The Tucson Hummingbird Project:
an experimental study of community ecology and reconciliation on a city-wide scale

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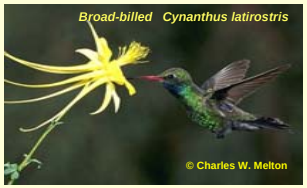


Introduction

Hummingbirds are native treasures we could potentially all enjoy in our backyards. However, as a group, hummingbirds are jeopardized by human development. Of ~340 known species, 68 are Red listed (IUCN 2006).

But development and biodiversity need not be conflicting, and urban areas may actually provide valuable surrogates for degraded habitats.

Our knowledge of community ecology can and should be applied to conservation in the wild, and reconciliation (Rosenzweig 2003a, b) in urbanized areas.

The Tucson Hummingbird Project (THP) is a citizen-science, reconciliation ecology project aimed to study community ecology, monitor and conserve hummingbirds in Tucson, Arizona.

Methods

- We recruited project participants from the local community, mainly birders and docents at the Arizona-Sonora Desert Museum (fig. 1).

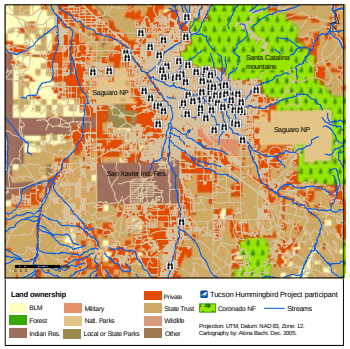
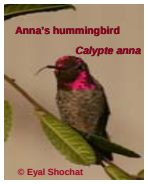


Figure 1: Distribution of all participants who registered to the project (n=107). The map depicts location of participants in Tucson, streams and land ownership.

- These citizen scientists collected hummingbird' data in their backyards once weekly, for 30 minutes in the morning.
- Initial registration included: address, details on yard landscaping, hummingbird plants and feeders.
- Participants were then sent instructions, a hummingbird guide and coupon to buy feeders.
- They reported hummingbird' abundance, foraging preferences, and behavior.
- To increase data reliability, we analyzed only data on males, which are easier to identify.
- All communication and data report were done via the project's web site.

Results

1. Four species of hummingbirds are most abundant in Tucson:



2. While Anna's and Black-chinned hummingbirds were abundant throughout Tucson, Costa's and Broad-billed hummingbirds were found predominantly in less populated areas, closer to natural habitats. Costa's was more abundant in the west and Broad-billed more abundant in east Tucson (fig. 2). These results resemble findings of the Tucson Bird Count (Turner, 2004).

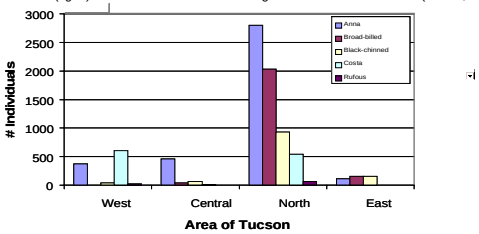


Figure 2. Abundance of hummingbirds in the various areas of Tucson

What can we do to change these patterns and increase diversity of native hummingbirds in cities?

3. What is the relationship between hummingbird abundance and diversity?

- Hummingbird diversity increased with population size
  (Linear regression, n= 35, P<0.0001 , R^2= 0.5541; Log S = 0.222 Log N + 0.0411)
- However, Fisher's a (Fisher et al. 1943) was independent of sample size
  (Linear regression: a = -0.0606 Log N + 0.8498, n= 35, P=0.4230 , R^2= 0.0196).
- Therefore, in order to eliminate sampling effect, we used Fisher's α in all further analysis.

4. How do landscape and feeders affect hummingbird diversity?

Feeders

- An average participant had two feeders and 2-3 hummingbird species.
- Diversity increased as the number of feeders increased (fig. 3a, 3c).

Landscape

- Landscape types in the various yards included one or more of the following: natural desert, native xeriscaping, non-native xeriscaping, other, and bare yard.
- Yards with more landscape types had a higher diversity (fig. 3b, 3c).

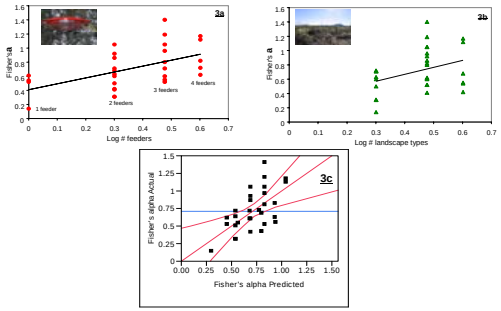


Figure 3. Both feeders (3a) and landscape (3b) had a significant effect on Fisher's a. There was no interaction between the two.
Multiple regression (5c): $P_{Log\ feeders}$ = 0.0031 ; $P_{Log\ landscape}$ = 0.0441; P_{Model} = 0.0017; R^2_{adj}=0.330.
Alpha = 0.0384987+0.7926694 Log feeders (bins) +0.8629824 Log Landscape Bin

Hypothesis

When resources are high (such as large number of feeders), competitive aggression among the hummingbirds will increase. This will result in an "Aggressive Neglect" * of the feeders, permitting access of other species to the feeders.

(* term adapted from: Udvardy, 1951; Hutchinson & MacArthur 1959)

5. What is the proportion of intra- vs. interspecific aggression?

- Aggression was quantified through chasing behavior.
- A total of 240 pair-wise chasing interactions were observed.
- Outcome of interspecific interactions varied between species (fig. 4).
- Anna's and Black-chinned hummingbirds were involved in a significantly higher proportion of Intraspecific chases vs. interspecific chases (table 1).

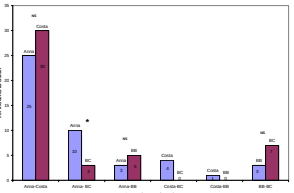


Figure 4. Outcome of pair-wise interspecific interactions (Results of X^2 and Exact Binomial tests; * denotes P<0.05).

Table 1. Observed # of intraspecific vs. intraspecific interactions. Expected number of intraspecific chases was generated by accounting for the relative abundances of each sp. per yard and the subsequent chase probability.

Hummingbird species	A (# of yards)	υ	Outcome	Fisher's combined P	P
Anna's	7	14	Intra>Inter	42.509	P<0.001
Costa's	8	16	NS	6.279	NS
Black-chinned	7	14	Intra>Inter	30.334	P<0.01
Broad-billed	6	12	NS	0.565	NS

Discussion

Community Ecology

Results suggest how hummingbird communities are organized, and explain how artificial and natural resource availability and community ecology are affecting their distribution in an urban area.

Hummingbird **diversity** (rather than merely abundance) increased with the increased amount of food.

We propose Aggressive Feeder Neglect as the mechanism underlying these results.

Powers & McKee (1994) report that when food was unlimited, more intraspecific intruders were chased. (see also Brown et al., 1984).

We found that this is species dependent. Some species chase conspecifics significantly more than heterospecifics, while other don't.

Reconciliation Ecology

This project demonstrates how we can reconcile a city in regards to hummingbird habitats.

We designed and tested a model system to monitor, conserve and augment native species, and provide stop-over habitats for migrating ones.

Citizen Science and Outreach

The latter was achieved with citizen scientists via large-scale outreach to the local community.

Projects such as the THP can and should serve to increase environmental justice and education.

Indeed, following the success of the THP, 2 similar projects have been designed and are about to be implemented in K-12 schools in Tucson.

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