# Drought and Time Modify Land-Use Effects on Bird Community Structure in an Urban Desert Ecosystem

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## Introduction:

CAP LTER teams have collected data on land-use and bird sightings on 45 sites across the Greater Phoenix Area over the last 15 years. Land-use effects and drought influence bird abundance and community species richness variation over time across these sites was investigated.

### Methods:

- Point count surveys conducted each quarter of each year (January, April, July and October) since 2000
- Land uses categorized into different habitats: *Agriculture, Desert,* and *Urban* sites separated by 3 landscaping types: *Mesic; Xeric,* and *Mesic/Xeric mix.*

# Analysis Methods:

- Bird dataset included data from Quarter
  1 (2001) through Quarter 2 (2014), 28
  quarterly samples from 45 sites, with
  some missing samples throughout
- General Linear Mixed Models used to investigate: 1) how land-use effects influenced bird abundance and richness over time, and 2) how present and previous drought conditions (as measured using Palmer's Drought Severity Index, PDSI) and time influence land use effect sizes, and bird abundance and richness in each land use type

## Results:

- 1. Results showed a significant land-use by time interaction on both species richness and abundance, indicating that land-use effects were not consistent over time (Figure 1).
- 2. GLMMs showed significant main effects of land-use and survey, and a significant land-use X survey interaction, for both bird abundance and richness (all effects p < 0.005).

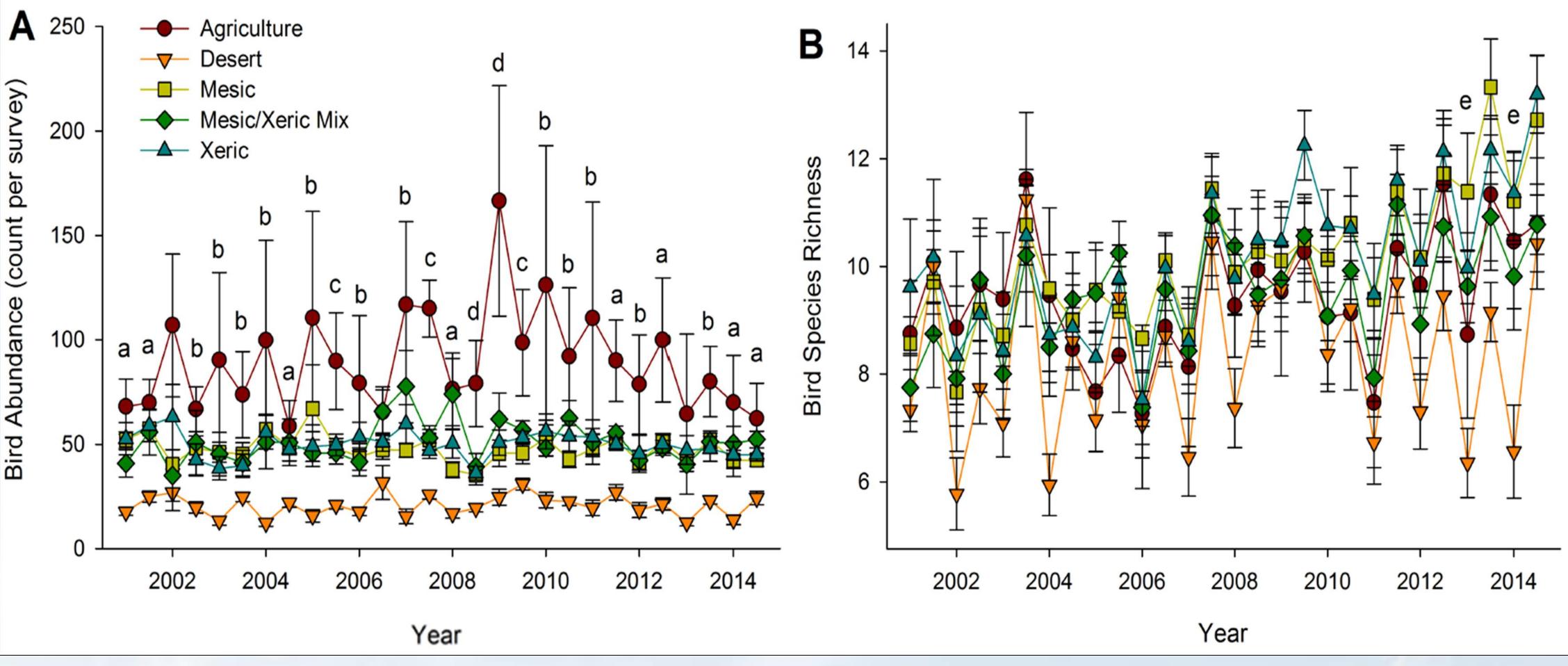


Figure 1. Bird abundance (A) and species richness (B) for each land-use type over time (total number collected per sampling event). In A and B, letters denote results of a priori planned contrasts: a, years with significant agriculture-desert and desert-urban contrasts; b, years with significant agriculture-desert contrast only; c, years with significant agriculture-desert, agriculture-urban, and desert-urban contrasts; d, years with significant agriculture-desert and agriculture-urban contrasts; and e, year with significant desert-urban contrast only ("urban" = equally weighted mesic, mesic/xeric mixed, and xeric land uses).

Variables in Model	Δi	wi	$R^2$
Bird Abundance			
PDSI 4 Qs prior (-0.047)	0.00	0.13	0.15
PDSI prior Q (-0.025), PDSI 4 Qs prior (-0.047)	0.64	0.09	0.17
PDSI current Q (-0.039), PDSI prior Q (0.062), PDSI 4 Qs prior (-0.060)	0.78	0.09	0.21
PDSI 2 Qs prior (-0.018), PDSI 4 Qs prior (-0.057)	1.65	0.06	0.15
Bird Species Richness			
PDSI current Q (0.025), PDSI prior Q (-0.030), Time (0.017)	0.00	0.13	0.33
Time (0.016)	0.11	0.12	0.25
PDSI current Q (0.033), PDSI prior Q (-0.037), PDSI 4 Qs prior (0.010),	0.76	0.09	0.35
Time (0.018)			
PDSI current Q (0.035), PDSI prior Q (-0.040), PDSI 3 Qs prior (0.011),	0.77	0.09	0.35
Time (0.018)			
PDSI current Q (0.007), Time (0.017)	1.49	0.06	0.26
PDSI 2 Qs prior (-0.009), Time (0.016)	1.54	0.06	0.26
PDSI prior Q (-0.007), Time (0.015)	1.69	0.06	0.25

Table 2. Best performing GLMMs (wi > 0.05) predicting mean bird abundance for each survey within land-use types.

Variables in Model	Δi	yri.	<b>R</b> ²
Agriculture			
PDSI 4 Qs prior (-0.010)	0.00	0.07	0.01
Time (0.004)	0.09	0.07	0.00
PDSI current Q (0.006)	0.15	0.07	0.00
PDSI prior Q (-0.005)	0.19	0.07	0.00
PDSI 2 Qs prior (-0.001)	0.23	0.06	0.00
PDSI 3 Qs prior (0.001)	0.23	0.06	0.00
Desert			
PDSI 3 Qs prior (0.044)	0.00	0.15	0.10
PDSI prior Q (-0.010), PDSI 3 Qs prior (0.044)	1.75	0.06	0.10
PDSI current Q (0.005), PDSI 3 Qs prior (0.044)	1.91	0.06	0.10
PDSI 2 Qs prior (0.004), PDSI 3 Qs prior (0.041)	1.97	0.06	0.10
PDSI 3 Qs prior (0.044), Time (0.001)	1.98	0.06	0.09
PDSI current Q (0.035), PDSI prior Q (-0.044), PDSI 3 Qs prior (0.058)	2.16	0.05	0.11
PDSI 4 Qs prior (0.036)	2.24	0.05	0.07
Mesic			
PDSI current Q (0.022)	0.00	0.12	0.14
PDSI current Q (0.022), Time (-0.006)	0.85	0.08	0.16
PDSI current Q (0.025), PDSI 3 Qs prior (0.008)	1.47	0.06	0.15
PDSI current Q (0.023), PDSI 2 Qs prior (0.007)	1.70	0.05	0.14
PDSI current Q (0.029), PDSI prior Q (-0.011)	1.71	0.05	0.14
Xeric/Mesic Mix			
Time (0.008)	0.00	0.08	0.03
PDSI prior Q (-0.016)	+	0.07	:
PDSI current Q (-0.009)	0.55	0.06	0.01
PDSI 3 Qs prior (-0.003)	0.80	0.05	0.00
PDSI 2 Qs prior (0.003)	0.82	0.05	0.00
PDSI 4 Qs prior (0.000)	0.84	0.05	0.00
Xeric			
PDSI 2 Qs prior (0.034)	0.00	0.13	0.19
PDSI current Q (0.009), PDSI 2 Qs prior (0.034)		0.08	
PDSI current Q (0.017), PDSI 3 Qs prior (0.027)		0.06	
PDSI 2 Qs prior (0.034), Time (-0.002)		0.05	
PDSI prior Q (0.004), PDSI 2 Qs prior (0.032)		0.05	:
PDSI 2 Qs prior (0.036), PDSI 2 Qs prior (-0.003)	1.97	0.05	0.19

Table 1. Best performing GLMMs (wi > 0.05) predicting land-use effect size (Cohen's d) on bird and ground-dwelling arthropod abundance and richness for each survey.

Table 3. Best performing GLMMs (wi > 0.05) predicting mean bird species richness for each survey within land-use types.

Variables in Model	Δi	Wi	<b>R</b> ²
Agriculture			
PDSI current Q (-0.252), PDSI 3 Qs prior (-0.276)	0.00	0.24	0.28
PDSI current Q (-0.248), PDSI 4 Qs prior (-0.271)	0.07	0.23	0.28
PDSI current Q (-0.253), PDSI prior Q (0.006), PDSI 4 Qs prior (-0.273)	1.64	0.11	0.28
PDSI current Q (-0.313), PDSI prior Q (0.090), PDSI 3 Qs prior (-0.302)	1.70	0.10	0.29
Desert			
PDSI current Q (0.129), PDSI prior Q (-0.100)	0.00	0.11	0.0
PDSI current Q (0.147), PDSI prior Q (-0.091), Time (0.050)	1.43	0.05	0.02
PDSI 2 Qs prior (-0.021)	1.48	0.05	0.00
Mesic			
PDSI 4 Qs prior (-0.129), Time (0.224)	0.00	0.18	0.50
PDSI prior Q (-0.067), PDSI 4 Qs prior (-0.131), Time (0.217)	0.92	0.11	0.50
PDSI 3 Qs prior (-0.118), Time (0.229)	1.24	0.10	0.49
PDSI current Q (-0.044), PDSI 4 Qs prior (-0.144), Time (0.217)	!	0.09	
PDSI prior Q (-0.119), PDSI 2 Qs prior (0.109), PDSI 4 Qs prior (-0.188),		0.07	
Time (0.212)			
PDSI 2 Qs prior (0.007), PDSI 4 Qs prior (-0.133), Time (0.224)	1.99	0.07	0.50
Xeric/Mesic Mix			
PDSI 3 Qs prior (-0.119), Time (0.119)	0.00	0.13	0.20
PDSI 2 Qs prior (-0.137), Time (0.118)	0.48	0.10	0.19
PDSI current Q (0.170), PDSI prior Q (-0.224), Time (0.126)	0.88	0.08	0.19
PDSI prior Q (-0.062), PDSI 3 Qs prior (-0.110), Time (0.113)	1.14	0.07	0.20
PDSI 4 Qs prior (-0.089), Time (0.117)	1.58	0.06	0.18
PDSI 2 Qs prior (-0.063), PDSI 3 Qs prior (-0.074), Time (0.118)	1.66	0.06	0.20
PDSI current Q (0.113), PDSI prior Q (-0.167), PDSI 3 Qs prior (-0.066),	1.74	0.05	0.20
Time (0.121)			
Xeric			
PDSI 4 Qs prior (-0.139), Time (0.209)	0.00	0.21	0.3
PDSI 3 Qs prior (-0.119), Time (0.214)	1.52	0.10	0.30
PDSI current Q (-0.034), PDSI 3 Qs prior (-0.150), Time (0.203)	1.72	0.09	0.37
PDSI 2 Qs prior (0.049), PDSI 4 Qs prior (-0.164), Time (0.209)	1.77	0.09	0.37
PDSI prior Q (-0.020), PDSI 4 Qs prior (-0.139), Time (0.207)	1.93	0.08	0.30

## Results (cont'd):

- 3. The magnitude of land use effect sizes on bird abundance were predicted to the occurrence of droughts (as measured by PDSI), with effect sizes being largest during dry periods one year prior to and during the survey (Table 1).
- 4. Land use effect sizes on bird species richness were also influenced by droughts, with larger effects during dry periods one year prior to and wet periods during the survey
- 5. However land use effect sizes on bird species richness also increased over time. In fact, a priori planned contrasts indicated that significant differences between land uses were not observed until 2013 and 2014.

### Conclusions:

- 1. Variation effects of land use on bird abundance and species richness were related to timelag and current effects of drought (Tables 2-3), and land effect use effect size on species richness also is growing over time.
- 2. Future work on this project will investigate the long-term effects of land use on beta diversity patterns, community structure, and functional trait diversity of bird communities.





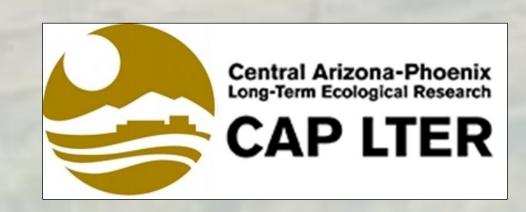


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