Drought modifies land-use effects on arthropod communities in an urban desert ecosystem

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Introduction:

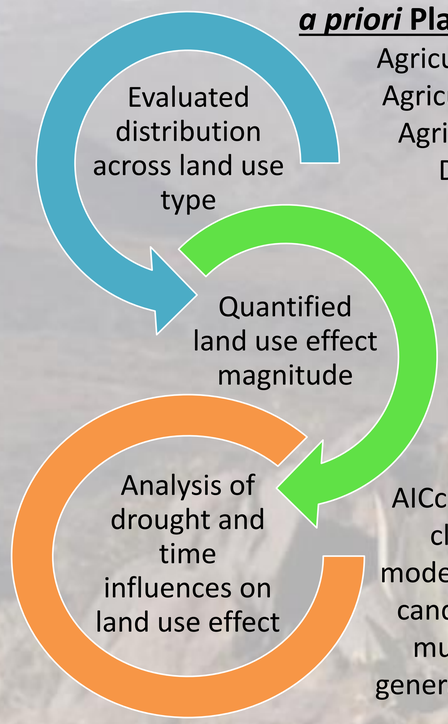
CAP LTER has conducted a long term survey of ground-dwelling arthropod communities inhabiting different types of land-use areas throughout the greater Phoenix metropolitan area. We investigated temporal and drought influences on arthropod pitfall traps surveyed from 2002-2014 across desert, agriculture, mesic urban, mesic/xeric mixed urban, and xeric urban areas.

Methods:

Ground-dwelling arthropods were collected using 10 dry pitfall traps at each of the 47 sites. Trap were spaced 5 m apart along a line transect. Organisms are identified to the lowest taxonomic resolution possible.

Analysis Methods:

Effects of land use and time Abundance and species richness were explored using General Linear Mixed Models (GLMMs). Land use effect magnitudes (Cohen's d) were calculated using the results of a priori contrasts .



***a priori* Planed Contrasts**

Agriculture vs. Desert
Agriculture vs. Mixed
Agriculture vs. Xeric
Desert vs. Mixed
Desert vs. Xeric
Mixed vs. Xeric

AICc model selection classified the best models out of a set of candidate single and multiple regression general linear models.

Results:

GLMMs showed significant main effects of land-use and survey, and a significant land-use X survey interaction, for abundance and richness (all effects $p < 0.005$).

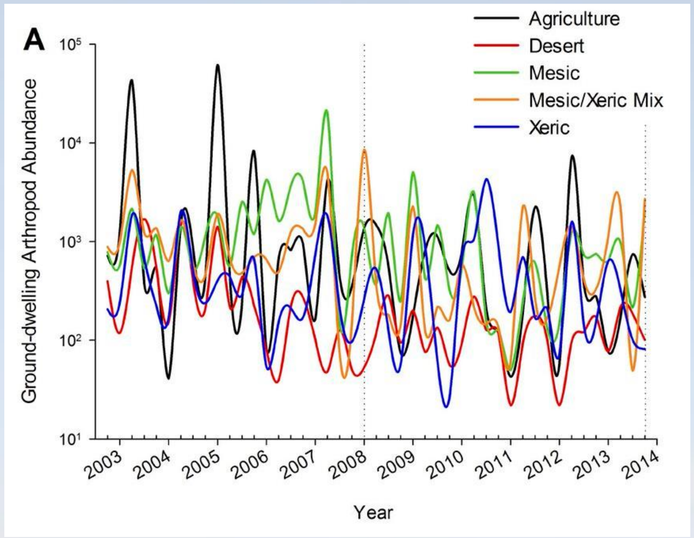


Figure 1A. Ground-dwelling arthropod abundance for each land-use type over time. Dashed lines denote significant of a priori planned contrast between land use types.

- Abundance in Agriculture and Desert land use types were significantly less than mesic and xeric/mesic mixed n quarter 1 of 2008.
- Abundance in residential land-use types with turf grass was significantly greater than those with xeric landscaping in quarter 4 of 2013.

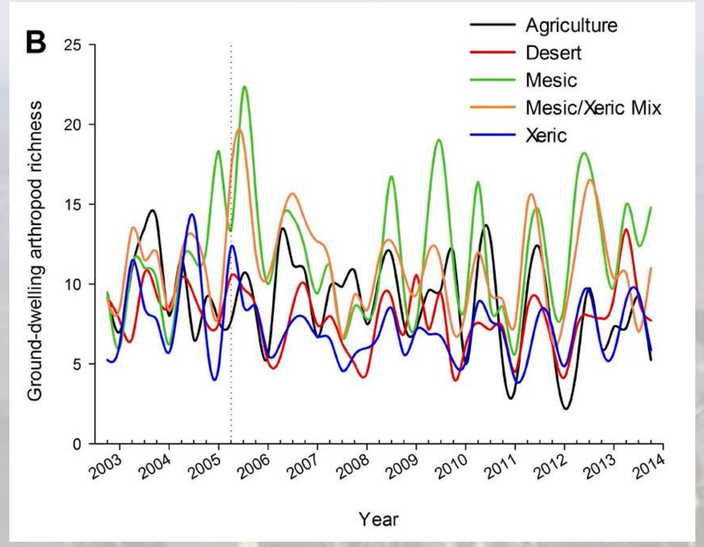


Figure 1B. Ground-dwelling arthropod species richness for each land-use type over.

- Richness in the agriculture land-use was lower than mesic and mesic/xeric mixed in quarter 2 of 2005.

Table 1. Best performing GLMMs predicting land-use effect size on ground-dwelling arthropod abundance and richness for each survey, Cohen's d. Δ_i, difference from the lowest AICc value from the set of candidate models; w_i, Akaike weight , PDSI, Palmer Drought Severity Index; Q, quarter. Marginal R^2 (proportion of variance explained by fixed-effects only) for each model and β estimates (in parentheses) for the independent variable(s) are given.

Arthropod Abundance			
Land Use Effect Size (Cohen's d) on Abundance	Δ_i	w_i	R^2
PDSI current Q (0.112), PDSI prior Q (-0.108)	0.00	0.09	0.07
PDSI 3 Q prior (-0.036)	1.16	0.05	0.02
Agriculture Land Use			
PDSI current Q (0.487), PDSI prior Q (-0.471), Time (-0.139)	0.00	0.25	0.23
PDSI current Q (0.556), PDSI prior Q (-0.556), PDSI 3 Qs prior (0.092), Time (-0.137)	1.43	0.12	0.24
PDSI current Q (0.513), PDSI prior Q (-0.488), PDSI 4 Qs prior (0.049), Time (-0.137)	1.77	0.10	0.23
PDSI current Q (0.306), PDSI 2 Qs prior (-0.489), PDSI 3 Qs prior (0.267), Time (-0.134)	3.08	0.05	0.22
PDSI current Q (0.517), PDSI prior Q (-0.457)	3.15	0.05	0.16
Desert Land Use			
PDSI current Q (0.159), PDSI 3 Qs prior (-0.107), Time (-0.143)	0.00	0.16	0.41
PDSI current Q (0.200), PDSI 2 Qs prior (-0.108), Time (-0.142)	0.52	0.13	0.40
PDSI current Q (0.144), PDSI 4 Qs prior (-0.091), Time (-0.144)	1.35	0.08	0.39
PDSI current Q (0.178), PDSI 2 Qs prior (-0.082), PDSI 4 Qs prior (-0.054), Time (-0.144)	1.69	0.07	0.40
PDSI current Q (0.175), PDSI 2 Qs prior (-0.042), PDSI 3 Qs prior (-0.073), Time (-0.143)	1.85	0.06	0.40
PDSI current Q (0.190), PDSI prior Q (-0.039), PDSI 3 Qs prior (-0.092), Time (-0.143)	1.88	0.06	0.40
PDSI current Q (0.156), PDSI 3 Qs prior (-0.098), PDSI 4 Qs prior (-0.012), Time (-0.143)	1.98	0.06	0.40
PDSI current Q (0.259), PDSI Prior Q (-0.125), Time (-0.141)	2.02	0.06	0.38
PDSI current Q (0.218), PDSI prior Q (-0.097), PDSI 4 Qs prior (-0.076), Time (-0.145)	2.10	0.06	0.40
PDSI current Q (0.164), Time (-0.139)	2.11	0.06	0.36
Mesic Land Use			
Time (-0.106)	0.00	0.12	0.08
PDSI 4 Qs prior (0.091), Time (-0.103)	0.82	0.08	0.10
PDSI current Q (0.080), PDSI prior Q (-0.078),Time (-0.105)	1.71	0.05	0.12
Xeric/Mesic Mix Land Use			
Time (-0.105)	0.00	0.10	0.07
PDSI 3 Qs prior (-0.104), Time (-0.109)	0.37	0.08	0.10
PDSI 2 Qs prior (-0.099), Time (-0.111)	0.51	0.08	0.10
PDSI prior Q (-0.086), Time (-0.113)	0.95	0.06	0.09
Xeric Land Use			
PDSI 2 Qs prior (0.294), PDSI 3 Qs prior (-0.340)	0.00	0.12	0.14
PDSI 2 Qs prior (0.294), PDSI 3 Qs prior (-0.340), Time (-0.038)	1.14	0.07	0.14
PDSI 4 Qs prior (-0.173)	1.60	0.06	0.09
PDSI 2 Qs prior (0.103), PDSI 3 Qs prior (-0.209)	1.69	0.05	0.11
Arthropod Taxonomic Richness			
Land Use Effect Size (Cohen's d) on Richness	Δ_i	w_i	R^2
PDSI prior Q (0.013)	0.00	0.08	0.04
Time (-0.007)	0.45	0.06	0.03
Agriculture Land Use			
Time (-0.328)	0.00	0.14	0.13
PDSI 3 Qs prior (-0.405), PDSI 4 Qs prior (0.374), Time (-0.331)	0.84	0.09	0.16
PDSI prior Q (-0.342), Time (-0.146)	1.16	0.08	0.14
PDSI 3 Qs prior (-0.117), Time (-0.332)	1.40	0.07	0.14
PDSI 2 Qs prior (-0.117), Time (-0.335)	1.42	0.07	0.14
PDSI current Q (-0.067), Time (-0.335)	1.82	0.06	0.13
PDSI 4 Qs prior (0.061), Time (-0.327)	1.84	0.06	0.13
Desert Land Use			
PDSI prior Q (0.328), PDSI 3 Qs prior (-0.277)	0.00	0.09	0.12
PDSI 2 Qs prior (0.030), Time (-0.082)	1.10	0.05	0.10
Mesic Land Use			
PDSI current Q (1.312), PDSI 4 Qs prior (0.421), Time (0.221)	0.00	0.10	0.20
PDSI current Q (0.915), PDSI prior Q (-0.634) PDSI 3 Qs prior (0.593), Time (0.210)	0.53	0.08	0.21
PDSI current Q (0.841), PDSI 4 Qs prior (0.387)	0.83	0.07	0.17
PDSI current Q (0.820), PDSI 3 Qs prior (0.353), Time (0.210)	0.96	0.06	0.19
PDSI current Q (1.253), PDSI prior Q (-0.636), PDSI 3 Qs prior (0.571)	1.26	0.06	0.18
PDSI current Q (1.121), PDSI prior Q (-0.256), PDSI 4 Qs prior (0.461), Time (0.220)	1.45	0.05	0.20
Mesic/Xeric Mix Land Use			
PDSI current Q (0.706), PDSI 3 Qs prior (-0.584), PDSI 4 Qs prior (0.691)	0.00	0.11	0.16
PDSI prior Q (0.472)	0.80	0.07	0.10
PDSI prior Q (0.479), PDSI 4 Qs prior (0.235)	1.05	0.06	0.12
PDSI current Q (0.677), PDSI 3 Qs prior (-0.562), PDSI 4 Qs prior (0.667), Time (-0.080)	1.43	0.05	0.17
Xeric Land Use			
PDSI prior Q (0.306), PDSI 3 Qs prior (-0.244), Time (0.130)	0.00	0.08	0.13
PDSI 2 Qs prior (0.425), PDSI 3 Qs prior (-0.465), Time (0.140)	0.45	0.07	0.12
PDSI prior Q (0.341), PDSI 3 Qs prior (-0.245)	0.94	0.05	0.09

Conclusion:

Drought had strong effects on arthropod abundance in desert land uses, but weaker effects on abundance in agriculture and urban land uses. Arthropod richness variation was explained and positively influenced in mesic models in which current and prior PDSI values were present. PDSI and temporal influences did not fully explain the significant variations in land use effect magnitude. This suggests some other factor may also be responsible. Future work on this project will be to investigate the long-term effects of land use on beta diversity patterns and community structure of arthropod communities.