



Intra- and Interspecific Calling in a Tropical Owl Community

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Abstract.—We studied the intra- and interspecific responses to playback of pre-recorded calls by five tropical humid forest owl species at La Selva preserve in northeastern Costa Rica from April to September 1995. Response to conspecific broadcast calls differed among species ($X^2 = 24.4$; $df = 1$; $P < 0.001$): Vermiculated Screech-owls (*Otus guatemalae*) responded to 47.6 per cent of broadcasts, followed by Crested Owls (*Lophotrix cristata*, 45 per cent), Mottled Owls (*Ciccaba virgata*, 18.3 per cent), and Black-and-white Owls (*C. nigrolineata*, 9 per cent). Crested Owls ($\bar{x} = 16.37$, $sd = 2.6$), Mottled Owls ($\bar{x} = 11.7$, $sd = 7.1$), and Vermiculated Screech-owls ($\bar{x} = 10.9$, $sd = 0.9$) responded to interspecific playback more than did Black-and-white Owls ($\bar{x} = 2.04$, $sd = 2$) ($H = 10.6$; $P = 0.01$). Spectacled Owls (*Pulsatrix perspicillata*) did not respond at all during our broadcasting period. Both types of response showed some monthly variation. Response to the calling of other owls also depended on ecological variables such as habitat selection, population density, and resource use. Our data suggest that the development of relationships within the tropical owl community at La Selva may have been mediated in part by intra- and interspecific calling.

The interactions between owl species in tropical communities have been poorly studied. In northern Europe, the behavioral ecology of owl communities has received some attention (Korpimäki 1987), but no community-based owl research has been conducted in the Neotropics. Single-species research has examined the food habits (Gerhardt et al. 1994a) and breeding biology (Gerhardt et al. 1994b) of Neotropical owls, and the calling behavior of one widespread species (Gerhardt 1991). Community ecology is central to understand factors that regulate the structure, dynamics, and evolution of owl populations (Pianka 1988), and the effects of an inter- and intra-species interaction, and eventually, the conservation of those communities. In this paper we report the calling interactions among five Neotropical rainforest owls from La Selva Biological Station, Costa Rica.

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STUDY AREA

La Selva Biological Station is located in Sarapiquí county, Heredia province, Costa Rica (10°26'N 83°59'W). The station adjoins Braulio Carrillo National Park to the south and agricultural land and cattle pasture to the north. La Selva encompasses 1,513 ha, and main habitats are primary humid forest, young second growth, grassland in the process of succession, abandoned plantations, swamps, forest study plots, and open areas with buildings. Elevation ranges from 35 to 150 m. Weather conditions are very humid, with 4,000 to 4,500 mm of annual precipitation. Annual temperatures range from 24.7 to 27.1°C.

METHODS

Intra- and interspecific interactions among five owl species; Vermiculated Screech-owl (*Otus guatemalae*), Crested Owl (*Lophotrix cristata*), Spectacled Owl (*Pulsatrix perspicillata*), Mottled Owl (*Ciccaba virgata*), and Black-and-white Owl (*C. nigrolineata*), were studied through broadcasting of vocalizations from April to September 1995. Broadcasting has been a consistent

method for surveying woodland owls in North America (Ganey 1990, McGarigal and Fraser 1985, Mosher et al. 1990), and the Neotropicals (Enríquez 1995, Gerhardt 1991).

At La Selva, and prior to our broadcasting period, we recorded the typical vocalizations of the five owl species studied. An Uher 4000RL and an Electrovoice Unidirectional Microphone were used to record the vocalizations. Once we had obtained quality recordings, they were copied onto independent cassettes for each owl species. Closed loop cassettes used consisted of 3 minutes of typical vocalizations; "hoot" rates differed slightly among species.

We established 30 survey stations on the major trails (10 stations/trail). The trails selected covered proportionally all habitats at La Selva ($P > 0.05$, Enríquez 1995). Starting points at each trail were at least 400 m apart. Survey stations along trails were 200 m apart from each other following Forsman (1983). The sampling period was 10 minutes at each station, consisting of 3 minutes of broadcasting followed by 7 minutes of listening. Throughout this period, we noted the vocalizations of any owl that responded. To avoid provoking different species at the same station (Kochert 1986), we randomly selected the broadcast order of the five species and played the vocalizations of only one species at each station. Then, we selected a new broadcast order twice on each trail. We conducted surveys on each trail twice monthly ($N = 36$). No surveys were conducted during rain. Sampling methods are described in more detail in Enríquez (1995). Collected data were analyzed using a Chi-square test (X^2) to evaluate the intraspecific response, a

Kruskal-Wallis test (H) to compare multiple intra- and interspecific response percentages, Kolmogorov-Smirnov two sample test (D) for testing distributions of species responses to coexisting species and responses of coexisting species to the target species, and Shapiro-Wilk statistic (W) to test that interspecific responses followed a normal distribution.

RESULTS

The owl community in La Selva and the surrounding area are represented by eight species; five are listed in table 1 and, the Barn Owl (*Tyto alba*), Least Pygmy-owl (*Glaucidium minutissimum*), and Striped Owl (*Asio clamator*). During our broadcasting period we taped 340 broadcast vocalizations. An intraspecific response was obtained 82 times (25 per cent of total broadcasts), whereas an interspecific response was obtained 110 times (32.3 per cent). The Spectacled Owl did not respond at all during our broadcasting period.

Intraspecific Responses

Most of the owl species at La Selva responded generally more to the broadcasting of conspecific vocalizations (table 1). Percentages of intraspecific responses differed among owl species ($X^2 = 24.4$, $df 1$, $P < 0.001$). The Vermiculated Screech-owl and Crested Owls had higher percentages of intraspecific responses than Mottled and Black-and-white Owls (table 1).

Among those owl species that responded intraspecifically, variation on monthly per cent

Table 1.—Total mean of response percentages to broadcasting of pre-recorded vocalizations of five species of tropical humid forest owls at La Selva preserve in northeastern Costa Rica, from April to September, 1995.

Responses by ¹	Broadcasting Vocalization by ¹				
	VSO	CO	SO	MO	BWO
VSO	47.62	11.51	10.10	11.36	10.67
CO	16.89	45.11	16.63	18.55	13.42
SO					
MO	7.19	6.95	15.10	18.29	17.63
BWO		3.05	5.11		9.01

¹ VSO (Vermiculated Screech-owl), CO (Crested Owl), SO (Spectacled Owl), MO (Mottled Owl), BWO (Black-and-white Owl).



of responses was distributed normally (Shapiro-Wilks test, $P > 0.05$). Crested and Vermiculated Screech-owls showed more monthly variation in intraspecific response than did Mottled and Black-and-white Owls ($H = 15.05$, $df 3$, $P < 0.05$) (fig. 1).

Interspecific Responses

Species that responded to calls of all other sympatric species included in this survey were Crested Owl, Vermiculated Screech-owl, and Mottled Owl. Meanwhile, the Black-and-white Owl responded to only two sympatric species the Crested Owl and the Spectacled Owl (table 1). Crested Owls responded more frequently to interspecific broadcast vocalizations ($\bar{x} = 16.37$, $sd = 2.6$) than did Mottled Owls ($\bar{x} = 11.7$, $sd = 7.1$), Vermiculated Screech-owls ($\bar{x} = 10.9$, $sd = 0.9$), or Black-and-white Owls ($\bar{x} = 2.04$, $sd = 2$) ($H = 10.6$; $P < 0.01$). On the other hand, we did not find differences in response to any one of the five owl vocalizations broadcast ($H = 2.06$; $P = 0.72$).

Crested Owls responded more frequently to other species than other species responded to

Crested Owls' broadcast vocalizations ($D = 1.41$, $P < 0.05$). We did not find this behavior for any other owl species surveyed ($P > 0.05$). Monthly variation of interspecific responses is shown in figures 2-5. Vermiculated Screech-owls showed some monthly variation in response to Black-and-white Owl vocalizations ($W = 0.659$, $P < 0.05$) (fig. 3). Also, Black-and-white Owls exhibited monthly variation in their response to vocalizations of Crested Owls ($W = 0.678$, $P < 0.05$) and Spectacled Owls ($W = 0.7$, $P < 0.05$) (fig. 5).

DISCUSSION

Responses to broadcast of conspecific calls were more frequent than interspecific responses at La Selva for two of five species studied. Our results suggest that Crested, Vermiculated Screech-, and Mottled Owls were more responsive, both intra- and interspecifically, than Black-and-white and Spectacled Owls. In temperate forest, interspecific responses also varied among owl species, mostly during the breeding season (Bosakowski et al. 1987, Springer 1978). But, Smith et al. (1987) found that the Eastern Screech-owl (*Otus asio*)

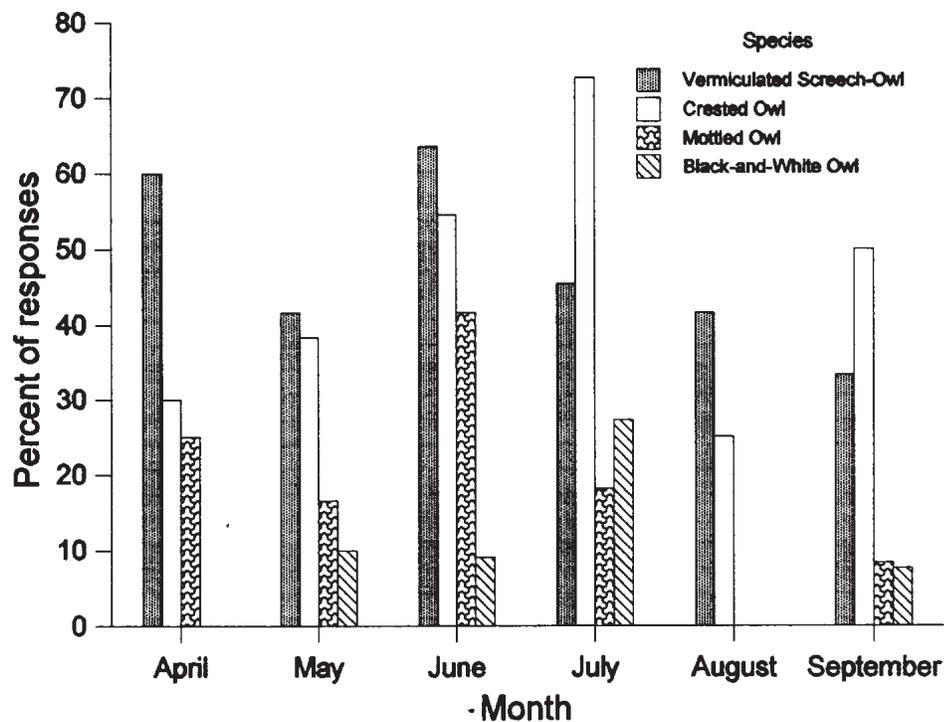


Figure 1.—Monthly responses to intraspecific broadcasting of pre-recorded vocalizations of four species of tropical humid forest owls at La Selva preserve, northeastern Costa Rica, in 1995.

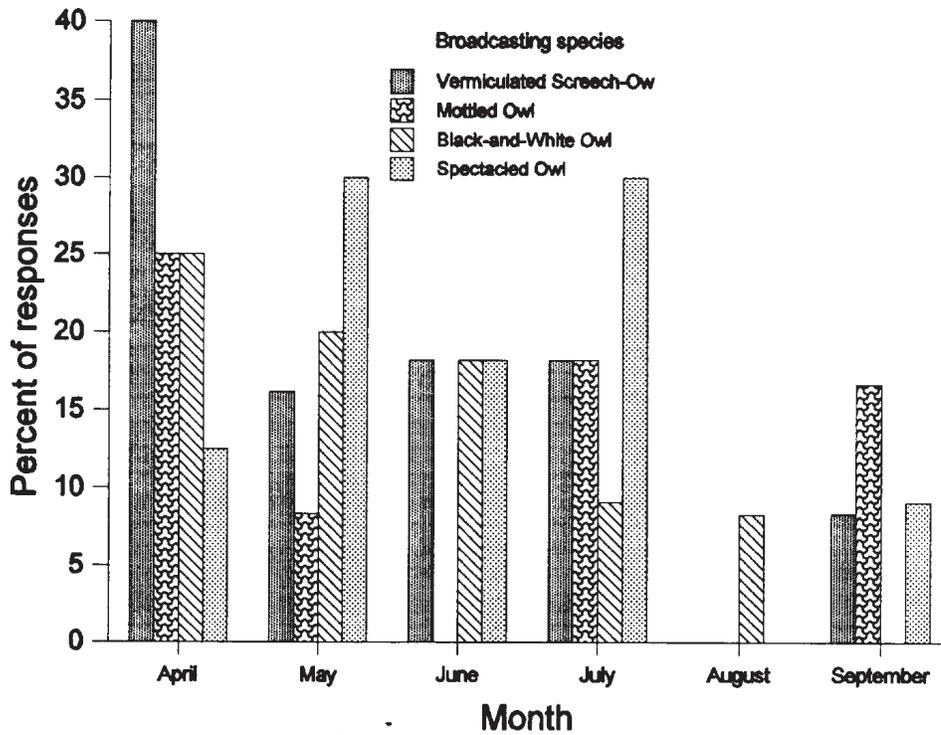


Figure 2.—Crested Owl monthly responses to interspecific broadcasting vocalizations of co-existing species of tropical humid forest owls at La Selva preserve, northeastern Costa Rica, in 1995.

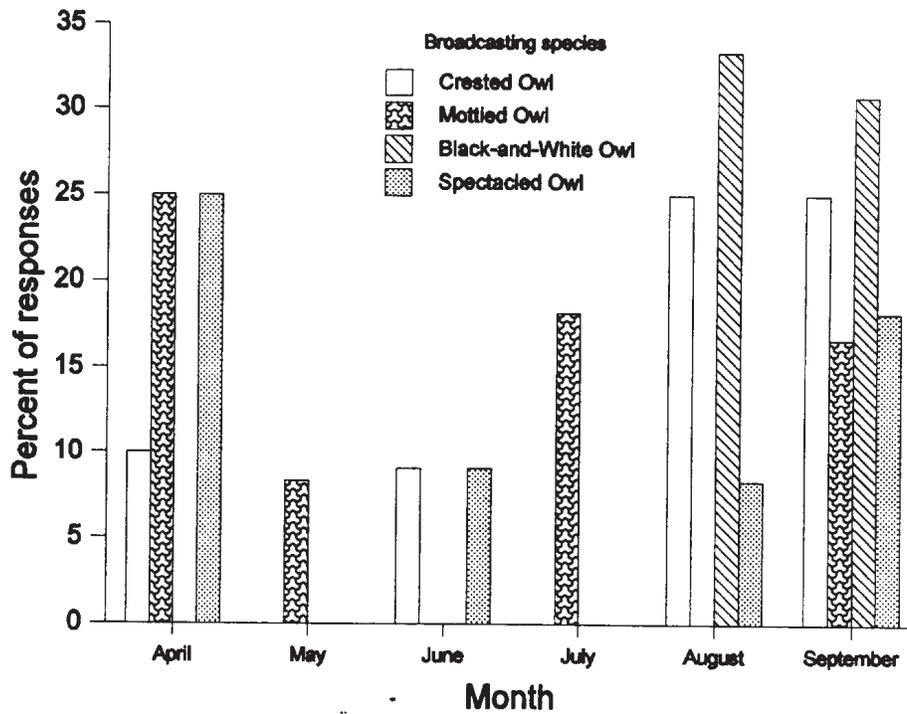


Figure 3.—Vermiculated Screech-owl monthly responses to interspecific broadcasting vocalizations of co-existing species of tropical humid forest owls at La Selva preserve, northeastern Costa Rica, in 1995.

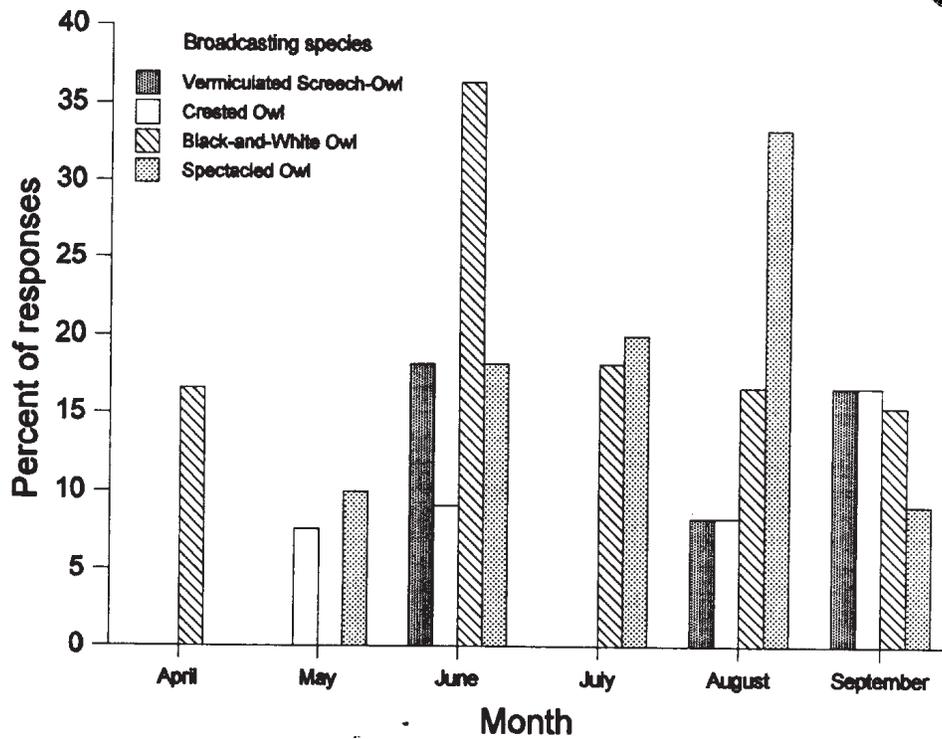


Figure 4.—Mottled Owl monthly responses to interspecific broadcasting vocalizations of co-existing species of tropical humid forest owls at La Selva preserve, northeastern Costa Rica, in 1995.

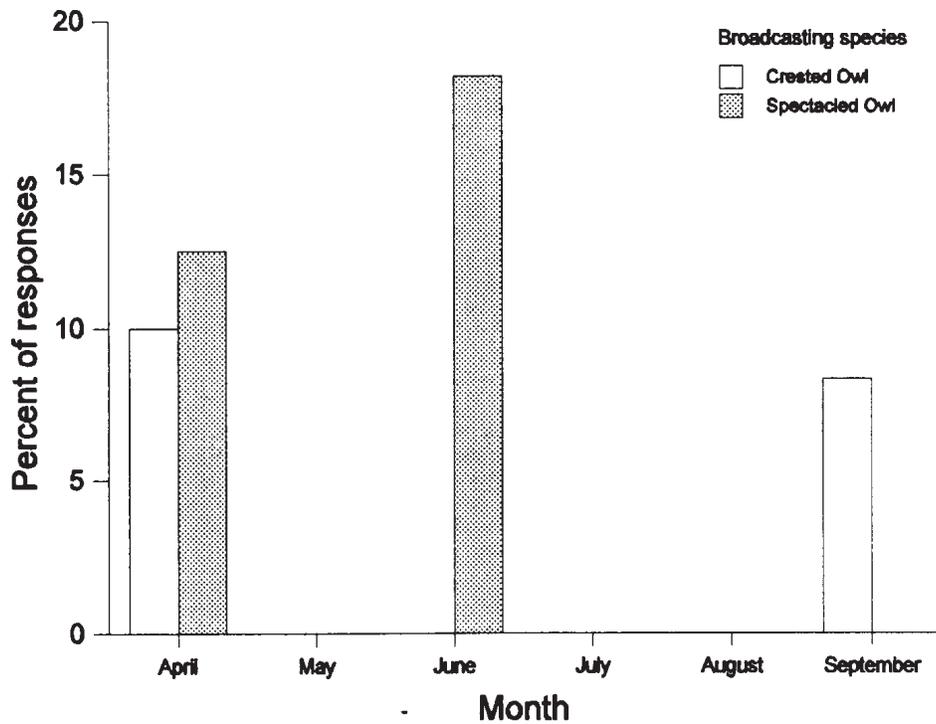


Figure 5.—Black-and-white Owl monthly responses to interspecific broadcasting vocalizations of co-existing species of tropical humid forest owls at La Selva preserve, northeastern Costa Rica, in 1995.

responded less during the breeding season. In a tropical forest in Guatemala, Gerhardt (1991) reported that Mottled Owls responded to 40 percent of broadcasts during the breeding season. Mottled Owls responded less frequently in our study site than they did in Guatemala. Crested and Vermiculated Screech-owls responded to over 45 percent of conspecific broadcasts. The differences in the percentage of responses to broadcasting could be related in part to the species abundance in the study area. Enríquez (1995) found that Crested and Vermiculated Screech-owls were quite abundant and Spectacled Owls less abundant at La Selva. Lack of responses by Spectacled Owls and few responses by Black-and-white Owls could be associated with their home range size. In Guatemala, a single Black-and-white Owl had a home range 20 times larger than Mottled Owls had (Gerhardt et al. 1994b).

Habitat influences the abundance of some species (Will 1986). Forests and old second growth habitats at La Selva favor the Crested Owl. This rare species is probably a relict of a group that spread around the tropics and survived in old forests with small changes through the period of climatic cooling (Hekstra 1973). The Vermiculated Screech-owl and Mottled Owl are widely distributed and common in Neotropical forests (Gerhardt 1991, Stiles and Skutch 1989). On the other hand, Spectacled Owls use open habitats with nearby woodlots to vocalize, hunt, roost, and breed. The Black-and-white Owl is rare throughout its entire distribution and may not use a particular habitat at La Selva (Enríquez 1995). We recorded this species in different habitats, calling and probably hunting. Nicholls and Warner (1972) mentioned that although owl species may use one habitat more than another, the habitat that is used less may not be less important, since it could contain resources critical to the species' survival.

We did not find seasonality in owl responses in this study; Spectacled Owls, however, vocalized from January to March only. Therefore this species had a seasonality to its calling behavior and our surveys were conducted outside the season during which it was most vocal.

Interspecific relations may include overlap in distribution, hunting period, habitats, and food (Mikkola 1983). Three species (Crested Owl, Vermiculated Screech-owl, and Mottled Owl) at

La Selva responded to all other species included in this survey. Meanwhile, Black-and-white Owls responded to only two owl species. Crested Owls responded more frequently to interspecific broadcast vocalizations than did Mottled Owls, Vermiculated Screech-owls, and Black-and-white Owls. The observed differences in interspecific responses at La Selva may be related to differences in population density, habitat use, and food habits. Also, calling behavior of forest owls is affected by environmental variables (Carpenter 1987), as observed at La Selva (Enríquez 1995).

Crested Owls responded more to Mottled Owl vocalizations than other species pair combinations. These species used the same habitat at La Selva (Enríquez 1995). We found these species calling together in different vegetation strata. Mottled Owls feed on vertebrates like small rodents, but are considered mainly insectivorous (Gerhardt et al. 1994a). Possibly these species differ in feeding time, strategies and sites. On the other hand, the Mottled Owl is more tolerant of habitat change and so is both abundant and broadly distributed (Mikkola 1992). Also, Mottled Owls can visit urban areas to feed.

Ciccaba owls showed also a high level of interaction, mostly when Mottled Owls responded to Black-and-white Owl calls. These Ciccaba species overlapped in distribution and activity patterns, and several times we listened to both species calling simultaneously. Although these species both took large numbers of insects, the mammalian part of their diet showed little overlap (Gerhardt et al. 1994a), they likely used different foraging strategies and capture techniques, and they used quite different breeding sites (Gerhardt et al. 1994b).

In order of size, Vermiculated, Mottled, and Crested Owls feed mainly on invertebrates (Hekstra 1973), Black-and-white and Spectacled Owls feed mainly on vertebrates (Ibañez et al. 1992). Insects, caterpillars, crabs, mammals, birds, and reptiles were reported as prey for Spectacled Owl (Mikkola 1992). Johnsgard (1988) mentioned that owl species that feed mainly on insects have small territories. For those owl species that have similar diets, competition can be reduced by utilizing different time or space. For Crested and Vermiculated Screech-owls, the habitat most utilized was the cacao orchard, but these species occupied different vegetation strata. We found



Crested Owls calling in the canopy and Vermiculated Screech-owls were in the understory. Crested Owls roost in the mid-canopy of the forest and Vermiculated Screech-owls in dense shrubs.

At La Selva forest preserve, the Crested Owl, Vermiculated Screech-owl, and Mottled Owl responded more to intra- and interspecific broadcasting vocalizations; Black-and-white Owls responded less, and Spectacled Owls not at all. Differences in response levels to other owl species depended on ecological variables such as habitat selection, population density, and resource used. Our data suggest that the development of relationships within the tropical owl community at La Selva may have been mediated in part by intra- and interspecific calling behavior. The interspecific relationships could be a mechanism of habitat and resource selection, and knowledge of these interactions would be useful in developing management plans or conservation programs (Mikkola 1983). Habitat transformation in the surrounding area at La Selva has shown that owl abundances have varied through time (Enríquez 1995). In the Neotropics, protected areas such as reserves and national parks function as refuges for many species of wildlife that depend on forested habitats (e.g., Crested Owls). Finally, further information on owl behavior is required in order to better understand the ecology of owl communities and factors affecting owls in protected natural areas. Indeed, in tropical areas habitat is the most important factor to protect and safeguard an owl community (Mikkola 1983).

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LITERATURE CITED

- Bosakowski, Thomas; Spelser, R.; Benzinger, J. 1987. Distribution, density, and habitat relationships of the Barred Owl in North New Jersey. In: Nero, R.W.; Clark, R.J.; Knapton, R.J.; Hamre, R.H., eds. *Biology and conservation of northern forest owls: symposium proceedings*; 1987 February 3-7; Winnipeg, MB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 135-143.
- Carpenter, W. Thomas. 1987. Effect of environmental variables on responses of Eastern Screech-owl to playback. In: Nero, R.W.; Clark, R.J.; Knapton, R.J.; Hamre, R.H., eds. *Biology and conservation of northern forest owls: symposium proceedings*; 1987 February 3-7; Winnipeg, MB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 277-280.
- Enríquez, Paula L. 1995. Abundancia relativa, uso de hábitat y conocimiento popular de los Strigiformes en un bosque húmedo tropical en Costa Rica. *Heredia, Costa Rica: Universidad Nacional*. 81 p. M.S. dissertation.
- Forsman, Eric D. 1983. *Methods and materials for locating and studying Spotted Owls*. Gen. Tech. Rep. PNW-162. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 8 p.
- Ganey, Joseph. 1990. Calling behavior of Spotted Owls in Northern Arizona. *Condor*. 92: 485-490.
- Gerhardt, Richard. 1991. Response of the Mottled Owl (*Ciccaba virgata*) to broadcast of conspecific call. *Journal of Field Ornithology*. 62(2): 239-244.
- Gerhardt, Richard; Gerhardt, D.M.; Flatten, C.J.; Bonilla, G.N. 1994a. The food habits of sympatric *Ciccaba* owls in Northern Guatemala. *Journal of Field Ornithology*. 65(2): 258-264.
- Gerhardt, Richard; Bonilla, G.N.; Gerhardt, D.M.; Flatten, C.J. 1994b. Breeding biology and home range of two *Ciccaba* owls. *Wilson Bulletin*. 106(4): 629-639.
- Hekstra, G.P. 1973. Scops and screech owls. In: *Owls of the world*. London, England: Peter Lowe, Eurobook: 94-115.

Ibañez, C.; Ramo, C.; Busto, B. 1992. Notes on food habits of the Black-and-white Owl. *Condor*. 94: 529-531.

Johnsgard, Paul. 1988. North American owls. Washington, DC: Smithsonian Institution Press. 295 p.

Kochert, M.N. 1986. Raptors. In: Inventory and monitoring of wildlife habitat. U.S. Department of the Interior: 313-349.

Korpimäki, Erkki. 1987. Composition of the owl communities in four areas in western Finland: importance of habitats and interspecific competition. In: Proceedings of the 5th Nordic ornithological congress; 1985; Acta Regiae Societatis Scientiarum et Litterarum Gothoburgensis Zoologica. 14: 118-123.

McGarigal, K.; Fraser, J.D. 1985. Barred Owl responses to recorded vocalizations. *Condor*. 87: 552-553.

Mikkola, Heimo. 1983. Owls of Europe. Calton, England: T. & A.D. Poyser. 397 p.

Mikkola, Heimo. 1992. Wood owls. In: Owls of the world. Netherlands, Holland: Peter Lowe, Eurobook: 108-140.

Mosher, James, A.; Fuller, M.R.; Kopeny, M. 1990. Surveying woodland raptors by broadcast of conspecific vocalizations. *Journal of Field Ornithology*. 61(4): 453-561.

Nicholls, Thomas H.; Warner, D.W. 1972. Barred Owl habitat use as determined by radiotelemetry. *Journal of Wildlife Management*. 36: 213-225.

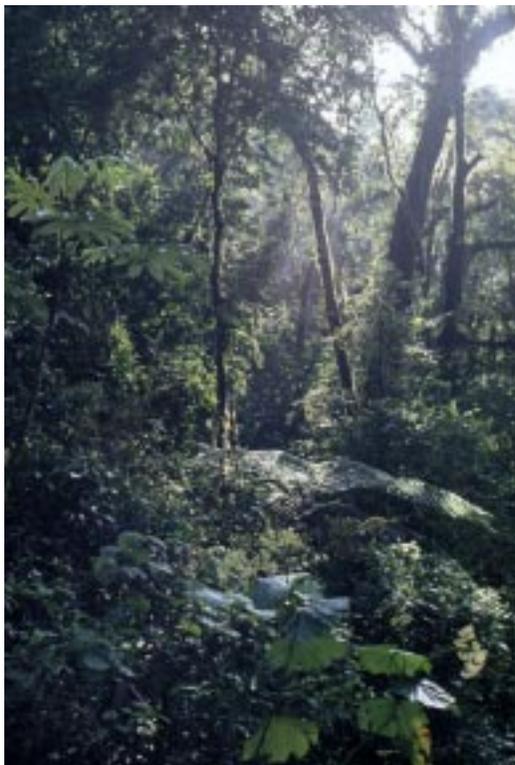
Pianka, Eric. 1988. Evolutionary ecology. New York, NY: Harper & Row. Publishers. 468 p.

Smith, Dwight; Devine, A.; Walsh, D. 1987. Censusing Screech Owls in southern Connecticut. In: Nero, R.W.; Clark, R.J.; Knapp, R.J.; Hamre, R.H., eds. Biology and conservation of northern forest owls: symposium proceedings; 1987 February 3-7; Winnipeg, MB. Gen. Tech. Rep. RM-142. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 255-267.

Springer, M.A. 1978. Foot surveys versus owl calling surveys: a comparative study of two Great Horned Owl censusing techniques. *Inland Bird Banding News*. 50: 83-93.

Stiles, Gary; Skutch, A. 1989. A guide to the birds of Costa Rica. Ithaca, NY: Cornell University Press. 511 p.

Will, Thomas C. 1986. The behavior ecology of species replacement: Blue-winged and Golden-winged warblers in Michigan. Ann Arbor, MI: University of Michigan. 126 p. Ph.D. dissertation.



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Forest habitat at La Selva Biological Station, Costa Rica.