Impacts of land fragmentation on biodiversity in the Phoenix metropolitan region

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1. INTRODUCTION

Land fragmentation, which is in part a product of land use and land cover changes attributed to urbanization, is regarded as a key driver of declining global biodiversity. However, little is known about its impact on biodiversity dynamics in complex urban settings where its interaction with social dynamics is intense. This research explores the impacts of land fragmentation on biodiversity change in the Phoenix metropolitan region in order to understand how and to what extent, various drivers affect biodiversity.

2. METHODS

Biodiversity data are drawn from the Central Arizona Phoenix Long Term Ecological Research (CAP LTER) bird survey for years 2003 and 2005. The data document abundance and distribution of birds at 51 sites that represent four habitats: Urban (18 sites) Desert (15 sites) Riparian (11 sites) and Agricultural (7 sites). Land fragmentation patterns and metrics are generated from the 2001 National Land Cover Dataset. We tested the correlation between the abundance and species richness of 92 species of birds (2003) and land fragmentation *Contagion* index, then we selected eight species based on their habitat preferences, and evaluated the relationship between the distribution of each species (2005) and land fragmentation.

3. ANALYSIS AND RESULTS

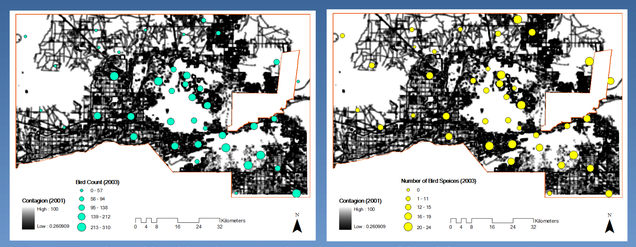

Fig. 1 Overlay of bird biodiversity distribution and land fragmentation

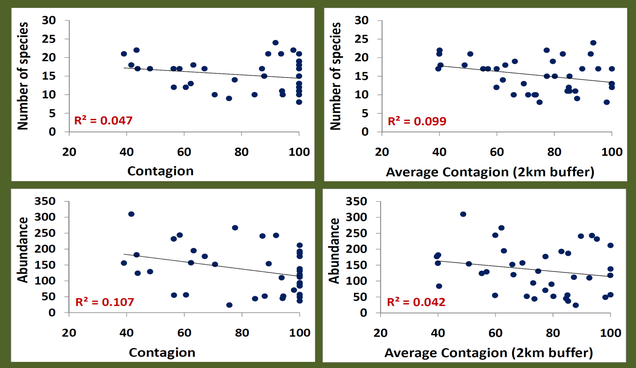

Fig. 2 Relationship between Contagion and 92 bird species richness and abundance (2003)

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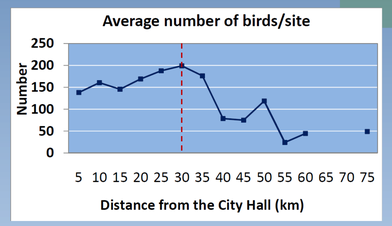
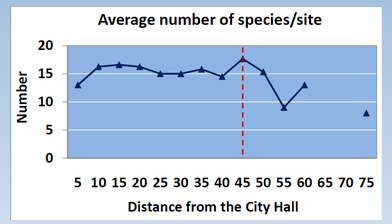




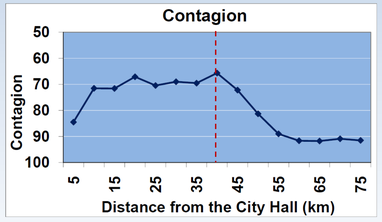


Fig. 3 Bird species richness, abundance (2003) and land fragmentation at different distance to city center

Overall ninety-two bird species (2003)

Eight selected bird species (2005)

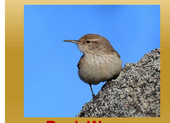
Birds in Urban

Rock Dove (RODO) - Exotic

Great-tailed Grackle (GTGR)

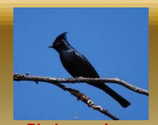
European Starling (EUST)-Exotic

Birds in Desert



Rock Wren (ROWR)

Cactus Wren (CACW)



Phainopepla (PHAI)

Birds in Both Areas

House Sparrow (HOSP)-Exotic

Anna's Hummingbird (ANHU)

4. NEXT STEP

Work with the team of Dr. Paige Warren and establish a model of bird biodiversity. The model will include such variables as elevation, temperature, water, percent of vegetation and trees, human population density, household income levels, and distance from city center. A robust model of bird biodiversity dynamics must be based on careful selection of fragmentation and diversity indices, and must group birds based on comprehensive understanding of bird behavior.

Once such a model is established, we will be able to compare biodiversity change over time. Because desert cities maybe significantly different from other cities, it will be interesting to compare Phoenix with non-desert cities.

R2	Species	Num of Sites	Developed	Cultivated	Riparian	Undeveloped
Urban birds	Great-tailed Grackle	46	<0.1	<0.1	0.618 (-)	0.16 (-)
	European Starling	51	<0.1	<0.1	<0.1	0.39 (-)
	Rock Dove	38	<0.1	<0.1	0.20 (-)	0.22 (-)
Desert birds	Cactus Wren	52	0.10 (+)	0.50 (+)	0.29 (+)	<0.1
	Rock Wren	20	0.32 (+)	<0.10	n.a.	<0.1
	Phainopepla	25	0.64 (+)	0.10 (+)	0.61 (+)	0.21 (+)
Birds in both	House Sparrow	52	<0.10	<0.10	<0.10	<0.10
	Anna's Hummingbird	53	<0.10	<0.10	<0.10	<0.10

Table 1 Correlation between Contagion and the abundance of eight bird species (2005)

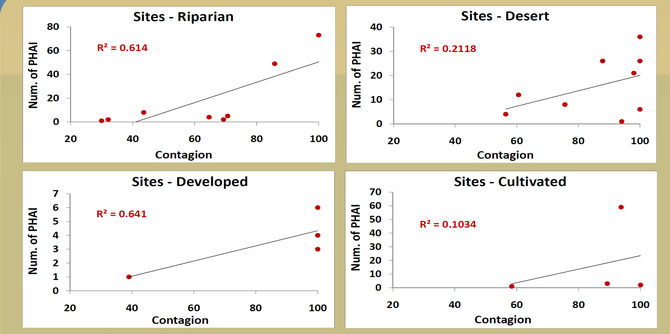


Fig. 4 Relationship between Contagion and Phainopepla abundance (2005)

Main Findings

- Because the bird species studies are so specific in their habitat preferences, it is not effective to group all species of birds together when studying the relationships between land fragmentation and abundance and species richness (Fig.2). Instead, bird species must be grouped together according to their land-area requirements and preferred cover type.
- Peaks in bird abundance and species richness are found at 30km and 45km from the city center; the highest fragmentation is found at 40km from the city center (Fig.3).
- Monitoring sites should be analyzed according to land-cover type because species have different land-cover preferences. For example, grackle habitat preference includes wetlands and grackles eat aquatic life; only by looking at the riparian habitat type can we find the correlation between number of grackles and riparian fragmentation (R^2=0.62) (Table1, Fig. 4).
- Abundance of the urban bird species studied displays a positive relationship with land fragmentation in undeveloped and riparian habitat types, while abundance of the desert bird species studied displays a negative relationship with fragmentation in all four habitat types (Table 1).
- Urban birds are less sensitive to land fragmentation than desert birds (Table 1).
- The overall correlation between abundance and land fragmentation is weak. Because birds can fly, they may not be as sensitive to land fragmentation as ground-dwelling animals or animals that require a large habitat area, such as large mammals.
- Phenomenon of slow response of species change to the process of land fragmentation needs to be considered: the influence of land fragmentation on abundance may not be observable until several years after fragmentation occurs.