EVALUATING THE INFLUENCE OF SURFACE WATER ON BIRD DIVERSITY AND ABUNDANCE IN SOUTHWESTERN RIPARIAN WOODLANDS

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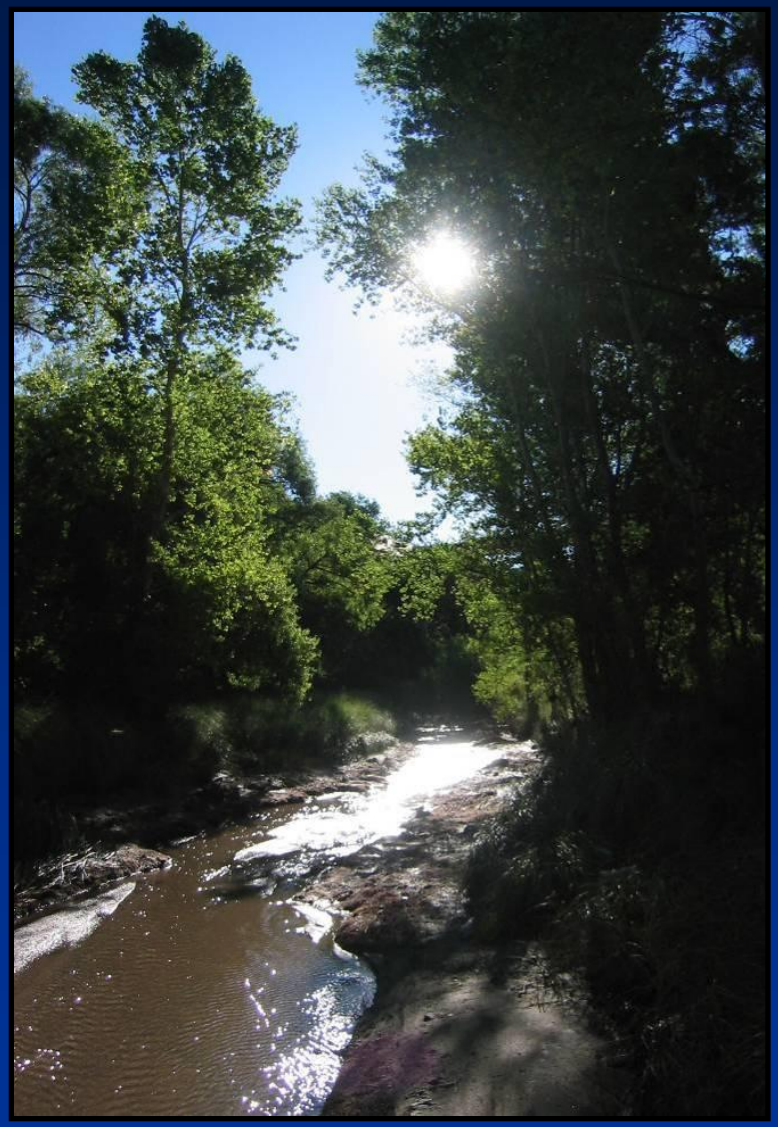
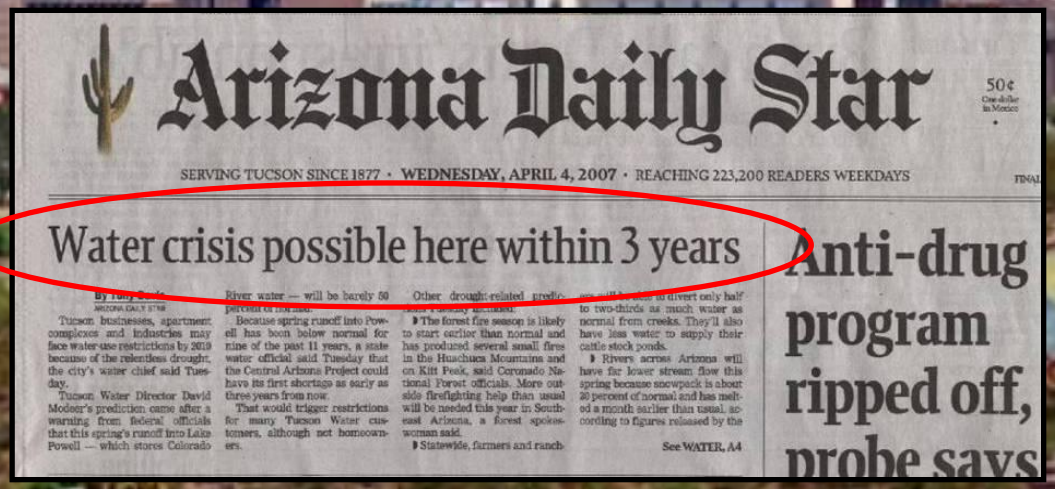


Arizona's Riparian Woodlands

- Cover <1% of the State's landmass
- Support >50% of breeding bird species, including birds of conservation concern
- Provide critical stopover habitat for numerous species of long-distance migratory birds

Increasing demand for limited water resources in Arizona

Population growth
Continued drought
Climate change



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FINAL

Water crisis possible here within 3 years

Anti-drug program ripped off, probe says

By Tony Davis
ARIZONA DAILY STAR

Tucson businesses, apartment complexes and industries may face water-use restrictions by 2019 because of the relentless drought, the city's water chief said Tuesday.

Tucson Water Director David Modeer's prediction came after a warning from federal officials that this spring's runoff into Lake Powell — which stores Colorado River water — will be barely 50 percent of normal.

Because spring runoff into Powell has been below normal for nine of the past 11 years, a state water official said Tuesday that the Central Arizona Project could have its first shortage as early as three years from now.

That would trigger restrictions for many Tucson Water customers, although not homeowners.

Other drought-related predic-

▶ The forest fire season is likely to start earlier than normal and has produced several small fires in the Huachuca Mountains and on Kitt Peak, said Coronado National Forest officials. More outside firefighting help than usual will be needed this year in Southeast Arizona, a forest spokeswoman said.

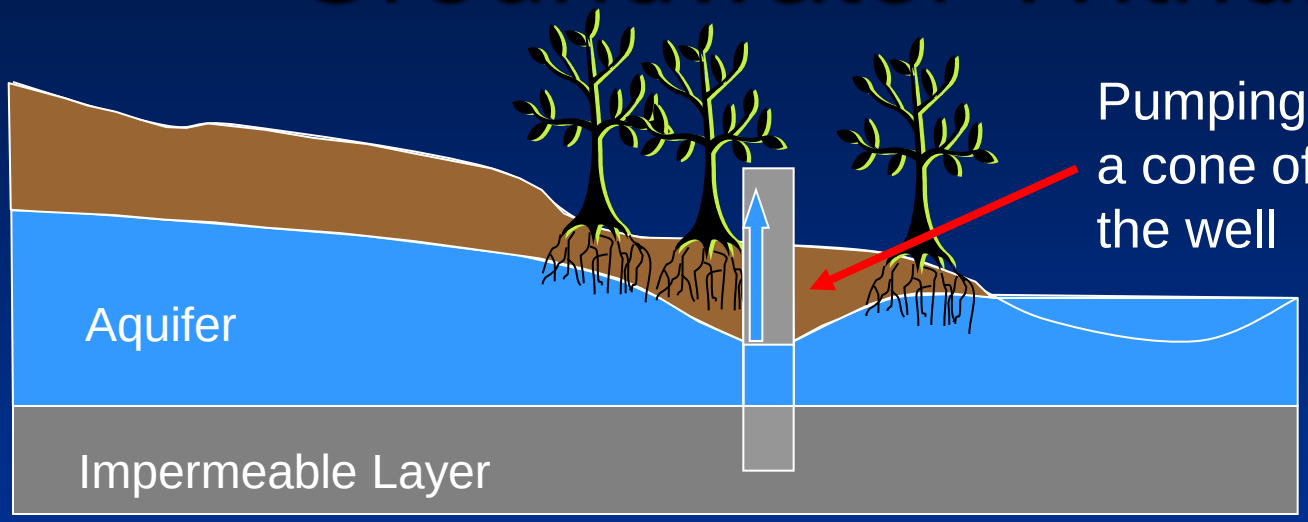
▶ Statewide, farmers and ranch-

to two-thirds as much water as normal from creeks. They'll also have less water to supply their cattle stock ponds.

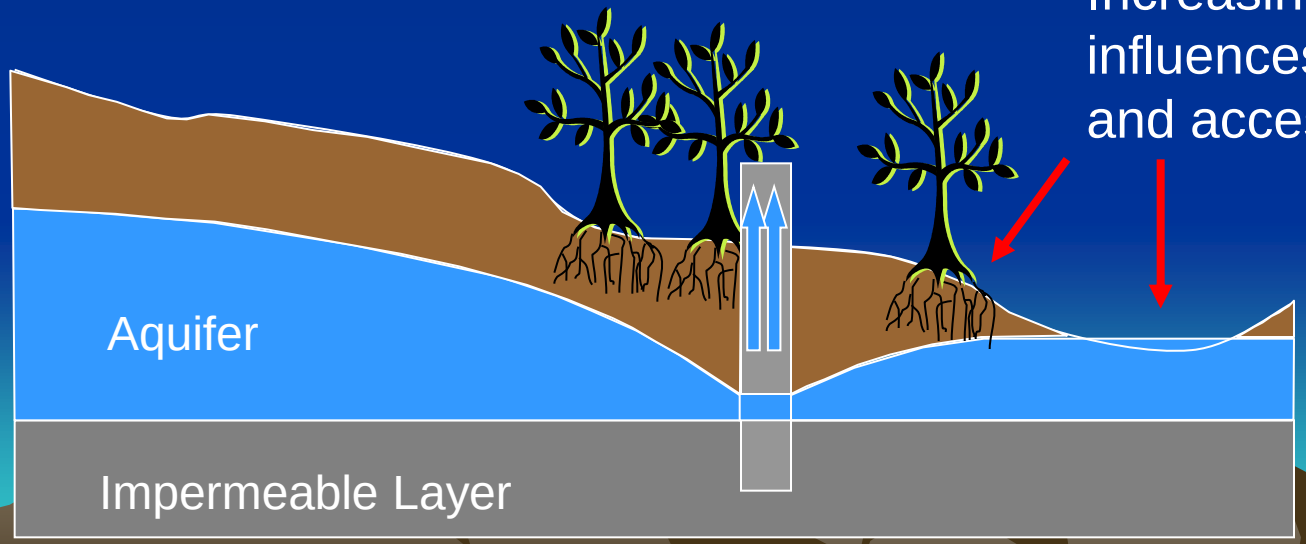
▶ Rivers across Arizona will have far lower stream flow this spring because snowpack is about 30 percent of normal and has melted a month earlier than usual, according to figures released by the

See WATER, A4

Groundwater Withdrawal



Pumping ground water creates a cone of depression around the well



Increasing cone of depression influences water level in stream and access to water by trees

"…losses in riparian vegetation are strongly associated with extensive groundwater use…" (Webb and Leake 2006)

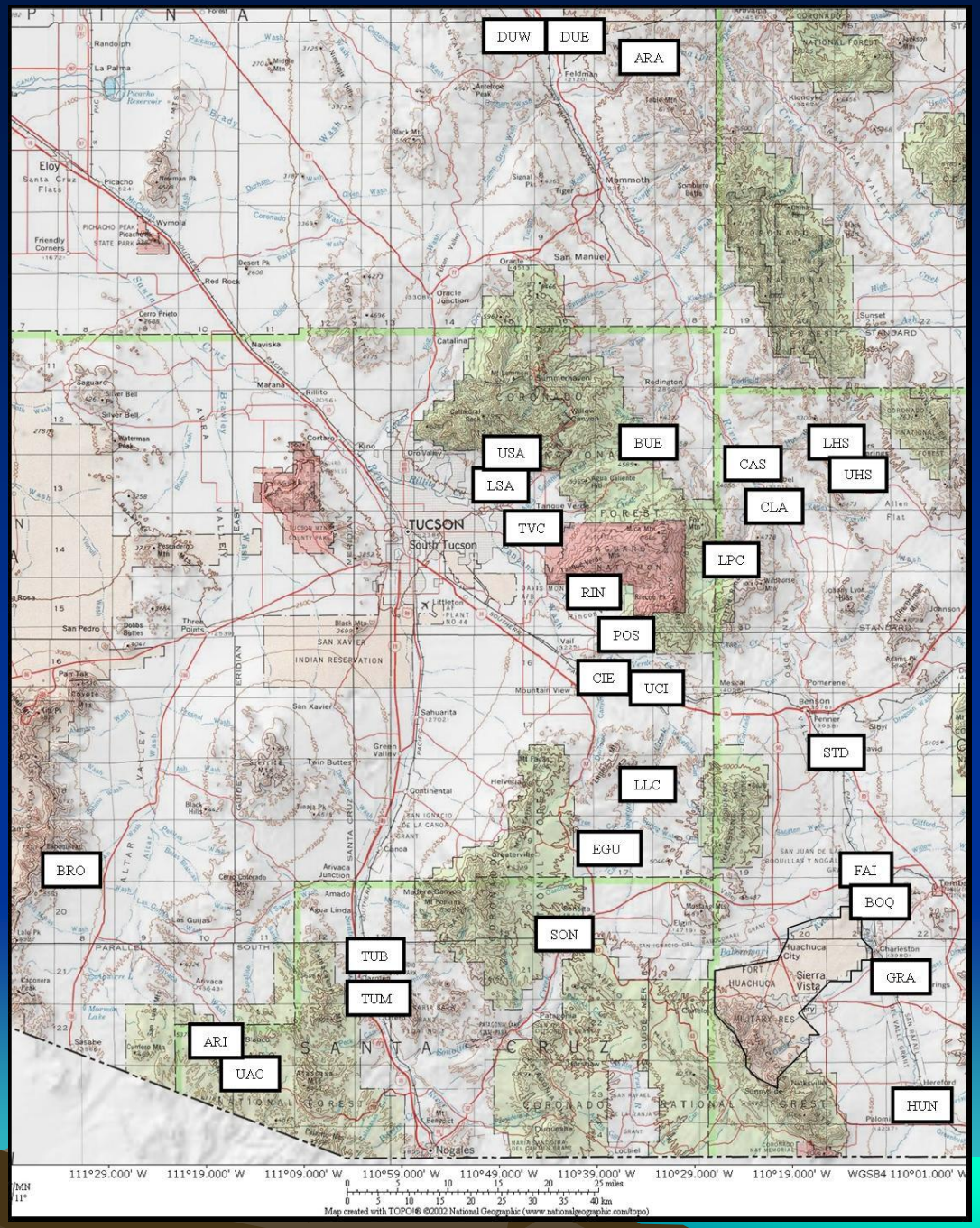
Study Objectives

- Understand the connection between surface water and the health of the riparian bird communities
- Examine what may influence these connections (i.e. what role do food resources play)
- Predict the effects of decreasing surface water on riparian bird communities

Map of Study Sites

- 6 Ephemeral Sites
- 14 Intermittent Sites
- 9 Perennial Sites

Using GIS, we selected sites to be similar in stream order, elevation, topography and vegetation type



Range of Conditions Among Sites

Perennial Surface Water

Healthy Vegetation

⇔

Intermittent Surface Water

Healthy Vegetation

⇔

No Surface Water

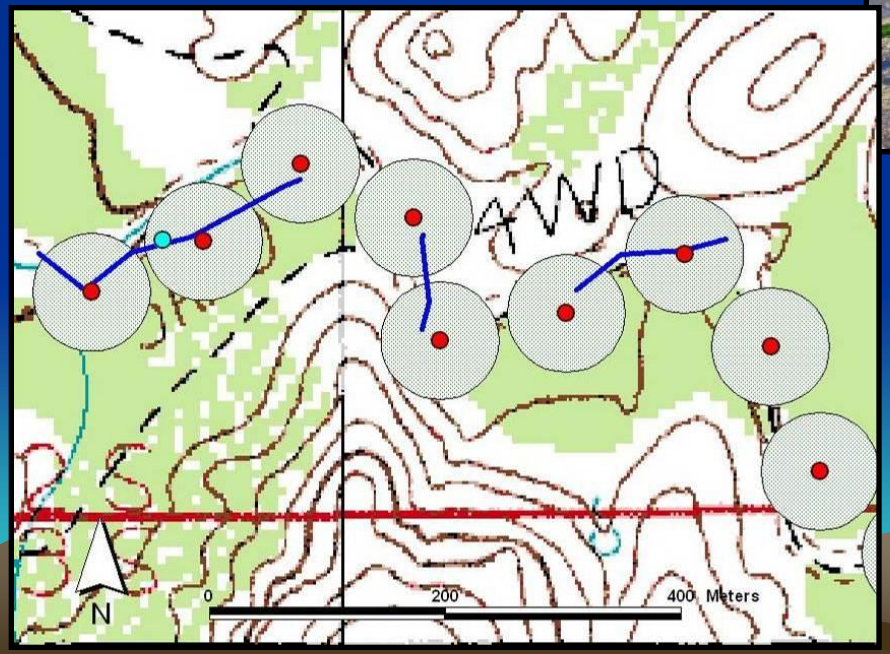
Stressed Vegetation

Bird Surveys

- Surveyed 28 sites throughout SE AZ over 3 years
- Conducted 4 replicate surveys per site during the breeding season

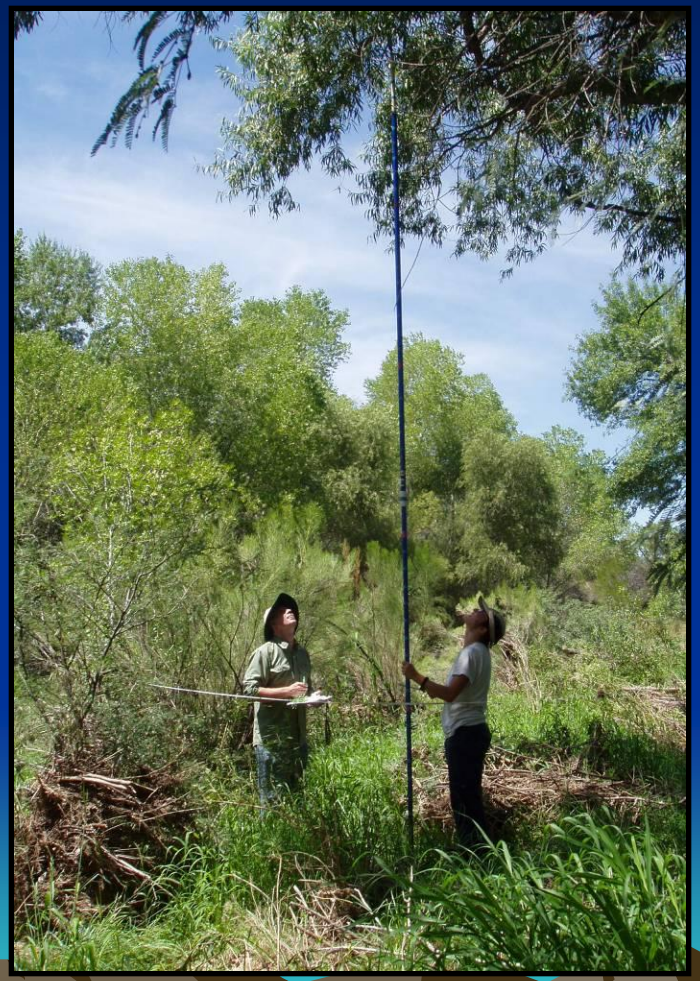
Water Measurements

We estimated the surface area of standing pools and flowing water within 50m of survey points after each survey.



2 Surface water variables:
1)Average Surface water
2)Number of visits with water

Vegetation Measurements



We estimateed the total volume of both live and dead vegetation by species into three height classes

Understory (0-2.5m)

Midstory (2.5-5m)

Overstory (5-20m)

Arthropod Sampling

- We sampled aerial arthropods at a subset of 11 wet and dry sites

Statistical Analysis

- We used Factor Analysis to reduce a large set of vegetation variables (*n*=44) to a relatively small set of uncorrelated Factors (*n*=11)
- We collected information on an additional 7 variables including lattitude, canopy height, width of riparian vegetation, etc.
- We employed an Information-Theoretic Approach to determine support for alternative *a priori* models describing associations of surface water, vegetation health, etc. with bird species richness and relative abundance

Statistical Analysis

- We used a linear mixed model in SPSS to account for non-independence between survey points (*n*=337) nested within our 28 study sites.

- We computed Akaike's Information Criterion (AICc) and ranked models based on ΔAICc values and Akaike weights (*Wi*)

Candidate Models for Community Level Parameters

- 32 candidate models total including a null
- Started with 10 models which did not include suface water
- Added a surface water component to make an additional 10 models
- Added interactions between water and vegeation to make another 11 models

Community Level Top Ranked Models

Top-ranked Models (n = total models) for Community Level Parameters	*K*	AIC_c	ΔAIC_c	W_i
Total Relative Abundance (*n* = 31)				
All Live Understory Veg, Number of Visits with Water, Interaction	6	1726.35	0.00	0.35
All Live Understory Veg	4	1726.57	0.22	0.31
Cottonwood Overstory & Other Live Overstory Veg, All Live Understory Veg	5	1729.28	2.92	0.08
Number of Visits with Water	4	1729.84	3.48	0.06
Cottonwood Overstory & Other Live Overstory Veg, Number of Visits with Water, Interaction	6	1730.12	3.77	0.05
Breeding Relative Abundance (*n* = 31)				
All Live Understory Veg, Number of Visits with Water, Interaction	6	1629.12	0.00	0.44
All Live Understory Veg	4	1629.76	0.64	0.32
Cottonwood Overstory & Other Live Overstory Veg, Number of Visits with Water, Interaction	6	1632.64	3.52	0.08
Cottonwood Overstory & Other Live Overstory Veg, All Live Understory Veg	5	1632.92	3.80	0.07
All Live Understory Veg, Number of Visits with Water, Average Surface Water	6	1634.90	5.78	0.02
Breeding Species Richness (*n* = 31)				
Cottonwood Overstory & Other Live Overstory Veg, All Live Understory Veg	5	1723.02	0.00	0.36
Cottonwood Overstory & Other Live Overstory Veg	4	1724.87	1.85	0.14
Cottonwood Overstory & Other Live Overstory Veg, All Live Understory Veg, All Dead Understory Veg, All Dead Overstory Veg	7	1724.94	1.92	0.14
All live Understory Veg	4	1725.00	1.98	0.13
Cottonwood Overstory & Other Live Overstory Veg, Number of Visits with Water, Interaction	6	1725.28	2.26	0.12

Candidate Models for Species Level Parameters

- Generated separate candidate models for each species
- Models were generated from existing literature and personal theory
- Added a surface water component to all models

Species Level Top Ranked Models

Top-ranked Models (n = total models) for Community Level Parameters	*K*	AIC_c	ΔAIC_c	W_i
Yellow Warbler (*n* = 22)				
Canopy Height, Width of Riparian Veg, Cottonwood Overstory & Other Live Overstory Veg	6	793.81	0.00	0.84
Canopy Height, Width of Riparian Veg, Cottonwood Overstory & Other Live Overstory Veg, Number of Visits with Water	7	797.21	3.40	0.15
Canopy Height, Width of Riparian Veg, Cottonwood Overstory & Other Live Overstory Veg, Average Surface Water	7	802.57	8.76	0.01
Concensus (All Variables)	13	822.12	28.31	0.00
Canopy Height, Goodding Willow	5	824.88	31.07	0.00
Yellow-breasted Chat (*n* = 31)				
Width of Riparian Veg	4	461.46	0.00	0.40
Width of Riparian Veg, Number of Visits with Water	5	462.28	0.81	0.27
Corridor or Oasis Site	4	463.47	2.01	0.15
Corridor or Oasis Site, Number of Visits with Water	5	464.24	2.78	0.10
Width of Riparian Veg, Average Surface Water	5	464.97	3.51	0.07
Song Sparrow (*n* = 25)				
Width of Riparian Veg, Number of Visits with Water	5	504.30	0.00	0.27
Width of Riparian Veg, Average Surface Water	5	504.71	0.41	0.22
All Live Understory Veg, Alll Dead Understory Veg, Tamarisk, Average Surface Water	7	505.71	1.41	0.13
Width of Riparian Veg, Seep Willow, Number of Visits with Water	6	505.95	1.65	0.12
Width of Riparian Veg, Seep Willow, Number of Visits with Water, Average Surface Water	6	506.01	1.71	0.12

Effects of Surface Water

- At the community level, surface water was positively associated with total bird relative abundance, breeding bird relative abundance, and breeding bird species richness

Surface Water

Top-ranked Models (n = total models) for Community Level Parameters	*K*	AIC_c	ΔAIC_c	W_i
Total Relative Abundance (*n* = 31)				
All Live Understory Veg, Number of Visits with Water, Interaction	6	1726.35	0.00	0.35
All Live Understory Veg	4	1726.57	0.22	0.31
Cottonwood Overstory & Other Live Overstory Veg, All Live Understory Veg	5	1729.28	2.92	0.08
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All Live Understory Veg, Number of Visits with Water, Average Surface Water	6	1634.90	5.78	0.02
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Cottonwood Overstory & Other Live Overstory Veg, All Live Understory Veg, All Dead Understory Veg, All Dead Overstory Veg	7	1724.94	1.92	0.14
All live Understory Veg	4	1725.00	1.98	0.13
Cottonwood Overstory & Other Live Overstory Veg, Number of Visits with Water, Interaction	6	1725.28	2.26	0.12

Effects of Surface Water

- At the species level, surface water was positively associated with relative abundance of Song Sparrow, Yellow Warbler, and Yellow-breasted Chat

Species Level Top Ranked Models

Top-ranked Models (n = total models) for Community Level Parameters	*K*	AIC_c	ΔAIC_c	W_i
Yellow Warbler (*n* = 22)				
Canopy Height, Width of Riparian Veg, Cottonwood Overstory & Other Live Overstory Veg	6	793.81	0.00	0.84
Canopy Height, Width of Riparian Veg, Cottonwood Overstory & Other Live Overstory Veg, Number of Visits with Water	7	797.21	3.40	0.15
Canopy Height, Width of Riparian Veg, Cottonwood Overstory & Other Live Overstory Veg, Average Surface Water	7	802.57	8.76	0.01
Concensus (All Variables)	13	822.12	28.31	0.00
Canopy Height, Goodding Willow	5	824.88	31.07	0.00
Yellow-breasted Chat (*n* = 31)				
Width of Riparian Veg	4	461.46	0.00	0.40
Width of Riparian Veg, Number of Visits with Water	5	462.28	0.81	0.27
Corridor or Oasis Site	4	463.47	2.01	0.15
Corridor or Oasis Site, Number of Visits with Water	5	464.24	2.78	0.10
Width of Riparian Veg, Average Surface Water	5	464.97	3.51	0.07
Song Sparrow (*n* = 25)				
Width of Riparian Veg, Number of Visits with Water	5	504.30	0.00	0.27
Width of Riparian Veg, Average Surface Water	5	504.71	0.41	0.22
All Live Understory Veg, Alll Dead Understory Veg, Tamarisk, Average Surface Water	7	505.71	1.41	0.13
Width of Riparian Veg, Seep Willow, Number of Visits with Water	6	505.95	1.65	0.12
Width of Riparian Veg, Seep Willow, Number of Visits with Water, Average Surface Water	6	506.01	1.71	0.12

Post Hoc Predictive Models

- We selected all variables from our top ranked models (Royal 1997)
- We ran all possible combinations of these variables
- We used model averaging to estimate the parameters and standard errors (accounting for model selection uncertainty)

Model Averaged Parameters

Parameter Estimates for Total Relative Abundance

Total Relative Abundance		
Parameter	*B*	SE
Intercept	17.48	0.95
Cottonwood Overstory & Other Live Overstory Veg	-.08	0.50
Live Understory Veg	0.38	0.58
Number of Visits with Water	0.26	0.16
Number of Visits with Water x Live Understory Veg	0.18	0.25

Model Averaged Parameters

Parameter Estimates for Breeding Species Relative Abundance

Breeding Species Relative Abundance		
Parameter	*B*	SE
Intercept	14.37	0.85
Cottonwood Overstory & Other Live Overstory Veg	0.09	0.50
Live Understory Veg	0.40	0.53
Number of Visits with Water	0.34	0.38
Number of Visits with Water x Live Understory Veg	0.18	0.25

Model Averaged Parameters

Parameter Estimates for Song Sparrow Abundance

Song Sparrow		
Parameter	*B*	SE
Intercept	0.50	0.31
Riparian Veg Width	0.30	0.36
Number of Visits with Water	0.04	0.11
Average Surface Water	0.03	0.07
Tamarisk	0.14	0.21
Live Understory Veg	0.07	0.19
Dead Understory Veg	0.14	0.19
Canopy Height	-0.02	0.10

Model Averaged Parameters

Parameter Estimates for Yellow Warbler Abundance

Yellow Warbler		
Parameter	*B*	SE
Intercept	1.92	0.40
Cottonwood Overstory & Other Live Overstory Veg	0.22	0.22
Riparian Veg Width	0.73	0.45
Number of Visits with Water	0.07	0.20

Model Averaged Parameters

Parameter Estimates for Yellow-breasted Chat Abundance

4) Yellow-breasted Chat		
Parameter	*B*	SE
Intercept	0.67	0.38
Corridor or Oasis Site	0.66	0.47
Riparian Veg Width	0.43	0.36
Number of Visits with Water	0.06	0.16
Average Surface Water	0.01	0.08

Conclusions

- In general duration of water through the breeding season (“Number of Visits with Water”) was more important than the total amount of surface water (“Average Surface Water”)
- Preserving the presence of surface water throughout the breeding season would likely benefit many species

Conclusions

Loss of surface water would likely lead to:

- Total Bird Abundance
- Breeding Bird Abundance
- Song Sparrow, Yellow Warbler and Yellow-breasted Chat Abundance
- Species Richness

Future Work

- Incorporate information from insect traps, plant moisture stress measurements, nest monitoring etc.
- Model the effect of surface water for other species
- Collect more targeted data on important variables to determine possible causal pathways

Field Assistants: Moez Ali, James Barr, Gavin Bieber, Kylan Frye, Zach Holderby, Patrick Rainbolt, Eli Rose, Nicholle Stephens, Sarah Taos, Caroline Pott, Scott Carey, Mary Ann Hollenbeck, Ann Johnson, Jake Mohlmann, Robert "Bob" Beatson, and Gabrielle Robinson.

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