Landscape-level influences of urbanization on reptile communities in the Phoenix Metropolitan Area

Laura Becht
School of Life Sciences, Arizona State University, Tempe

Integrating Pattern, Process, Scale and Hierarchy
Landscape Ecology and Modeling Laboratory (LEML)
Arizona State University

CAP LTER
Central Arizona-Phoenix Long-Term Ecological Research

ABSTRACT

There is urgent need for landscape level analysis of the relationships between vertebrate taxa, habitat variables, and the impact of urbanization. This research focuses on the effects of habitat fragmentation and increased patch isolation on populations of lizards in Phoenix and the surrounding urban area. The goal is to produce a spatially realistic GIS model that investigates the influences of the structure and composition of the surrounding landscape on lizard populations within patches of desert habitat. This landscape level analysis will provide information on the relationships between abiotic and biotic variables and the distribution and abundance of five lizards occurring in the Phoenix Metropolitan area of the Sonoran Desert. Remote sensing data, GIS, ecological modeling, and field surveys will be combined to model habitat degradation and species abundance for five lizard species utilizing habitat along the urban gradient. Model development will include a model building phase followed by field testing of predictions of species distribution. Initially, a habitat model will be developed for each species based on known habitat preferences. Remote sensing imagery will be used in association with GIS coverages of land cover to identify patches of potential habitat. Information on species home range and dispersal patterns will then be incorporated into the model and used to identify potential habitat patches. A sample of the potential patches will then be visited to determine presence/absence and species abundance. The model will then be analyzed for relationships between the structure of the landscape, attributes of the habitat patches, and species abundance.

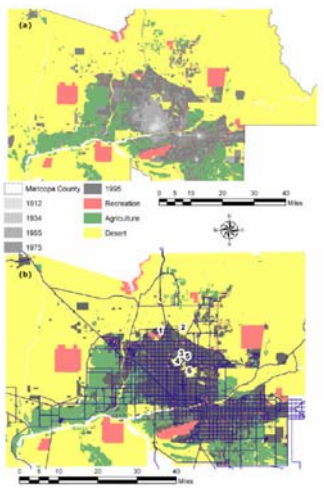

Figure 1. (a) Urbanization of the Phoenix area from 1912 to 1995 (from CAP LTER); (b) Locations of the six parks and recreation areas: 1 - Adobe Dam Recreation Site (534 ha), 2 - Cave Buttes Recreation Site (737 ha), 3 - Lookout Mountain Preserve (143 ha), 4 – North Mountain Preserve (773 ha), 5 – Shadow Mountain Preserve (103 ha), and 6 – Squaw Peak Mountain Preserve (1,492 ha).

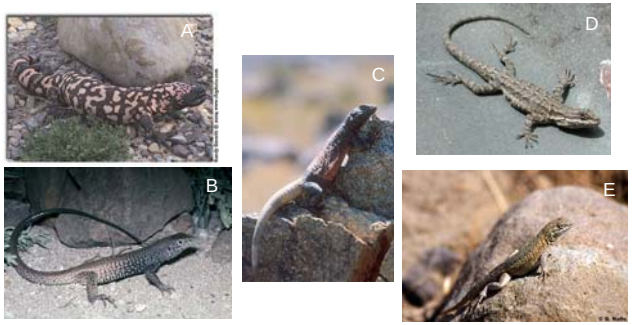

Figure 2. Lizards used in study A. Gila Monster (*Heloderma suspectum*); B. Tiger Whiptai (*Aspidoscelis tigris*);; C. Chuckwalla (*Sauromalus ater*); D. Tree Lizard (*Urosaurus ornatus*); E. Side-Blotched Lizard (*Uta stansburiana*)

Table 1. Listing of target species for model building and validation.

Common Name	Species Name
Plants	
Barrel cactus	*Ferocactus acanthodes*
Blue palo verde	*Cercidium floridum*
Brittlebush	*Encelia farinose*
Bursage	*Ambrosia deltoidea*
Creosote bush	*Larrea tridentate*
Desert broom	*Baccharis sarothroides*
Foothill palo verde	*C. microphyllum*
Ironwood	*Olneya tesota*
Jojoba	*Simmondsia chinensis*
Mesquite	*Prosopis velutina*
Saguaro	*Carnegiea gigantea*
Teddy bear cholla	*Opuntia bigelovii*
Wolfberry	*Lycium* spp.
Reptiles	
Chuckwalla	*Sauromalus ater*
Gila monster	*Heloderma suspectum*
Side-blotched lizard	*Uta stansburiana*
Tree lizard	*Urosaurus ornatus*
Tiger Whiptail	*Aspidoscelis tigris*

INTRODUCTION

Urbanization has rapidly and profoundly altered the desert landscape in the Phoenix Metropolitan area over the last century (Figure 1). Such landscape fragmentation has been widely recognized as a major threat to biodiversity (Shafer, 1990). Empirical and modeling studies of spatially structured populations at the landscape level have shown that the spatial pattern of the habitat determines the persistence of natural populations (Opdam et al., 2003). If areas are to be set aside in an attempt to preserve the biological diversity of natural communities, then it is critical that we understand the conditions that promote the maintenance of such biological communities. Information on the impact of urbanization on Sonoran Desert communities is lacking. However the system of nature preserves in the Phoenix metropolitan area provide an excellent opportunity for research to address the relationship among habitat fragmentation, landscape pattern and biodiversity. These preserves contain a range of habitats, cover different geographic areas, exhibit a variety of shapes, and border areas with different land uses.

RESEARCH OBJECTIVES

The primary objective of this investigation is to design a spatially realistic GIS model of the landscape effects of urbanization on habitat degradation and distribution of lizards within the Phoenix Metropolitan area. This will be accomplished by building habitat models for each of five lizard species (Table 1, Figure 2) and identifying potential habitat patches within the Phoenix Metro area. Sample patches will then be surveyed for presence and abundance. The validated model will then be analyzed for relationships between landscape structure, habitat patch characteristics, and species abundance. This model will incorporate the concept of cohesion indices (Opdam et al., 2003) to analyze the structure and pattern of patches in the landscape in addition to more common landscape indices. This will investigate the ability of cohesion indices to explicitly represent population processes at multiple scales.

This study will address questions related to 1) Which landscape characteristics (matrix composition, connectivity, fragmentation of desert remnant habitat) have the strongest influence on community composition and diversity. 2) The relationship between fragmentation, landscape pattern, and lizard abundance. 3) How the type and intensity of urbanization affect total species diversity and community dynamics (i.e. composition and relative abundance) in desert remnants. 4) Does incorporating measures such as matrix permeability and landscape cohesion improve the explanatory nature of the model.

METHODS

Sites in desert remnants will be classified based on criteria known to have important impacts on species diversity, including: 1) total area of site, 2) shape of site, 3) distance from other sites, 4) distance from major roads, and 5) variation in topography. Sites will then be randomly selected for each species to be surveyed for presence and relative abundance.

MODEL METHODOLOGY

Using known habitat preferences, habitat models will be developed for each of the selected species. Remote sensing imagery will then be categorized into potential habitat patches and urban matrix. Home range and dispersal information will be incorporated into the models in addition to matrix permeability. Patches of potential habitat will be randomly selected to be surveyed for model validation and accuracy assessment. Relationships between the species measures, habitat attributes, and landscape structure will then be established.

LITERATURE CITED

Opdam, P., J. Verboom, and R. Pouwels. 2003. Landscape cohesion: and index for the conservation potential of landscapes for biodiversity. Landscape Ecology, 18: 113-126.

Shafer, C. L. 1990. Nature Reserves: Island Theory and Conservation Practice. Smithsonian Institution Press, Washington, D.C.