FORAGING DECISIONS, BIRD COMMUNITY STRUCTURE AND RESIDENTIAL LANDSCAPES: FINDING THE LINKS

Susannah B. Lerman[1] and Paige S. Warren[2]

[1]Graduate Program in Organismic and Evolutionary Biology, University of Massachusetts, Amherst, MA
[2]Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA

CAP LTER
Central Arizona–Phoenix Long-Term Ecological Research

INTRODUCTION

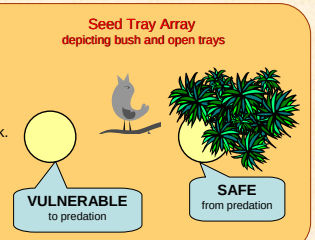
Urbanization, as it transforms natural biotic systems into human-dominated landscapes, has become recognized as one of the greatest threats to bird diversity throughout the world. Emlen (1974) suggested that carrying capacity of urban environments is increased relative to wildland environments because of human subsidies. Numerous studies support this pattern of high densities and a decrease in bird diversity (Marzluff 2001). However, the processes underlying these patterns still remain unclear due to the lack of experimental studies in urban systems (Marzluff et al. 2001).

Together with Citizen Scientists, we evaluated why certain birds are able to persist within clearly defined residential habitat parameters. We conducted foraging experiments in Phoenix, AZ, to provide a mechanistic approach and potentially uncover some of the causal relationships between urbanization and biodiversity. Furthermore, we focused within residential landscapes to determine if specific designs potentially enable the persistence of a natural bird community. Ultimately, residential landscapes may provide mini refugia within urban areas, adding to their conservation value.

METHODS

By applying Optimal Foraging Theory (Charnov 1976, Brown 1988) we measured foraging decisions (Giving Up Density - GUD) at artificial food patches. The GUD quantifies a forager's perception of costs and risks associated with a patch, as well as the quality of the habitat (Brown 1988). We compared behavior between the two dominant landscape designs (mesic and xeric) in 10 Phoenix yards. We also manipulated tray placement to account for predation risk.

Artificial Food Patches:
- 3 kg sand in plastic tray
- 20 g millet seed mixed in sand
- Place trays in residential landscapes for 24h X 2 days
- Measure the amount of seed remaining after 24h = GUD



RESEARCH QUESTIONS

1. Are birds foraging in mesic designs with dense vegetation more efficient foragers than birds in xeric designs?
2. Does a perceived predation risk exist and if so, does it differ between mesic and xeric yards?

RESULTS

There was no significant difference between day 1 and day 2 of the experiment therefore we combined both days for further analysis.
Birds demonstrated a significant difference in foraging behavior between mesic and xeric yards, (Repeated Measures ANOVA, F =4.562, p= 0.0479, Figure 2a) with birds foraging in mesic yards exhibiting greater foraging efficiency. This suggests that competition for food resources is greater in these mesic landscapes. In addition, these conditions may make it possible for certain urban-adapted species to out compete the native, desert-adapted species. Predation risk was insignificant in both landscape designs (ANOVA, F = 0.0755, p = 0.7971 for Mesic and F = 0.1046, p = 0.752 for Xeric yards, Figure 2b and 2c respectively).

FORAGING BEHAVIOR DIFFERS BETWEEN MESIC AND XERIC RESIDENTIAL LANDSCAPES

Figure 1. Examples of mesic and xeric landscapes with seed tray experiments. Red arrows point to seed trays either placed under a bush (protection from predation) or in the open (vulnerable from predation).

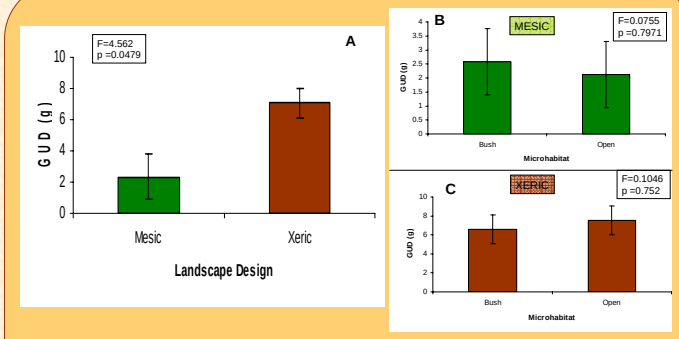


Figure 2. rmANOVA results for testing foraging differences between landscape designs (2a) and microhabitats within mesic (2b) and xeric (2c) yards. Birds foraging in mesic yards were more efficient than birds foraging in xeric yards. However, microhabitat (testing for predation risk) did not differ between the two landscape designs. Standard error bars shown.

Figure 3. Examples of urban birds. Clockwise: Curve-billed Thrasher, House Finch, House Sparrow and Mourning Dove. The House Sparrow and Mourning Dove are highly efficient foragers and thus potentially compete with and or exclude Curve-billed Thrashers, House Finches and other desert birds from mesic landscapes (Shochat et al. 2004).

CONCLUSIONS

Our research suggests that competition for food resources is greater in mesic landscapes. In addition, these conditions may make it possible for certain urban-adapted species to out compete the native, desert-adapted species (Figure 3).

In arid cities, such as Phoenix, the availability of water encourages the persistence of high densities of exploitive and adaptive species within the lush, mesic landscapes. Because of the increased competition, individuals must optimize their foraging, whereby greater efficiency ultimately translates to higher survival and reproductive success.

Birds foraged in both landscape designs as though predation risk was low, despite the presence of domesticated predators like cats. This suggests that predation risk is not a major mechanism structuring urban bird diversity in Phoenix.

We recommend xeric landscape designs as a potential strategy for fostering a native bird community in future developments.

REFERENCES

Bowers, M. A., and B. Breland. 1996. Foraging of gray squirrels on an urban-rural gradient: Use of the GUD to assess anthropogenic impact. *Ecological Applications* **6**:1135-1142.
Brown, J. S. 1988. Patch Use as an Indicator of Habitat Preference, Predation Risk, and Competition. *Behavioral Ecology and Sociobiology* **22**:37-47.
Charnov, E.L. 1976. Optimal foraging: the marginal value theorem. *Theoretical Population Biology* **9***:129-136.*
Emlen, J.T. 1974. An urban bird community in Tucson, AZ: derivation, structure, regulation. *Condor* **76**:184-197.
Marzluff, J.M. 2001. Worldwide urbanization and its effects on birds. Pages 19-38 in J.M Marzluff, R. Bowman, and R. Donnelly, eds. *Avian ecology and conservation in an urbanizing world*. Kluwer, Boston.
Marzluff, J.M. R. Bowman and R. Donnely. 2001. A historical perspective on urban bird research: trends, terms and approaches. Pages 1-17 *in* J.M Marzluff, R. Bowman, and R. Donnelly, eds. *Avian ecology and conservation in an urbanizing world*. Kluwer, Boston.
Shochat, E., S. B. Lerman, M. Katti, and D. B. Lewis. 2004. Linking optimal foraging behavior to bird community structure in an urban-desert landscape: Field experiments with artificial food patches. *American Naturalist* **164**:232-243.

Acknowledgements
We thank Eyal Shochat for help with study design, bird photos and advice. We also thank Naomi Lerman, Janet Spielmann, Michelle Finley, Wayne Porter, Jon Romberg, The Carr Family, Pam Bass , Susie Pringle, The Evanstead Family, and Debbie Zimmerman for allowing us to conduct experiments in their yards.
This material is based upon work supported by the National Science Foundation under Grant No. DEB-0423704, Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER). Any opinions, findings and conclusions or recommendation expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).