Do human-provided resources mediate effects of temperature on bird abundances in residential neighborhoods? First look and next steps…

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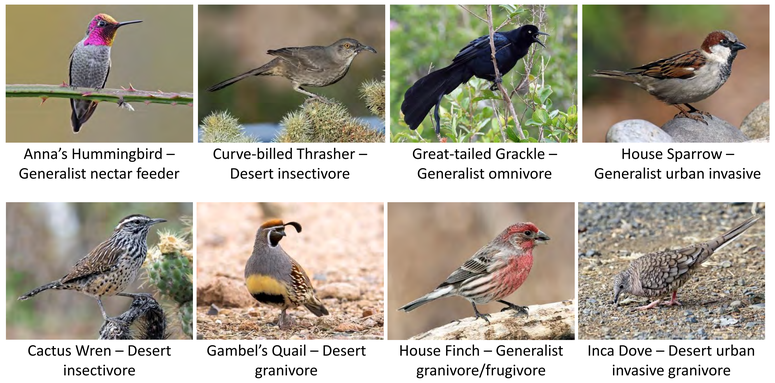
Background

In urban environments there are significant shifts in community composition and species diversity.[1, 2, 3, 4] In general, urban wildlife communities are characterized by a decrease in species richness and increased abundances of a few urban generalist species.[2] Human-provided resources are one significant mechanism for composition and diversity shifts.[1,3] Humans alter trophic dynamics by intentionally or unintentionally providing resources such as food (e.g., bird feeders, refuse/litter, gardening, landscaping) and water (e.g., irrigation, landscaped water features, bird baths). These trophic changes are especially profound in water-limited desert ecosystems.[2] Species with different trophic (e.g., insectivore vs. omnivore) and environmental (e.g., desert specialist, urban invasive) niches should respond differently to different human-provided resources.[2] Using the **Bird Census** and **PASS survey datasets** from the **CAP LTER** study system, we examined the influence of human-provided food resources on species-specific abundances of select avian species (**Figure 1**). We test the following **hypothesis**: Abundances of frugivorous and granivorous generalists will be influenced by proportion of yards per neighborhood that contain human-provided resources of (1) planted fruit trees and (2) vegetable gardens.



Anna's Hummingbird – Generalist nectar feeder | Curve-billed Thrasher – Desert insectivore | Great-tailed Grackle – Generalist omnivore | House Sparrow – Generalist urban invasive

Cactus Wren – Desert insectivore | Gambel's Quail – Desert granivore | House Finch – Generalist granivore/frugivore | Inca Dove – Desert urban invasive granivore

Figure 1. Focal species with different trophic and environmental niches.

Methods

Data Sources: We used responses from the **2011 PASS Survey** question:

"Q230. Which of the following do you have at home for growing food? Please select all that apply: Vegetable garden, fruit trees, plants in pots, poultry or other animals, other, none of these, don't know, prefer not to answer." Answers to each were coded as "Yes" or "No."

We used these responses to generate a proportion of residences with fruit trees and vegetable gardens in their yards for each neighborhood. We used **PASS Bird Census data from 2008-2012** and calculated bird abundances. For weather parameters, we used the Phoenix Sky Harbor airport **NOAA monthly climate dataset**.

Sample Sizes: n = 41 neighborhoods, n = 18 visits (3 per season; winter and spring, 2008, 2011, 2012).

Methods cont.

Data Analysis Steps:

- Fit N-mixture models, which estimate detection and abundance from point count data, using package *unmarked* in program R.[5, 6]
- AIC model selection to select: model mixture (Poisson, Negative Binomial, or Zero-inflated Poisson), detection, and then abundance covariates.[6]
- Goodness of fit test confirmed model fits.[6]
- Use model to produce estimates of abundance response to fruit trees and vegetable gardens.
- Fit separate N-mixture models using the above covariates for each season and year from 2006 – 2016, extract abundance estimates and standard errors, and compare with NOAA drought index values (Palmer drought severity index; PDSI) to generate descriptive **Figure 3.**

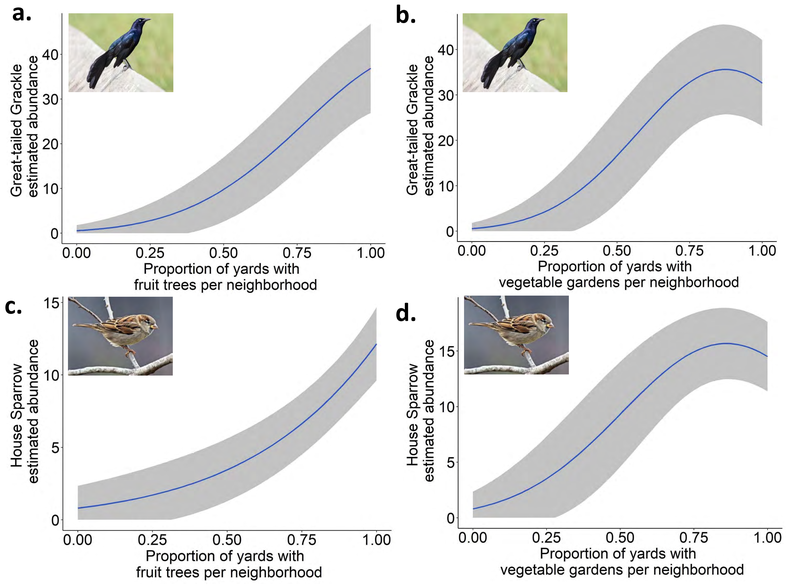


Figure 2. N-mixture model-fitted estimated abundances of Great-tailed Grackle (a-b) and House Sparrow (c-d) by proportion of PASS 2011 respondents that have fruit trees (a,c)and vegetable gardens (b,d) per neighborhood. Gray bands are +/- SEs.

Results

- Of models fit for 8 species, 2 species abundances had significant relationships to human-provided resource availability (**Figure 2**):
- **Great-tailed Grackle** – Negative binomial N-mixture model
  - Detection: observer + time start
  - Abundance: veg gardens x fruit trees + veg gardens^2 x fruit trees^2
- **House Sparrow** – Zero-inflated Poisson N-mixture model
  - Detection: observer + season
  - Abundance: veg gardens x fruit trees + veg gardens^2 x fruit trees^2
- Seasonal Great-tailed Grackle abundance appears to be negatively correlated with drought values **(Figure 3),** although it is unclear if proportion of vegetable gardens influences the relationship between drought intensity and abundance responses.

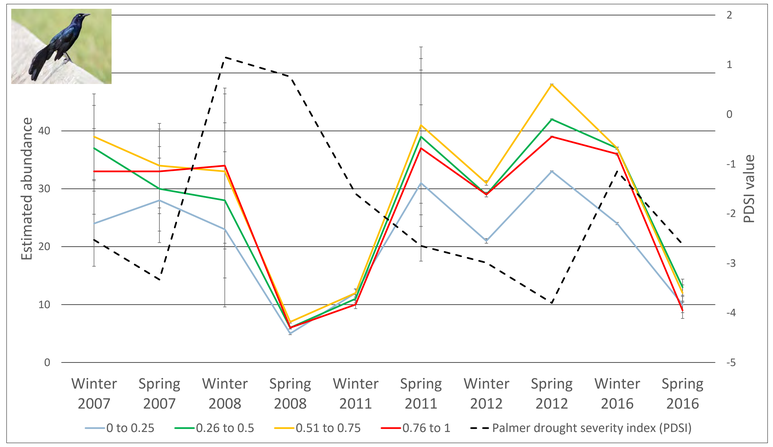


Figure 3. Estimated seasonal abundance for Great-tailed Grackle (2006 – 2016; +/- SEs) binned by proportion of respondents with vegetable gardens per neighborhood (PASS 2011; see legend for color-coding) and overlaid by Palmer drought severity index values (NOAA PDSI) for Phoenix, AZ.

Discussion

- Only generalist urban species (Great-tailed Grackles and House Sparrows) abundances included human-provided resources as significant covariates.
- In both cases, species abundances had a positive non-linear response to vegetable gardens, fruit trees, and the interaction between them.
- This indicates that the proportion of one resource available could mediate the influence of the other resource on bird abundances.
- Human-provided food resources could be supporting artificially-inflated abundances of urban generalist species while not influencing native ecosystem specialists – a pattern seen across many urban systems.[2]
- It's probable that other species groups' abundances will respond differently to difference types of human-provided resources, such as nectar bird feeders, irrigation, or mesic vs. xeric landscaping.

Next Steps

- Test effects of human-provided water resources on abundances using **PASS 2006 and 2011** data.
- Test effects of bird feeders on abundances using **PASS 2017** data and the latest **PASS Bird Census** data.

- Test the **hypothesis** that human-provided resources are *mediating* the effects of temperature and drought-related stress over time. We will do so by:
  - Implementing "stacking" method for N-mixture models - treat season-year as separate "sites" and include season-year as a site covariate.
  - Using weather data from NOAA Climate Monitoring dataset as site covariate. Variables will include: Mean monthly temperature, maximum monthly temperature, mean monthly precipitation, monthly Palmer drought severity index (PDSI). See **Figure 3** for example.
  - Example abundance model structure testing mediation hypothesis: vegetable garden x fruit trees x mean temperature + vegetable garden^2 x fruit trees^2 x mean temperature^2

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