The Condor 89:659–662

NEST SITE SELECTION BY ELF OWLS IN SAGUARO NATIONAL MONUMENT, ARIZONA[1]

M. SUSANNA GOAD[2]
Cooperative Wildlife Research Unit, 210 Biological Sciences East, University of Arizona, Tucson, AZ 85721

R. WILLIAM MANNAN
School of Renewable Natural Resources, 214 Biological Sciences East, University of Arizona, Tucson, AZ 85721

Key words: Elf Owl; nest site; saguaro cacti; Sonoran Desert; cavity.

Elf Owls (*Micrathene whitneyi*) in the Sonoran Desert nest in cavities that have been excavated by Gila Woodpeckers (*Melanerpes uropygialis*) or Northern Flickers (*Colaptes auratus*). Most of the cavities are in saguaro (*Cereus giganteus*) and cardon (*Cereus pringlei*) cacti. Elf Owls also nest in cavities in the Madrean evergreen woodlands in southern Arizona and Sonora, Mexico, and the Sinaloan deciduous forests in Sonora and Sinaloa, Mexico (Ligon 1968). In the United States, Elf Owls nest throughout most of southern Arizona and southwestern New Mexico (Ligon 1961, Phillips et al. 1964). They also nest along the lower Colorado River where they occupy remnant stands of cottonwoods, *Populus* spp. and willows, *Salix* spp. (Gould 1979). The winter range of Elf Owls, known only from a few sightings and specimens, apparently is limited to Mexico and extends from Oaxaca northwest to southwestern Michoacan, and from Morelos south to Guerrero.

Little is known about the habitat requirements of Elf Owls outside of the Madrean evergreen woodlands (Ligon 1968). Our study was designed to examine nest site selection by Elf Owls in the Sonoran Desert. Objectives were to detect associations between the abundance of Elf Owls and selected characteristics of vegetation, and compare the availability and use of cavities in saguaro cacti as nest sites.

STUDY AREA AND METHODS

The study was conducted between 1983 and 1986 in the Rincon Mountain Unit of Saguaro National Monument, Arizona. Only the area below 1,249 m (the approximate upper elevation limit of saguaro cacti) was examined. This is an area of about 59 km^2.

Vegetation in the study area is in the Arizona Upland Subdivision of the Sonoran Desert. We identified vege-

[1] Received 10 January 1986. Final acceptance 28 January 1987.

[2] Present address: Bureau of Land Management, P.O. Box 5680, Yuma, AZ 85364.

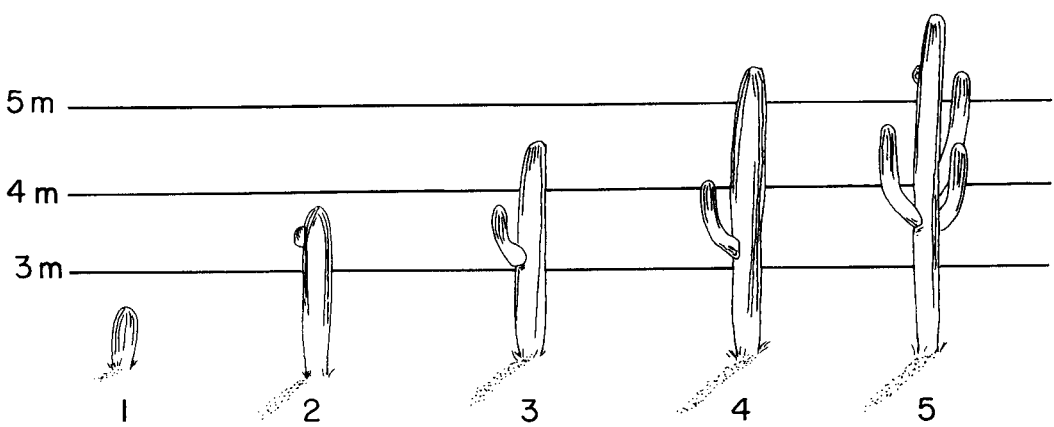

FIGURE 1. Classes of saguaro cacti based on height, and number and length of branches: class 1—saguaros ≤3 m tall with no branches; class 2—saguaros >3 m tall with branches <6 cm in length; class 3—saguaros >4 m tall with branches 6 cm to 1 m in length; class 4—saguaros >5 m tall with one to two branches >1 m in length; and class 5—saguaros >5 m tall with at least three branches >1 m in length.

TABLE 1. The number of territories and nests of Elf Owls on nine 10-ha plots in Saguaro National Monument, Arizona, 1984.

Vegetation series	No. territories	No. nests
Paloverde–mixed cacti	4	4
	3	2
	2	2
	3	3
	0	0
	2	2
Mixed grass–mixed shrub	3	3
	0	0
	2	2

tation series based on the divisions of Brown and Lowe (1974), and Brown (1982). The paloverde-mixed cacti series occurs below 1,067 m in elevation on the bajada of the Rincon Mountains. This series is dominated by foothill paloverde (*Cercidium microphyllum*) and mesquite (*Propis juliflora*), and covers approximately 40 km². Above 1,067 m is the mixed grass–mixed shrub series. Dominant plants are burroweed (*Haplopappus laricifolius*) and foothill paloverde. This series covers approximately 19 km² and occupies the steep, rocky western foothills of the Rincon Mountains.

We established nine 10-ha plots (316 m × 316 m) on the study area according to a stratified random design. Six plots were in the paloverde–mixed cacti series, and three were in the mixed grass–mixed shrub series. Plot boundaries were marked with surveyor's flagging and reflective tags. We randomly placed 12 to 17 points on each plot to aid in sampling vegetation. The number of points placed on a particular plot depended on the variability of vegetation on that plot. At each point, we laid two perpendicular 30-m transects on the ground; the tapes intersected at the 15-m mark. Compass orientation of the transects was selected randomly. We measured the cover of perennial shrubs at all points using the line intercept method (Canfield 1941). Shrubs were placed into one of two height classes: ≥250 cm in height, or <250 cm in height. We selected these height classes because Elf Owls frequently roosted and perched in tall vegetation (pers. observ.). All saguaro cacti within 20 m of the random points were counted and placed into five classes based on height, length, and number of branches (Fig. 1). We noted the presence or absence of cavities in each saguaro.

We measured the heights and noted the orientations of the entrances of all cavities on the four plots with the greatest numbers of cavities. We also placed each cavity on the four plots into one of two groups; those made by Gila Woodpeckers, or those made by Northern Flickers. Kerpez (1986) found that the vertical and horizontal diameters of the entrances of cavities made by Gila Woodpeckers and Northern Flickers differed significantly (Gila Woodpecker—average vertical diameter of entrance = 5.7 cm, average horizontal diameter of entrance = 6.3 cm, $n = 32$; Northern Flicker—average vertical diameter of entrance = 7.0 cm, average horizontal diameter of entrance = 8.3 cm, $n = 15$). We

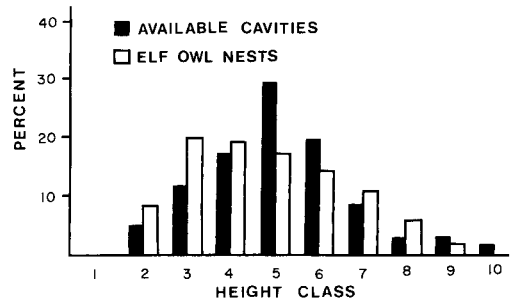

FIGURE 2. Comparison of heights of Elf Owl nests ($\bar{x} = 6.3$, SD = 1.7, $n = 62$) to heights of available cavities ($\bar{x} = 6.5$, SD = 1.7, $n = 133$) in four 10-ha plots on Saguaro National Monument, Arizona ($G = 15.41$, $P > 0.05$, df = 9; Sokal and Rohlf 1969). Height classes are: 1 = 2.0–2.9 m, 2 = 3.0–3.9 m, 3 = 4.0–4.9 m, 4 = 5.0–5.9 m, 5 = 6.0–6.9 m, 6 = 7.0–7.9 m, 7 = 8.0–8.9 m, 8 = 9.0–9.9 m, 9 = 10.0–10.9 m, 10 = 11.0–11.9 m.

placed cardboard discs of different sizes near each cavity, with the aid of an extendible pole, to help determine whether the entrance of the cavity was closest in size to the average size of cavity made by Gila Woodpeckers or Northern Flickers. Cavities were identified from ground observation only.

We estimated the number of Elf Owl territories on all plots by the spot-mapping method (Williams 1936, Robbins 1970). Each plot was visited at least five times between late March and mid-May 1984. On each visit, we mapped the position of male Elf Owls when they called. We elicited responses from Elf Owls by playing a taped Elf Owl call at numerous locations around the perimeter and in the interior of the plot (Johnson et al. 1981). Each visit lasted about 2 hr. The surveys were conducted at different times of the night. Each plot, however, was visited at least twice, just after dark or just before daylight when we found territorial activity to be most intense.

We located 67 Elf Owl nests both on and around the plots between March and July in 1983 and 1984. We initially found nests by investigating cavities within suspected territories. Later, nests were located by listening for nestlings calling from cavities (Ligon 1968). We measured the height, classified the size (see above), and noted the orientations of the entrances of all nest cavities. We also recorded whether the cavities were in the arm or main stem of the saguaro.

RESULTS

ABUNDANCE OF ELF OWLS

The number of territories on the nine plots ranged from 0–4 (Table 1). We found nests on all but one territory (Table 1).

ABUNDANCE OF ELF OWLS AND CHARACTERISTICS OF VEGETATION

We tested for associations between the abundance of Elf Owls (i.e., number of territories) and characteristics of vegetation on the nine plots with Spearman's rank

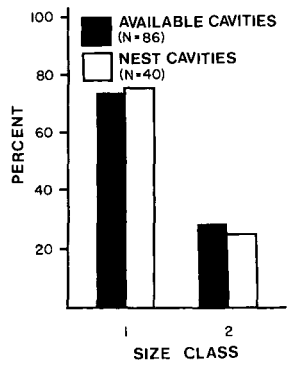

FIGURE 3. Comparison of opening sizes of cavities used by Elf Owls as nest sites to the opening sizes of available cavities in four 10-ha plots on Saguaro National Monument, Arizona ($G = 0.04$, $P > 0.05$, df = 1; Sokal and Rohlf 1969). Nest cavities and available cavities were placed into one of two size classes: 1—those made by Gila Woodpeckers (average vertical diameter of entrance = 5.7 cm, average horizontal diameter of entrance = 6.3 cm); and 2—those made by Northern Flickers (average vertical diameter of entrance = 7.0 cm, average horizontal diameter of entrance = 8.3 cm; Kerpez 1986). Numbers of nest cavities and available cavities used in this analysis were about 35% lower than those reported in Figure 2 because information on cavity size was collected in 1986, and several large saguaros, which had supported cavities in 1984, had fallen.

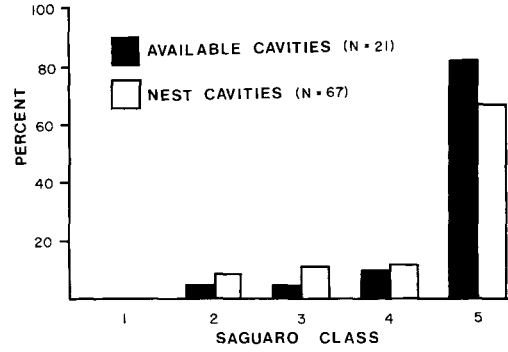

FIGURE 4. Availability and use of cavities as Elf Owl nest sites by saguaro class, Saguaro National Monument, Arizona ($G = 8.88$, $P > 0.05$, df = 4; Sokal and Rohlf 1969). Only cavities found in the random sample of saguaros were used in this analysis. Saguaro classes are described in Figure 1.

correlation coefficient (Gibbons 1976). Characteristics used in this analysis were densities of saguaros in each of the five classes, total density of saguaros, percent cover of shrubs ≥250 cm in height, percent cover of shrubs <250 cm in height, and total cover of shrubs. Only the density of saguaros in class 5 showed a significant positive association with the nesting density of Elf Owls ($r = 0.64$, $P < 0.05$).

USE OF CAVITIES

Nest heights ranged from 3.4 to 10.9 m, and averaged 6.3 m (SD = 1.7, $n = 62$; five nest saguaros fell before cavity height was measured). Comparison of nest cavities and available cavities by height class and size of entrance indicated that the heights and sizes of cavities used by Elf Owls were no different than expected on the basis of availability (Figs. 2, 3). Compass orientation of the entrances of available cavities and nest cavities was random (available: $\chi^2 = 0.6$, $P > 0.05$, df = 5; nests: $\chi^2 = 1.92$, $P > 0.05$, df = 5) (Batschelet 1965).

USE OF SAGUAROS

All nest cavities were in saguaro cacti; 46% were in branches, and 54% were in main stems. Elf Owls nested in cavities in saguaros in about the same proportions that cavities occurred by class; most were in the largest saguaros (Fig. 4). More cavities, and therefore more Elf Owl nests, were in saguaros in class 5 than would be expected on the basis of the availability of saguaros in both vegetation series (Fig. 5).

DISCUSSION

Elf Owls did not nest in some of our study plots because of the limited number of cavities. The plot with no nesting Elf Owls in the paloverde–mixed cacti series contained only two saguaro cacti and one cavity, and the cavity was occupied by a Northern Flicker in the summer of 1984. The plot with no nesting Elf Owls in the mixed grass–mixed shrub series contained many small saguaros, but only one unoccupied cavity. Conversely, three or four pairs of nesting Elf Owls were

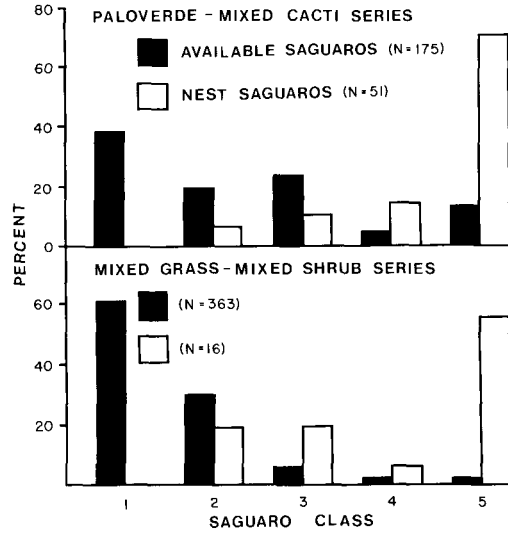

FIGURE 5. Availability and use of saguaros as nest sites by Elf Owls in Saguaro National Monument, Arizona (paloverde–mixed cacti series: $G = 122.19$, $P < 0.01$, df = 4; mixed grass–mixed shrub series: $G = 73.42$, $P < 0.01$, df = 4; Sokal and Rohlf 1969). Saguaro classes are described in Figure 1.

present on four plots. We believe that territorial behavior limited the number of nesting pairs on these plots because there were more available cavities ($n >$ 40 for each of the two plots with data from 1984) than nesting pairs of all cavity-nesting birds combined.

Elf Owls apparently do not discriminate among height, size, or orientation of the entrances of cavities when they select nest sites. Of interest is the contrast between the random orientation of the entrances of cavities (both available and nest cavities) on Saguaro National Monument, and the tendency toward a northwest orientation of cavities on the Organ Pipe Cactus National Monument, Arizona (Inouye et al. 1981, Korol and Hutto 1984). We cannot explain the difference in the orientation of cavities between these two areas.

Gila Woodpeckers and Northern Flickers, and subsequently Elf Owls, nested primarily in large saguaro cacti. The nesting density of Elf Owls was associated with the abundance of saguaros in class 5. Korol and Hutto (1984) also found that Gila Woodpeckers excavated more cavities in tall saguaros and saguaros with branches. Large saguaros may contain most of the cavities because they provide the greatest surface area for preferred nest sites (i.e., those over 4 m), and have been available to woodpeckers for the longest periods of time.

We wish to thank H. Coss and the rest of the staff at the Rincon Mountain Unit of Saguaro National Monument for their cooperation and assistance throughout this study. C. Abrams, J. Ashton, D. Duncan, G. Ferguson, P. Hathaway, B. Henry, J. Hoffman, S. Horton, L. Haight, R. Loyn, J. Meitl, B. Peachy, and B. Zoellick assisted in field work. R. L. Hutto, R. T. Reynolds, W. W. Shaw, D. Smith, and N. S. Smith reviewed the manuscript. Funding was provided by the Cooperative Wildlife Research Unit, and the Cooperative National Park Resources Study Unit, University of Arizona, Tucson, Arizona 85721.

LITERATURE CITED

BATSCHELET, E. 1965. Statistical methods for the analysis of problems in animal orientation and certain biological rhythms. Am. Inst. Biol. Sci., Washington, DC.

BROWN, D. E., [ED.] 1982. Biotic communities of the American southwest—United States and Mexico. Desert Plants 4(1–4).

BROWN, D. E., AND C. H. LOWE 1974. A digitized computer-compatible classification for natural and potential vegetation in the Southwest with particular reference to Arizona. J. Ariz. Acad. Sci. 9, Suppl. 2:1–11.

CANFIELD, R. H. 1941. Application of the line intercept method in sampling range vegetation. J. For. 39:388–394.

GIBBONS, J. D. 1976. Nonparametric methods for quantitative analysis. Holt, Rinehart, and Winston, New York.

GOULD, G. I. 1979. Status and management of Elf and Spotted owls in California, p. 86–97. *In* P. P. Schaeffer and S. M. Ehlers [eds.], National Audubon Society symposium on owls of the west: their ecology and conservation. Natl. Audubon Soc. West. Ed. Center, Tiburon, CA.

INOUYE, R. S., N. J. HUNTLY, AND D. W. INOUYE. 1981. Non-random orientation of Gila Woodpecker nest entrances in saguaro cacti. Condor 83: 88–89.

JOHNSON, R. R., B. T. BROWN, L. T. HAIGHT, AND J. M. SIMPSON. 1981. Playback recordings as a special avian censusing technique. Stud. Avian Biol. 6:68–75.

KERPEZ, T. A. 1986. Competition between European Starlings and native woodpeckers for nest cavities in saguaros. M.S.thesis, Univ. Arizona, Tucson.

KOROL, J. J., AND R. L.HUTTO. 1984. Factors affecting nest site location in Gila Woodpeckers. Condor 86:73–78.

LIGON, J. D. 1968. The biology of the Elf Owl (*Micrathene whitneyi*). Misc. Publ. Mus. Zool. Univ. Mich. 136.

LIGON, J. S. 1961. New Mexico birds and where to find them. Univ. New Mexico Press, Albuquerque.

PHILLIPS, A. R., J. T. MARSHALL, JR., AND G. MONSON. 1964. The birds of Arizona. Univ. Arizona Press, Tucson.

ROBBINS, C. S. 1970. Recommendations for an international standard for a mapping method in bird census work. Audubon Field Notes 24:722–726.

SOKAL, R. R., AND F. L. ROHLF. 1969. Biometry. W. H. Freeman and Co., San Francisco.

WILLIAMS, A. B. 1936. The composition and dynamics of a beech-maple climax community. Ecol. Monogr. 6:317–408.