

Urban Naturalist

No. 19

2018

Preserving Habitat for *Athene
cunicularia floridana* (Florida
Burrowing Owl): Challenges and
Solutions from Cape Coral, Florida,
USA

Hubert B. Stroud and Mary K. Kilmer



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Cover Photograph: Adult burrowing owl on a T-perch in Cape Coral, FL. Photograph © Judy Stroud.

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Preserving Habitat for *Athene cunicularia floridana* (Florida Burrowing Owl): Challenges and Solutions from Cape Coral, Florida, USA

Hubert B. Stroud¹ and Mary K. Kilmer^{2,*}

Abstract - Urban/suburban development generally results in a loss of native habitat and a concomitant decrease in biodiversity. However, for species able to adapt or adjust to human environments, such as *Athene cunicularia* (Burrowing Owl), potential exists to protect and preserve suitable habitat in developing areas, thus aiding in species preservation. In many areas, suburban lands represent the dominant available habitat for this species. Cape Coral, Florida, USA is a suburban community that currently contains 10–35% of the entire state-wide population of Florida Burrowing Owls—a state-listed threatened species—while also being one of the fastest-growing cities in the US. Thus, this city faces the challenge of protecting habitat for a threatened species within a framework of rapid development. Here we present the solutions employed by Cape Coral as an example for other suburban communities facing similar issues.

Introduction

Urban development and habitat loss

As the 20th century progressed, a population shift occurred in the US, with large portions of the population moving out of densely populated urban areas and into suburban communities; by the 1960s, previously sparsely occupied rural land was being subdivided for sale at an unprecedented rate (Stroud 1995). Suburban areas, by their nature, have relatively low population density and tend to sprawl across vast acreages, which means that a greater amount of land is converted from its original use than is the case for denser urban development. This sprawling pattern of development reduces habitat for both plants and animals and is detrimental for many species. Not surprisingly, suburban development is closely related to a decrease in biodiversity (McKinney 2002). While many species are harmed by development, some species, known as urban exploiters, adapt well and thrive in urban environments, including smaller species, such as *Columbia livia* Gmelin (Rock Dove) (Kark et al. 2007) and *Rattus* spp. (rats) (McKinney 2002), and larger species, such as *Lynx rufus* (Schreiber) (Bobcat) and *Canis latrans* Say (Coyote) (reviewed in Bateman and Fleming 2012).

Suburban environments are unique in that they represent a moderately disturbed habitat. The intermediate-disturbance hypothesis suggests that biodiversity would

¹Department of Criminology, Sociology, and Geography, Arkansas State University, PO Box 2410, State University, AR 72411, USA. ²Department of Biology and Environmental Health, Missouri Southern State University, 3950 East Newman Road, Joplin, MO 64801, USA. *Corresponding author - Kilmer-M@mssu.edu.

be relatively high in these areas; the hypothesis is supported by greater animal and plant species diversity of many taxa in these areas compared to more-natural areas (reviewed in McKinney 2002). Edge species (termed “urban adaptors”) can often thrive in these areas, particularly if utilization of urban areas provides some sort of ecological release (Rebolo-Ifrán et al. 2017). Thus, suburban developments can provide potential habitat for threatened species that are also urban adaptors, while simultaneously allowing for development of land (McKinney 2002). One potential “urban adaptor” is *Athene cunicularia* Molina (Burrowing Owl), a species historically found in open habitats such as grasslands and deserts, but which is currently found in suburban areas such as Cape Coral, FL, USA. In this study, we provide an overview of Burrowing Owl ecology and use Cape Coral as an example of the potential for suburban areas to provide valuable habitat for this threatened species.

***Athene cunicularia* (Burrowing Owl), as an Urban Adaptor**

The Burrowing Owl is well known for both its wide distribution and its adaptability to environmental change (Berardelli et al. 2010). Throughout the US, much of the original Burrowing Owl habitat has been lost due to conversion of grasslands to agricultural land and urban and suburban development (Berardelli et al. 2010, Millsap and Bear 2000, Restani et al. 2008). This loss has resulted in well-documented declines in Burrowing Owl populations throughout the US (Desmond and Savidge 1996, Sauer et al. 2007, Stroud and Self 2008) and Canada, where it is currently listed as a species of concern (IUCN Red List 2017). Interestingly, this decline in populations has been accompanied by a shift in populations to open suburban environments, such as golf courses and vacant building-sites.

Food availability has been found to be crucial to the survival of Burrowing Owls in natural habitats (Haley 2002), and it stands to reason that this would also be true in anthropogenic environments. Several studies have compared the diet of rural and urban Burrowing Owls. Trulio and Higgins (2012) conducted a detailed analysis of the diet of *Athene cunicularia* Molina ssp. *hypugaea* Bonaparte (Western Burrowing Owl). and concluded that although invertebrates were represented in greater numbers than vertebrates, the biomass provided by vertebrates (specifically rodents) made up ~70% of the Western Burrowing Owl diet. Urban settings tend to have limited rodent populations; thus, the authors suggest increasing the rodent population especially during the breeding season. It is worth noting that Trulio and Higgins (2012) did not find a difference between relative proportions of invertebrate and vertebrate prey in rural and urban populations but did find a difference in prey composition. Myrkalo et al. (2009) obtained a similar result in *Athene cunicularia* Mollina ssp. *floridana* (Ridgway) (Florida Burrowing Owl). Although the comparison was limited to a single rural and a single urban population, those authors found similar invertebrate:vertebrate-prey ratios between the 2 populations but differences in diet composition, with urban populations consuming more avian prey (Mrykalo et al. 2009).

Burrowing Owls have been particularly successful in urban settings. A survey in Cape Coral in 2000 found a large number of Burrowing Owl nests on vacant

residential lots (Millsap and Bear 2000), a result mirrored in other urban settings in Florida (Bowen 2001). Further support for the Burrowing Owl as an urban adaptor was provided by Rebolo-Ifrán et al. (2017) who found that urban landscapes in Argentina had average densities 7 times greater than nearby rural habitats. Not only were average densities greater in urban habitats, but breeding success was also greater in these areas. Forty-five percent of nests in rural sites were affected by breeding failure, while only 27% of nests in urban sites exhibited such failure (Rebolo-Ifrán et al. 2017). Millsap and Bear (2000) also found an increase in breeding success along an urban gradient but noted that this increase ceased as development approached 60% of total land area. These results, along with observations by local wildlife biologists, indicate that Burrowing Owls seem to be urban adaptors and are possibly even urban exploiters (J. Herman, Department of Biological Sciences, Florida Gulf Coast University, Ft. Meyers, FL, USA, pers. comm.). However, it is possible that their presence in urban habitats is simply a result of the loss of natural habitat, rather than a true preference for developed areas (De Sante et al. 1997, Rosenberg and Haley 2004).

Burrowing Owl ecology and conservation status

As the common name of the species implies, Burrowing Owls make their homes by either occupying the abandoned burrows of small mammals (most common in Western Burrowing Owls [Desmond and Savidge 1996]) or by burrowing a hole or tunnel in the ground (most common in Florida Burrowing Owls [Millsap 1997]). Burrowing Owls hunt on the ground during the day and use their underground burrow for nesting and raising young (Sibley 2000). Burrowing Owls prefer treeless, open grassland and sandy well-drained soil, but can adapt to other habitats, particularly when their favored habitat is no longer available (Green and Anthony 1989, Williford et al. 2009). Although Burrowing Owls most often dig their own burrows, they can also take advantage of abandoned *Cynomys* sp. (prairie dog) colonies, and *Marmota monax* L. (Groundhog), Sciuridae (squirrel), and Geomyidae (gopher) holes (Green and Anthony 1989), and will occasionally use humanmade structures such as pipes or post holes (Williford et al. 2009). The historic range of the Burrowing Owl was primarily dependent upon grassland habitat inhabited by burrowing mammals and extended across the western-half of the US (Fig. 1) and from the Canadian prairie provinces to South America. Burrowing Owls are also found in Florida and the Caribbean islands (Poulin et al. 2011).

In the US state of Florida, the Florida Fish and Wildlife Conservation Commission has designated Florida Burrowing Owl as a threatened species (FWC 2017). This designation was updated in January 2017, following roughly 3 decades of the species having the designation of species of “special concern”. This upgraded designation indicates that Burrowing Owl populations within the state are considered to be at increased risk. The Florida Burrowing Owl is protected under Chapter 39 of the Florida Administrative Code. The Migratory Bird Treaty Act also protects this species due to the presence of populations within both the US and Mexico.

Distribution of Florida Burrowing Owls

The historical habitat of the Florida Burrowing Owl existed primarily across native prairies of central Florida. Extensive portions of this habitat have been converted to agricultural and urban land usage, and the species now has a patchy distribution in Florida. Burrowing Owls were either forced to relocate or simply moved to the suitable habitat that was being created outside the historic range (Millsap and Bear 2000).

There have been a few notable surveys of Florida Burrowing Owls, some of which are rigorous and scientific in nature, while others were less sophisticated but nevertheless provide insight into the Burrowing Owl population. Although population data are limited, the Florida Fish and Wildlife Conservation Commission has estimated the statewide Florida Burrowing Owl population at between 3000 and 10,000 pairs (C. Faulhaber, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA, pers. comm.; FWC 2011; Millsap 1997). Below, we highlight some of the details of the most important censuses to date.

The earliest published survey in which Florida Burrowing Owl populations were quantified occurred between 1987 and 1990 and consisted of twice-weekly surveys between the months of January and March in a 35.5-km² area in Cape Coral, FL, USA (Millsap and Bear 2000). The survey included areas across the spectrum of

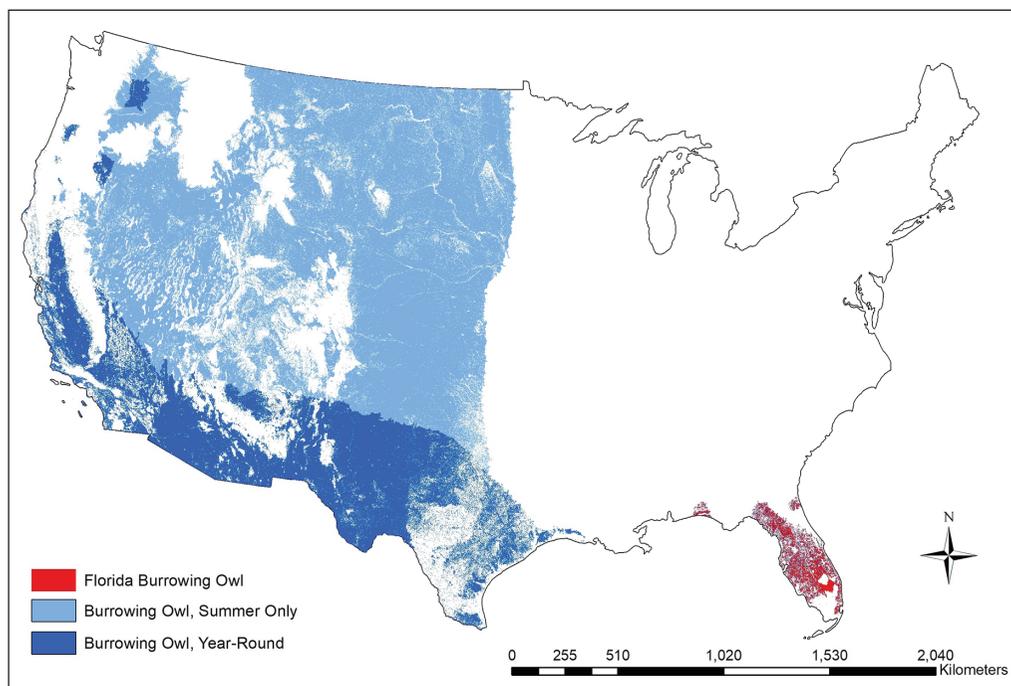


Figure 1. Historical range of *Athene cunicularia* (Burrowing Owl) and *Athene cunicularia* ssp. *floridana* (Florida Burrowing Owl). The Burrowing Owl is a permanent resident in parts of the US and a temporary summer resident in other parts. Map created by M.K. Kilmer with GIS layers from US Census Bureau and US Geological Survey National Gap-Analysis Program.

urban development within Cape Coral, ranging from areas with <2% development to those with >80% development. That survey tracked breeding attempts at 264 unique nest sites within the study area and found that maximum population densities were ~7 pairs of owls per km², with an estimate of roughly 1000 breeding pairs within Cape Coral. Interestingly, nesting-site density and number of young fledged per nest increased linearly along a developmental gradient to ~60% development; at levels of development >60%, both of the previous metrics had an inverse relationship with development (Millsap and Bear 2000). That survey was conducted in a limited area; thus, it is difficult to extrapolate the results to the entire meta-population of Florida Burrowing Owls.

Perhaps the most comprehensive survey of Florida Burrowing Owls was conducted as part of the Florida Burrowing Owl Project, coordinated through the University of Central Florida in 1999. That survey was based on the methods used by De Sante et al. (1997) to census Burrowing Owls in California, which employed random and nonrandom block sampling based on where Burrowing Owls had been historically known to breed. The 1999 survey by Bowen included 1035 historic and current breeding-owl locations in 62 Florida counties (Bowen 2001, 2006). While relatively comprehensive in geographic coverage, Bowen's 1999 census consisted primarily of roadside surveys that inherently limited the results to owl burrows visible from the road. When possible, Bowen attempted to correct for this bias by conducting walking surveys to interior locations, but this correction was limited to properties where owners allowed access (Bowen 2001). More than 50 surveyors were involved in that study; 1 census team was assigned to each county that was found to contain occupied burrows. Despite its shortcomings, the survey by Bowen (2001) found owls at 946 territories within 32 of the 62 counties surveyed. A total of 1757 adults and 759 juvenile owls were recorded, and a large proportion of individuals (~780) were found on vacant residential lots in Southwest Florida (Bowen 2001).

The most recent survey of Florida Burrowing Owls occurred in June 2017 but was limited in scope to the population within Cape Coral, FL, USA, making it more comparable to the Millsap and Bear (2000) surveys. The survey was much more limited in time, consisting of a single day, but had a relatively high level of participation, with over 50 volunteers. The participants were divided into small teams that counted the number of owls within unique quadrants of the city (J. Heller, Environmental Planner, City of Cape Coral, Cape Coral, FL, USA, pers. comm.). All roads within the study area were sampled and, given the dense network of roads, volunteers were able to observe the entire landscape. Thus, there were no problems associated with interior locations as there were with the Bowen census in 1999. The June 2017 survey found ~3800 owls within the city, though this number consisted of both adults and juveniles, rather than just adult pairs, as observed by Millsap and Bear (2000). Adults represented 1400–2400 of the owls counted (H. Phillips, Senior Environmental Recreation Specialist, Rotary Park, City of Cape Coral, Cape Coral, FL, USA, pers. comm.). However, this census consisted of many volunteer observers with limited amounts of training in survey techniques, which

may have impacted the results (C. Bear, Coordinator of Programs and Services, Randell Research Center, Pine Land, FL, USA, pers. comm.). Volunteers were unable to consistently differentiate adults and juveniles; thus, it is most appropriate to use the total number of owls counted as the defining metric in this survey. It should be noted that the June 2017 survey was part of an ongoing analysis of Burrowing Owls in Cape Coral being carried out by researchers at Florida Gulf Coast University (J. Herman, pers. comm.). Although the survey was flawed in some respects, it provided a “snapshot” of current populations of Florida Burrowing Owls in Cape Coral and indicated that populations were stable or even possibly increasing within Cape Coral. Although this result is encouraging news, there is no consensus as to the success of the Cape Coral population at this time. Plans are already being made to survey the Burrowing Owl population every year or 2 over the next few years to determine if a trend is present (J. Herman, pers. comm.).

A direct comparison of surveys of this species is not possible because completed studies have varied in their timing, geographic distribution, and survey methods. However, the numbers of owls located, particularly within developed areas such as Cape Coral, compared to overall statewide estimates (3000–10,000 pairs), indicates that residential areas are currently serving as important habitat for this species. Based on survey results, the population of Florida Burrowing Owls in Cape Coral is considered the largest and densest population within the state of Florida and possibly east of the Mississippi River (Bowen 2001; J. Herman, pers. comm.; H. Phillips, pers. comm.). It seems clear that the success of this population (and other urban populations) could be the key to maintaining a stable Florida Burrowing Owl population (J. Heller, pers. comm., Stroud and Self 2008). Unfortunately, although Cape Coral represents important habitat for Florida Burrowing Owls, it is also a rapidly growing city with a population that has increased from ~11,000 in 1970 to over 180,000 today (Blissman 2005; W. Daltry, Senior Planner, City of Cape Coral, Cape Coral, FL, USA, pers. comm.). This >1000% increase makes Cape Coral the 11th-largest city in the state of Florida and the fastest growing city in the US (Sharf 2017).

Development of the Urban Habitat: Cape Coral, Florida

The development of Cape Coral began in 1957 when the Rosen brothers purchased a section of coastal land across the Caloosahatchee River from Fort Myers, FL, USA (Dodrill 1993, Stroud 1995). Nearly all vegetation was removed over an area of ~24,281 ha (~60,000 ac) through bulldozing and leveling (central and northern portions), and dredge and fill operations (southern portions). As much as 90% of the original tree canopy was removed during the clearing and development process (Stroud 1995), creating an area that closely matched the preferred habitat of Florida Burrowing Owls. Concomitant with the development of Cape Coral, The Florida Burrowing Owl began a range expansion, moving into suburban and urban areas (Ligon 1963), though it is unclear if this expansion represented a range shift, due to loss of preferred habitat in the center of the state or simply an opportunistic colonization of the newly emerging habitat.

To date, Cape Coral has a large number of vacant lots that are ideal habitat for Florida Burrowing Owls (J. Heller, pers. comm.). Only ~35% of the more than 135,000 residential building sites are occupied by homes, though this number is rapidly declining in some areas. Burrowing Owls can coexist moderately well with humans as long as housing densities are not too high. Moderate levels of urbanization may actually provide more prey availability and protection from predators than nearby undeveloped areas, allowing urban populations to be more successful than those in undeveloped areas (Orth and Kennedy 2001, Rebolo-Ifrán et al. 2017, Weseman and Rowe 1987). However, at high levels of development, this success may be offset by several negative factors, including higher mortality from human-caused agents (Orth and Kennedy 2001). Fewer nesting pairs are found in areas of Cape Coral that are approaching full development, in part, because of limited space available for nesting sites. Other problems include more traffic and a higher incidence of owls being hit by cars. There is also greater potential for harassment from humans and more frequent attacks by *Felis silvestris catus* L. (Domestic Cat) and *Canis lupus familiaris* L. (Domestic Dog) (P. Donaldson, volunteer, Cape Coral Friends of Wildlife, Cape Coral, FL, USA, pers. comm.). Pesticides are often used on developed lots within Cape Coral. Burrowing Owls can be directly affected by chronic exposure to pesticides, particularly if these pesticides become concentrated in eggs (García-Hernández et al. 2006) or indirectly affected if the insecticides used impact the available food supply (Gervais and Anthony 2003).

The level of human development that is acceptable to Florida Burrowing Owl populations is not fully understood, though Millsap and Bear (2000) found an increase in population density and nest success up to a development level of roughly 60%. This level of development was supported in 2007 by a local planning technician who suggested that owls appear to be the most successful in neighborhoods that are between 50% and 75% developed (L. Blydenburgh, Planning Technician, City of Cape Coral, Cape Coral, FL, USA, pers. comm.). More recently, the environmental planner at Cape Coral pointed to the difficulty of establishing a preferred level of development. He emphasized the importance of open space and the ability of owls to survive even in areas of the city that are more or less fully developed. Obviously, more research is needed to determine this important urban metric (J. Heller, pers. comm.; J. Herman, pers. comm.).

Preserving Burrowing Owl Habitat in Cape Coral, Florida

Current strategies

Though development is inevitable in Cape Coral, city planners are attempting to protect and preserve current Florida Burrowing Owl populations through a variety of strategies (Table 1). First, in recent years, the city has mapped the owls' exact burrow locations and is working to establish clearly marked protection zones (Fig. 2). This process is crucial because the city mows grass in vacant lots, and clearly identifying the protection zone allows mowers to avoid occupied nesting areas; the area inside the protection zones is mowed by hand (J. Heller, pers. comm.).

Table 1. Current and proposed conservation strategies to protect *Athene cunicularia floridana* (Florida Burrowing Owl).

Strategy	Status	Projected effect
Map burrows, establish protection zones	Current	Reduce impact of mowing on burrows, decrease harassment of burrows
Limit use of pesticides	Current	Reduce direct and indirect impacts to owl populations
Restrict development in areas with occupied burrows	Current	Maintain sufficient habitat for current population
Increased educational outreach	Current	Increase awareness of species and ecological importance, decrease harassment of burrows
Increase ties with local organizations	Current	Increase awareness and education, increase volunteer efforts to protect species
Establish starter burrows, remove sod from small areas	Proposed	Entice owls to desired locations
Lot buy-back by city	Proposed	Protect suitable habitat from development
Provide additional resources for enforcement of current statutes	Proposed	Decrease harassment of owls and destruction of burrows



Figure 2. Example of protection zone (PVC pipes) around an occupied nesting burrow with T-perch near burrow in Cape Coral, FL, USA. Photograph © Hubert Stroud.

Furthermore, city officials are encouraging homeowners not to use pesticides during the owl's nesting season (J. Heller, pers. comm.; Stroud and Self 2008).

Second, both the city and the state have enacted restrictions on development in areas with burrows serving as occupied nesting areas. Although current restrictions do not prohibit building on a lot with an existing owl burrow, a protection zone must be established that extends 3 m (10 ft) in all directions from the burrow entrance. If it is not possible to construct a project and maintain the required protection zone, the developer must request a permit from the Florida Fish and Wildlife Conservation Commission to destroy the nest. Currently, the state permit prevents destruction of the nest while owls are actively incubating eggs or rearing flightless chicks. Although the Florida Fish and Wildlife Conservation Commission protects the owl population and the burrows from harassment (Fig. 3), enforcement

Figure 3. Photograph of sign in Cape Coral, FL, USA, indicating the protected status of *Athene cunicularia floridana* (Florida Burrowing Owl) nesting sites. Photograph © Judy Stroud.



is difficult because many of the nests in Cape Coral occupy privately owned building sites (P. Donaldson, pers. comm.; H. Phillips, pers. comm.). Ensuring resources for enforcement of current statutes or initiating more state and local legislation to protect the owl will be a critical step in preserving the owl population, both in Cape Coral and in other communities.

Third, the City of Cape Coral has increased its efforts to educate individuals about the value of Florida Burrowing Owl populations. Following their surveys, Millsap and Bear (2000) noted that cases of harassment declined shortly after the implementation of a formal, mandatory education program about the owls. The city website for Cape Coral provides detailed information about the Florida Burrowing Owl, including how to protect burrows during construction, details concerning federal and state protection laws, and information on how individuals can help protect owls and view them in an appropriate manner. Additionally, a volunteer program has been established with a local organization, the Cape Coral Friends of Wildlife. This organization has a group of people that monitor and maintain burrows throughout the city (B. McNee, Volunteer, Cape Coral Friends of Wildlife, Cape Coral, FL, USA, pers. comm.). Any destructive or inappropriate encroachment activities are reported to the Florida Fish and Wildlife Conservation Commission (City of Cape Coral 2017; J. Heller, pers. comm.).

The city maintains close ties with other groups and agencies, including nearby universities, the Florida Fish and Wildlife Conservation Commission, and the Cape Coral Friends of Wildlife, to survey, map and monitor populations of Florida Burrowing Owl. The recent survey, conducted in June 2017, represented a joint effort between faculty and students from Florida Gulf Coast University, volunteers from the Cape Coral Friends of Wildlife, City of Cape Coral Department of Community Development staff, and volunteers from the general population (B. McNee, Volunteer, Cape Coral Friends of Wildlife, Cape Coral, FL, USA, pers. comm.; S. Luaces, Graduate Student, Department of Biological Sciences, Florida Gulf Coast University, Fort Myers, FL, USA, pers. comm.).

Future strategies

Options are available to communities interested in preserving the Burrowing Owl and its habitat. Although owls tend to burrow on vacant lots or take over existing unoccupied burrows, they can be enticed to inhabit starter burrows created by removing a portion of lawn turf, starting a tunnel and placing a T-perch near the tunnel entrance (Fig. 4). Owls in need of a new home have demonstrated a willingness to move into such starter burrows, particularly owls that are becoming a part of the breeding population for the first time, or, which have been displaced by ongoing development (Richie 2011). By offering starter burrows on lawns, Cape Coral citizens can encourage owls to move onto portions of developed land and prevent owls from burrowing on lots that are slated for future alteration or disturbance. Although data are anecdotal and more research is needed, it appears that starter burrows are particularly appealing to displaced owls (J. Heller, pers. comm.).

An additional way in which landowners can help to preserve Florida Burrowing Owl habitat is to buy multiple adjacent lots, only one of which is developed

into a home site. Additional lots could be lawn or open space, which could serve as owl habitat. This option would have the additional benefit of reducing overall development densities within a community and is an ambitious idea for individual citizens because lots in Cape Coral are relatively expensive; however, it may be practical for the city to take an active role in land acquisition or to participate in a buy-back program for tax-delinquent property. This land could be used to meet open-space needs or other public uses while also providing habitat for Florida Burrowing Owls. Even providing a scattering of vacant lots is beneficial. At Marco Island, for example, just a few vacant parcels plus the use of burrows in yards of developed lots and in city parks has been sufficient to maintain over 100 pairs of owls (C. Chustz, Environmental Specialist, City of Marco Island, Marco Island, FL, USA, pers. comm.).

Conclusions

The Florida Burrowing Owl population is slowly disappearing from the state's interior due to growth and development associated with an ever-expanding human population. This decline prompted the state to recently reclassify the Florida Burrowing Owl as a threatened species (FWC 2017). Fortunately, new potential habitat has emerged within areas cleared for suburban development. One of the most important developments is Cape Coral, a large pre-platted subdivision with extensive



Figure 4. Photograph showing T-perch—emplacement near occupied nesting burrow in Cape Coral, FL, USA. Photograph © Judy Stroud.

areas of cleared land. Unfortunately, as these communities approach build-out and ideal nesting conditions diminish, the owl population may be negatively affected. Although it is unknown what results full development may have, monitoring in communities such as Cape Coral and Marco Island provides information that could help to improve management strategies over time.

Burrowing Owls appear to be urban adaptors and have the potential to co-exist with sizeable human populations. The key to maintaining these owl populations seems to be for humans to be sensitive to Burrowing Owl requirements and to accommodate current nesting owls by maintaining areas of open space when possible. Providing open space for owls would also benefit other wildlife populations as well as humans by creating more livable communities for all inhabitants. Greater public awareness included as part of a general education program geared toward preservation of Burrowing Owls can also go a long way toward protecting the birds for future generations to enjoy.

Cape Coral provides an excellent example of preservation of crucial habitat for a threatened species within a suburban area that is undergoing rapid land-development. This community is also a model for cities that seek to balance necessary development with the needs of species within the urban network. As development increases throughout the world (and habitat stress on species increases), the lessons learned in Cape Coral can provide valuable insights into how we can maintain biodiversity in the face of a rapidly expanding human population.

Acknowledgments

The authors would like to thank Justin Heller, an environmental planner with the City of Cape Coral, FL, for his assistance in locating burrowing owl nest sites and for his insightful comments concerning the care and protection of the burrowing owl population at Cape Coral. We would also like to thank 2 anonymous reviewers for their thoughtful comments and feedback that helped to improve this manuscript. Finally, we would like to thank Judy Stroud for her excellent photographs of the burrowing owl.

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