J. Raptor Res. 47(2):208–213

NEST-BOX OCCUPANCY BY NEOTROPICAL RAPTORS IN A NATIVE FOREST OF CENTRAL ARGENTINA

M. Soledad Liébana[1] and José H. Sarasola
Instituto de Ciencias de La Tierra y Ambientales de La Pampa (INCITAP) –Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Avenida Uruguay 151, (6300) Santa Rosa, Argentina
and
Centro para el Estudio y Conservación de Aves Rapaces en Argentina (CECARA), Departamento de Recursos Naturales, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Avenida Uruguay 151, (6300) Santa Rosa, Argentina

Miguel Á. Santillán
Centro para el Estudio y Conservación de Aves Rapaces en Argentina (CECARA), Departamento de Recursos Naturales, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Avenida Uruguay 151, (6300) Santa Rosa, Argentina

Abstract.—Breeding populations of raptors are sometimes limited by nest-site availability and the use of nest boxes to bolster such populations is widespread. In the neotropical forest, little is known about the ecology of cavity-nesting raptors and their use of nest boxes. Here we examine occupancy patterns of nest boxes by five raptor species during eight years in a semiarid forest of central Argentina: the American Kestrel (*Falco sparverius*), the Spot-winged Falconet (*Spiziapteryx circumcincta*), the Tropical Screech-Owl (*Megascops choliba*), the Barn Owl (*Tyto alba*), and the Ferruginous Pygmy-Owl (*Glaucidium brasilianum*). We analyze the influence of vegetation type on nest-box selection, report cases of nest usurpation, and present information on the breeding rates of some of these species. The raptor species showed a marked selection for nest boxes surrounded by grassland, where hunting success may be higher, and avoided those nest boxes placed in habitats dominated by dense shrublands. We observed two cases of nest usurpation (i.e., a species takes over active nests of another species for breeding purposes), in which two different boxes were occupied almost simultaneously by the Ferruginous Pygmy-Owl and the American Kestrel.

Key Words: *Argentina*; *breeding*; *neotropical raptors*; *nest boxes*; *nest usurpation*; *reproductive rate*; *semiarid forest.*

OCUPACIÓN DE CAJAS NIDO POR RAPACES NEOTROPICALES EN UN BOSQUE NATIVO DEL CENTRO DE ARGENTINA

Resumen.—Las poblaciones reproductivas de aves rapaces a menudo se encuentran limitadas por la disponibilidad de sitios de nidificación, y los programas de cajas nido para aumentar dichas poblaciones han sido ampliamente implementados. En los bosques neotropicales poco se conoce acerca de la ecología de las rapaces que nidifican en cavidades y de la ocupación de las cajas nido por su parte. En este trabajo examinamos los patrones de ocupación de cajas nido por parte de cinco especies de rapaces durante ocho años en un bosque semiárido del centro de Argentina: *Falco sparverius, Spiziapteryx circumcincta, Megascops choliba, Tyto alba* y *Glaucidium brasilianum.* Analizamos si el tipo de vegetación que rodea las cajas nido influye en su selección, reportamos casos de usurpación de nidos y presentamos datos de la biología reproductiva de algunas de las especies. Estas especies mostraron una marcada selección, siendo más usadas aquellas cajas que presentaban pastizales en sus alrededores, donde el éxito de caza podría ser mayor, y evitaron aquellas cajas situadas en zonas donde la vegetación dominante era el arbustal cerrado. Observamos dos casos de usurpación de nidos (es decir, una especie ocupa nidos activos de otra especie con fines reproductivos), donde dos cajas diferentes fueron ocupadas simultáneamente por *G. brasilianum* y *Falco sparverius.*

[Traducción de los autores editada]

[1] Email address: soleliebana@hotmail.com

Secondary cavity-nesting birds require existing tree cavities for their reproduction, which may limit their population numbers (Newton 1994, 1998, Cockle et al. 2011). Most data on natural cavities and nest-box use has come from human-modified landscapes in North America and Europe (Wiebe 2011). However, in the neotropical forest, little is known about the ecology of cavity-nesting birds or the availability of suitable nest sites in mature or disturbed forests (Cornelius et al. 2008, Cockle et al. 2011).

To supplement the limited number of natural cavities available, many nest-box programs have been developed for several avian species, and the use of nest boxes to bolster and maintain raptor populations is widespread (Millsap et al. 1987, Katzner et al. 2005, Smallwood and Collopy 2009). In addition, the use of artificial nest sites is valuable for studies of cavity-nesting birds, facilitating collection of data on reproduction, clutch size, and nestling growth rate (Lambrechts et al. 2012).

In the semiarid forest of central Argentina there are five species of raptors that use cavities (or nest that resemble cavities, such as Monk Parakeet [*Myiopsitta monachus*] nests) and that, consequently, could potentially accept nest boxes for breeding: (*i*) the American Kestrel (*Falco sparverius*); (*ii*) the Spot-winged Falconet (*Spiziapteryx circumcincta*); (*iii*) the Tropical Screech-Owl (*Megascops choliba*); (*iv*) the Barn Owl (*Tyto alba*) and the Ferruginous Pygmy-Owl (*Glaucidium* brasilianum; Bechard et al. 2004, Liébana et al. 2009). The semiarid forests potentially provide a variety of cavities that these species can use: natural cavities in dried or burned wood of Caldén (*Prosopis caldenia*), woodpeckers' holes (*Veniliornis mixtus, Colaptes campestris, C. melanochloros*), or nests of bird species that resemble tree cavities, such as Monk Parakeet nests, as well as most of the nests of the Furnariidae family.

In this study, we examined the: (a) occupancy patterns of nest boxes by these five raptor species during 8 yr; and (b) the influence of surrounding vegetation types on nest box selection by raptors. In addition, we also reported cases of nest usurpation/interspecific competition, as well as some basic information on breeding biology.

STUDY AREA AND METHODS

The study area was located in south-central Argentina in the Parque Luro Natural Reserve (36°55′S, 64°16′W). The reserve (7604 ha) consists mainly of xerophytic open forest of Caldén (*Prosopsis caldenia*), which represents the characteristic landscape of the *Espinal* biome in the semiarid pampas of Argentina (Sarasola et al. 2005). This semiarid forest has hot summers and cold winters with low humidity and low annual rainfall, which occurs primarily in spring and summer (Cabrera 1994).

We placed 10 nest boxes during August 1998 and 40 more during 1999 on trees and on electric poles. Nest boxes were built following the standard design proposed by Bortolotti (1994) and placed about 1 km apart from each other (mean ± SD = 1.1 ± 0.3 km) at >3 m high. Nest boxes were monitored from October to December (late spring to early austral summer) during 1998 to 2003, 2006, and 2010. We recorded the species occupying the nest box and, when possible, we also recorded information on clutch size, number of hatched young, and number of fledglings.

To determine which vegetation type best explained variation in nest-box occupancy by raptors at our study site, we performed a Generalized Linear Model (GLM, McCullagh and Nelder 1989) with binomial error distribution and logit link function. The GLM included the ratio between years of occupancy and years of monitoring as the dependent variable and the area occupied by each vegetation type as explanatory variables; their contribution to explain variation in nest-box occupancy was estimated by means of a restricted maximum-likelihood (REML) procedure (JMP 8 software; SAS Institute Inc., Cary, North Carolina). We followed a stepwise removal procedure (Hosmer and Lemeshow 1989), excluding all the variables with $P > 0.15$, which resulted in a final model only including significant effects ($P < 0.05$). We drew a buffer circle with a radius of 0.5 km around each box and calculated the area of the circle occupied by each vegetation type. We classified six vegetation types from a classified Landsat image using the Software ArcView GIS 3.2 (ESRI, Inc. Redlands, California, U.S.A.): (1) dense forest; (2) open forest, (3) dense shrubland, (4) open shrubland, (5) grassland and (6) crops.

RESULTS

Six species of birds occupied our nest boxes, including two passerines (the White Monjita [*Xolmis irupero*] and the House Wren [*Troglodytes aedon*]) and four of the five cavity-nesting raptors inhabiting the study area: American Kestrels, Tropical Screech-Owls, Barn Owls, and Ferruginous Pygmy-Owls (Table 1). Mean percentage of the nest boxes occupied per year was 28.9% ± 14.4 (n = 8 yr). Yearly occupancy rates of nest boxes were variable among years, ranging from 14% to 58.3%. Reproductive rates were calculated for

Table 1. Nest-box availability and occupant species in a semiarid forest in central Argentina.

YEAR	1998	1999	2000	2001	2002	2003	2006[a]	2010
Available nest boxes	10	50	42	42	42	42	13	19
American Kestrel (*Falco sparverius*)	2	7	7	8	8	5	6	6
Tropical Screech-Owl (*Megascops choliba*)	0	0	2	5	1	0	1	1
Barn Owl (*Tyto alba*)	0	0	1	2	1	0	0	0
Ferruginous Pygmy-Owl (*Glaucidium brasilianum*)	0	0	0	0	2	3	0	0
Passerine birds[b]	3	14	19	19	11	6	0	3
Honey bees and wasps	2	1	3	0	4	3	0	1
Total occupied by raptor species	2	7	10	15	12	8	7	7

[a] From Liébana et al. 2009.
[b] White Monjita (*Xolmis irupero*) and House Wren (*Troglodytes aedon*).

American Kestrels and Tropical Screech-Owls, the most common raptors using the nest boxes (Table 2).

Twenty-eight nest boxes were never occupied during the study period, seven were occupied once, three twice, four three times and eight on more than three occasions (mean ± SE = 4.25 ± 1.6 uses). Of the 28 boxes never used by raptors, 24 were used at least once by passerines, and on 16 occasions, boxes were infested by European honey bees (*Apis mellifera*) or wasps (*Polistes canadensis*).

Nest-box occupancy (intercept: estimate ±SE = −1.35 ± 0.38, $\chi^2 = 14.01$, $P = 0.0001$) was positively and negatively associated with the presence of grasslands (estimate ±SE = 0.06 ± 0.02, $\chi^2 = 8.63$, $P = 0.003$) and dense shrublands (estimate ±SE = −0.03 ± 0.02; $\chi^2 = 5.28$, $P = 0.02$), respectively.

During the breeding seasons of 2002 and 2003, two different boxes were occupied almost simultaneously by two raptor species, the Ferruginous Pygmy-Owl and the American Kestrel. In the first case, six eggs were found, five of American Kestrels and one of the Ferruginous Pygmy-Owl. At our next visit, 10 d later, we found only eggshells and an adult pygmy-owl dead under the nest box. During 2003, we found seven eggs in one box, four of the American Kestrel and three of the Ferruginous Pygmy-Owl. Fifteen days later, two nestlings and two eggs of the American Kestrel and three Ferruginous Pygmy-Owl eggs that never hatched were found in the box. Adult and nestling kestrels were later killed by an unidentified predator.

DISCUSSION

The percentage of boxes occupied by all the raptor species through the 8 yr of study was low compared with occupancy rates of nest-box programs at sites with intensive anthropic disturbance (e.g, 85.6% ± 9.4 in Katzner et al. 2005; 50 to 100% in Bechard and Bechard 1996; 48% ± 14 in Steenhof and Peterson 2009; 60% in Eschenbauch et al. 2009). This difference may be due to greater availability of natural cavities in the semiarid forest of central Argentina; however, additional studies are needed to assess the availability and use of natural cavities by raptors in this type of forest.

We found a preference for those nest boxes surrounded by grasslands. Raptors mainly select nest sites close to the best hunting areas in order to reduce time and energy devoted to foraging, and open areas are among the preferred hunting grounds for American Kestrels and Barn Owls, at

Table 2. Reproductive parameters of American Kestrels and Tropical Screech-Owls breeding in nest boxes in a semiarid forest of central Argentina.

	AMERICAN KESTREL			TROPICAL SCREECH-OWL		
	EGGS	NESTLINGS	FLEDGINGS	EGGS	NESTLINGS	FLEDGINGS
Mean	4.35	2.68	1.63	2.00	1.80	1.57
Standard deviation	0.86	1.98	1.81	0.00	1.32	1.51
Median	4	3	1	2	2	2
No. of nest boxes	37	45	40	4	10	7

least (Smallwood 1987, Taylor 1994). Thus, because of the large number of American Kestrels in our nest boxes, it is possible that our results were biased by its habitat preference.

The low occupancy rates we recorded for our nest boxes may suggest that a number of them were located in unsuitable habitats: this may be the case for the nest boxes close to dense shrublands, where hunting may be difficult (Newton 1998). We recommend that other resources, such as vegetation structure and food availability, should be considered when starting a nest-box program (Smith et al. 2005). It is worth noting that the Spot-winged Falconet never used our nest boxes. This species is a little-known neotropical bird endemic to southern South America (Olrog 1959) and, although it has been found using cavity-like nests of ovenbirds (*Seiurus aurocapilla*) and Monk Parakeets (Narosky et al. 1992, Martella et al. 1985), we do not have any explanation for the absence of this species.

The use of nest boxes by American Kestrel is well known (Balgooyen 1990, Bortolotti 1994, Butler et al. 2009, Liébana et al. 2009, Lambrechts et al. 2012). In some kestrel populations, a preference of boxes over cavities appears to exist, even when the latter are available (Cade 1982, Toland and Elder 1987, Bortolotti 1994). The reproductive rates we documented in this study were similar to those recorded for populations of American Kestrels in North and Central America (Heintzelman and Nagy 1968, Bloom and Hawks 1983, Wilmers 1983, Toland and Elder 1987, Wheeler 1992, Varland and Loughlin 1993, Jacobs 1995).

The second-most common species occupying the nest boxes was the Tropical Screech Owl, a regular user of artificial nesting sites (Valdez et al. 2000). The Tropical Screech Owl is a common and widespread resident in the neotropics, from Costa Rica to Argentina; other than this, little ecological information is available on this species, except for some information on natural history, food habits, breeding and nest-box use (Thomas 1977, Smith 1983, Motta-Junior 2002, Trejo 2007, König and Weick 2008, Lima and Lima 2009). In Argentina, it has been usually found nesting in others birds' nests (Salvador 2012) and the average reproductive rates documented at natural nests seem to be higher than the rates observed in this study (2.75 ± 1.2 eggs, $n = 4$ vs. 2.2 ± 0.5 nestlings, $n = 5$; de la Peña 2010). Until this study, there were no available data on the number of fledglings per occupied nest (Trejo 2007).

Two others species that occasionally occupied the nest boxes were the Ferruginous Pygmy-Owl and the Barn Owl. The use of nest boxes by Ferruginous Pygmy-Owls has been previously recorded only in one Brazilian report (Lima and Lima 2008). Because of the exceptional abundance of the Ferruginous Pygmy-Owl in the study area (Bechard et al. 2004, Campioni et al. 2013), the low occupancy of the nest boxes suggests adequate suitable natural nest sites in the area. In other areas, Barn Owls frequently use nest boxes (Bellocq and Kravetz 1993, Petty et al. 1994, Lambrechts et al. 2012). Thus, the recorded low occupancy rates in our study might be explained by the characteristics of the nest boxes we used, which were smaller than those generally used for the Barn Owl in other studies (Bellocq and Kravetz 1993).

Usurpation of nest boxes occurs when the same nest is used by different species (Newton 1998). In our study, this competitive overlap occurred between American Kestrels and Ferruginous Pygmy-Owls. Unlike brood parasites that lay their eggs in another bird's nest and leave, providing no parental care, nest usurpers incubate and feed their young in the nest of another (Lindell 1996). This unusual behavior has been previously recorded for American Kestrel (Breen and Parrish 1996, Dawson and Bortolotti 1997). A similar situation was reported in a Brazilian nest-box program (Lima and Lima 2009), in which a Ferruginous Pygmy-Owl laid its eggs on the same box that was already occupied by a Tropical Screech-Owl. In our study, we did not know which species were the usurpers, but we found that the last occupant was the Ferruginous Pygmy-Owl in the first case and the American Kestrel in the second. These observations imply that there is competition for nest sites in our study area in spite of the low proportion of boxes occupied and availability of natural sites: such competition for particular nest boxes suggests that they were placed in high-quality habitats (Dawson and Bortolotti 1997).

ACKNOWLEDGMENTS

We are grateful to many people for help in setting and monitoring nest boxes during several years, but we are particularly grateful to Maximiliano Galmes, Agustín Lanusse, and Marc Bechard. Juan Manuel Grande and Juan Ignacio Zanón helped with data and GIS analysis. The Dirección de Recursos Naturales and Subsecretaría de Ecología of La Pampa province made this work possible by giving permission to carry out fieldwork in Parque Luro Reserve. This study received financial support from the Unversidad Nacional de La Pampa and Idea Wild. Ana

Sanz Aguilar, Vincenzo Penteriani, Cheryl Dykstra, and one anonymous reviewer greatly improved this report. We dedicate this study to the memory of Gary Bortolotti, appreciated friend and colleague, for his numerous contributions on the use of nest boxes in studies of raptors, and especially for encouraging the work and scientific vocations of many raptor biologists around the world.

LITERATURE CITED

BALGOOYEN, T. 1990. The orientation of American Kestrel nest cavities revisited. *Journal of Raptor Research* 24:27–28.

BECHARD, M.J. AND J.M. BECHARD. 1996. Competition for nest boxes between American Kestrels and European Starlings in an agricultural area of southern Idaho. Pages 155–162 *in* D.M. Bird, D.E. Varland, and J.J. Negro [EDS.], Raptors in human landscapes: adaptations to built and cultivated environments. Academic Press, London, U.K.

———, J.H. SARASOLA, AND A.J. HELBIG. 2004. Morphometric measures of male and female Spot-winged Falconets *Spiziapteryx circumcinctus* sexed using PCR amplification methods. Pages 451–458 *in* R.D. Chancellor and B.-U. Meyburg [EDS.], Raptors worldwide. World Working Group on Birds of Prey/MME-BirdLife Hungary, Berlin, and Budapest.

BELLOCQ, M.I. AND F.O. KRAVETZ. 1993. Productividad de la Lechuza de Campanario *(Tyto alba)* en nidos artificiales en agrosistemas pampeanos. *Hornero* 13:277–312.

BORTOLOTTI, G.R. 1994. Effect of nest-box size on nest-site preference and reproduction in American Kestrels. *Journal of Raptor Research* 28:127–133.

BLOOM, P.H. AND S.J. HAWKS. 1983. Nest box use and reproductive biology of the American Kestrel in Lassen County, California. *Journal of Raptor Research* 17:9–14.

BREEN, T.F. AND J.W. PARRISH, JR. 1996. Eastern Screech-Owl hatches an American Kestrel. *Journal of Field Ornithology* 67:612–613.

BUTLER, M.W., B.A. WHITMAN, AND A.M. DUFTY, JR. 2009. Nest box temperature and hatching success of American Kestrels varies with nest box orientation. *Wilson Journal of Ornithology* 121:778–782.

CABRERA, A.L. 1994. Regiones fitogeográficas Argentinas. Enciclopedia Argentina de agricultura y jardinería. Primera Reimpresión, Tomo II, Fascículo I, Editorial Acme, Buenos Aires, Argentina.

CADE, T.J. 1982. The falcons of the world. Cornell Univ. Press, Ithaca, NY U.S.A.

CAMPIONI, L., J.H. SARASOLA, M. SANTILLÁN, AND M.M. REYES. 2013. Breeding season habitat selection by Ferruginous Pygmy Owl *Glaucidium brasilianum* in central Argentina. *Bird Study* 60:35–43.

COCKLE, K.L., K. MARTIN, AND T. WESOŁOWSKI. 2011. Woodpeckers, decay, and the future of cavity-nesting vertebrate communities worldwide. *Frontiers in Ecology and the Environment* 9:377–382.

CORNELIUS, C., K. COCKLE, N. POLITI, I. BERKUNSKY, L. SANDOVAL, V. OJEDA, L. RIVERA, M. HUNTER, JR., AND K. MARTIN. 2008. Cavity-nesting birds in neotropical forests: cavities as a potentially limiting resource. *Ornitología Neotropical* 19:253–268.

DAWSON, R. AND G.R. BORTOLOTTI. 1997. Misdirected incubation in American Kestrels: a case of competition for nest sites? *Wilson Bulletin* 109:732–734.

DE LA PEÑA, M.R. 2010. Nidos de aves Argentinas. CD-ROM. Editorial Universidad Nacional del Litoral, Santa Fe, Argentina.

ESRI (ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE). 2000. ArcView GIS (Version 3.2a). ESRI, Inc., Redlands, CA U.S.A.

ESCHENBAUCH, J.E., E.A. JACOBS, AND R.N. ROSENFIELD. 2009. Nest box occupancy and reproductive performance of kestrels in central Wisconsin. *Journal of Raptor Research* 43:365–369.

HEINTZELMAN, D.S. AND A.C. NAGY. 1968. Clutch sizes, hatchability rates, and sex ratios of sparrow hawks in eastern Pennsylvania. *Wilson Bulletin* 80:306–311.

HOSMER, D.W. AND S. LEMESHOW. 1989. Applied logistic regression. Wiley, New York, NY U.S.A.

JACOBS, E. 1995. American Kestrel reproduction and dispersal in central Wisconsin. *Journal of Raptor Research* 29:135–137.

KATZNER, T., S. ROBERTSON, B. ROBERTSON, J. KLUCSARITS, K. MCCARTY, AND K.L. BILDSTEIN. 2005. Results from a long-term nest-box program for American Kestrels: implications for improved population monitoring and conservation. *Journal of Field Ornithology* 76:217–226.

KÖNIG, C. AND F. WEICK. 2008. Owls of the world. Second Ed. Yale Univ. Press, New Haven, CT U.S.A.

LAMBRECHTS, M.M., K.L. WIEBE, P. SUNDE, T. SOLONEN, F. SERGIO, A. ROULIN, A.P. MØLLER, B.C. LÓPEZ, J.A. FARGALLO, K.-Mi. EXO, G. DELL'OMO, D. COSTANTINI, M. CHARTER, M.W. BUTLER, G.R. BORTOLOTTI, R. ARLETTAZ, AND E. KORPIMÄKI. 2012. Nest box design for the study of diurnal raptors and owls is still an overlooked point in ecological, evolutionary and conservation studies: a review. *Journal of Ornithology* 153:23–34.

LIÉBANA, M.S., J.H. SARASOLA, AND M.S. BÓ. 2009. Parental care and behavior of American Kestrel, *Falco sparverius*, breeding at semiarid forest of central Argentina. *Journal of Raptor Research* 43:338–344.

LIMA, P.C. AND T.N.C. LIMA. 2008. O comportamento reprodutivo do caburé *Glaucidium brasilianum* (Gmelin, 1788) no Litoral Norte da Bahia: um ensaio foto gráfico. *Atualidades Ornitológicas Online* 141:65–86.

——— AND ———. 2009. O comportamento reprodutivo da corujinha-do-mato *Otus choliba choliba* (Strigiformes: Strigidae) no litoral norte da Bahia: um ensaio fotográfico. *Atualidades Ornitológicas Online* 152:41–65.

LINDELL, C. 1996. Patterns of nest usurpation: when should species converge on nest niches? *Condor* 98:464–473.

MARTELLA, M.B., J.L. NAVARRO, AND E.H. BUCHER. 1985. Vertebrados asociados a los nidos de la cotorra (*Myiopsitta monachus*) en Córdoba y La Rioja. *Physis* 43:49–51.

MCCULLAGH, P. AND J.A. NELDER. 1989. Generalized linear models, Second Ed. Chapman and Hall, London, U.K.

MILLSAP, B.A., K.W. CLINE, AND B.A. GIRON PENDLETON. 1987. Habitat management. Pages 215–238 *in* B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird [EDS.], Raptor management techniques manual. National Wildlife Federation, Washington, DC U.S.A.

MOTTA-JUNIOR, J.C. 2002. Diet of breeding Tropical Screech-Owl (*Otus choliba*) in southeastern Brazil. *Journal of Raptor Research* 36:332–334.

NAROSKY, T., M. BABARSKAS, AND B. LÓPEZ LANUS. 1992. Hallazgo del primer nido del halconcito gris (*Spiziapteryx circumcinctus*) en Buenos Aires. *Hornero* 13:246–247.

NEWTON, I. 1994. The role of nest sites in limiting the numbers of hole-nesting birds – a review. *Biological Conservation* 70:265–276.

———. 1998. Population limitation in birds. Academic Press, London, U.K.

OLROG, C.C. 1959. Las aves Argentinas. Una guía de campo. Instituto Miguel Lillo, Tucumán, Argentina.

PETTY, S.J., G. SHAW, AND D.I.K. ANDERSON. 1994. Value of nest boxes for population studies and conservation of owls in coniferous forests in Britain. *Journal of Raptor Research* 28:134–142.

SARASOLA, J.H., L.A. BRAGAGNOLO, AND R.A. SOSA. 2005. Changes in woody plant structure in fire-disturbed Caldén forests of Parque Luro Reserve, Argentina. *Natural Areas Journal* 25:374–380.

SAS INSTITUTE, INC. 1994. JMP statistics and graphics guide, Version 8 of JMP. Cary, NC U.S.A.

SALVADOR, S.A. 2012. Reutilización de nidos por aves en el área central de Córdoba, Argentina. *Nótulas Faunísticas* 91:1–9.

SMALLWOOD, J.A. 1987. Sexual segregation by habitat in American Kestrels (*Falco sparverius*) wintering in south-central Florida: vegetative structure and responses to differential prey availability. *Condor* 89:842–849.

——— AND M.W. COLLOPY. 2009. Southeastern American Kestrels respond to an increase in the availability of nest cavities in north-central Florida. *Journal of Raptor Research* 43:291–300.

SMITH, M.D., J.F. KELLY, AND D.M. FINCH. 2005. Avian nest box selection and nest success in burned and unburned southwestern riparian forest. *Journal of Wildlife Management* 71:411–421.

SMITH, S.M. 1983. *Otus choliba*. Pages 592–593 *in* D.H. Janzen [ED.], Costa Rican natural history. Univ. of Chicago Press, Chicago, IL U.S.A.

STEENHOF, K. AND B.E. PETERSON. 2009. American Kestrel reproduction in southwestern Idaho: annual variation and long-term trends. *Journal of Raptor Research* 43:283–290.

TAYLOR, I.R. 1994. Barn Owls. Cambridge Univ. Press, Cambridge, U.K.

THOMAS, B.T. 1977. Tropical Screech-Owl nest defense and nestling growth rate. *Wilson Bulletin* 89:609–612.

TOLAND, B.R. AND W.H. ELDER. 1987. Influence of nest box placement and density on abundance and productivity of American Kestrels in central Missouri. *Wilson Bulletin* 99:712–717.

TREJO, A. 2007. Identificación de especies y áreas prioritarias para el estudio de la reproducción de aves rapaces de Argentina. *Hornero* 22:85–96.

VALDEZ, U., S. ROBERTSON, B. ROBERTSON, AND K.L. BILDSTEIN. 2000. Nestbox use by American Kestrels (*Falco sparverius*) and European Starlings (*Sturnus vulgaris*) in eastern Pennsylvania. *Pennsylvania Birds* 14:150–153.

VARLAND, D.E. AND T.M. LOUGHLIN. 1993. Reproductive success of American Kestrels nesting along an interstate highway in central Iowa. *Wilson Bulletin* 105:465–474.

WHEELER, A.H. 1992. Reproductive parameters for free ranging American Kestrels (*Falco sparverius*) using nest boxes in Montana and Wyoming. *Journal of Raptor Research* 26:6–9.

WIEBE, K.L. 2011. Nest sites as limiting resources for cavity-nesting birds in mature forest ecosystems: a review of the evidence. *Journal of Field Ornithology* 82:239–248.

WILMERS, T.J. 1983. Kestrel use of nest boxes on reclaimed surface mines in West Virginia. *Journal of Raptor Research* 17:30–31.

Received 16 September 2012; accepted 23 January 2013
Associate Editor: Vincenzo Penteriani