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NONURBAN HABITAT USE OF FLORIDA BURROWING OWLS: IDENTIFYING AREAS OF CONSERVATION IMPORTANCE

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ABSTRACT.—Statewide distribution and habitat use of the Florida Burrowing Owl (*Athene cunicularia floridana*), currently state-listed as a ''Species of Special Concern,'' is not well-understood, particularly in remote, nonurban areas. Its status as a protected species is currently being reevaluated and information is needed to help state wildlife managers better understand habitat usage in nonurban areas. To help address this need, we visited Burrowing Owl sites from historical databases to verify and update them while also documenting new locations. We quantified land cover within empirically-derived distances around burrows with confirmed or probable breeding activity, then compared observed and available proportions of habitat, calculated selection indices, and determined selection/avoidance for each land-cover class. These empirical results were used in combination with literature review and field observations to select land-cover criteria for suitable habitat. The final results appear to correlate well with the overall distribution of known nonurban Burrowing Owl records, and demonstrate that a substantial amount of potentially suitable breeding habitat exists throughout Florida's central interior, but only a small proportion of it occurs inside conservation-managed areas. Improved pasture, the most prevalent land-cover class, was the most strongly selected in our study and may be of high importance to nonurban breeding Burrowing Owls. These results may assist wildlife managers in both management actions and species status decisions. We recommend increasing surveys and conservation efforts in nonurban areas and enhancing cooperation with landowners, particularly ranchers, as success on private lands seems crucial to the long-term persistence of this species in Florida.

KEY WORDS: *Burrowing Owl*; Athene cunicularia; *Florida*; *GIS*; *habitat*; *suitability*.

USO DE HÁBITAT EN ÁREAS NO URBANAS POR *ATHENE CUNICULARIA FLORIDANA*: IDENTIFICACIÓN DE ÁREAS DE IMPORTANCIA CONSERVACIONISTA

RESUMEN.—La distribución y el uso del hábitat en todo el estado de Florida por parte de *Athene cunicularia floridana*, una especie cuya conservación reviste especial preocupación, son poco conocidos especialmente en áreas remotas no urbanas. Su estatus como especie protegida está siendo reevaluado en la actualidad y se requiere información para ayudar a los gestores de vida silvestre a comprender el uso del hábitat en áreas no urbanas. Para contribuir a suplir esta necesidad, visitamos sitios de donde se conoce la especie según bases de datos históricas para verificarlos y actualizar la información, además de documentar nuevas localidades. Cuantificamos las coberturas del suelo en perímetros definidos empíricamente alrededor de las madrigueras en las que había actividad reproductiva confirmada o probable. Posteriormente comparamos las proporciones de hábitats observadas y las disponibles, calculamos índices de selectividad y determinamos la selección/evasión para cada clase de cobertura del suelo. Los resultados empíricos fueron empleados junto con una revisión de la literatura y observaciones de campo para seleccionar criterios de identificación de hábitats idóneos para la especie basados en la cobertura del suelo. Los resultados finales

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parecen estar bien correlacionados con la distribución general de los registros conocidos de *A. c. floridana* en ambientes no urbanos. Además, demuestran que una cantidad sustancial de hábitat potencialmente idóneo para la reproducción existe en áreas del interior central de Florida, pero sólo una fracción pequeña se encuentra dentro de áreas manejadas para conservación. Los pastizales mejorados, la clase de cobertura del suelo más prevalente, fueron los ambientes más fuertemente seleccionados en nuestro estudio y podrían ser de importancia alta para los individuos de la especie que crían en áreas no urbanas. Estos resultados podrían ayudar a los gestores de vida silvestre para la realización de acciones de manejo y para la toma de decisiones sobre el estatus de la especie. Recomendamos que se hagan más censos y se emprendan más esfuerzos de conservación en áreas no urbanas y que se promueva la cooperación con los dueños de la tierra ya que el éxito en tierras privadas parece crucial para la persistencia de esta especie en Florida a largo plazo.

[Traducción del equipo editorial]

The Florida Burrowing Owl (*Athene cunicularia floridana*) has been classified since 1979 as a ''Species of Special Concern'' by the Florida Fish and Wildlife Commission (FWC) because of threats from ''habitat modification, environmental alteration, human disturbance, or human exploitation'' which may further endanger it ''unless appropriate protective or management techniques are initiated'' (FWC 2010). This status is now being reevaluated, along with that of 60 other species, under new imperiled species listing criteria and rules recently passed by the Commission, which require increased use of quantitative data, and the FWC is requesting information to aid in this reevaluation (FWC 2010).

Statewide distribution and habitat use of Florida Burrowing Owls (''owls'') is not well-understood, particularly in remote, nonurban areas (Mueller et al. 2007). Indeed, almost all of the literature for this subspecies focuses on suburban/urban populations that face various anthropogenic threats (Millsap and Bear 1988, Millsap and Bear 2000, USFWS 2003, FWC 2009). Despite calls to expand inventories and monitoring of breeding populations (Owre 1978, Millsap 1996, USFWS 2003), relatively little research has been done in nonurban areas, which at one time constituted almost all of the breeding habitat in the state (Courser 1979). Reasons for this lack of effort include uncertainty about owl locations stemming from a lack of resources to properly survey the entire state along with access restrictions that prevent documentation of occurrence on private property. These difficulties may compel survey efforts to focus on specific areas most likely to contain owls. This study attempts to provide this focus by using geospatial analysis techniques to characterize the distribution of nonurban breeding habitat in counties where nonurban owls are known to occur. We also describe the amount of suitable land cover present within Florida's conservation-managed areas (FNAI 2005) to gauge whether existing managed areas seem to provide adequate owl habitat. For this study, ''nonurban'' areas included grazed pastures, fire-maintained prairies, hay and sod farms, horse pastures, and similar landscapes. They did not include occupied or vacant residential lots, airport fields, golf courses, ball fields, or suburban areas typified by dense residential zoning. Although these areas support considerable numbers of Burrowing Owls, usage of these types of habitats has already been relatively well described by the majority of Florida Burrowing Owl research.

METHODS

We compiled and evaluated the utility of existing historical distribution data on breeding owls throughout a 38-county area (Fig. 1) from multiple sources which spanned a period of decades (see Mueller et al. 2007 for detailed methods). Given that groups of owls can disperse or be extirpated and also that land-cover changes over time, we did not assume that these historical owl presence records were spatially accurate or still represented actively used Burrowing Owl habitat, and therefore we performed field visits to as many known nonurban locations as possible between May–August 2005 (within two years of the satellite land-cover images). Our primary objective was to gather accurate GPS coordinates of burrows that were either currently active (owls seen in the immediate vicinity) or showed signs of probable activity within the last year (based on evidence of feathers, droppings, pellets or insect parts, and by the amount of debris such as cobwebs or vegetative litter covering the tunnel entrance, see Mueller et al. 2007). We also documented apparent land use for later comparison to the FWC land-cover classification. We considered 62 of our field-verified burrow locations (recorded using a WAAS-enabled handheld GPS) to be available for

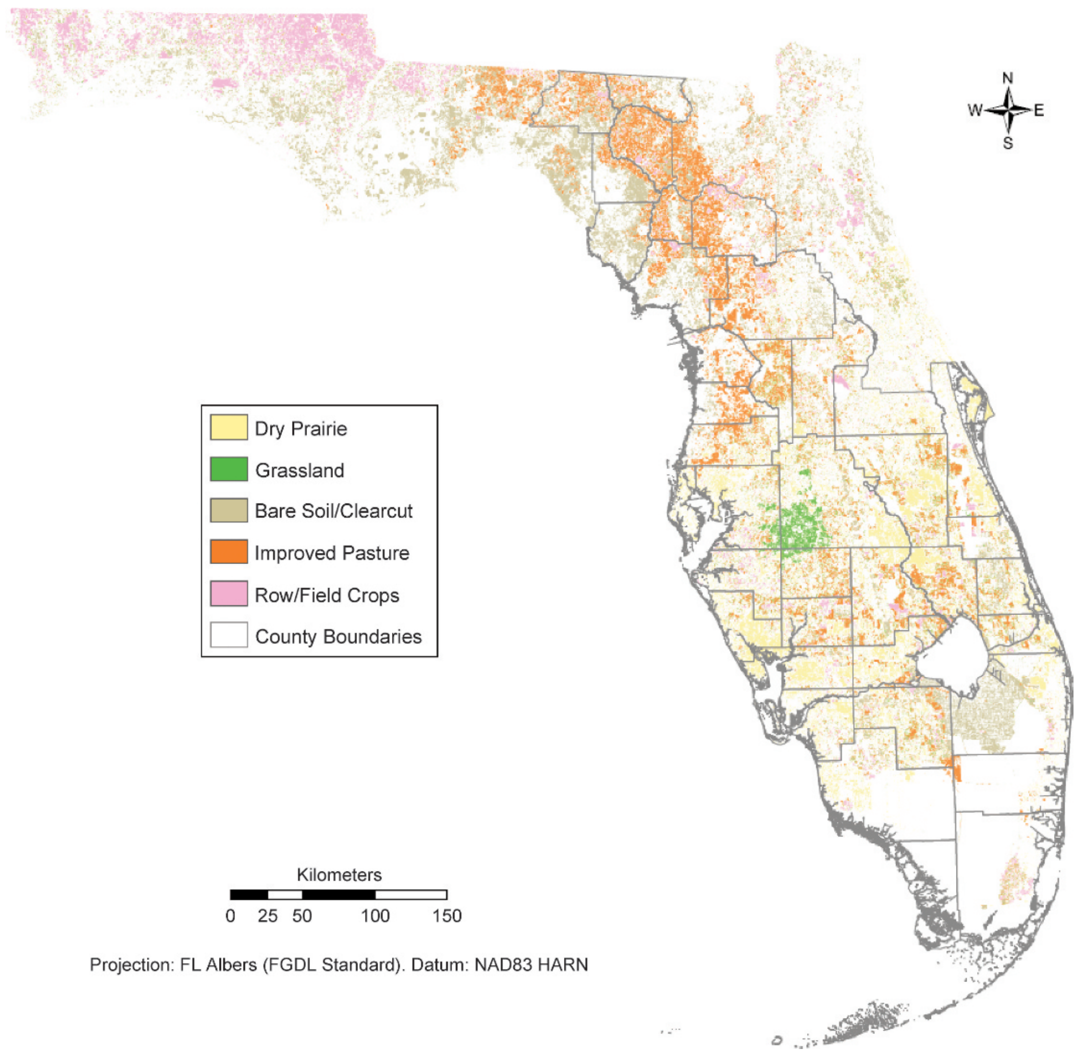

Figure 1. Statewide distribution of the five suitable land-cover classes, with boundaries of 38-county study area shown.

GIS analysis. However, to account for possible pseudo-replication bias, we used a systematic filtering method to reduce the number of point records used: points that fell within 120 m of another of the 62 nonurban points were grouped and only the burrow location with the greatest number of owls was retained (Mueller 2006). This conservative methodology reduced sample size to 30 unique points, but was necessary to reduce bias from large colonies and to prevent possible duplication of land-cover cells.

We generated and merged circular buffers around each of the retained points to estimate potentially used land cover, using the FWC's statewide ''Florida Vegetation and Land Cover'' 2003 raster dataset (Stys et al. 2004, FWC 2006) composed of 43 land-cover classes, represented with 30-m resolution cells. A 600-m radius was chosen based on two empirical studies of adult, nonurban Burrowing Owl movement patterns around nesting burrows that showed 80% (Gervais et al. 2003) to 95% (Haug and Oliphant 1990) of both diurnal and nocturnal movements were within 600 m. Both of these studies were of the Western Burrowing Owl; no similar studies have been completed on adult Florida Burrowing Owls in nonurban settings. Within the merged buffers, the land-cover cells were extracted and treated as ''used'' habitat. We pooled terrestrial

Table 1. Summary information for final five suitable land-cover classes for Burrowing Owls in Florida. Standardized Selection Index values are relative to all available classes and sum to 1 (Manly et al. 1993).

	Land-cover Type				
Metric	Improved Pasture	Row/Field Crops	Bare Soil/ Clearcut	Grassland	Dry Prairie
Standardized selection index rank	1	2	3	4	5
Standardized selection index value	0.16	0.14	0.10	0.08	0.05
% of extracted buffer areas	47.3	12.9	7.0	0.5	5.6
% of 38-county land cover	13	4	3	0.2	5
% of statewide managed areas land cover	1.9	0.5	2.0	0.1	3.8

land cover from the counties containing the 30 points and treated it as ''available'' breeding habitat. Following standard procedures described by Manly et al. (1993), we determined observed vs. expected proportions of land-cover and performed resource selection tests including calculation of standardized selection indices (which give relative use of each category) and (separately) selection/avoidance decisions for each land-cover class. The application of a Bonferroni inequality adjustment made selection/avoidance decisions more conservative. We used the selection/avoidance results as the main factor in determining the most suitable land-cover classes, but also considered literature review (including class descriptions provided by Stys et al. 2004) and input from other Florida Burrowing Owl biologists as a check against anomalous results. We extracted the suitable land-cover classes from within the boundaries of Florida's conservation-managed lands, using a detailed shoreline (FGDL 2006) to remove marine areas.

Results

Our selection process led to suitable land-cover classes that included expected classes of Dry Prairie, Grassland, Bare Soil/Clearcut, and Improved Pasture, but it also included two unexpected classes: Row/Field crops and Extractive. After careful investigation, the Extractive class was removed because we concluded that the land-cover classification process, which also relied on some ancillary land-use attribute data (Stys et al. 2004), was in error for a large swath of land-cover cells in one location. This class, described by Stys et al. (2004) as involving pit-mining operations, was determined to have been selected by our tests because of the proximity of several retained points in this general location. While the land was indeed owned by a phosphate-mining company and would later be actively mined (P. Nixon pers. comm.), our field observations indicated no mining activity of any kind in the vicinity at the time. Changing the land-cover values of the questionable cells was evaluated but abandoned as unacceptably inaccurate given the lack of detailed field measurements and a heterogeneous mix of other land-cover classes in the surrounding area, so instead the category was simply dropped. We also found that altering the cells' values would not have noticeably changed other selection/avoidance results. After removing this class along with Open Water, the five remaining suitable classes composed an estimated 26% of the total terrestrial land cover within the 38-county study area (Table 1). These five suitable land-cover classes composed only 8.3% of the total land-cover within the terrestrial boundaries of all of the state's conservation-managed areas (Table 1).

Discussion

We found five suitable land-cover classes for Burrowing Owls: improved pasture, row/field crops, bare soil/clearcut, grassland, and dry prairie. In general, these results were aligned with published reports of Burrowing Owl habitat (Millsap 1996, USFWS 2003). The substantial proportion of Row/Field Crops was somewhat surprising at first, but Stys et al. (2004) defines this class as including ''hay and grasses,'' and several historical sites observed by Mueller et al. (2007) occurred on or very near large hay and sod farms. Such areas may also provide favorable foraging opportunities, although the literature is conflicted about this (e.g., Haug and Oliphant 1990, Gervais et al. 2003). Although Unimproved Pasture's description of ''native grasses on cleared lands'' sounds favorable, the increased height and density of these grasses compared to

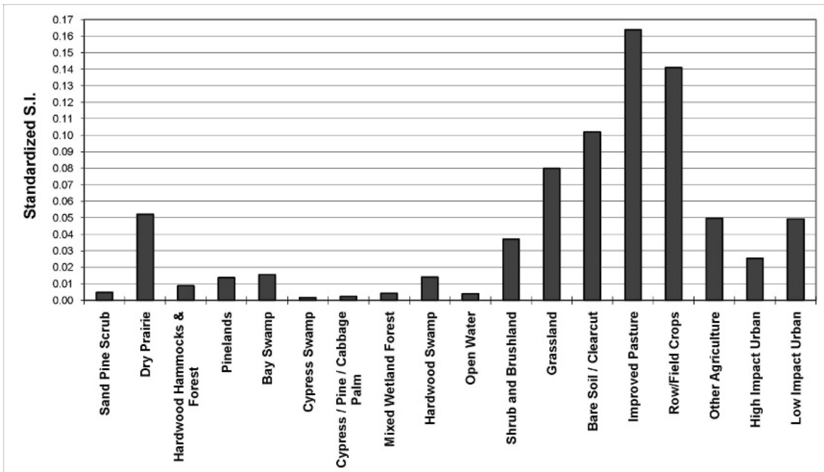

Figure 2. Standardized Selection Index comparison for 18 land-cover classes (rarer classes not shown). Values are relative to available classes and sum to 1 (Manly et al. 1993).

more consistently maintained (i.e., shorter) ones, and the inclusion of ''major stands of trees and brush'' (Stys et al. 2004) may be problematic. Of our final suitable classes, Improved Pasture composed a dominating 47% of the ''used'' land cover in the observed buffers and had the highest selection index value (Table 1, Fig. 2). Because the study area also has a very high relative proportion of this class (13%), the level required to attain statistically-significant selection for this class is also very high. Based on these results, the likely importance of this land-cover class to nonurban, breeding Burrowing Owls seems clear.

We found that although suitable land-cover classes composed 26% of the total terrestrial land cover in the 38-county study area, they made up only 8.3% of the total terrestrial land cover in all conservation-managed areas in Florida, something that may be important to state wildlife managers, especially in consideration of the possible change in legal protection status (FWC 2010). Further exploration of the land-cover data showed that wetland and forested classes dominated most of the existing conservation-managed areas. Although these classes may benefit the majority of Florida's wildlife species, they would not seem to directly benefit breeding Burrowing Owls. Although there are several managed areas in the central interior of the state (primarily Kissimmee Prairie Preserve State Park and Avon Park Air Force Base) where dry prairie-like habitat is intentionally maintained via prescribed burns and mechanical means, such areas are uncommon. Preserving or restoring additional tracts of suitable habitat within existing conservation-managed areas would be valuable, but, given the relatively small amount of conservation-managed land, we suggest that extending Burrowing Owl conservation efforts to suitable habitat in other areas could be even more beneficial. These efforts should include improved pastures on private lands (Noss 1994).

The observed high use of the human-disturbed land-cover classes Improved Pasture and Row/Field crops suggests some adaptability to nonnatural landscapes, similar to this species' adaptation to utilizing highly-disturbed urban habitats such as golf courses. However, any dependence on human-disturbed habitats—urban or nonurban—is of long-term conservation concern and requires careful monitoring. Burrowing Owls using such habitats face threats that differ from natural ones (e.g., collisions with vehicles and buildings, exposure to contaminants, etc.), and such areas can be more quickly altered by landowners and generally do not receive the same level of conservation attention as more natural habitats, especially those found in managed areas. Therefore, we recommend that the new management plan being developed by the FWC call for expanded and improved survey efforts for Florida Burrowing Owls in nonurban areas to better understand the species' overall distribution and viability. Although it is important that management efforts continue to sustain the large numbers of owls in urban areas—which are certainly significant for maintaining the overall population—we suggest that biological conclusions and management policy should not be based only on a few well-studied urban areas that are not necessarily representative of the entire species or its historical range.

Although our study focused exclusively on results obtained using the FWC's land-cover classification (Stys et al. 2004), we acknowledge that land cover is only one tool for estimating the suitability of habitat. Ideally, all potentially relevant habitat data would be considered. However, reliable habitat data do not always exist, particularly at the broad scale of this study. For example, soil type and characteristics are relevant to Burrowing Owl breeding habitat quality, as these can influence the likelihood of burrow collapse and/or flooding. Mueller (2006) analyzed SSURGO soils data (NRCS 1995) to estimate the suitability of various soil attributes, but that information is not included here because the soils data were incomplete and/or inconsistent. Where available, Mueller's (2006) best mapped estimate of suitable soils (which are generally dry and sandy but not so fine as to cause burrow collapse) in general did seem spatially coincident with the suitable land-cover classes.

The results of this habitat suitability study could serve as a starting point to help focus new field surveys and conservation initiatives for Burrowing Owls in Florida. As larger sample sizes of known nonurban breeding sites become available, suitability models can be iteratively tested and strengthened. Survey efforts may be hindered by restricted access to private properties because most of the potentially suitable habitat (and most of the known nonurban occurrence records) occur on large tracts of privately-owned land in remote areas. Therefore, further cooperation with private landowners—particularly livestock ranchers—is essential to effectively locate and conserve owls in nonurban areas (e.g., Mueller et al. 2005). Incentive-based strategies that maintain breeding habitat, such as conservation easements, could help. Given the variety of threats in urban areas (Millsap and Bear 2000, USFWS 2003) and questions about long-term persistence there (Millsap 1996), an increased emphasis on the potential value of nonurban areas for the Florida Burrowing Owl seems important.

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