Nest-site Selection by Cactus Ferruginous Pygmy-owls in northern Sonora Mexico.

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INTRODUCTION

Cactus ferruginous pygmy-owls (*Glaucidium brasilianum cactorum,* hereafter pygmy-owls) are the northernmost subspecies of ferruginous pygmy-owls (van Rossem 1937, Johnsgard 1988). Although once locally common in lowland central and southern Arizona (Bendire 1888, Fisher 1893, Breninger 1898, Gilman 1909, Bent 1938) pygmy-owls have been extirpated throughout much of their former range. In 1997 the United States Fish and Wildlife Service (USFWS) listed the population of pygmy-owls in Arizona as endangered (USFWS 1997). Although descriptions of areas used by pygmy-owls are essential for recovery and management efforts, research in Arizona has been limited, in part, because the scarcity of pygmy-owls has precluded detailed study.

In northern Sonora, Mexico, current information now indicates that pygmy-owls are locally common in desertscrub and semidesert grasslands within 100 km of the U.S. border (Flesch and Steidl 2000). In 2001, we located 53 pygmy-owl nests in the border region, many within 30 km of the U.S. Studying pygmy-owls in neighboring Sonora can provide information for management of U.S. populations. Our objectives are to describe the environment at and around pygmy-owl nests and to compare them to areas selected randomly within home ranges. Although preliminary, this information provides insight into the components necessary for an area to function as habitat for pygmy-owls.

METHODS

Study Area: We focused our efforts near the U.S.-Mexico border, in northern Sonora east and north of Mexico Route 2 and west of Mexico Route 15. This area is primarily within the Rio Altar, Sasabe, Plomo, and Sonoyta watersheds. Semidesert grassland and the Arizona Upland subdivision of the Sonoran Desert dominate vegetation in this region (Brown 1982).

Site selection and location: We focused nest searches along randomly selected transects surveyed as part of a more extensive statewide distribution study. We searched for nests at all times of day by using broadcast calls to elicit responses, observing and following owls, and searching for owl sign (pellets and scat) around potential nests. We also searched occupied sites found incidentally in 2000 and 2001. We compared the environment at and around nest-sites with sites selected at random within estimated home ranges to measure habitat selection in pygmy-owls. Home ranges of nesting pygmy-owls ranged from 9.2 to 58.8 ha in Texas (Proudfoot et al. 1999) and 9.9 to 47.3 ha in the Altar Valley, Arizona (Flesch, in press). Assuming a circular home range, this equals a maximum radius of approximately 430 m. To be conservative, therefore, we selected random points within 400 m of nests at a random direction and distance, and centered plots on the nearest potential nest substrate (columnar cactus or tree) with a suitable cavity (= 4.0 cm diameter).

Environmental measurements: We measured environmental features at nests and random sites at three spatial scales: nest cavity, nest substrate, and nest area. Within nest areas we established plots of 15- (0.07 ha), 30- (0.28 ha), and 90-m (2.54 ha) radius centered on nests and random substrates. We recorded the plant species of each substrate and measured their heights with either a pole or clinometer and diameter at breast height (dbh) with a measuring tape. We counted the number or arms large enough to harbor a cavity (>0.5 m long) in all saguaros (*Carnegiea gigantea*). We also recorded whether potential nest substrates were located in either upland or riparian areas, and whether the vegetation formation was woodland, desertscrub, savannah, or thornscrub.

We measured height, orientation, width, length, and location (arm or trunk) of all cavities possessing an internal chamber suitable for nesting in nest and random substrates. Entrance diameters were measured to the nearest half cm by placing a large ruler mounted on a telescoping pole at the widest horizontal and vertical dimensions and reading measurements with binoculars. To determine cavity contents we used a small monochrome video camera (0.05 lux) mounted on a pole attached to a liquid-crystal video display. Although some cavities were located and measured in the non-nesting season, pygmy-owls are known to appropriate cavities from other species. Therefore, we assumed that all cavities were available to pygmy-owls despite potential competition with American kestrels (*Falco sparverius*), western screech-owls (*Otus kennicottii*), and perhaps gilded flickers (*Colaptes chrysoides*).

We measured height and canopy dimensions (m) of all woody and succulent plants =2 m tall within 15 and 30 m of nest and random substrates. For canopies, we averaged the widest horizontal dimension with a perpendicular measurement across the canopy. Using a clinometer, we measured slope at the base of substrates from the lowest to highest point across 15-m plots. We measured the distance (m) between all substrates and the nearest vegetation edge (upland or riparian), drainage channel (=2 m wide), water, and man-made structure. We also measured distance and height (m) and recorded the species of the closest woody plant (=2 m tall) and saguaro (=3 m tall) in four, 90° quarters denoted by the cardinal directions (Cottam and Curtis 1956). We estimated the percent cover of each vegetation formation (desertscrub, woodland, savannah, grassland, or thornscrub) within 15, 30, and 90 m of substrates. We estimated cover to the nearest 10% when values were between 20 and 80% and to the nearest 5% otherwise.

Data Analyses: To describe nest cavities, substrates, and areas, we calculated summary statistics for all environmental variables. We classified orientations into 8 categories centered on north, northeast, east, southeast, south, southwest, west, and northwest. We calculated cover and height of each species and all species combined in 15- and 30-m plots. We compared means from nest sites with random sites using *t*-tests. For categorical variables we used Likelihood Ratio and Fisher's Exact tests to determine if use was proportional to availability. To determine factors that distinguished used from available resources, we used backward elimination multiple logistic regression (mLR).

RESULTS

We located 53 pygmy-owl nests during the 2001 breeding season between 484 and 1,032 m elevation (Fig.1). All nests were located in saguaro cavities except one, which was in a large chino (*Havardia mexicana*). Nests were located primarily in Semidesert Grasslands (n = 25), the Arizona Upland subdivision of the Sonoran Desert (n = 24), or their transition (n =3), with only one found in Lower Colorado River Valley desertscrub. Roughly 93% (n = 49 of 53) of nests occurred in uplands compared to 7% in riparian vegetation zones. Nests occurred most frequently in savannah (47.2%) and desertscrub (41.5%) vegetation formations and less in woodland (9.4%) or thornscrub (1.9%).

Nest substrates: Nest saguaros averaged 7.9 m tall (SE = 0.24, range = 3.9-12.3) and were an average of 0.8 m taller than random saguaros (t_{89} = 2.25, P = 0.027); their dbh averaged 53.7 cm (SE = 0.8), 7.5% larger than random saguaros (t_{88} = 3.23, P = 0.0017). Approximately 75% of nest saguaros had =3 arms and an average of 4.6 arms (SE = 0.4, range = 0-15) per plant. Approximately 50% of nest saguaros had =5 cavities and an average of 6.3 cavities (SE = 0.7, range = 1-20). Nest saguaros had 1.6 times more arms (t_{89} = 2.43, P = 0.017) and 2.6 times more cavities (t_{103} = 4.79, P < 0.0001) than random saguaros. Nest saguaros averaged 53.6 m (SE = 8.8, range = 1-250) from the closest vegetation edge (upland or riparian), 81.7 m (SE = 13.1, range = 5-420) from the closest drainage channel (= 2 m wide), and nearly 2 times closer to drainages and edges than random saguaros (t_{89} = 2.67, P = 0.009). Edge types were classified as riparian at 90.4% (n = 47 of 52) of nest saguaros.

Distance to edge and number of cavities best distinguished between used and random saguaros ($?^2_{84}$ = 26.0, P < 0.0001, mLR) after accounting for the influence of saguaro height, dbh, and number of arms. Each additional cavity increased the odds that a saguaro would be used for nesting by a factor of 1.3 ($\hat{b}$ = 0.256, SE = 0.086, P = 0.0030) when distance to nearest vegetation edge was controlled. Each additional meter between a vegetation edge and potential saguaro decreased the odds it would be used for nesting by 2% ($\hat{b}$ = -0.012, SE = 0.004, P = 0.0033) when the number of potential cavities was controlled.

<u>Nest cavities</u>: Owls selected cavities within a much narrower range of entrance areas than available in either used or random saguaros (Fig. 2). Nest cavity entrance dimensions averaged 5.6 cm (SE = 0.1, range = 3.7-8.5) in vertical breadth and 6.0 cm (SE = 0.1, range = 4.5-11) in horizontal breadth. Area of cavity entrances ($\bar{x} = 26.6$ cm^2, SE = 1.2) averaged 8.6 cm^2 smaller than available cavities within nest saguaros ($t_{333} = 2.42$, $P = 0.016$) and 20.8 cm^2 smaller within random saguaros ($t_{163} = 4.97$, $P < 0.0001$). Nest cavities averaged 5.7 m (SE = 0.2, range = 2.9-9.6) above the ground, with 50% between 4.9 and 6.7 m tall. Nest cavities averaged only 0.3 m taller than available cavities within nest saguaros ($t_{333} = 1.57$, $P = 0.12$) but were 0.8 m taller than cavities within random saguaros ($t_{163} = 3.34$, $P = 0.0009$). Nest cavities occurred in saguaro arms ($n = 32$ of 52) more frequently than in trucks but there was no evidence that arms were selected out of proportion to their availability within nest saguaros (Fisher's Exact test; df = 333, $P = 0.76$) and only limited evidence in random saguaros (Fisher's Exact test; df = 163, $P = 0.096$). Although most nest cavities were orientated south or southwest (42.3%) or north or northwest (28.9%), nest orientation was proportional to availability within random saguaros (Likelihood ratio $G^2 = 7.51$, df = 7, 150, $P = 0.38$). In contrast, however, orientation of nest cavities differed from available cavities within nest saguaros (Likelihood ratio $G^2 = 13.5$, df = 7, 321, $P = 0.060$).

Cavity height and entrance area best differentiated between nest cavities and those found in random saguaros ($?^2_{150} = 43.9$, $P < 0.0001$, mLR) after accounting for the influence of cavity orientation, and location (trunk or arm). Each additional meter of height increased the odds that a cavity would be used for nesting by a factor of 1.5 ($\hat{b} = 0.407$, SE = 0.147, $P = 0.0057$) after accounting for entrance area. Each additional squared cm of entrance area decreased the odds a cavity would be used for nesting by 7% ($\hat{b}$ = -0.068, SE = 0.017, $P < 0.0001$) after accounting for cavity height.

Nest areas: Total vegetation cover averaged 1.7 times greater around nests ($\bar{x}$ = 13,255 m^2, SE = 1,923, t_{79} = 2.05, P = 0.044) but density of plants (=2 m tall) within 15-m radius plots was similar around nests ($\bar{x}$ = 35.2, SE = 3.2) and random ($\bar{x}$ = 27.1, SE = 3.4) saguaros. Although mean vegetation height (=2 m tall and excluding saguaros) was nearly equal around nest ($\bar{x}$ = 3.2 m, SE = 0.06) and random ($\bar{x}$ = 3.1 m, SE = 0.07) saguaros, the range of heights near nests averaged 21% greater ($\bar{x}$ = 3.3 m, SE = 0.3, t_{79} = 2.45, P = 0.015). Mesquite (*Prosopis velutina*) density averaged 1.5 times greater around nest saguaros ($\bar{x}$ = 13.4 m, SE = 1.7) (t_{79} = 1.86, P = 0.067). In contrast, there was no evidence that paloverde (*Parkinsonia* sp.) or ironwood (*Olneya tesota*) densities differed near nest and random saguaros (t_{79} = 0.71, P = 0.48). Ironwood trees near nests averaged 1.2 times taller than those around random saguaros ($\bar{x}$ = 4.4 m, SE = 0.2, t_{79} = 2.79, P = 0.010).

DISCUSSION AND CONCLUSIONS

Although the vast majority of nest saguaros were located in uplands, they were clearly associated with drainages and nearby riparian vegetation. Riparian vegetation associated with all nests was xeroriparian and comprised of microphyllous rather than broadleaf species. Historical records of pygmy-owls in Arizona were generally from large mesic riparian areas and the importance of these areas for recovery and management is still debated. Our results imply that a combination of riparian vegetation and adjacent uplands form important elements of pygmy-owl nesting habitat. Management and recovery efforts should consider both elements, and target especially those upland areas containing saguaros that are within 250 m of xeroriparian vegetation areas.

In addition to proximity of riparian vegetation, the number of available cavities within nest saguaros seemed to influence selection more than saguaro size. Both male and female pygmy-owls were observed roosting and caching food in unoccupied cavities, behaviors observed for pygmy-owls in south Texas (Proudfoot and Johnson 2000). Some cavities in nest saguaros were occupied by other nesting species such as Gila woodpeckers and flycatchers. Pygmy-owls are known to prey on these species by inspecting cavities and pulling their contents (Proudfoot and Johnson 2000, A. Flesch. pers. obs.). Quantity of cavities in nest saguaros may be important by augmenting available food resources near activity centers or for the added cover they provide. Recovery efforts in southern Arizona that use artificial cavity substrates should therefore consider creation of >1 cavity per prospective nest area.

Pygmy-owls selected cavities with the smallest available entrance area and often higher above ground than those available. Selection of cavities with smaller openings may reduce predation by restricting nest access by larger species such as western screech-owls or American kestrels. Selection of cavities higher above ground may reduce the likelihood of predation by other non-flying species such as snakes or enhance visibility from nests.

Vegetation height in nest and random areas was similar, however, the range of vegetation heights within nest areas was broader. Although these results are preliminary, they suggest that large trees maybe be an important element for nesting areas. Pygmy-owls frequently perched, roosted, and consumed prey in the largest available tree within nest areas. These large “guard” trees are likely an important habitat features.

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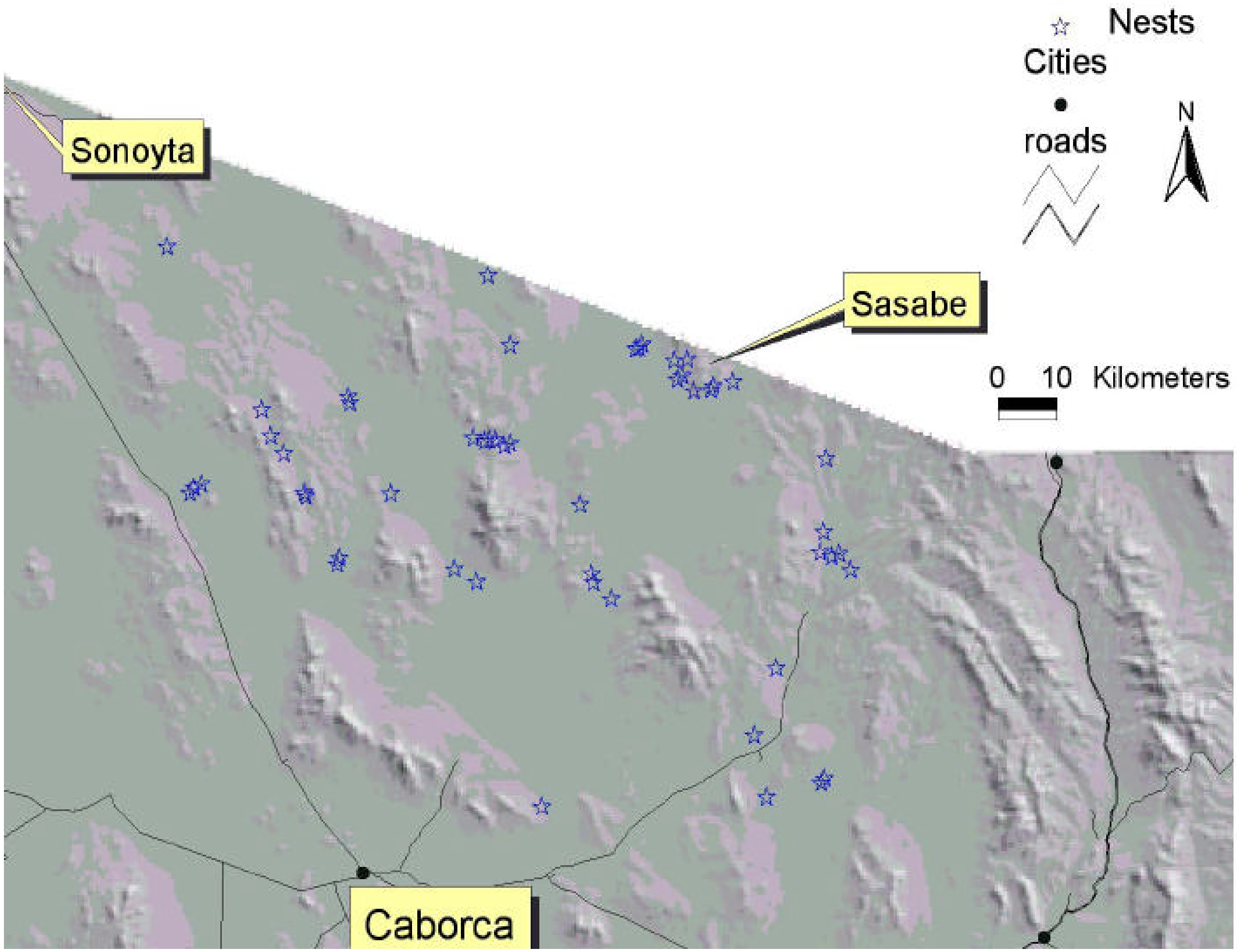

Fig 1. Distribution of ferruginous pygmy-owl nests in the border region of Sonora, Mexico 2001 breeding season.

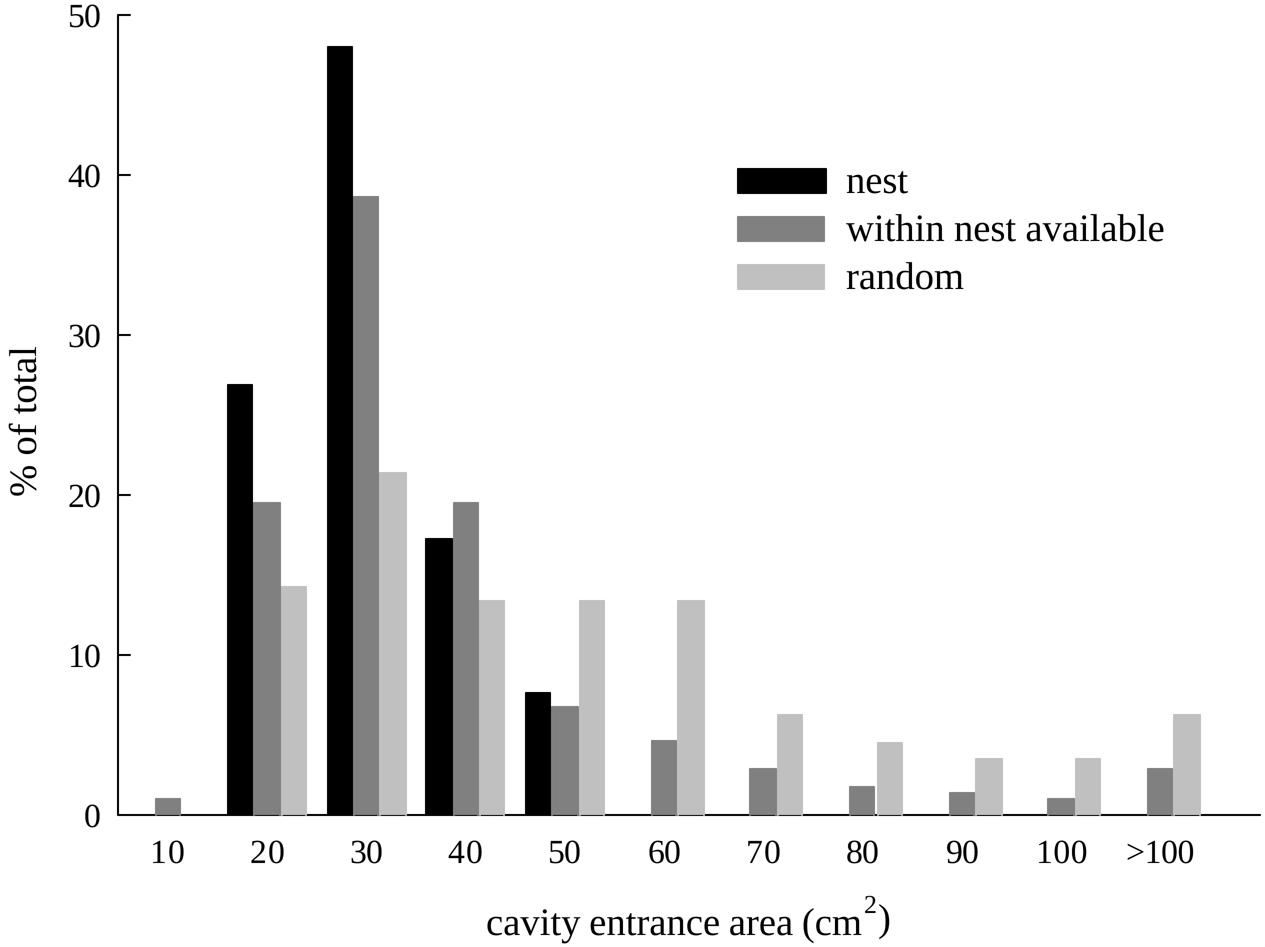

Fig. 2: Distribution of cavity entrance areas (cm^2) for nest cavities, available cavities within nests saguaros, and cavities in randomly selected saguaros.