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Population density and habitat use of the threatened Balsas screech owl in the Sierra de Huautla Biosphere Reserve, Mexico

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ABSTRACT: The Balsas screech owl *Megascops seductus* is a threatened species that is endemic to Mexico. We estimated the population density of the Balsas screech owl and evaluated habitat use during the dry season in the Sierra de Huautla Biosphere Reserve, Mexico. We estimated a total of 6.7 owls km^{-2} during the dry season (October 2001 to April 2002) by recording spontaneous calling and responses to playback of owl calls. October showed the highest density (12.2 owls km^{-2}) and February the lowest (2.8 owls km^{-2}); differences between months most likely were due to calling activity rather than density. Balsas screech owls used all 5 vegetation types identified in the Sierra de Huautla Biosphere Reserve; 4 were used in proportion with their availability, and *Gliricidia-Caesalpina* forest was used significantly less than its availability. There was significant variation in the number of owls recorded across different vegetation types. Conserved dry forest had the highest number of owl records, followed by thorn forest, disturbed forest, agricultural systems, and the fewest records in *Gliricidia-Caesalpina* forest. In order to design effective conservation plans for this threatened endemic owl, future research should prioritize population trends in various parts of its range and gather life history information.

KEY WORDS: Endemic · Threatened species · Tropical owl · Tropical dry forest

INTRODUCTION

The Balsas screech owl *Megascops seductus* is endemic to Mexico and has been listed as threatened by the Mexican Red List and Near Threatened globally by IUCN (Bird Life International 2008, SEMARNAT 2008). This listing is primarily due to lack of natural history information (e.g. the nests, eggs, and juveniles have not yet been described; König & Weick 2008), its restricted range in the basin of the Balsas River in the central-west region of Mexico (Howell & Webb 1995, del Hoyo et al. 1999), and its dependence on tropical dry forest, which is among the forest types most endangered by anthropogenic activities (Janzen 1988, Ceballos & García 1995).

Understanding how vegetation types and habitat attributes determine the distribution and density in a population are of prime concern in terrestrial bird ecology (Janes 1985). However, habitat use is not often described for most tropical forest owls (Marcot 1995). Mexican tropical dry forest is highly diverse and rich in endemic species, with 60% of the country's endemic species occurring here (Trejo & Dirzo 2000), and dry forests are thus considered centers of both diversification and endemism (Janzen 1988). However, they are threatened by high deforestation rates due to agriculture, grazing, and tourism development (Ceballos & García 1995). Only 27% of tropical dry forest in Mexico is conserved; the rest experiences high deforestation rates (Trejo & Dirzo 2000). For example, in the state of Morelos, 1.4% of dry forest has been destroyed annually for the past 3 decades (Trejo & Dirzo 2000).

Species with restricted distributions are highly susceptible to habitat loss and fragmentation. Therefore,

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knowledge of population status and habitat requirements is essential for their effective management and conservation. Our primary goals in this study were to estimate the population density of the threatened, endemic Balsas screech owl and evaluate its habitat use during the dry season in the Sierra de Huautla Biosphere Reserve, Morelos, Mexico.

MATERIALS AND METHODS

Study species. The Balsas screech owl is relatively large (25 cm long) and heavy (150 to 175 g), and is endemic to a small region in the basin of the Balsas River, Mexico, that encompasses areas in Southern Jalisco, Colima, Michoacán, central Guerrero and southern Morelos in southwestern Mexico (Howell & Webb 1995, del Hoyo et al. 1999). Its distribution may extend to the Balsas regions in southeast Puebla (A. Alba-Zúñiga pers. obs.). It ranges in elevation from 600 to 1700 m above sea level, and is found exclusively in tropical dry forest in arid open and semi-open areas, including mesquite, thorn forest, columnar cacti, and second growth (del Hoyo et al. 1999, König & Weick 2008). It feeds mainly on insects and other arthropods, although it also preys on small vertebrates (König & Weick 2008). Aside from museum skins and accidental records, virtually no biological or ecological information is available for this species, hindering conservation efforts.

Study area. The Sierra de Huautla Biosphere Reserve is located in the southeast of the state of Morelos (18° 20′ and 18° 39′ N; 98° 51′ and 98° 53′ W), Mexico (Fig. 1). The protected reserve comprises 59 000 ha and is the largest tract of dry forest remaining in Mexico (Argote et al. 2000). The mean annual temperature and precipitation are 24.3°C and 885 mm, respectively. The highest temperatures, about 27°C, occur in May, and the rainy season lasts from July to September (Argote et al. 2000). Most (90 %) of the vegetation in the Balsas basin is tropical dry forest that shows areas of extreme drought and includes arid areas with scattered trees and shrubs, columnar cactuses, and thorn woodlands. The forest has short trees (ca. 4 m), and abundant shrubs and lianas. Almost all vegetation loses its leaves for 5 to 7 mo during the dry season (Rzedowski 1986). The remaining 10 % of vegetation consists of xenophilic shrubs, aquatic vegetation, and cultivated areas (Argote et al. 2000). The dominant genera are *Bursera* (Burseraceae), *Ceiba* (Bombacaceae), *Cyrtocarpa* (Anacardiaceae), *Lonchocarpus* (Fabaceae), and *Ipomea* (Convolvulaceae). Columnar cacti are also abundant, including *Lemaireocerus, Neobuxbaumia, Pachycereus, Stenocereus, Myrtillocactus*, and *Cephalocereus* (Rzedowski 1986). In deforested areas, there are secondary associations of thorn shrubs, such as *Acacia farnesiana, A. pennatula, A. cochliacantha, A. bilimekkii, Pithecellobium acatlense, Mimosa polyantha, M. benthamii*, and *Eysenhardtia polystachya* (Rzedowski 1986).

Methodology. We estimated the density of Balsas screech owls by recording spontaneous calling and responses to playback of owl calls in line-transect distance sampling (Fuller & Mosher 1987) during the dry season, from October 2001 to April 2002. Three 3-km transects were selected along existing trails (Santiopan, Xochipala, and Ajuchitlán; Fig. 1). Transects covered all 5 vegetation types in the reserve: conserved dry forest, perturbed dry forest, thorn forest, areas under agricultural cultivation, and *Gliricidia sepium-Caesalpina pulcherrima* forest.

Conserved dry forest covered 212.3 ha, approximately 39.31 % of the study area. The main tree species in this ecosystem type included *Bursera* spp. (including *B. grandifolia* and *B. lancifolia*), *Pseudomosdingium perniciosum*, *Amphipterigium adstringens*, and *Conzattia multiflora*, all of which were associated with columnar cacti *Lemaireocereus thurberi, Pachicereus weberi,* and *Mirthilocactus* sp. Disturbed dry forest (126 ha, 23.33 % of the study area), mainly used for cattle, consisted of patches of perturbed dry and thorn forests, dominated by *Acacia cochliacantha* and *A. farnesiana.* These patches were characterized by the presence of *Gliricidia cepium* and *Helyocarpus venutilum*, which are considered to be indicators of perturbation (Rzedowski 1986). Thorn forest (137.55 ha, 25.47 % of the study area) was mainly dominated by 3 species: *Acacia cochliacantha, A. farnesiana*, and *Leucaena* sp. Agricultural areas (50.55 ha, 9.36 % of the study area) were mainly planted with maize *Zea mays*, sorghum *Sorgum vulgaris*, and bean *Phaseolus vulgaris*. *G. cepium-Caesalpina pulcherrima* forest occupied 13.5 ha, or 2.5 % of the study area.

All transects were surveyed an equal number of times by spontaneous calling and playback. To record spontaneous calling by owls, we walked each trail twice per month for 7 mo (n = 14 d) in suitable weather conditions. Surveys were conducted between 18:00 h and 22:00 h. All owls detected were counted and their locations triangulated by 2 people using compass bearings (Bell 1964). One person always remained at the point of the initial contact to avoid re-counting the same individual. Spot mapping allowed us to separate individuals along trails. We calculated the perpendicular distance from owl to transect after obtaining its location using the angle obtained with the compass (Bell 1964).

In order to increase detections, we also played taped vocalizations of conspecifics along roads (Fuller & Mosher 1987). Balsas screech owl vocalizations were obtained from Hardy et al. (1990) and were played

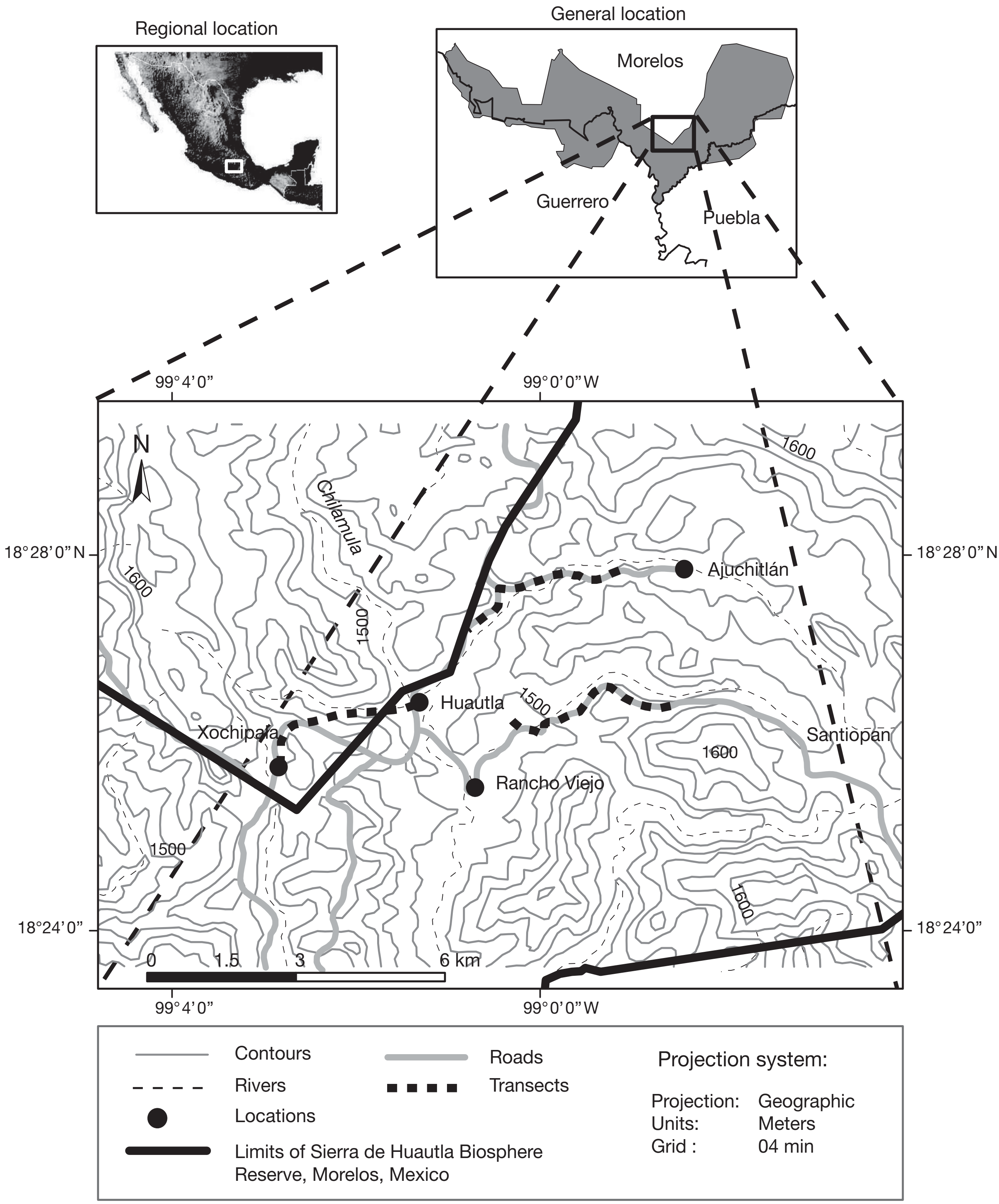

Fig. 1. Sierra de Huautla Biosphere Reserve, southeastern Morelos, Mexico. Three census transects were established along existing trails (Santiopan, Xochipala, and Ajuchitlán)

using a tape recorder (Aiwa JS189) with 2 loudspeakers (Sony SRS-A21) at each of 36 survey points 250 m apart throughout the transects. We stayed at each survey point for 10 min; the vocalization was played for 3 min. We recorded all owls that responded to the tape.

We estimated the number of owl vocalizations per km^2 using the program Distance 3.5 (Thomas et al. 1998). We were unable to determine sex or age of vocalizing owls due to the similarity of calls between sexes (König & Weick 2008). To evaluate habitat use, we compared owl location frequencies in each vegetation type versus vegetation availability. We followed Neu et al. (1974) to estimate habitat use comparing frequencies of use and availability in each habitat type, in order to determine whether owls used habitat types in proportion to their availability. To estimate habitat use, we performed χ^2 analysis with the program Habuse, and Bonferroni confidence limits were set at 95% to determine significance categories (Neu et al. 1974, Lund 1976). All statistical analyses were performed using JMP IN-SAS 5.1 (Sall et al. 2005). All means are presented ± 1 SD, and tests were considered significant at $\alpha = 0.05$.

RESULTS

We recorded 279 owl vocalizations. A total of 6.7 owls km^{-2} was estimated in the study area during the dry season (October to April). Owl density in the highest density month (October) was significantly higher than that in the lowest month (February; 12.2 versus 2.8 owls km^{-2}; $F_{6,14} = 6.13$, $p < 0.05$; Fig. 2).

Balsas screech owls used all 5 vegetation types identified in the Sierra de Huautla Biosphere Reserve. Four vegetation types were used in proportion to their availability (Table 1), but the owls used the *Gliricidia-Caesalpina* forest significantly less than its availability ($\chi^2_4 = 3.96$, $p < 0.05$). There were significant differences in the number of owls recorded in different vegetation types: conserved dry forest had the highest number of records, followed by thorn forest, perturbed forest, agricultural systems, and *Gliricidia-Caesalpina* forest ($F_{4,30} = 4.71$, $p < 0.05$).

Of the 279 total vocalizations recorded, 167 were in response to 369 playbacks (45.25%). Although owls were more frequently recorded responding to playback (59.9%) than calling spontaneously (40.1%), the difference was not significant ($F_{1,2} = 3.14$, $p > 0.05$).

DISCUSSION

The total density of Balsas screech owls in the Sierra de Huautla Biosphere Reserve was estimated to be 6.7 owls km^{-2} during the dry season. This estimated density suggests that this species can be considered to be moderately common in the study area. Based on the frequency of vocalizations, October showed the highest Balsas screech owl density and February the lowest. In tropical areas, species density fluctuations are related mainly to seasonal variation in precipitation (Boughey 1973). Precipitation in dry forests plays a key role in determining both the vegetation structure and dynamics (Braker & Greene 1994, Stotz et al. 1996). However, owl-calling activity may also change seasonally and with environmental conditions (Enríquez & Rangel-Salazar 2001). The decreased response of Balsas screech owls during the dry season could be a consequence of the high seasonal variation in the dry forest, which results in a decrease in vegetative cover (Janzen 1988).

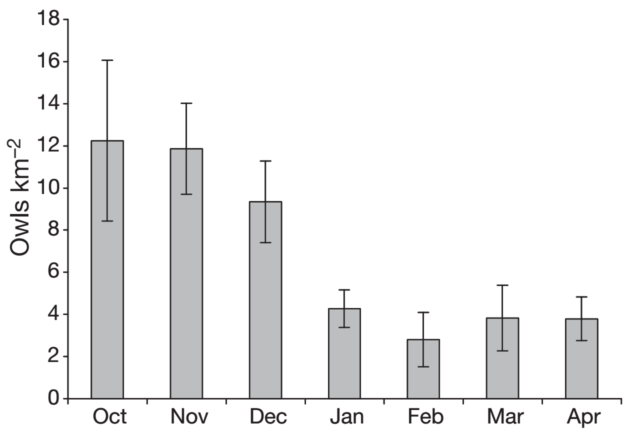

Fig. 2. *Megascops seductus.* Monthly mean (± 1 SD) total density (owls km^{-2}) in the Sierra de Huautla Biosphere Reserve (October 2001 to April 2002)

Table 1. *Megascops seductus.* Habitat use and availability at Sierra de Huautla Biosphere Reserve (October 2001 to April 2002). Use and availability were determined based on chi-squared analyses. Area: area of the reserve occupied by a given habitat type; Bonferroni: 95% Bonferroni confidence limits; U=A: habitat use was equal to availability; U<A: habitat was used significantly less often than predicted by availability; *G. sepium-C. pulcherrinea*: *Gliricidia sepium-Caesalpina pulcherrima* forest

Habitat type	Area (%)	Observed (used)	Expected (availability)	Bonferroni (p < 0.05)	Conclusion
Conserved dry forest	39.31	0.43	0.39	0.311–0.554	U=A
Perturbed dry forest	23.33	0.18	0.23	0.093–0.285	U=A
Thorn forest	25.47	0.29	0.25	0.186–0.409	U=A
Agrosystems	9.36	0.07	0.093	0.009–0.135	U=A
G. sepium-C. pulcherrima	2.52	0.009	0.025	0.000–0.032	U<A

Decreased response could also be related to the reproductive period of this species. The detectability of owls changes during the breeding season because reproductive adults may be either more responsive or more secretive (Fuller & Mosher 1987). For example, density estimates of eastern screech owls *Megascops asio* increase at the end of the breeding season as juveniles are added to the population as independent individuals (Smith et al. 1987, del Hoyo et al. 1999). However, other studies have reported that detectability of owls increases during the courtship period (e.g. Lynch & Smith 1984).

Balsas screech owls begin laying eggs in June (del Hoyo et al. 1999), so the maximum density estimates reported in October (12.2 ind. km^{-2}) and November (11.9 ind. km^{-2}) may be a result of vocalizations by recently independent juveniles (Smith et al. 1987). During this time, food availability is high because insects and small vertebrates increase in abundance (Ceballos 1995). Low-density estimates in February (2.8 ind. km^{-2}) and April (3.8 ind. km^{-2}) may be associated not only with the pre-reproductive period but also with fewer resources during the dry season. Fluctuations in owl annual density could occur in a 2-period pattern as has been reported for other bird populations: the number of individuals increases at the end of the reproductive period because the birth rate exceeds the mortality rate, and the number of individuals decreases in the non-reproductive period because the mortality rate exceeds the birth rate (Newton 1998).

The presence of Balsas screech owls was associated with forest habitat. In the present study, we classified 5 vegetation types based on tree species abundance. Balsas screech owls used 4 vegetation types (conserved dry forest, perturbed dry forest, thorn forest, and agricultural systems) as frequently as availability would predict. These results support previous studies (del Hoyo et al. 1999, König & Weick 2008). Balsas screech owls have also been reported to use habitats bordering cultivated areas (Lockshaw 2008); however, this species is uncommon in suburban areas (A. Alba Zúñiga pers. obs.). Tolerance of perturbed areas and variation in habitat use may be favored since habitat heterogeneity can increase the diversity of food resources and perch areas needed for survival (Morris 1987).

Food availability is one of the main factors determining habitat use by several bird species (Block & Brennan 1993), but other factors also determine habitat use. For example, occurrence of owls may be more influenced by vegetation type than by food availability *per se* (Janes 1985), since habitat structure is essential for protection and nesting and perching sites (Sparks et al. 1994). The dry forest provides sites for breeding and refuge for the Balsas screech owl in tree and columnar cactus holes (König & Weick 2008), perches for foraging and calling in bare trees or on posts in pastures (Lockshaw 2008), and perches in dense areas with canopy during the rainy season (A. Alba Zúñiga pers. obs.).

The *Gliricidia sepium-Caesalpina pulcherrima* forest was used less than availability would predict. This is an agro-forestry system with 2 dominant species. Heterogeneity in the other habitats may increase the diversity of food resources (Block & Brennan 1993), and could explain why the Balsas screech owls used this vegetation type less than predicted by its availability. The current state of the vegetation in the Huautla Biosphere Reserve is a consequence of human activities, including agriculture and cattle management, that have modified the original vegetation in the region. Our results help to identify areas of conservation for this threatened endemic owl. However, future research should prioritize population trends in different areas of its distribution range (in both core and peripheral areas) and gather life history information including long-term, year-round demography and habitat selection.

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