Variation in the Diet of Western Barn Owls (*Tyto alba*) Along an Urban-Rural Gradient

Author(s): Pablo Teta, Carina Hercolini, and Gerardo Cueto
Source: The Wilson Journal of Ornithology, 124(3):589-596. 2012.
Published By: The Wilson Ornithological Society
DOI: http://dx.doi.org/10.1676/11-173.1
URL: http://www.bioone.org/doi/full/10.1676/11-173.1

The Wilson Journal of Ornithology 124(3):589–596, 2012

VARIATION IN THE DIET OF WESTERN BARN OWLS (*TYTO ALBA*) ALONG AN URBAN-RURAL GRADIENT

PABLO TETA,[1,3] CARINA HERCOLINI,[2] AND GERARDO CUETO[2]

ABSTRACT.—We studied geographic variation in the diet of Western Barn Owls (*Tyto alba*) along a urban-rural gradient in central-eastern Argentina and identified 5,231 prey items. Mammals were present in all samples, whereas birds and amphibians were present in 79.1 and 50.0% of the samples, respectively. There were significant differences in vertebrate assemblages consumed by Barn Owls at the opposite extremes of the gradient. Native sigmodontine rodents comprised 85.8% of the total prey items, especially towards periurban and rural areas. Exotic murid rodents were the main prey item in urban sites, while birds increased in frequency in urban and periurban areas. Food niche breadth and standardized food niche breadth values were higher at intermediate levels of urbanization (= periurban). This 'periurban peak' in species diversity is a relatively well-known pattern, previously reported for taxa such as birds, lizards, bumblebees, and butterflies among others. The trophic habits of Barn Owls along this gradient were mostly similar to those reported in other studies in southern South America, where the main prey items were native rodents and food niche breadth values (measured at the level of Orders) were low. Western Barn Owls in our study maintained specialization as a micromammal predator. *Received 13 October 2011. Accepted 16 April 2012.*

The Western Barn Owl (*Tyto alba*) is one of the most common and best-studied raptors in the world (Marks et al. 1999). Its food habits have been widely documented throughout its distributional range, demonstrating this species has a marked preference for micromammalian prey (Taylor 2004). Despite the abundant information about its food habits in southern South America (e.g., Bellocq 2000, Bó et al. 2007), its trophic ecology in temperate latitudes is strongly biased towards studies in agricultural or relatively undisturbed grassland areas (e.g., Faverín 1987, Bellocq 1998, Leveau et al. 2006, González-Fischer et al. 2011). The diet of urban and periurban-dwelling Barn Owls in this same area is poorly known with a few exceptions (e.g., Massoia 1988, 1989). Literature about dietary responses at regional scales, especially along abrupt environmental gradients, is also scarce (e.g., Travaini et al. 1997, Leveau et al. 2006, Trejo and Lambertucci 2007).

Barn Owls commonly breed in urban areas that provide suitable nest sites (e.g., Salvati et al. 2002), but the trophic ecology of the species in these habitats is poorly known. Vargas et al. (1984) indicated birds and reptiles accounted for >50% of the prey items at urban locations in southern Spain, suggesting that small mammals were secondary resources in urban habitats. Use of alternative prey in urban environments was also recorded for central Argentina, where bats were seasonally dominant in the diet of this owl. Salvati et al. (2002) and Charter et al. (2007), in contrast, found high rodent consumption in urbanized neighborhoods of central Italy and Israel. Understanding food preferences of this species of special concern in relation to other parameters (e.g., breeding success, habitat use) may provide useful information for a variety of habitats, including urban and rural areas (Salvati et al. 2002). The objective of our study was to provide new information on the trophic ecology of Western Barn Owls along a urban to rural gradient in central-eastern Argentina.

METHODS

Study Area.—The area studied is between 34° 00 to 34° 50′ S and 57° 59 to 59° 11′ W, Province of Buenos Aires, central-eastern Argentina (Fig. 1), including the City of Buenos Aires and its influence area or 'Gran Buenos Aires'. The area was originally covered by grasslands, patches of xerophylous forests, wetlands, and subtropical riverside forests (Cabrera 1968). This landscape has been gradually modified by agriculture and human settlement since formation of the city of Buenos Aires in the 16th century (Morello et al. 2000). Today, this area is one of the most populated in southern South America with ~13 million people (Instituto Nacional de Estadísticas y Censos; http://www.indec.gov.ar/). The matrix

[1] Unidad de Investigación Diversidad, Sistemática y Evolución, Centro Nacional Patagónico, CC 128, 9120 Puerto Madryn, Chubut, Argentina.

[2] Departamento de Ecología, Genética y Evolución, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Avenida Intendente Güiraldes 216, Ciudad Universitaria, Pabellón II, 4° Piso, (C1428EHA), Buenos Aires, Argentina.

[3] Corresponding author; e-mail: antheca@yahoo.com.ar

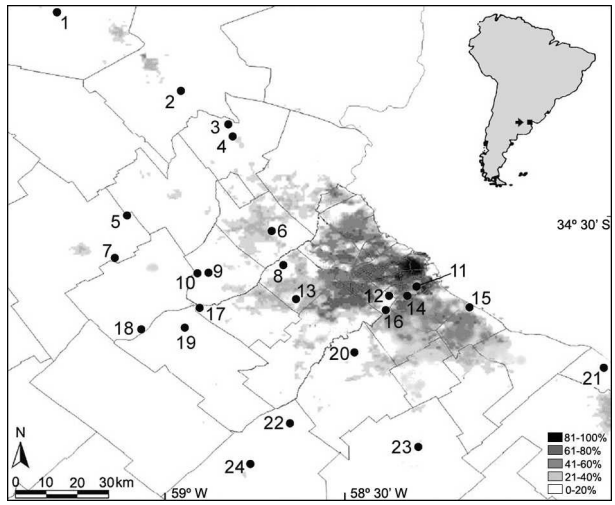

FIG. 1. Study area, northeastern Buenos Aires Province, central-eastern Argentina; shaded areas represent the surface on which buildings, paved roads, or other construction replaced the natural substrate (= 'built habitat'). Sites are arranged from north to south. Numbers correspond to those in Table 1.

of Buenos Aires is formed by buildings and paved streets with patches of parks and open green areas (Morello et al. 2000, Cavia et al. 2009). Towards the north, west, and south, urbanization is gradually replaced by pastures and cultivated fields, where grasses occupy small relicts along field borders and roads (Soriano et al. 1991). The landscape in some littoral areas is still composed of small, highly fragmented, fringes of humid grasslands intermixed with reduced patches of riparian thickets and xerophylous forests (Matteucci et al. 1999). The climate is characterized by mean annual precipitation of 1,014 mm and mean temperatures of 23 °C in January (summer) and 10 °C in July (winter) (Murphy 2008).

Data Collection.—Fresh pellets were collected mostly between 2005 and 2006 at nest and roosting sites from 24 localities (Fig. 1). One to six collections were made at each site. All results from each roost were combined, and each site provided only one sample. Pooling data was necessary to minimize the effects of possible seasonal and annual biases, given there were insufficient data to use in the analysis (Clark and Bunck 1991, Love et al. 2000). Analyses were performed only with samples from sites with >100 prey items. Studied sites were ordered along a urban to rural gradient (Table 1) considering buildings, paved roads, or other construction that replaced the natural substrate or the percentage of tree and herbaceous cover, among others (Table 1; Hercolini 2007). We follow Morello et al. (2000) in defining 'urban', 'periurban', and 'rural'. We used the area covered by human constructions ('built habitat', *sensu* Whitney 1985) as an approximate measure of urbanization for statistical procedures (Hercolini 2007, Cavia et al. 2009; Table 1). Landscape variables, including 'built habitat', were recorded for each site in an area of 2.5-km radius using the continuous land classification of Hansen et al. (2002) and data from MODIS (Moderate Resolution Imaging Spectroradiometer). We used a 2.5-km radius coinciding with the mean home range of Barn Owls (Hercolini 2007).

Vertebrate prey items were identified to species level by comparisons with reference collections housed at the Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia' (Buenos Aires, Argentina). We computed the food niche breadth for each sample ($FNB = 1/(\sum pi^2)$ where pi is the proportion of each class i in the diet (Orders = class) and the standardized food niche breadth ($FNBst = FNB - 1)/(n - 1)$ where n is the total number of prey classes (Marti 1987). A Principal Component Analysis (PCA) was performed using software Infostat (Di Rienzo et al. 2010) to detect and describe changes in the composition and abundance of prey categories; i.e., Orders Anura, Columbiformes, Passeriformes, Didelphimorphia, Chiroptera, Rodentia (native and exotic species were considered separately following Clark and Bunck 1991), and Lagomorpha.

RESULTS

We identified 5,152 prey items, mostly native sigmodontine and exotic murid rodents (Table 1). Mammals were present at all sites, whereas birds and amphibians were present at 79.1 and 50.0% of the sites, respectively (Table 1). We identified 4,815 mammals of which 4,729 (98.2%) were of species with mass <250 g. Larger mammals (>500 g) occurred in low frequencies and included young lagomorphs (*Lepus europaeus*), caviomorphs (*Cavia aperea*), and marsupials (*Didelphis albiventris*).

The native sigmodontine rodents *Akodon azarae*, *Calomys* spp. (including *C. laucha* and *C. musculinus*), and *Oligoryzomys flavescens* comprised 85.8% of the total prey items (Table 1). These species were prominent toward periurban (*Akodon azarae, Oligoryzomys flavescens*) and rural areas (*Calomys* spp.), and were replaced by exotic murid rodents, such as *Mus musculus* and *Rattus* spp. in urban settlements (Table 1, Fig. 2). Birds, especially passerines, were present in low to moderate proportions (0.4–40.0%) in most samples, increasing in frequency at urban and periurban areas (Table 1, Fig. 2).

FNB varied between 1.00 and 2.92, while FNBst varied between 0 and 0.48; both parameters increased in values at intermediate levels of built habitat, decreasing towards the extremes of the gradient and describing second order polynomial functions ($R^2 = 0.655$ and $R^2 = 0.468$, respectively).

The two first axes generated by PCA analysis accounted for 99.3% of the variance in the diet (Fig. 2). Representation of sites and prey categories (i.e., Orders Anura, Columbiformes, Passeriformes, Didelphimorphia, Chiroptera, Rodentia [exotic], Rodentia [native], and Lagomorpha) defined by the two first factors segregated urban from periurban and rural samples. Prey in urban sites included mostly exotic murid rodents, while in periurban and rural areas the most common prey were native sigmodontine rodents (Fig. 2, Table 1). Birds were more abundant at urban and periurban areas.

DISCUSSION

Barn Owls feed primarily on micromammalian prey with weights between 10 and 150 g (Taylor 2004). Stenophagy and specialization, which are characteristics of these owls, decrease when the diversity and abundance of its main prey decreases (Taylor 2004). Birds, amphibians, arthropods, and bats have been reported as prey of Barn Owls when preferred micromammalian prey species declined (Vargas et al. 1984, Bosè and Guidali 2001), such as in urban areas (Charter et al. 2007). However, our study documented that small mammals represented the main prey items, and were only partially replaced by other taxa at some sites (e.g., by birds in some urban and periurban areas [e.g., sites 12, 13, 16; Fig. 1] or amphibians near wetlands or water courses [e.g., sites 4, 15; Fig. 1]). Barn Owls in our study, unlike other birds of prey that switch their diet from small mammals in rural areas to birds in cities (e.g., Yalden 1980, Pikula et al. 1984, Kubler et al. 2005), maintained their selectivity as micromammal predators. Dominance of small mammals in the diet at all sites explained the low values for FNB and FNBst. Overall, our results are in agreement with those of Bellocq (1998), Leveau et al. (2006), and González-Fischer et al. (2011) who studied food habits of Barn Owls at similar latitudes in central-eastern Argentina; they also found high predation on micromammalian prey and low values of food niche breadth (at the level of Order) for this species.

Urban development produces some of the greatest extinction rates and frequently eliminates the large majority of native species (McKinney 2002 and references therein). This is certainly true in the case of native sigmodontine rodents, which were almost completely replaced by exotic rats and mice in urban areas of central-eastern Argentina (e.g., Massoia and Fornes 1967, Cavia et al. 2009). Hercolini (2007) described in detail the micromammal communities along the same gradient that we studied and suggested that exotic rodents, such as *Rattus* spp. and *Mus musculus* prevail at the urbanized extreme, while mice of the genus *Calomys* spp. were the most frequent species in rural areas. High proportions of some native species (e.g., *Akodon azarae*, *Oligoryzomys flavescens*) occur at middle portions of the gradient in periurban areas surrounded by large patches of parklands and spontaneous vegetation (Hercolini 2007; Table 1). This 'periurban peak' in species diversity is a relatively well-known pattern, previously reported for taxa such as birds, lizards, bumblebees, and butterflies (Racey and Euler 1982, Pawlikowski and Pokorniecka 1990, Blair 2001, Germaine and Wakeling 2001). The increase of FNB and FNBst values at intermediate urbanization levels in our study agrees with this pattern.

It is usually accepted that Barn Owls may capture commensal rodents in low frequencies,

TABLE 1. Relative frequency (%) of prey items in Western Barn Owl pellets sampled along an urban to rural gradient in northeastern Buenos Aires province, central-eastern Argentina (see Hercolini 2007 for more detail about the site arrangement along the gradient). Numbers correspond to those in Fig. 1. Abbreviations: FNB = food niche breadth, FNBst = standardized food niche breadth.

	(11) Barracas, Buenos Aires	(14) Piñeyro, Avellaneda	(16) Banfield, Lomas de Zamora	(13) Morón, Morón	(12) Villa Soldati, Buenos Aires	(15) Villa Dominico, Avellaneda	(6) San Miguel, San Miguel	(9) Moreno, Moreno	(8) INTA, Ituzaingó	(21) Punta Lara, Ensenada	(10) Francisco Álvarez, Moreno	(23) San Vicente, San Vicente	(24) Cañuelas, Cañuelas,	(20) Barrio Uno, Ezeiza	(1) Lima, Zárate	(5) Río Lujan, Luján	(7) Luján, Luján	(3) Escobar, Escobar	(2) Otamendi, Campana	(17) Mariano Acosta, Merlo	(22) Máximo Paz, Cañuelas	(4) Aeroclub Escobar, Escobar	(18) Estación Ptomer, General Las Heras	(19) Marcos Paz, Marcos Paz
	Urban[a]									Periurban[a]									Rural[a]					
Built habitat[b]	39.1	37.1	17.4	16.5	13.9	10.4	6.02	4.58	2	1.30	1.11	0.66	0.4	0.4	0.31	0.31	0.24	0.21	0.14	0.13	0.07	0.03	0.00	0.00
Class Mammalia																								
Order Didelphimorphia	-	-	0.53	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	0.93	-	-
Cryptonanus chacoensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.46	-	-
Didelphis albiventris	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Didelphidae	-	-	0.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.46	-	-
Order Chiroptera	-	-	-	-	0.44	1.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eumops bonariensis	-	-	-	-	-	0.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molossus molossus																								
Tadarida brasiliensis	-	-	-	-	0.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order Rodentia (native)	11.8	13.5	32.6	83.6	41.8	70.4	92.3	97	95.2	100	94.3	96.4	99.6	97.9	98.3	96	97.4	95.1	91.1	92.9	98.2	87.5	98.1	98.6
Akodon azarae	2.94	4.5	12.3	22.1	4.89	25	26.4	23.2	14.4	35.4	29	26.1	32.9	36.5	11.3	24	19.1	12	5.73	26.8	17	20.4	20.5	9.51
Bibimys torresi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.1	-	-	-	-	-
Calomys spp.	2.21	2.5	3.74	7.71	-	-	25.3	39.2	52.7	10.1	17.8	17.1	26.3	10.2	62.7	2	43.9	26.1	1.91	36.6	38.4	22.7	56.4	69.7
Cavia aperea	-	-	0.53	8.21	1.78	0.66	12.1	-	0.6	1.12	2.38	-	-	-	-	2	1.42	-	3.82	1.79	-	0.93	0.64	0.35
Deltamys kempi	-	-	-	-	-	1.32	-	-	-	-	-	-	-	-	-	-	-	-	4.46	-	-	-	-	-
Holochilus brasiliensis	-	-	-	-	0.44	3.95	-	-	-	-	-	0.9	-	-	1.69	2	-	3.52	8.92	-	-	12	1.28	-
Oligoryzomys nigripes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.18	-	-	-	-	-
O. flavescens	6.62	6.5	16	45.5	34.7	38.8	28.6	34.6	27.5	52.2	45.1	52.3	40.4	51.2	18.6	56	33	51.4	37.6	27.7	42.9	30.6	19.2	19
Oxymycterus rufus	-	-	-	-	-	-	-	-	-	0.56	-	-	-	-	1.13	6	-	-	5.73	-	-	0.93	-	-
Scapteromys aquaticus	-	-	-	-	-	0.66	-	-	-	0.56	-	-	-	-	2.82	4	-	2.11	14.6	-	-	-	-	-
Order Rodentia (exotic)	78.7	77.5	42.8	5.47	15.6	13.2	5.49	3.04	2.4	-	1.9	-	-	-	1.13	-	1.42	3.52	-	-	0.89	-	1.92	-
Mus musculus	17.6	15	4.28	0.25	6.67	2.63	3.3	0.38	0.6	-	-	-	-	-	-	-	-	0.7	-	-	-	-	0.64	-
Mesocricetus auratus	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
Rattus spp.	61	62	38.5	5.22	8.89	10.5	2.2	2.66	1.8	-	1.9	-	-	-	1.13	-	1.42	2.82	0	-	0.89	-	1.28	-
Order Lagomorpha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.24	-	-	-	-	-	-	-
Lepus europaeus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.24	-	-	-	-	-	-	-

TABLE 1. Continued.

	(11) Barracas, Buenos Aires	(14) Piñeyro, Avellaneda	(16) Banfield, Lomas de Zamora	(13) Morón, Morón	(12) Villa Soldati, Buenos Aires	(15) Villa Dominico, Avellaneda	(6) San Miguel, San Miguel	(9) Moreno, Moreno	(8) INTA, Ituzaingó	(21) Punta Lara, Ensenada	(10) Francisco Álvarez, Moreno	(23) San Vicente, San Vicente	(24) Cañuelas, Cañuelas,	(20) Barrio Uno, Ezeiza	(1) Lima, Zárate	(5) Río Luján, Luján	(7) Luján, Luján	(3) Escobar, Escobar	(2) Otamendi, Campana	(17) Mariano Acosta, Merlo	(22) Máximo Paz, Cañuelas	(4) Aeroclub Escobar, Escobar	(18) Estación Plomer, General Las Heras	(19) Marcos Paz, Marcos Paz
	Urban[a]									Periurban[a]								Rural[a]						
Class Birds																								
Order Columbiformes	0.74	1	-	0.25	1.33	-	-	-	-	-	-	-	-	-	-	0.71	-	-	0.89	-	-	-	-
Columba livia	0.74	-	-	-	0.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Columbina picui	-	1	-	0.25	0.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zenaida auriculata	-	-	-	-	0.44	-	-	-	-	-	-	-	-	-	-	0.71	-	-	0.89	-	-	-	-
Order Passeriformes	8.82	8	23	10.2	38.7	7.24	2.2	-	1.8	-	3.56	0.9	0.44	1.78	-	4	-	1.41	8.92	6.25	-	1.85	-	1.06
Furnarius rufus	-	1	0.53	-	10.7	0.66	-	-	-	-	1.66	-	-	-	-	-	-	-	-	1.79	-	-	-	-
Mimus saturninus	-	-	0.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myopsitta monacha	-	-	-	-	0.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitangus sulphuratus	-	-	-	0.25	1.33	-	-	-	-	-	0.24	-	-	-	-	-	-	-	-	-	-	-	-	-
Troglodytes aedon	-	-	-	-	0.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turdus rufiventris	-	0.5	-	0	4.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passer domesticus	-	3.5	-	0	0.89	-	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.35
Unidentified Hirundinidae	-	-	-	0	5.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Emberizidae	-	-	-	1	0.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Icteridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.41	-	-	-	-	-	-
Unidentified Passeriformes	8.82	3	21.9	8.96	14.2	6.58	1.1	-	1.8	-	1.66	0.9	0.44	1.78	-	4	-	-	8.92	4.46	-	1.85	-	0.7
Class Amphibia																								
Order Anura	-	-	1.07	0.5	2.22	7.89	-	-	-	-	0.24	2.7	-	0.36	0.56	-	0.24	-	-	-	0.89	9.72	-	0.35
Unidentified Anura	-	-	1.07	0.5	1.33	7.89	-	-	-	-	0.24	2.7	-	0.36	0.56	-	0.24	-	-	-	0.89	9.72	-	0.35
Rhinella fernandezae	-	-	-	-	0.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	136	200	187	402	225	152	91	263	167	178	421	111	228	561	177	50	424	142	157	112	112	216	156	284
FNB	1.56	1.62	2.92	1.40	2.87	1.91	1.17	1.06	1.10	1.00	1.12	1.08	1.01	1.04	1.03	1.08	1.05	1.10	1.19	1.15	1.04	1.29	1.04	1.03
FNBst	0.19	0.21	0.48	0.10	0.37	0.23	0.08	0.06	0.03	0	0.04	0.04	0.01	0.02	0.02	0.08	0.01	0.05	0.19	0.08	0.02	0.10	0.04	0.01

[a] *Sensu* Morello et al. (2000).
[b] Surface, expressed as percentage, on which buildings, paved roads, or other human construction replaced the natural substrate.

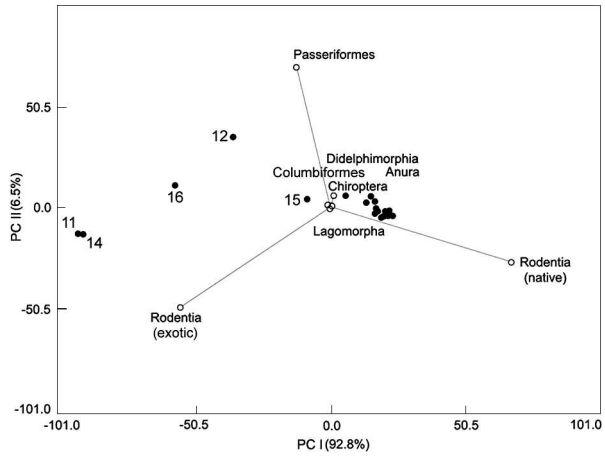

FIG. 2. Representation of sites (black dots) and Western Barn Owl prey categories (open circles) on the plane defined by axes I and II of a principal component analysis. Numbers for urban settlements correspond to those in Table 1.

even in anthropically modified areas (e.g., Clark and Bunck 1991, Magrini and Facure 2008). However, we found high consumption rates of exotic rats and mice at the urbanized extreme of our gradient, demonstrating the opportunistic behavior of Barn Owls under certain environmental conditions (Taylor 2004). Commensal rodents are mainly associated with human activities, and an increase in their abundance in Barn Owl diets can be used as an indicator of environmental degradation (Clark and Bunck 1991). Moderate to high frequencies of exotic murid rodents were also reported in the diet of this owl at other periurban localities of southern South America (e.g., Nores and Gutiérrez 1990, González Acuña et al. 2004).

The dominant prey species along the study gradient of the entire sample was *Oligoryzomys flavescens*, the main hantavirus reservoir in central-eastern Argentina (Enria and Levis 2004). Hantaviruses are infectious agents disseminated by rodents in several parts of the world (Enria and Levis 2004); they cause Hantavirus Pulmonary Syndrome (HPS) with a lethality that reaches 50%, which is transmitted to humans through inhalation of particles in excretions of wild rodents. The expansion of urban areas is a reality in the present world (e.g., McKinney 2002) and political actions are needed to preserve minimum spaces of natural habitats that ensure maintenance of predator-prey relationships. Barn Owls may have an important role in control of *O. flavescens*, especially at periurban places of central-eastern Argentina, where ~13 million people live and HPS is an endemic disease (Busch et al. 2004).

ACKNOWLEDGMENTS

Emiliano Muschetto and Martín Zamero participated in collection and disaggregation of owl pellets. U. F. J. Pardiñas provided some of the samples and literature, and made valuable comments on an earlier version of this manuscript.

LITERATURE CITED

BELLOCQ, M. I. 1998. Prey selection by breeding and nonbreeding Barn Owls in Argentina. Auk 115:224–229.

BELLOCQ, M. I. 2000. A review of the trophic ecology of the Barn Owl in Argentina. Journal of Raptor Research 34:108–119.

BLAIR, R. B. 2001. Birds and butterflies along urban gradients in two ecoregions of the U.S. Pages 33–36 *in* Biotic homogenization (J. L. Lockwood and M. L. McKinney, Editors). Kluwer, Norwell, Massachusetts, USA.

BÓ, M. S., A. V. BALADRÓN, AND L. M. BIONDI. 2007. Ecología trófica de Falconiformes y Strigiformes: tiempo de síntesis. Hornero 22:97–115.

BOSÈ, M. AND F. GUIDALI. 2001. Seasonal and geographic differences in the diet of the Barn Owl in an agro–ecosystem in northern Italy. Journal of Raptor Research 35:240–246.

BUSCH, M., R. CAVIA, A. E. CARBAJO, C. BELLOMO, S. GONZALEZ CAPRIA, AND P. PADULA. 2004. Spatial and temporal analysis of the distribution of hantavirus pulmonary syndrome in Buenos Aires Province, and its relation to rodent distribution, agricultural and demographic variables. Tropical Medicine and International Health 9:508–519.

CABRERA, A. L. 1968. Vegetación de la Provincia de Buenos Aires. Pages 101–120 *in* Flora de la provincia de Buenos Aires (A. L. Cabrera, Editor). INTA, Colección Científica 4.

CAVIA, R., G. R. CUETO, AND O. V. SUÁREZ. 2009. Changes in rodent communities according to the landscape structure in an urban ecosystem. Landscape and Urban Planning 90:11–19

CHARTER, M., I. IZHAKI, L. SHAPIRA, AND Y. LESHEM. 2007. Diets of urban breeding Barn Owls, *Tyto Alba* in Tel Aviv, Israel. Wilson Journal of Ornithology 119:484–485.

CLARK, D. R. AND C. M. BUNCK. 1991. Trends in North American small mammals found in Common Barn-owl (*Tyto alba*) dietary studies. Canadian Journal of Zoology 69:3093–3102.

DI RIENZO, J. A., F. CASANOVES, M. G. BALZARINI, L. GONZALEZ, M. TABLADA, AND C. W. ROBLEDO. 2010. InfoStat Versión 2010. Grupo InfoStat, FCA, Universidad Nacional de Córdoba, Argentina.

ENRÍA, D. A. M. AND S. C. LEVIS. 2004. Zoonosis virales emergentes: las infecciones por Hantavirus. Revue Scientifique et technique Office International des Epizooties 23:595–611.

FAVERÍN, C. 1987. Variación de la dieta de la Lechuza del campanario (*Tyto alba*) en Lobos, provincia de Buenos Aires. Thesis. Universidad Nacional de Mar del Plata, Argentina.

GERMAINE, S. S. AND B. F. WAKELING. 2001. Lizard species distribution and habitat occupation along an urban gradient in Tucson, Arizona, USA. Biological Conservation 97:229–237.

GONZÁLEZ ACUÑA, D., M. AUSSET SALGADO, O. SKEWES RAMM, AND R. A. FIGUEROA ROJAS. 2004. Variación estacional en el consumo de roedores por la Lechuza de Campanario (*Tyto alba*) en un área suburbana de Chillán, centro-sur de Chile. Hornero 19:61–68.

GONZÁLEZ-FISCHER, C. M., M. CODESIDO, P. TETA, AND D. BILENCA. 2011. Seasonal and geographic variation in the diet of Barn Owls (*Tyto alba*) in temperate agroecosystems of Argentina. Ornitología Neotropical 22:295–305.

HANSEN, M. C., R. S. DEFRIES, J. R. G. TOWNSHEND, R. SOHLBERG, C. DIMICELI, AND M. CARROLL. 2002. Towards an operational MODIS continuous field of percent tree cover algorithm: examples using AVHRR and MODIS data. Remote Sensing of Environment 83: 303–319.

HERCOLINI, C. 2007. Efectos de la urbanización sobre las comunidades de pequeños roedores del Área Metropolitana de Buenos Aires, Argentina. Thesis. Universidad de Buenos Aires, Argentina.

KÜBLER, S., S. KUPKO, AND U. ZELLER. 2005. The Kestrel (*Falco tinnunculus* L.) in Berlin: investigation of breeding biology and feeding ecology. Journal of Ornithology 146:271–278.

LEVEAU, L. M., P. TETA, R. BOGDASCHEWSKY, AND U. F. J. PARDIÑAS. 2006. Feeding habits of the Barn Owl (*Tyto alba*) along a longitudinal-latitudinal gradient in central Argentina. Ornitología Neotropical 17:353–362.

LOVE, R. A., C. WEBBON, D. E. BLUE, AND S. HARRIS. 2000. Changes in the food of British Barn Owls (*Tyto alba*) between 1947 and 1997. Mammalian Review 30:107–129.

MAGRINI, L. AND K. G. FACURE. 2008. Barn Owl (*Tyto alba*) predation on small mammals and its role in the control of hantavirus natural reservoirs in a periurban area in southeastern Brazil. Brazilian Journal of Biology 68:733–740.

MARKS, J. S., R. J. CANNINGS, AND H. MIKKOLA. 1999. Family Strigidae (typical owls). Pages 76–242 *in* Handbook of the birds of the world. Volume 5. Barn Owls to hummingbirds (J. del Hoyo, A. Elliott, and J. Sargatal, Editors). Lynx Ediciones, Barcelona, España.

MARTI, C. D. 1987. Raptor food habits studies. Pages 67–80 *in* Raptor management techniques manual (G. B. Pendleton, B. A. Milsap, K. W. Cline, and D. M. Bird, Editors). National Wildlife Federation, Washington, D.C., USA.

MASSOIA, E. 1988. Análisis de regurgitados de *Tyto alba* de Ituzaingó, partido de Morón, provincia de Buenos Aires. Boletín Científico de la Asociación para la Protección de la Naturaleza 2:13–20.

MASSOIA, E. 1989. Animales depredados por *Tyto alba* en la Ciudad de San Miguel, partido de General Sarmiento, provincia de Buenos Aires. Boletín Científico de la Asociación para la Protección de la Naturaleza 15:2–7.

MASSOIA, E. AND A. FORNES. 1967. Roedores recolectados en la Capital Federal (Caviidae, Cricetidae y Muridae). IDIA (INTA) 240:47–53.

MATTEUCCI, S. D., J. MORELLO, A. RODRÍGUEZ, G. D. BUZAI, AND C. BAXENDALE. 1999. El crecimiento de la metrópoli y los cambios de biodiversidad: el caso de Buenos Aires. Pages 549–580 *in* Biodiversidad y uso de la tierra. Conceptos y ejemplos de Latinoamérica (S. D. Matteucci, O. T. Solbrig, J. Morillo, and G. Halffter, Editors). Eudeba, Buenos Aires, Argentina.

MCKINNEY, M. L. 2002. Urbanization, biodiversity and conservation. BioScience 52:883–890.

MORELLO, J., G. D. BUZAI, C. A. BAXENDALE, A. F. RODRÍGUEZ, S. D. MATTEUCCI, R. E. GODAGNONE, AND R. R. CASAS. 2000. Urbanization and the consumption of fertile land and other ecological changes: the case of Buenos Aires. Environment and Urbanization 12:119–131.

MURPHY, G. M. 2008. Atlas agroclimático de la Argentina. Editorial Facultad de Agronomía, Universidad de Buenos Aires, Argentina.

NORES, A. I. AND M. GUTIÉRREZ. 1990. Dieta de la lechuza de campanario (*Tyto alba*) en Córdoba, Argentina. Hornero 13:129–132.

PAWLIKOWSKI, T. AND J. POKORNIECKA. 1990. Observations on the structure of bumblebee communities of the town-forest areas in Torun Basin, North Poland. Acta Universitatis Nicolai Copernici Biologia 37:3–22.

PIKULA, J., M. BEKLOVÁ, AND V. KUBIK. 1984. The nidobiology of *Falco tinnunculus*. Acta Scientiarum Naturalium, Academiae Scientiarum Bohemoslovacae 18:1–55.

RACEY, G. D. AND D. L. EULER. 1982. Small mammal and habitat response to shoreline cottage development in

central Ontario, Canada. Canadian Journal of Zoology 60:865–880.

SALVATI, L., L. RANAZZI, AND A. MANGANARO. 2002. Habitat preferences, breeding success, and diet of the Barn Owl (*Tyto alba*) in Rome: urban versus rural territories. Journal of Raptor Research 36:224–228.

SORIANO, A., R. J. C. LEÓN, O. E. SALA, R. S. LAVADO, V. A. DEREGIBUS, M. A. CAHUÉPÉ, O. A. SCAGLIA, C. A. VELÁZQUEZ, AND J. H. LEMCOFF. 1991. Río de la Plata grasslands. Pages 367–407 *in* Ecosystems of the world 8A. Natural grasslands. Introduction and Western Hemisphere (R. T. Coupland, Editor). Elsevier, New York, USA.

TAYLOR, I. 2004. Barn Owls. Predator-prey relationships and conservation. Cambridge University Press, Cambridge, United Kingdom.

TRAVAINI, A., J. DONAZAR, O. CEBALLOS, A. RODRÍGUEZ, F. HIRALDO, AND M. DELIBES. 1997. Food habits of Common Barn-owls along an elevational gradient in Andean Argentine Patagonia. Journal of Raptor Research 31:59–64.

TREJO, A. AND S. LAMBERTUCCI. 2007. Feeding habits of Barn Owls along a vegetative gradient in northern Patagonia. Journal of Raptor Research 41:277–287.

VARGAS, J. M., J. C. ESCUDERO, AND M. MOREY. 1984. Estructura del nicho trófico de Tyto alba en el sur de España. Amplitud y solapamiento de nichos. Stvdia Oecologica 5:199–218.

WHITNEY, G. G. 1985. A quantitative analysis of the flora and plant communities of a representative Midwestern U.S. town. Urban Ecology 9:143–160.

YALDEN, D. W. 1980. Notes on the diet of urban Kestrels. Bird Study 27:235–238.