Do Anthropogenic Resources Buffer Avian Species Against Environmental Stressors in Residential Landscapes?

Aaron M. Grade[1], Susannah B. Lerman[2], Paige S. Warren[3]

[1]Program in Organismic and Evolutionary Biology, University of Massachusetts Amherst; [2]USDA Forest Service Northern Research Station, Amherst, MA;
[3]Department of Environmental Conservation, University of Massachusetts Amherst

Background

As urbanization expands into previously unsettled areas, we need to understand how animals adapt to anthropogenic influences (Mckinney 2002). Birds in residential landscapes are known to take advantage of human-provided resources such as bird feeders and bird baths (Fuller et al. 2007). These resources can be relatively stable across seasons and between years but are often heterogeneously distributed across residential landscapes (Chamberlain et al. 2005). In times of environmental stress, such as severe drought, anthropogenic resources may act as a buffer against natural resource shortages (Shochat 2004). The extent of buffering is likely to differ among species depending on their association with human-dominated habitats (e.g., urban invasive vs. desert dwelling animals), trophic niche (e.g., granivorous vs. insectivorous), and behavioral plasticity (e.g., generalist vs. specialist). These factors may play a role in structuring urban communities – and may help explain why urban bird communities have higher densities of individuals with lower overall species richness (Shochat et al. 2010). Birds that are well-adapted to take advantage of anthropogenic resources, especially in times of environmental stress, may be able to inflate their population numbers past the natural "carrying capacity" (Shochat 2004). In this study, we aim to investigate resource-buffer effects on 10 bird species (Table 2) in residential yards that are part of the Central Arizona-Phoenix Long Term Ecological Research (CAP LTER) program.

Study Objectives

- Assess whether bird abundances are related to human-provided resource availability. How does this vary by species and life history traits?
- Determine if there is a change in species/resource relationship with severe drought. Do resources act as a buffer in times of environmental stress? Is the effect different depending on species life history?

Study System & Data Sources

- Residential yards clustered in neighborhoods part of the **CAP LTER** study area
- Neighborhoods involved in **Phoenix Area Social Survey** (PASS), along with associated **bird census data** (2011 and 2016)
- Phoenix area **climate data**, indicating **2011** was a severe drought year as compared to **2016**
- Bird life history traits
- Human-provided resource data (Table 1) collected for **Ecological Survey of Central Arizona** (ESCA) at PASS sites (2010 and 2015)

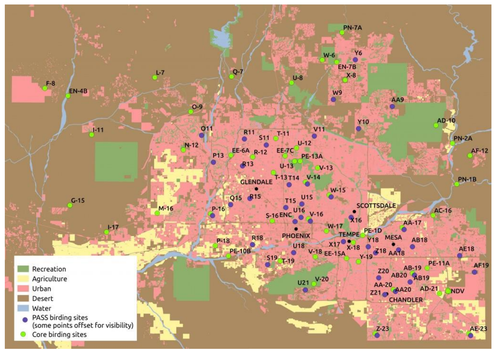

Figure 1. Land cover map containing PASS study locations.

Table 1. Anthropogenic resource data from ESCA dataset (2010 & 2015)

Anthro Resource	Data Type
Bird feeders	Presence/absence
Water features	Presence/absence
Litter/refuse	Presence/absence
Local/neighborhood irrigation	Presence/absence
Landscaping type	Mesic/mixed/xeric
Lawn health/quality	Categorical
Ground cover composition	% cover
Vegetation composition	Multiple variables: count and % cover

Proposed Methods

- Generate separate species-specific generalized linear mixed models (GLMMs) for **2011** and **2016** data (Schliep et al. 2018):
  - Predictor variables: Combinations of human-provided resource variables at sites (spatial coordinates = random effect)
  - Response variable: Species abundance at sites
  - Select best fit model for each species using MLE and AIC selection
  - Generate abundance-informed species-distribution model (SDM) maps
- Compare 2011 GLMMs with 2016 GLMMs to test buffer hypothesis

Table 2. Proposed set of species (common names) along with habitat types for SDMs.

Species	Habitat Category	Species	Habitat Category
House Sparrow	Generalist Urban Invasive	Anna's Hummingbird	Generalist Nectar Feeder
Inca Dove	Desert Urban Invasive	Costa's Hummingbird	Desert Nectar Feeder
House Finch	Generalist	Gamble's Quail	Desert
Great-tailed Grackle	Generalist	Curve-billed Thrasher	Desert
Ruby-crowned Kinglet	Generalist	Cactus Wren	Desert

Figure 2. Select species from different habitat categories: House Sparrow (top left), Ruby-crowned Kinglet (top right), Costa's Hummingbird (bottom left), and Cactus Wren (bottom right.

Figure 3. Mesic (top) versus xeric (bottom) yard types in the CAP LTER study system.

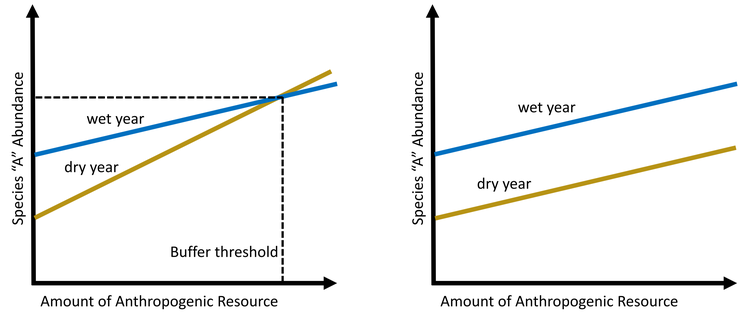

Figure 4. Theoretical predictions for buffer (left) vs. no buffer (right) outcomes of fitted 2011 (yellow; dry) vs. 2016 (blue; wet) GLMMs.

Predicted Outcomes

- **Species abundance** for most species should be reduced overall (i.e., different intercepts) in dry vs. wet years
- Some species show a **buffer effect** in which their relationship is stronger (i.e., steeper slope) in dry vs. wet years
- **Urban specialists:** less likely to show buffer effect since they are always reliant on anthropogenic resources, though we expect to see reduced abundance in dry vs. wet years
- **Generalists:** less likely to exhibit buffer effect and reduced abundance in dry vs. wet years, since they can readily switch between resources
- **Nectar feeders:** more likely to show buffer effect and reduced abundance in dry vs. wet years, since they can switch between natural and anthropogenic nectar sources
- **Desert specialists:** less likely to exhibit a buffer effect since they are adapted to utilize natural resources and habitats, though we still expect to see reduced abundance in dry vs. wet years

Next Steps

- Prepare available data for analysis, and generate life history table
- Conduct exploratory analyses on anthropogenic resource variables, including collinearity
- Investigate use of abundance informed SDMs and generate detailed analytical protocol

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Photos: Fig. 1. CAP LTER; Fig. 2 Wikimedia Commons, Audubon.org (Ruby-crowned Kinglet); Fig. 3 Susannah Lerman

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