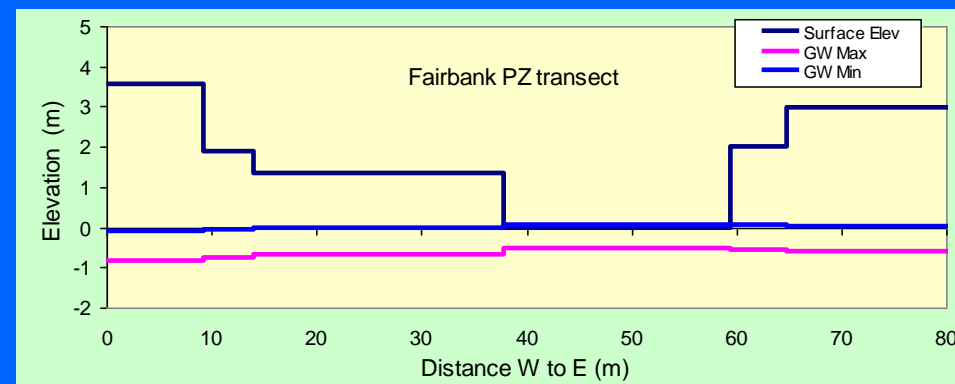
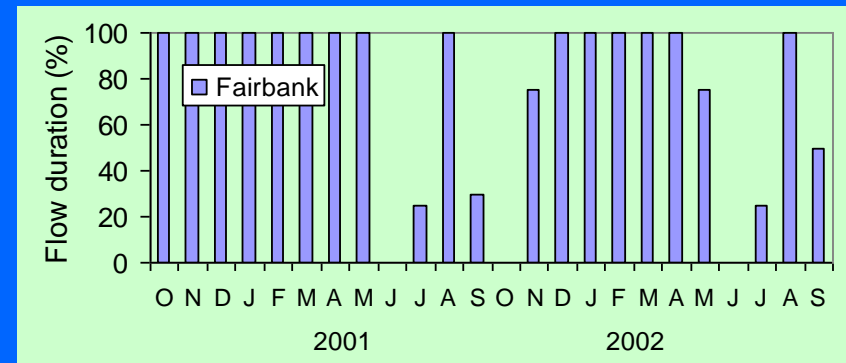
Class 1 (Dry)

- 'Intermittent-dry' stream flow (present <60% of time)
- Deep (>3.5 m in dry season) and highly fluctuating (>1 m/yr) ground water
- Tamarisk dominant
- Short shrublands with limited canopy cover
- Sparse streamside herbaceous cover
- Herbaceous cover dominated by mesic species.



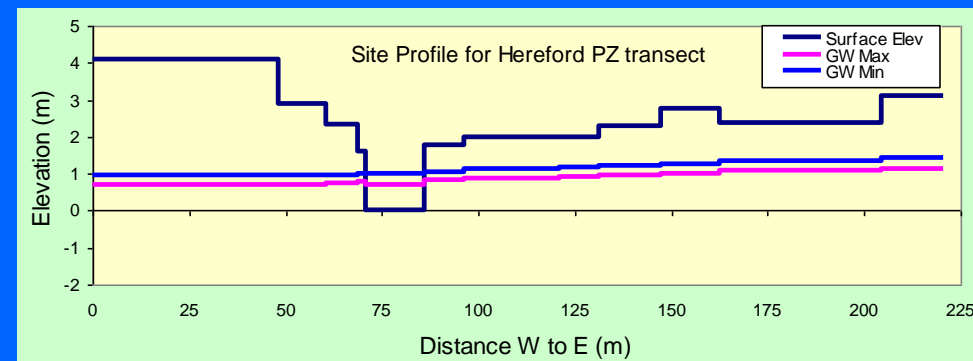
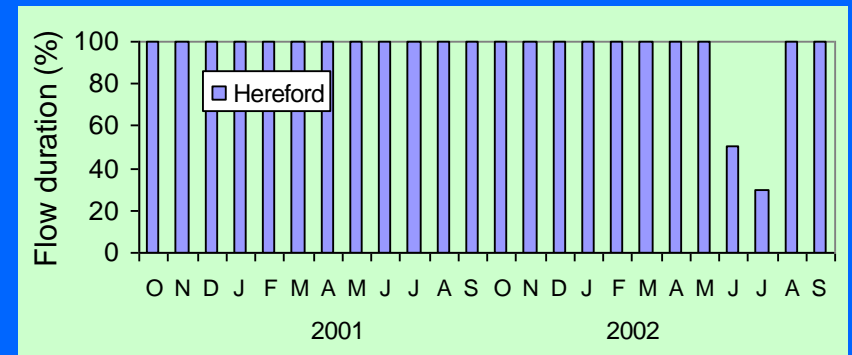
Class 2 (Intermediate)

- Intermittent-wet stream flows (present >60% of time)
- Moderately deep and fluctuating ground water
- Tamarisk has increased, although cottonwood-willow still dominant.
- Streamside herbaceous cover is reduced, and hydric herb species replaced by mesic species.

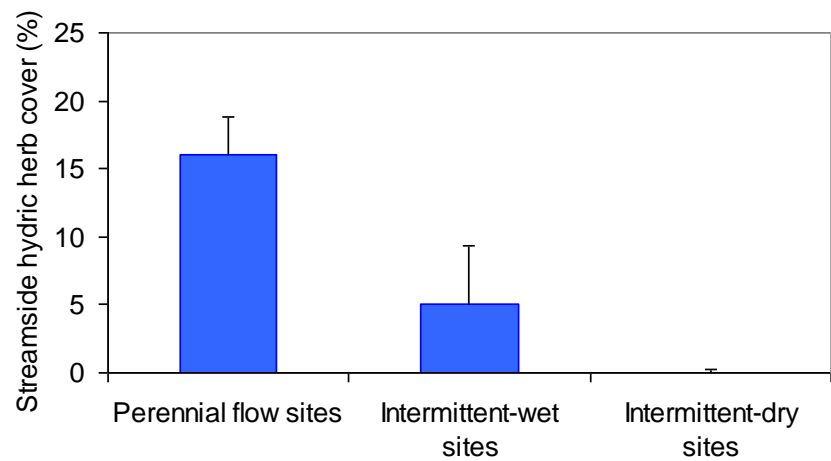
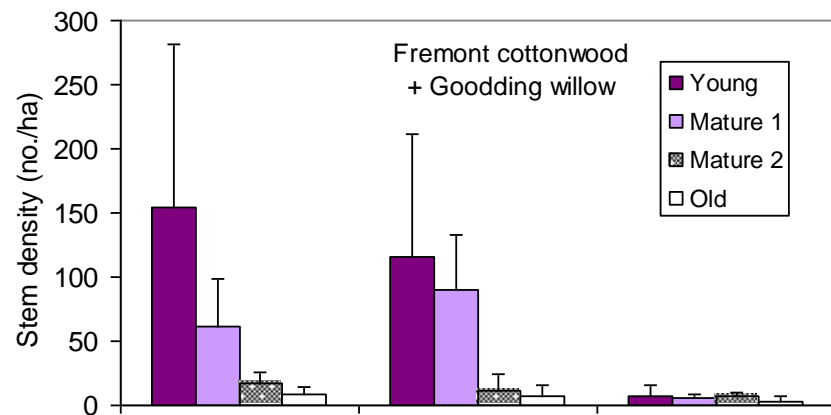
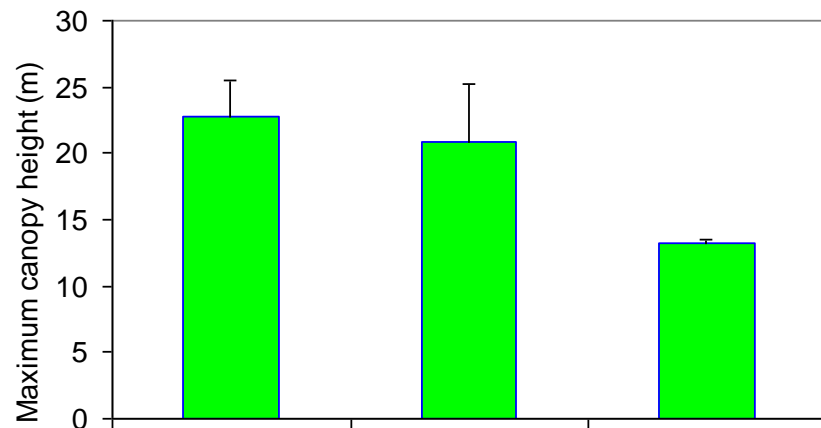


Class 3 (Reference)

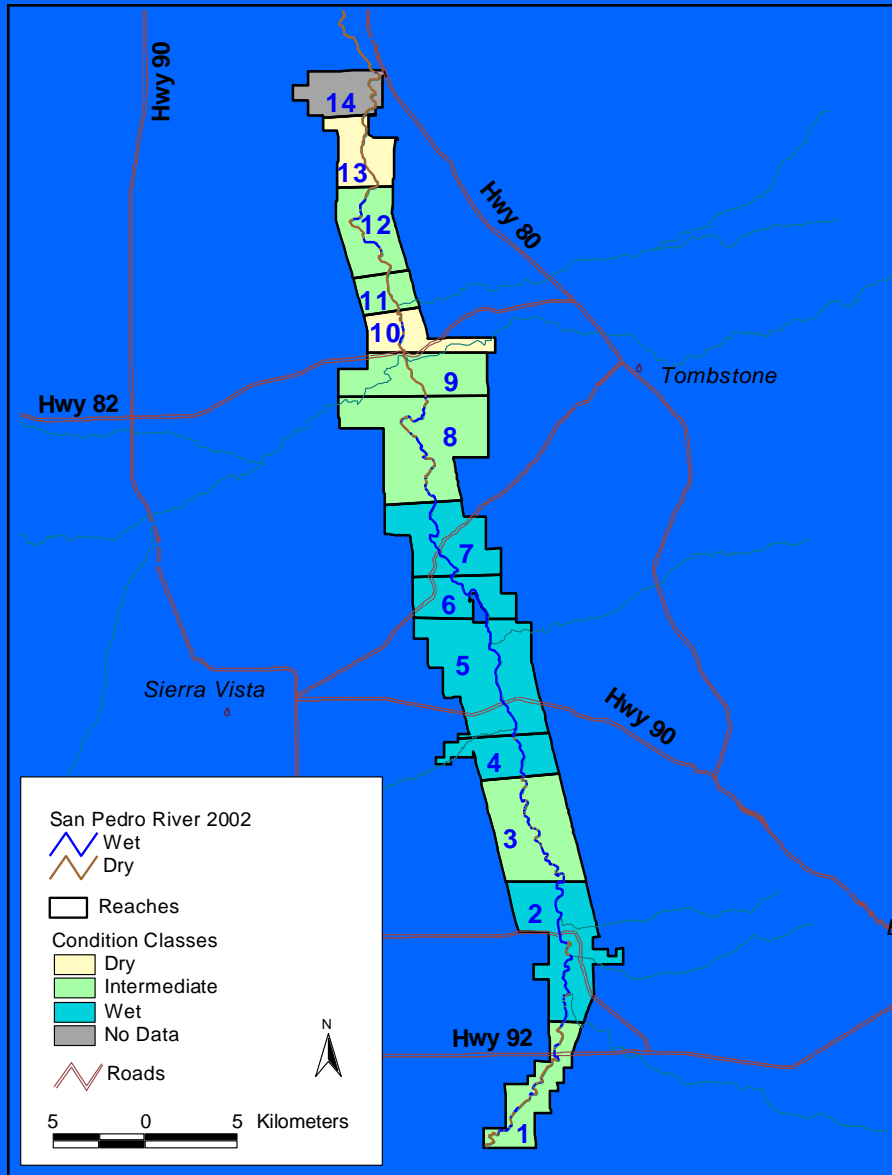
- Perennial or near-perennial stream flow (present >95% of time)
- Shallow ground-water (dry season depth averages <2.5m) with little seasonal fluctuation (<0.5 m/yr)
- Tall, dense, multi-aged cottonwood-willow forests.
- Salt cedar subdominant or absent.
- Channel lined by dense herbaceous cover.



Vegetation traits of SPRNCA sites classified by condition class



Distribution of condition classes within the San Pedro Riparian National Conservation Area, 2002



Management Applications

Track and predict changes resulting from ground-water and surface flow depletion or augmentation

Restoration planning and monitoring



Acknowledgments

A person wearing a white hat, a blue shirt, and light-colored pants stands on a gravelly bank next to a river. They are holding a clipboard and looking down at it. The background shows a river with some trees and a sandy bank.

Funding

- U.S. Environmental Protection Agency's Water and Watershed Research Program
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- ADWR, BLM, Upper San Pedro Partnership: San Pedro Water Needs Study
- Southwest Center for Environmental Research and Policy