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A COMPARISON OF AVAILABLE PREY AND DIET OF FLORIDA BURROWING OWLS IN URBAN AND RURAL ENVIRONMENTS: A FIRST STUDY

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Abstract. The distribution of the Florida Burrowing Owl (*Athene cunicularia floridana*) has expanded from primarily rural areas in south-central Florida to include urban/suburban areas to the north, northwest, south, and southeast. While Florida Burrowing Owls still reside in rural areas, the majority of previous research and current management strategies focus on urban/suburban populations. Determining differences in the owl's ecology between rural and urban/suburban areas can aid in creating effective statewide management strategies for this species. We compared the available prey and diet of Burrowing Owls in a rural and urban environment. Although, on the basis of analysis of pellets, insects and arachnids were the two most frequent food items at both the rural and urban sites, the diets at the two sites differed, largely because of greater consumption of avian prey in the urban habitat. This study is the first comparison of dietary and prey-availability differences between rural and urban Burrowing Owl populations.

Key words: Athene cunicularia, *Burrowing Owl, diet, raptors, species of special concern, prey analysis.*

Comparación de las Presas Disponibles y las Encontradas en la Dieta de Athene cunicularia floridana en Ambientes Urbanos y Rurales: Un Primer Estudio

Resumen. La distribución de *Athene cunicularia floridana* se ha expandido desde las zonas principalmente rurales del centro-sur de la Florida e incluye ahora zonas urbanas y suburbanas ubicadas al norte, noroeste, sur y sureste. Si bien *A. c. floridana* se encuentra todavía en las zonas rurales, la mayoría de las investigaciones anteriores y las estrategias de gestión actuales se centran en poblaciones urbanas y suburbanas. La determinación de posibles diferencias en la ecología de esta lechuza entre zonas rurales y urbanas/suburbanas puede ayudar a desarrollar estrategias de gestión efectivas para esta especie a nivel estatal. Comparamos las presas disponibles y la dieta de *A. c. floridana* entre un ambiente rural y uno urbano. Con base en análisis de egagrópilas, los invertebrados y los arácnidos fueron los dos alimentos más frecuentes tanto en la zona rural como en la urbana. Sin embargo, las dietas difirieron entre los sitios debido en gran parte a un mayor consumo de aves en el ambiente urbano. Este estudio representa la primera evaluación de las diferencias entre las presas consumidas y las disponibles en el ambiente entre poblaciones rurales y urbanas de *A. c. floridana.*

The distribution and habitats of the Florida Burrowing Owl (*Athene cunicularia floridana*) have changed since this species was first documented breeding on dry prairies in south-central Florida in the late 19th century (Cahoon 1885, Hoxie 1889, Rhoads 1892, Scott 1892, Palmer 1896). Extensive development and agriculture have displaced this primary habitat, and Burrowing Owls now reside in human-altered areas such as pastures (Mealey 1997), private residences (Mealey 1997), vacant urban lots (Wesemann 1986, Millsap and Bear 1990), college campuses (Courser 1976), airports (Owre 1978, Mealey 1997), and borders of highways (Owre 1978). While the Burrowing Owl's breeding habitat has expanded north, northwest, south, and southeast of the original dry prairies (MacKenzie 1944, Neill 1954, Ligon 1963, Courser 1979, Hennemann 1980), increases in land development may cause a decrease in the owl's use of the new habitat over time (Courser 1976, Wesemann 1986, Millsap and Bear 2000). In 1979 the Florida Burrowing Owl was listed as a species of special concern (Florida Department of State 1979) because of its vulnerability to habitat/environmental modification and human disturbance/exploitation (Florida Fish and Wildlife Conservation Commission 2008).

The shift of a species from rural to urban habitats can influence its diet, territory size, predation risk, social structure, and basic demography (McGowan 2001). The effective management of such a species requires an understanding of its habitat and food requirements over a variety of spatial and temporal scales (Litvaitis et al. 1996). Currently, statewide management of the Florida Burrowing Owl is limited to resolving conflicts between land developers and the protection of Burrowing Owl breeding habitat in urban and suburban areas (Florida Fish and Wildlife Conservation Commission 2004). In addition, previous research on the Florida Burrowing Owl has focused largely on urban/suburban populations (Courser 1976, Wesemann 1986, Mealey 1997, Millsap and Bear 1997, Millsap and Bear 2000). Only recently have studies on this species begun to address rural populations (Yosef and Deyrup 1994, Mrykalo et al. 2007, Mueller et al. 2007).

In cities and suburbs Florida Burrowing Owls appear to prey mostly on ground-dwelling insects (Hennemann 1980, Wesemann 1986). Prey other than insects includes mice (*Peromyscus*

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sp.), rabbits (*Sylvilagus* sp.), anoles (*Anolis* sp.), tree frogs (*Hyla* sp.), southern toads (*Bufo terrestris*), rosy wolfsnails (*Euglandina rosea*), marsh crabs (*Sesarma reticulatum*) (Wesemann 1986), blue Florida crayfish (*Procambarus alleni*), hispid cotton rats (*Sigmodon hispidus*) (Owre 1978), eastern spadefoot toads (*Scaphiopus holbrooki*), and Least Terns (*Sternula antillarum*) (Hennemann 1980).

Insects have also been documented as the predominant prey in the diet of Burrowing Owls from rural areas (Ridgway 1874, Cahoon 1885, Hoxie 1889, Rhoads 1892, Palmer 1896, Bent 1938, Yosef and Deyrup 1994). In these habitats prey other than insects include Savannah Sparrows (*Passerculus sandwichensis*), Bobolinks (*Dolichonyx oryzivorus*), and unknown species of rodents, lizards, frogs, fish (Rhoads 1892), crabs (Bent 1938), crayfish (Rhoads 1892, Palmer 1896), and snakes (Rhoads 1892, Bent 1938). The majority of these reports, however, have been largely anecdotal (Ridgway 1874, Cahoon 1885, Hoxie 1889, Rhoads 1892, Palmer 1896, Bent 1938).

As Florida's rural habitats continue to decline, it is important to understand the potential effects of land conversion on this species of special concern. The purpose of this study was to expand information available for the species' management by comparing the diet and available prey of Burrowing Owls in a rural and an urban environment. This research was conducted concurrently with a study examining the spatial ecology and behavior of Florida Burrowing Owls in rural environments (Mrykalo 2005, Mrykalo et al. 2007).

METHODS

The study was undertaken on Marco Island (urban) and at Rutland Ranch (rural) from October 2003 to October 2004. The two areas are approximately 182 km apart. Marco Island is a 36.3-km^2 barrier island located off the southwest coast of Florida (25° 56′ N, 81° 43′ W). Approximately 15 000 people reside there year round, and the winter population peaks at roughly 35 000 (Marco Island City Hall 2003). The vast majority of Burrowing Owls on Marco Island breed on vacant lots. In 2004, 113 vacant lots were occupied by adult Burrowing Owls, which had excavated 133 burrows (N. Ritchie, pers. comm.).

Rutland Ranch, located in Bradenton, encompasses approximately 2372 ha. The ranch contains a mixture of habitats including oak scrub, herbaceous marshes, riparian hardwoods, pine flatwoods, and pastures of non-native grass (Barnwell et al. 2003). The land surrounding Rutland Ranch is used primarily for agriculture and cattle ranching. Burrowing Owls excavate burrows on an 81-ha improved pasture that undergoes prescribed burning yearly (27° 30′ N, 82° 15′ W). In 2004, five pairs of adult Burrowing Owls were located within the improved pasture and had excavated 14 burrows.

DIET

We hypothesized that the diet of Burrowing Owls on Rutland Ranch and Marco Island differs. Every other month we collected whole regurgitated pellets from each study area from five randomly selected active burrows, composed of main and satellite burrows. We used a dissecting microscope to identify insect prey from the remains of body parts found in pellets. Personnel from the Florida State Collection of Arthropods assisted in classifying insect and arachnid remains (P. Skelley, pers. comm.). The mandibles, heads, elytra, legs, and forceps were examined to identify insects and arachnids to the level of family in each pellet and counted to approximate the number of insects and arachnids within pellets (Gleason and Craig 1979). The Florida Museum of Natural History assisted in the identification of jaws, bones, and bone fragments in pellets (C. McCaffery, pers. comm.). We classified diet according to the abundance of prey found within owl pellets. We were unable to discern if prey was scavenged or captured.

PREY SURVEYS

We hypothesized that the abundances of insect and mammalian prey on Rutland Ranch and Marco Island differ significantly. To compare potential mammalian prey in the two study areas, we established five transects, each 50 m long, randomly within the improved pasture at Rutland Ranch and also on five randomly selected lots containing Burrowing Owls on Marco Island.

We placed Sherman small-mammal traps at 10-m intervals ($n = 5$) along each transect and baited each with either shelled peanuts or a mixture of rolled oats and shelled peanuts. Initially, we lost trap bait continually lost to fire ants (*Solenopsis invicta*) in both study areas. so we sprayed an insecticide on the ground in a 2-m circumference around each trap (Mitchell et al. 1996). We trapped small mammals concurrently with pellet collection, setting traps at sunset and checking them each morning. Each trapping session consisted of 50 trap-nights: 25 traps × 2 nights.

To compare potential insect and arachnid prey at Rutland Ranch and Marco Island, we randomly placed two pitfall traps, between 0 and 360°, approximately 5 m from the starting point of each transect. Pitfall traps consisted of number 10 cans buried in the ground and level with the soil surface (Wesemann 1986). We placed 5 cm of water in the bottom of each can to deter insects from climbing out and baited traps with either spoiled meat or fruit (Wesemann 1986). We placed a covering of Plexiglas and wire mesh several centimeters above each trap to deter rain and predators. We trapped insects concurrently with small mammals. Each morning we removed the captured insects and pinned them for later identification to order or family. Each insect-trapping session consisted of 20 trap-nights: 10 traps × 2 nights.

STATISTICAL METHODS

We tested for differences between prey classes found in pellets collected from the urban and rural sites with a two-by-six chi-squared contingency table (Zar 1999). We tested for differences in insect and arachnid prey captured in pitfall traps at the rural and urban sites with a two-by-two chi-squared contingency table (Zar 1999).

RESULTS

DIET

We collected 55 pellets at Marco Island and 29 pellets from Rutland Ranch. In both areas, insects were the most frequent prey, constituting 86% of the diet at Marco Island and 89% at Rutland Ranch (Table 1). Arachnids were the second most frequent prey item (Marco Island 9%; Rutland Ranch 8%; Table 1). When the prey were categorized by class (Insecta, Arachnida, Gastropoda, Aves, Reptilia, Mammalia), the diets at the two sites differed significantly ($\chi^2 = 13.8$, $P < 0.025$). The largest contribution to the chi-squared value, and poorest fit to the expected value, came from the lower number of avian prey in pellets collected at the rural site. At Marco Island avian prey occurred within pellets during all sampling periods.

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TABLE 1. Classification of prey remains found in Burrowing Owl pellets collected from Rutland Ranch (rural habitat, 29 pellets) and Marco Island (urban habitat, 55 pellets).

	Rutland Ranch		Marco Island	
Taxon	Total	Percentage	Total	Percentage
Insecta				
Coleoptera				
Scarabaeidae	146	31.8	250	40.0
Dermaptera	127	27.7	58	9.3
Orthoptera				
Acrididae	48	10.5	23	3.7
Gryllidae	47	10.2	196	31.4
Hemiptera				
Reduviidae	7	1.5		
Coleoptera				
Cerambycidae	4	0.9		
Carabidae	19	4.1	5	0.8
Curculionidae	11	2.4	5	0.8
Arachnida				
Araneae				
Clubionidae	38	8.3	57	9.1
Gastropoda				
Stylommatophora				
Spiraxidae	8	1.7	5	0.8
Reptilia				
Squamata				
Polychrotidae			6	1.0
Aves	3	0.7	18	2.9
Mammalia				
Rodentia	1	0.2	2	0.3

PREY SURVEYS

No small mammals were captured during the 300 trap-nights at either site. Insect pitfall trapping was conducted for 120 trap nights at both study sites. At Marco Island we captured in pitfall traps one arachnid and 17 insects, of which the family Gryllidae was the most frequent ($n = 6$; Table 2). At Rutland Ranch we captured 24 arachnids and 42 insects, of which the Gryllidae were again the most frequent ($n = 29$; Table 2). Insect and arachnid abundance on Marco Island and Rutland Ranch differed significantly ($\chi^2 = 6.4$, $P < 0.025$). The largest contribution to the chi-squared value, and poorest fit to the expected value, came from the number of arachnids captured in urban pitfall traps.

TABLE 2. Total number of insects and arachnids captured in pitfall traps at Marco Island and Rutland Ranch.

	Quantity captured	
Taxon	Marco Island	Rutland Ranch
Insecta		
Orthoptera		
Gryllidae	6	29
Acrididae	0	4
Tettigoniidae	0	2
Coleoptera		
Carabidae	5	7
Diptera	4	0
Hemiptera		
Cicadellidae	1	0
Gelastocoridae	1	0
Arachnida		
Araneae		
Clubionidae	1	24

DISCUSSION

Our results indicate the Burrowing Owl's diet and prey availability in the rural and urban study areas differed significantly. Insects and arachnids were the two categories found most frequently in owl pellets at each site. Non-insect prey constituted 11% of the owl's diet at the rural site (Rutland Ranch), 14% at the urban site (Marco Island). Future studies could compare the effectiveness of pellet analysis to other methods such as analysis of prey remains (Simmons et al. 1991), direct observations (Sanchez et al. 2008), and camera or video documentation (Tornberg and Reif 2007) for determining the diet of Florida Burrowing Owls.

Because we sampled only one rural and one urban site, we do not know if the higher percentage and greater variety of insects in the diet of the owls at Rutland Ranch was a result of habitat differences between the rural and urban study areas. Urbanization can cause habitat loss, habitat fragmentation, and alteration of habitat quality, resulting in the increase in some insect species or the decrease in others (Connor et al. 2002). The pasture at Rutland Ranch is composed of various grasses and herbaceous vegetation. The surrounding landscape, however, contains a variety of habitats such as pine flatwoods, oak scrub, riparian hardwoods, and herbaceous marshes (Barnwell et al. 2003), and Mrykalo et al. (2007) documented owls using habitats other than improved pasture. The urban environment of Marco Island consists of either vacant housing lots that are routinely mowed, developed lots containing office buildings or homes, or open areas such as small parks, athletic fields, and playgrounds. Developed lots and open areas are commonly covered by uniform lawns and small areas of native or ornamental trees and/or shrubs. Sampling a larger number of urban and rural sites in future diet studies would help determine if owls in these habitats differ in diet.

Pitfall trapping may not have represented the Burrowing Owl's potential ground-dwelling prey on Marco Island and Rutland Ranch accurately. For example, no insects of the family Scarabaeidae were caught in pitfall traps even though they were the most frequent prey in regurgitated pellets from both areas and pitfall traps have previously proven successful in capturing insects of this family (Goehring et al. 2002). Differences between studies in the success of trapping Scarabaeidae may be the result of differences in habitat types and the number of traps. Goehring et al. (2002) used a larger number of pitfall traps, and their study areas included small forests, large forests, and coffee plantations. Pitfall trapping in other Florida cattle pastures has been successful in capturing insects of the family Scarabaeidae (RS, pers. obs.).

Ours is the first study to compare the diet and prey availability of rural and urban Burrowing Owl populations. As land development and conversion continue in Florida, determining factors that limit population growth in rural and urban/suburban Burrowing Owl populations will be an important tool for the management and conservation of this species throughout the state.

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