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Cover Photograph: Female Barn Owl roosting in her typical location under the Avondale Bridge at the Baseline and Meridian Wildlife Area located within the Southwest Phoenix Metropolitan, AZ, USA. Photo by Dylan A. Cooper.

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Tyto alba (Barn Owl) Food Habits in Metropolitan Phoenix, Arizona, USA: A Shift in Diet and Behavior

Dylan A. Cooper [1,*] and Keith Geluso[1]

Abstract - Urban metropolitan areas continue to expand with human population growth. Wildlife composition and abundance can change as natural landscapes are converted to human landscapes. In altered landscapes, non-native species can become common, leading to changes in interactions between species and behavioral changes within species. We examined diet of *Tyto alba* (Scopoli) (Barn Owls) along the Gila River in Phoenix, Arizona, USA. We identified 12 taxa, with most prey items consisting of native gophers and pocket mice. Two non-native prey also were documented that historically were rare in Arizona but can cause ecological and human health issues. Barn Owls in our study were year-round residents but migratory in a previous study in Phoenix. This behavioral change likely was associated with more reliable and abundant prey related to urbanization. Our research demonstrated that Barn Owls are generalists and consume various native and non-native species in urban environments.

Introduction

Tyto alba (Scopoli) (Barn Owl) is a medium-sized, nocturnal bird of prey with a nearly worldwide distribution (Bent 1938). Dietary analysis of cast pellets indicates that Barn Owls prey upon small mammals, with rodents sometimes comprising the vast majority of their diets (Donadio et al. 2009, Marti 2010, Marti et al. 2020). Barn Owls rarely specialize on a particular species but will generally hunt prey easiest to capture (Hawbecker 1945). Barn Owls are opportunistic predators that demonstrate the ability to readily switch between prey as availability changes (Tores et al. 2005). Due to their catholic feeding habits on small mammals, diets of Barn Owls are used as indicators of small mammal communities (e.g., Avenant 2005, Heisler et al. 2016, McDowell and Medlin 2009, Meek et al. 2012, Riegert et al. 2021) and are used to examine distributions of mammals (e.g., Almeida et al. 2021, Bonner and Geluso 2010, Goguen 2016, Merlino et al. 2012). Barn Owl diets have been extensively researched worldwide with a few prior studies from Arizona (Lange and Mikita 1959), including one from the Phoenix Metropolitan Area (Franzreb and Laudenslayer 1982).

The extent of migration in Barn Owls is currently unknown, but this species is generally considered a year-round resident throughout its range (Marti et al. 2020). Some northern populations, however, might make long-distance migrations (Stewart 1952). At the southern portions of their range where Barn Owls are thought of as non-migratory, they often still make small-distance movements to utilize different habitat types for foraging in different seasons based on prey availability (Tomé and Valkama 2001). For example, a pair of Barn Owls occupying a residential area in Tempe, Arizona for approximately 3 years ate progressively more Thomomys bottae (Eydoux and Gervais) (Botta's Pocket Gopher) and less *Sigmodon arizonae* Mearns (Arizona Cotton Rats) as the months advanced from October–May before ultimately vacating the site each year during the summer months from June–September (Franzreb and Laudenslayer 1982). Small scale seasonal movements by Barn Owls at southern latitudes, as demonstrated in the Franzreb and Laudenslayer (1982)

[1]Department of Biology, University of Nebraska at Kearney, Kearney, NE 68849, USA.
[*]Corresponding author: dylancooper837@gmail.com
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study, might be particularly pronounced in arid subtropical or tropical climates that experience only wet and dry seasons during which prey availability and owl diet composition can drastically change (Debrot et al. 2001, Rasoma and Goodman 2007). However, studies on the movement ecology of Barn Owls in desert biomes are still needed. Finally, despite their overall high site fidelity, adult Barn Owls also occasionally move short distances across habitats to change nest sites (Marti 1999).

The desert southwest, including Phoenix, Arizona, has experienced some of the highest human population growth rates of any region in the United States in recent years (Beavers et al. 2022). Given that human population expansion can change community assemblages and cause shifts in predator-prey relationships (Green et al. 2022), our recent study on diets of Barn Owls in the Phoenix Metropolitan Area offers insights into the ecology of urban-dwelling individuals in the desert southwest. Here we describe prey composition in an urban setting, compare our data to a nearby historical account (Franzreb and Laudenslayer 1982), and discuss the effects of urbanization on trophic interactions and behaviors in Barn Owls.

Methods

During 2022 we collected Barn Owl pellets from the Baseline and Meridian Wildlife Area located along the Gila River in southwestern Phoenix, Arizona. We obtained >50 pellets and vertebrate cranial debris from decomposed pellets below a bridge that pairs of Barn Owls have used. For >10 years at our study site, a pair of Barn Owls roosted and nested at the Avondale Bridge throughout the year (eBird 2023). The pellets we collected under this bridge were in different stages of decomposition that ranged from fresh to multiple years old. Thus, our samples represented data on the diets of a pair of adult Barn Owls and their fledged young across a number of breeding seasons. To remove vertebrate cranial materials from cast pellets, we soaked pellets in water for 0.5-1.0 min. Once softened, we used forceps to gently separate hair from bones. Cranial and dentary bones of vertebrates were kept for identification whereas non-cranial bones and all other debris were discarded. Various taxonomic keys were used to identify prey items to the lowest taxonomic level (Frey 2007, Hoffmeister 1986). Only cranial bones were counted to determine prey frequency. Dentary bones were used to support positive identification of cranial material when necessary.

Substrate below the Avondale Bridge was sandy and habitat immediately surrounding the bridge was primarily wetland/riparian. Dominant vegetation included *Populus fremontii* S. Watson (Fremont Cottonwood), *Salix gooddingii* C. R. Ball (Goodding's Willow), *Prosopis* L. (Mesquite), *Baccharis sarothroides* A. Gray (Desert Broom), *Washingtonia* H.A. Wendl (Fan Palms), *Tamarix* L. (Salt Cedar), and *Typha* L. (Cattails). The understory contained few to no grasses or dense vegetation. Many open sandy areas existed with limited vegetative ground cover and patchy canopies of trees throughout riparian habitats. Barn Owls have large home ranges (165–7843 acres; 72–3174 ha; see Massa et al. 2015). As such, upland Sonoran Desert, agricultural, and suburban habitats adjacent to riparian habitats along the Gila River were within close enough proximity to be used for hunting by the pair of Barn Owls living underneath the Avondale Bridge at our study site. We used QGIS (QGIS Development Team 2023) to generate a land use map for our study site.

Results

We identified 154 vertebrates, including 11 mammalian taxa and 2 unidentified avian crania, in the diet of Barn Owls under a bridge at the Base and Meridian Wildlife Area,

Maricopa County, Arizona (Table 1). Barn Owls foraged almost exclusively upon rodents, which accounted for 98% of prey items. The most common prey items were native Botta's Pocket Gopher and various *Chaetodipus* Merriam (Pocket Mice), but synanthropic species of rodents also were noted in their diet (Table 1). Of rodents consumed, taxa were associated with all surrounding habitats, including agricultural, desert, riparian/woodland, and urban environments (Fig. 1). Some overlap occurred between habitat types, with multiple prey species likely inhabiting more than one habitat (Table 1). Barn Owls were reported every month of the year at Base and Meridian Wildlife Area during 2021 (Fig. 2), with fledglings noted in April and May (eBird 2023).

Discussion

Rodents were the main prey items of Barn Owls on the southwestern edge of the Phoenix Metropolitan Area in 2022. Our results differed from another examination of Barn Owl diets from south-central Phoenix Metropolitan Area (Tempe Area) in the mid-1970s, 35 km east of our site (Franzreb and Laudenslayer 1982). Likely explanations for this difference in prey include methodology and variations in nearby habitats. Franzreb and Laudenslayer (1982) did not identify crania of non-Geomyid rodents to species, except for Arizona Cotton Rats. Rather, those authors reported most rodents as unidentified "miscellaneous mammals." Our identification of non-Geomyid rodents to species certainly contributed to the higher diversity of rodent prey items documented in our study compared to Franzreb and Laudenslayer (1982). Additionally, the large variety of habitat types at our study site (i.e., agricultural, desert, riparian/wooded, and urban) also likely increased prey composition. Franzreb and Laudenslayer (1982) documented that Arizona Cotton Rats were the dominant species consumed by Barn Owls, whereas Arizona Cotton Rats were only a small proportion in the

Table 1. Total number (n) and percentage composition (%) of individual prey taxa from regurgitated pellets of *Tyto alba* (Barn Owls) at Base and Meridian Wildlife Area, Maricopa County, Arizona, in 2022. Listed are the predicted habitat types for each of the taxa in the study area.

	n	%	Habitat Type[a]
Thomomys bottae	73	47.4	A, D, R
Chaetodipus intermedius/penicillatus	52	33.8	D/R
Neotoma spp.	8	5.2	D
Peromyscus spp.	5	3.2	D, R
Mus musculus	4	2.6	A, U
Passerine spp.	2	1.3	A/D/R/U
Dipodomys merriami	2	1.3	D
Rattus rattus	2	1.3	U
Reithrodontomys megalotis/montanus	2	1.3	A
Sigmodon arizonae	2	1.3	A
Chaetodipus baileyi	1	<1	D
Sylvilagus audubonii	1	<1	D, R
TOTAL	154		

[a]Habitats: A=Agricultural; D=Desert; R=Riparian/Woodland; U=Urban

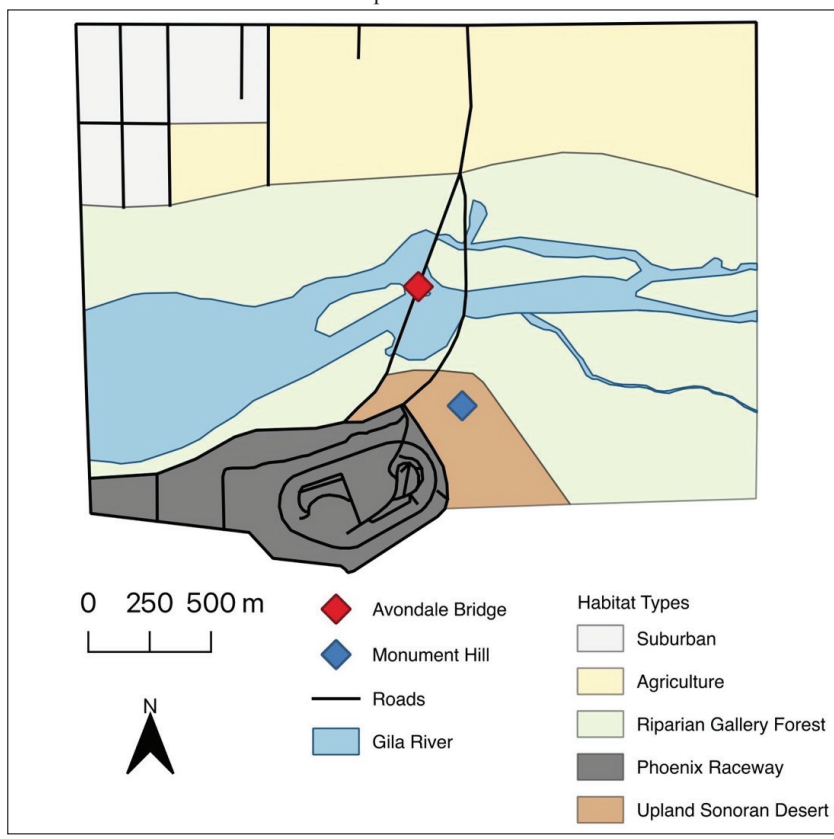

Figure 1. Map of Baseline and Meridian Wildlife Area showing land-use data around the estimated home range of a Barn Owl pair occupying the Avondale Bridge in southwestern Phoenix, AZ.

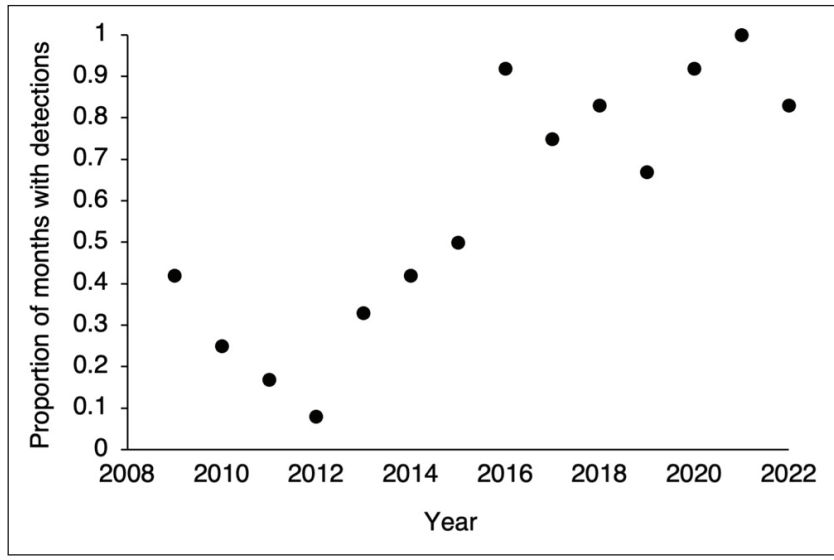

Figure 2. Proportion of months in which Barn Owls were detected each year at Base and Meridian Wildlife Area, Arizona, Maricopa County, from 2009-2022 based on eBird data. A value of 0.5 indicates that Barn Owls were detected 6 out of 12 months, and a value of 1 indicates that they were detected every month.

diet of Barn Owls at our study site (Table 1). Furthermore, those authors collected owl pellets from a roost site in a sparsely vegetated field next to agricultural fields within a mainly residential area. Whereas, we did not observe areas of dense of ground cover in our study site, which would be the preferred habitats for Arizona Cotton Rats. Overall, we identified 8 additional rodent taxa from 154 crania obtained in >50 pellets than those authors did from 84 crania obtained in 77 pellets. The two dominant taxa at our site were Pocket Gophers and Pocket Mice, which are common prey for Barn Owls in deserts of the southwestern United States (Fitch 1947, Lange and Mikita 1959, Jones and Baxter 2004). The diversity of prey items in our analysis likely reflects more rigorous methodologies as well as increased habitat diversity at our study site.

We observed that Barn Owls in our study were resident throughout the year, fledging young in some years (eBird 2023, DAC, Kearney, NE, pers. observ.). The Barn Owls that Franzreb and Laudenslayer (1982) studied were migratory, or at least moved away from their site, with researchers collecting data only from August to May, during the cooler months. On the other hand, we collected pellets that accumulated over the span of many seasons. Animals migrate when food resources become unreliable or scarce (Friedemann et al. 2020). It is plausible that the study site of Franzreb and Laudenslayer (1982) did not offer Barn Owls an adequate food source during the harsh summer months when rodent populations in deserts can become depressed (Geluso and Geluso 2004, Lewis 1972). In contrast, Barn Owls at our study site likely remained and did not migrate because of the proximity to 4 different habitat types, likely yielding a greater abundance of rodents. For example, agriculture areas at our study site likely have an abundance of rodents even during hot dry summers due to year-round irrigation from water impoundments. Food security is one of the greatest advantages for urban carnivores, where food resources are more reliable in cities compared to natural areas (Bateman and Fleming 2012). Urban expansion might further facilitate continual site fidelity by providing owls with additional species of synanthropic prey (Bateman and Fleming 2012), such as non-native rodents (i.e., *Rattus* spp. and *Mus* sp.), during summer months when rodent abundance might be otherwise low. Limited data presented herein indirectly suggests urbanization might have affected migratory behaviors in Barn Owls. This has been observed with other species of birds in urban areas, such as *Zenaida asiatica* (Linnaeus) (White-winged Doves) and *Accipiter cooperii* Bonaparte (Cooper's Hawks), due to increased food and water resources (Small et al. 2006, Millsap 2018).

We observed that Barn Owls roosted and nested under a large bridge during this study. Other studies also document that Barn Owls take advantage of anthropogenic sites for nesting in human-altered environments, including abandoned castles, barns, chimneys, grain silos, mine shafts, towers, and wells (Debrot et al. 2001, Meyrom et al. 2008, Rihane et al. 2004). In more natural settings, this species roosts and nests in a variety of sites such as tree cavities and rocky crevices (Taylor 2003). Barn Owls will even occasionally nest in burrows along riverbanks when occupying habitats where cavities and abandoned buildings are scarce resources (Martin 1973). Their plasticity in nest site selection and ability to use a wide variety of sites for nesting is adaptive, given that Barn Owls typically do not build their own nests (Millsap and Millsap 1987).

Urbanization often accelerates the spread of non-native species (Cadotte et al. 2017, Lechuga-Lago et al. 2017, Santana Marquez et al. 2020). Such species can thrive in novel habitats due to ecological releases from predators and parasites (Keane and Crawley 2002, Shea and Chesson 2002) or their ability to adapt to urban ecosystems (Borden and Flory 2021). In many instances, expansion of non-native species beyond their native range is human mediated via railway, vessel, airline, waterway, and roadway transportation routes that

connect to urban centers (Hulme 2009). *Rattus rattus* (Linnaeus) (Black Rats) first arrived at the East Coast of the U.S. in the mid-1500s via a ship from Europe (Armitage 1993). The spread of non-native rats into interior areas in the United States is seemingly a result of sporadic human-mediated dispersal events from coastal populations (Armitage 1993, Lack et al. 2013). Our observations of Black Rats in metropolitan Phoenix further supports human-mediated transportation into this city (Sullivan 2002), as the species is not known from surrounding arid natural habitats in Arizona (Hoffmeister 1986), but more from coastal regions in the United States (Lack et al. 2013).

We find the presence of Black Rats noteworthy in our study, as this and other *Rattus* species are damaging to natural ecosystems and an issue for economic and human health (Armitage 1993, see Lack et al. 2013). Although occurrence of Old-World rats in the Barn Owl's diet has been documented in California (Hawbecker 1945), previous studies on Barn Owl diets conducted in metropolitan areas of Arizona did not document Old-World rats (Franzreb and Laudenslayer 1982; Lange and Mikita 1959). Additionally, Hoffmeister (1986) did not report any Black Rats from Phoenix, and postulated that this species was no longer present at most of the 6 sites in Arizona where occurrences were previously documented. Since 2001, Black Rats have been identified as problematic to homeowners in the growing metropolitan Phoenix (Sullivan 2002). Our data show that Barn Owls in southwestern Phoenix now have a partial urban diet, which supports Hindmarch and Elliot's study (2015) that demonstrated a significant positive correlation between extent of urbanization in home range of Barn Owls and number of non-native rats in their diets. In an extreme case where non-native rodents dominated the prey base in an area, dietary analysis showed that Barn Owls preyed largely on *M. musculus* Linnaeus (House Mice) and *Rattus* spp. (Hernández-Muñoz and Mancina 2011). Dietary switches have been observed in other urban-dwelling carnivores, with many species using species commonly associated with humans (Bateman and Fleming 2012).

Where native species of conservation concern occur, it is of interest to monitor increases in non-native species that can negatively impact them. For example, non-native rodents, such as the *Rattus norvegicus* (Berkenhout) (Norway Rat), have led to egg losses of the endangered *Rallus obsoletus* Ridgway (Ridgway's Rail) in California (Schwarzbach et al. 2006). Riparian areas along the Gila River in the Phoenix Metropolitan Area represent the easternmost extent of the Ridgway's Rail's range within the United States. An increase in non-native pests such as *Rattus* spp. at our study site could be facilitated by the presence of non-native palms. The Black Rat differs behaviorally from native species of rodents due to its habit of foraging and nesting in elevated areas such as palms (Sullivan 2002). Presence of Barn Owls may help to deter such an increase in abundance along the Gila River in southwestern Phoenix. Barn Owl establishment has been successfully implemented as a mode of invasive rodent control in agricultural settings (Lee 1997) and has recently been proposed as a possible method for biological control of non-native rodents in urban settings as well (Saufi et al. 2020). Our study contributes to the evidence that some native species can adapt their diet compositions and behaviors in response to urbanization.

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