Residential Irrigation as a Driver of Urban Bird Communities

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Fresno Bird Count

How does residential irrigation influence urban bird communities?

Water availability is one of the most important variables determining habitat quality for birds, particularly in arid regions such as the San Joaquin Valley of California. Human decisions about mode and intensity of irrigation have a direct effect on soil composition, vegetation type, and the primary productivity of an area. In arid regions, the dramatic increase in vegetation due to irrigation could increase (*or decrease*) bird species diversity by increasing the amount of cover, nesting areas, and food supply for birds.

Urban-suburban areas provide a variety of complex landscapes that often substitute for specific habitats occurring in nearby or distant natural settings. Urban dwellers make decisions about the design / maintenance of landscapes that also affect wildlife populations. In turn, the decisions citizens make are driven by socioeconomic and cultural variables. Recent studies in nearby Arizona, for instance, have found strong positive correlations between neighborhood socioeconomic status and plant and bird diversity. The underlying causal pathway remains unclear, but is likely to involve human landscaping and water management decisions. Here we present preliminary results from the ***Fresno Bird Count*** *(a citizen science project; see box on right for details)* analyzing the relationships between neighborhood poverty, residential irrigation regime, plant cover, and bird diversity.

Why is this important to Fresno and other western American cities?

Both globally and locally the demand for fresh water has largely outpaced supplies. Therefore, government policies governing the distribution and cost of water are changing with water becoming increasingly expensive. The city of Fresno is implementing a new policy of metered water in single family homes.

- Currently, 51% of Fresno water is used residentially
- 70% of residential water is used for irrigation
- Starting in 2013, flat rate water is replaced by metered water
- As water becomes more expensive, residents are expected to reduce consumption
- Residential irrigation is therefore predicted to decrease
- Decreased irrigation is in turn predicted to lower/alter bird diversity
- The effects may be more extreme in impoverished urban areas

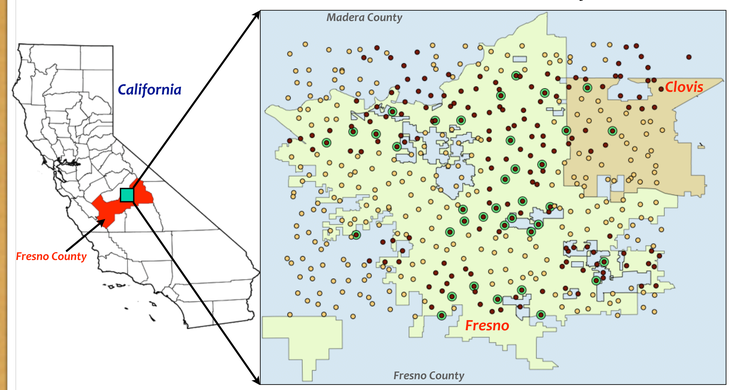
Hypotheses

- Neighborhood poverty is correlated with irrigation intensity.
- Irrigation intensity is correlated with plant cover variables.
- Poverty level and irrigation intensity are both correlated with bird species richness, acting through other habitat variables.

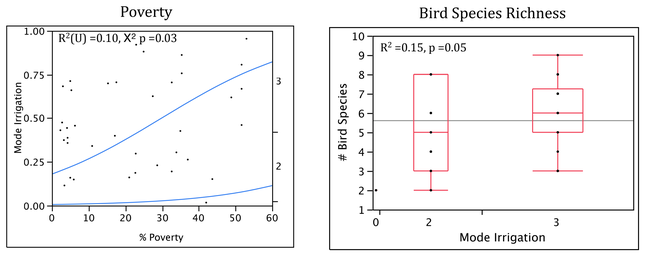
Methods

- Under the ***Fresno Bird Count (FBC)***, birds are censused by volunteers once a year between April 15 - May 15 in fixed radius (40m), 5-min point counts.
- The sampling grid consists of 460 random points, one in each Km^2, throughout the Fresno-Clovis metropolitan area.
- 186 of these sites were censused in spring 2008.
- A further subset (38) of these 186 points, located in residential areas only, were assessed for socioeconomic and habitat variables (see list).
- Socioeconomic data are from US Census; habitat measurements are based on 20m-radius plots centered on bird count sites.
- Relationships between number of bird species and habitat and socioeconomic variables were examined by using ANOVA, linear and logistic regression. All analyses conducted in JMP (*v. 8.0.1, Mac OS X*)
- Multivariate analyses are under way, with some interesting preliminary results reported here.

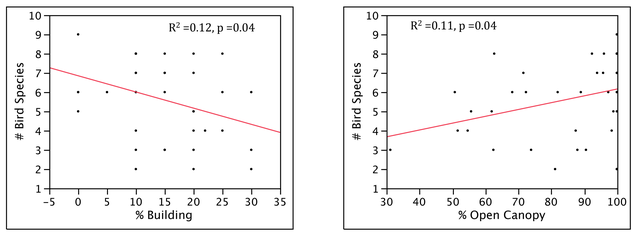
Fresno Bird Count Study Area



Irrigation is correlated with...



Bird Species Richness is also correlated with...

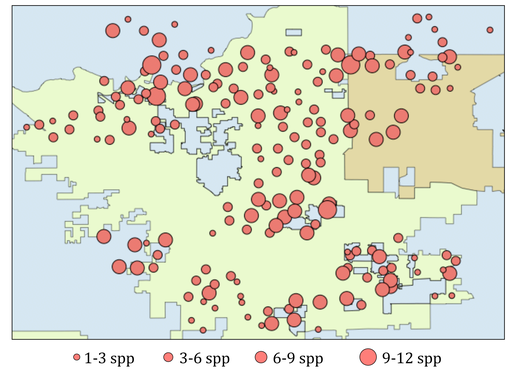


List of Habitat and Socioeconomic Variables

- Location (latitude/longitude)
- Percent of Open Canopy Cover (from densiometer)
- Ground cover: % grass, impervious substrate, dirt/mulch, buildings, and gravel (estimated visually)
- Number of Trees
- Average Tree Height (measured using a clinometer)
- Number of Shrubs
- Average Shrub Height (estimated visually)
- Grass Height (estimated visually)
- Irrigation intensity score (on a 4 point scale 0-3) recorded for each residence overlapping plot; the Mode of this score is used in analyses presented here
- Percent population in surrounding census block group living below poverty level (<$18,310/yr for a family of three)*

**Department of Health and Human Services 2008 - 2009*

Distribution of Bird Species Richness (2008)



Multivariate Drivers of Bird Diversity

- Stepwise regression: 9 variables, 8 interaction terms, mixed procedure
- Best fit model as shown in table below
- Whole model R^2=0.64 (adj. R^2=0.53), $F_{(8,24)}$=5.43, P=0.0006

Source	+/-	F-ratio	Prob >F
Mean Grass Height*Mode Irrigation	+	**10.7069**	**0.0032***
% Building	-	**7.9252**	**0.0096***
Mean Grass Height (cm)	-	**4.8076**	**0.0383***
% Poverty*Mode Irrigation	+	**4.3290**	**0.0483***
% Poverty*% Building	+	2.5477	0.1235
Mean Shrub Height (m)	-	2.1562	0.1550
Mode Irrigation	+	0.8627	0.3622
% Poverty	-	0.0478	0.8289

- *Model comparison based inference supported the above results; the lowest AICc = 119.665 for comparison of 56 8-paramater models*

Conclusions

- Urban bird diversity increased significantly with irrigation intensity.
- Bird diversity decreased significantly with %building (as ground cover), and increased with %open canopy.
- Residential irrigation intensity decreased significantly with increasing poverty levels.
- Neighborhood poverty level (i.e., economic status) has strong effects on irrigation intensity even without water metering.
- Poverty also has strong indirect effects on bird species richness through intermediate variables including irrigation intensity, grass height, % building cover, and shrub height.
- Multivariate effects are now being further tested through more comprehensive model comparison, causal modeling, and ordination-based approaches.
- In an arid region like the San Joaquin Valley irrigation dramatically alters the landscape and may be providing additional food and cover for bird species that would not otherwise be available.
- Socioeconomic status and related irrigation / landscape management practices by residents appear to be strong drivers of habitat structure for birds, and overall bird diversity in the Fresno Clovis metro area.
- The socioeconomic correlates of biodiversity also point to
- These results provide a baseline for assessing the effects of the new policy of metering in Fresno on landscaping practices and their consequences for urban biodiversity.

The **Fresno Bird Count** (http://fresnobirds.org/) addresses the impacts of urbanization on the distribution and abundance of birds species in Fresno-Clovis, California. We are a volunteer citizen network established in 2008 to conduct bird counts in the field. We are modeled after the long-running Tucson Birds project in Arizona, and the more recent Ottawa Birds in Canada. We plan to disseminate the knowledge generated among various urban constituencies including developers, city planners, architects, conservation practitioners, and residents.

Examples of Irrigation Regimes

Zero

Two

Three

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