Short Communication

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Establishing a Lesser Kestrel Colony in an Urban Environment for Research Purposes

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Raptors are top predators sensitive to changes and perturbations in the food chain, and as a consequence, they function as good bioindicators for environmental and ecosystem health. Captive breeding facilities have been created at research centers or universities to study biological traits of several raptor species (e.g., the American Kestrel (*Falco sparverius*) has been used as a wildlife study model for over four decades, probably becoming one of the most studied raptors in the world; Bardo and Bird 2009). Among wild populations, the Lesser Kestrel (*Falco naumanni*) is one of the most studied raptors in Europe, especially in the Mediterranean Basin. It is a study model species for a variety of biological disciplines: genetics, physiology, migration, behavioral ecology, population ecology, and conservation biology in a broad sense. The goal of this report is to describe the development of a project to establish an artificial Lesser Kestrel colony on the roof of a biological research center located within an urban area (Seville, southern Spain). This colony provides many of the logistic advantages of a captive breeding facility, but uses wild birds; and consequently, will be useful for studies of the species' biology and ecology. In addition, our colony will help conserve the species in an urban environment by providing predator-free nest-sites and reinforcing a decimated population.

Methods

Study Species. The Lesser Kestrel is one of the smallest European raptors (wingspan 58–72 cm, body mass 120–140 g). Breeding range of this migratory falcon extends from China to the Iberian Peninsula and its wintering grounds are located in sub-Saharan Africa. It breeds in small colonies numbering 1 to 100 breeding pairs. Lesser Kestrels nest in holes and crevices available on natural cliffs, but also in buildings such as castles, churches, and old buildings, especially in its western breeding range. It is linked to steppes and pseudo-steppes (cereal fields and pasturelands), where it obtains its primary prey, arthropods (i.e., grasshoppers, beetles, crickets; see Negro 1997 for more information on the species).

The Lesser Kestrel suffered a severe decline during the second half of the 20th century probably due to habitat loss and degradation as a result of agriculture intensification. However, as the population has been stable for the last two decades, it has been downlisted from Vulnerable to Least Concern according to IUCN criteria (BirdLife International 2011). Because of the decline of the Lesser Kestrel, numerous conservation programs involving captive breeding for reintroduction and reinforcement purposes (Pomarol 1993, Alcaide et al. 2010), rehabilitation of nests and colonies (Pomarol 1996, Bux et al. 2008, Catry et al. 2009, Pérez et al. 2011), and enhancement of foraging habitats have been put in place.

Creating a New Lesser Kestrel Colony. The physical structure for the colony consisted of two elongated brick constructions on the roof of a five-floor building, at the headquarters of Doñana Biological Station, at a height of 28 m above the street level (Fig. 1). Although the building is located within the urban area of the Isla de La Cartuja, Seville, southern Spain, it is on the northernmost edge of the city facing agricultural fields. Cereal fields extend toward the northwest, the nearest ones <500 m away from the office building and thus the colony. This area is intensively cultivated, with small plots of cereal, sunflower, olive groves, and other minor crops. Forty wooden nest boxes with easy access (for capture of birds at the nests from inside the building) were mounted on the north wall (Fig. 1). Nest-box dimensions were 40 × 30 × 25 cm.

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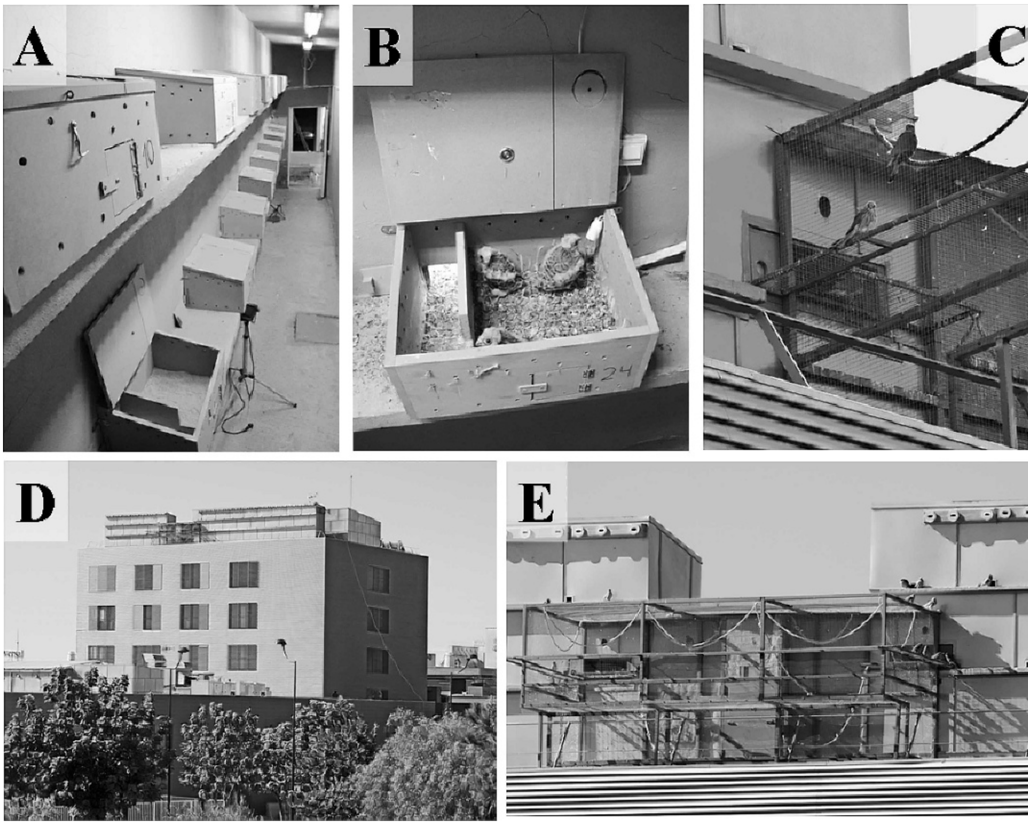

Figure 1. Lesser Kestrel breeding colony located at the headquarters of Doñana Biological Station (Seville, Spain). (A) Inside view (Photo: Airam Rodríguez). (B) Nestlings in a nest box used by wild Lesser Kestrels (Photo: Airam Rodríguez). (C) Female Lesser Kestrel hacked and resighted at the colony (Photo: José Antolín/DEMA). (D) Headquarters of Doñana Biological Station in Seville with the Lesser Kestrel colony located at the roof (Photo: José Antolín/DEMA). (E) Cage with adult birds inside and hacked fledglings resting outside (Photo: José Antolín/DEMA).

The size of the entrance was 7.5 cm in width and the corridor to enter the nest-box breeding chamber was 15 cm long to exclude feral pigeons (*Columba livia*) and jackdaws (*Corvus monedula*), potential competitors for nest-holes (Forero et al. 1996). Sand was added to the nest boxes to provide a soft substrate and minimize egg-rolling. In Seville city, to our knowledge the largest city in western Europe with Lesser Kestrel colonies, at least three urban colonies contain a total of about 100 pairs (Negro et al. 2000).

Hacking Program. *Nestlings.* In 2008, a hacking program was started by releasing nestlings 18- to 24-d old from a captive breeding program (Lesser Kestrel Breeding Center of DEMA, Almendralejo, Spain, www.demaprimilla.org). Nestlings were banded with metal and plastic bands, and released into the hacking nest boxes. Food (white mice) was cut up into pieces of different size according to nestling age and provided *ad libitum.*

Conspecific attraction. In addition, captive adult Lesser Kestrels (1–4 birds per year) were maintained during four breeding seasons (2008–11) from late February to late July in an external wire netting cage ($6 \times 2 \times 2$ m). These kestrels were permanently injured and could not be rehabilitated to be released to the wild. They were provided by DEMA from their captive stock. The purpose of keeping captive birds was twofold. First, Lesser Kestrel colonies seem to grow due to conspecific attraction (Serrano and Tella 2003, Serrano et al. 2003, 2004), and therefore, they might attract conspecifics to the colony after their prebreeding migration, both free-living and hacked birds. Second, the cage of adults was situated in the front portion of the colony and it was adjacent to the nestlings' hacking nest boxes, separated from them only by a wire mesh through which the adults could feed the nestlings. Thus, when adults were fed, nestlings begged for food and captive adult birds acted as foster parents feeding the nestlings (see Antolín 2001).

Supplementary feeding. During the 2008–12 breeding seasons we provided supplemental food to the colony. We

Table 1. Number of individuals sighted and breeding rates of the Lesser Kestrel (*Falco naumanni*) at the breeding colony in Doñana Biological Station, Seville, Spain.

	YEAR					
	2008	2009	2010	2011	2012	TOTAL
No. of fledglings released (hacking)	51	58	40	-	-	149
No. of birds resighted[1]	0	10(1)	16(6)	16(8)	10(6)	35(12)
No. of pairs established	0	1	3	6	3	13
No. of eggs laid	-	0	20[2]	26[3]	12	58
No. of chicks fledged	-	-	5	6	9	20
Mean clutch size[4]	-	-	5	4	4	4.25
Breeding success (fledglings per successful pair)	-	-	2.5	3	3	2.86
Breeding success (fledglings per breeding attempt)	-	-	1.67	1	3	1.54

[1] No. of birds resighted = Adult birds individually identified by PVC bands. In parentheses is the number of adult birds originating from other colonies.
[2] One pair laid ten eggs in four different nest boxes.
[3] Two pairs laid four and six eggs in four and four different nest boxes, respectively.
[4] Excluding abnormal clutches (i.e., those clutches coming from pairs laying eggs in different nest boxes).

used dead 3-d-old chicken chicks and white mice provided by a commercial supplier. Food was left on the captive kestrels' cage and in the vicinity of the artificial colony. The amount of food provided depended on the number of birds and phase of the breeding season.

RESULTS AND DISCUSSION

A total of 149 captive-hatched nestlings were released from 2008 to 2010 (Table 1). One and ten wild-reared nestlings fallen from their nests and admitted to the DEMA facilities in 2008 and 2009, respectively, were additionally released in the hacking program. In 2009, captive birds kept in the central cage raised two additional fledglings that were eventually released by hacking.

Twenty-three of the 162 nestlings of different origins released by hacking (14%) were observed at the colony during the years post-release (Fig. 2). Eight of the 23 birds sighted have tried to breed at least once (5% of released birds). Furthermore, one fledgling released by hacking from our colony in 2010 was recaptured as a breeder in 2011 and 2012 at a colony 48 km away, and at least one other fledgling was sighted as a breeder at another nearby colony (<1 km away) that was not used by Lesser Kestrels when the program started. The return and recruitment rates observed in the following years at our colony were lower than or similar to those reported for other reintroduction programs carried out in Catalonia (25% of hacked birds were resighted and 17% recruited as breeders; Pomarol et al. 2001, 2009) or in Valencia (12.5% of hacked birds were resighted; M. Romero pers. comm.). However, in Catalonia, rates were calculated taking into consideration the sightings and recruitments at nearby colonies (buildings), whereas we only routinely monitored the one colony on our roof. It is known that conspecific attraction plays an important role in the settlement of Lesser Kestrels (Serrano and Tella 2003, Serrano et al. 2003, 2004); therefore, the probability of natal dispersal to another colony, i.e., the probability of breeding at a colony other than the natal colony, decreases with the size of the natal colony and with the distance to the nearest colony (Serrano et al. 2003). Therefore, hacked birds from our building may be recruiting to other larger neighboring colonies in Seville.

Breeding pairs were established in the second year of the release project (Table 1). The first breeding pair was

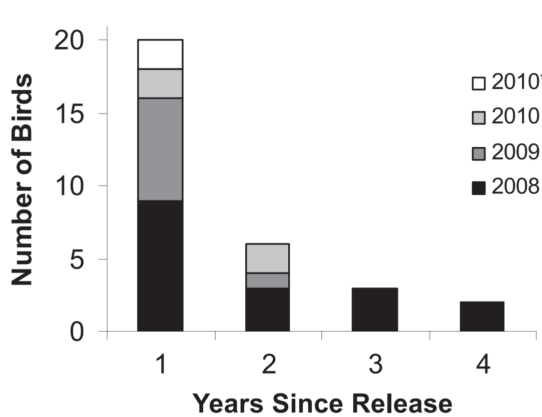

Figure 2. Number of hacked fledglings resighted at the colony during subsequent years. * Open bar for 2010 indicates fledglings produced by breeding pairs established at the colony (i.e., they were not released by hacking).

formed by yearlings (one female released the previous year and a first-year-plumage wild male). The age of this pair corresponds well with the information reported from other sites, i.e., high frequency of yearlings and first-time breeders in small colonies (Serrano and Tella 2007). Six of the 13 individually identified breeders involved in the 13 breeding attempts were hacked as fledglings at our colony. Therefore, at least 54% of the breeder birds were of wild origin and were attracted from elsewhere (note that two birds were not captured and banded when they attempted to breed, and thus, this percentage may be higher). The majority of Lesser Kestrels in Europe breed in old buildings with a high availability of holes due to their poor condition or poor maintenance. However, if these old buildings are finally repaired or restored, holes are usually eliminated, limiting the availability of nest sites (although this practice is currently changing thanks to conservation guidelines; de la Riva and Serrano 2004). Therefore, the provision of 40 nest boxes in our colony has increased nesting sites for the species, assisting in its conservation as indicated by the fact that immigrants from other colonies have been able to breed at our building (but see Pérez et al. 2011). Our colony located on the roof represents safe (free from predators) and long-lasting nesting sites for Lesser Kestrels (Franco et al. 2005). In a similar way, the Lesser Kestrel population in Portugal has benefited by the provision of nest boxes, and currently 52% of that country's population breeds in artificial nest cavities (Catry et al. 2009).

Rural colonies of Lesser Kestrels tend to have higher breeding and prey delivery rates than urban colonies (Tella et al. 1996, Negro et al. 2000). However, the breeding success of our colony ranged between 2.5–3 fledglings per successful pair, higher rates than those reported in nearby rural colonies (e.g., Rodríguez et al. 2006). The high breeding success may be related to the supplementary feeding. All breeders at our colony were observed eating supplemented food at least once (birds released by hacking were observed using supplemented food more frequently than wild birds), as well as some Lesser Kestrels from other colonies and at least two female Eurasian Kestrels (*Falco tinnunculus*). The provision of safe nest sites and supplemental food has benefited not only Lesser Kestrels (Pomarol 1996, Bux et al. 2008, Catry et al. 2009), but also other kestrel species, such as the endangered Mauritius Kestrel (*F. punctatus*). Supplementary feeding allowed Mauritius Kestrel pairs to raise larger broods, and nest boxes increased the numbers of breeding kestrels by providing nest sites in areas previously lacking them (Jones 2004).

Despite the recent implementation of the project (only 5 yr ago) and the small number of pairs breeding at the colony, it is already yielding scientific outputs. Two different projects have been carried out using the colony as a model. In one study, we have combined the use of GPS data-logger information obtained from free-ranging birds, and environmental information recorded by unmanned aerial systems (UASs) to study foraging habitat selection of breeders, demonstrating that UASs can obtain environmental information at quasi-real time for wildlife studies (Rodríguez et al. 2012). In another study, we have measured the metabolic costs of the immune response of hacked and wild-reared nestlings. As a caveat, we note the small size of the colony so far makes it possible that the colony might yet fail.

Conclusions. Urban bird species have an environmental, cultural, touristic, and even educational value, and play a key role for enhancing environmental awareness among city dwellers. They should not be neglected or overlooked in a modern world where urban areas increase along with the proportion of the human population inhabiting them. In the case of the Lesser Kestrel, it has been predicted that the western European population will soon depend on artificial nest sites (Catry et al. 2009). Modern architecture, often heralded as eco-friendly, should not only target economic, energetic, and functional optimization, but also consider providing suitable nesting habitat for important, native urban species.

ESTABLECIMIENTO DE UNA COLONIA DE CERNÍCALO PRIMILLA *FALCO NAUMANNI* EN UN AMBIENTE URBANO CON PROPÓSITOS DE INVESTIGACIÓN

RESUMEN.—Debido al declive reciente de las poblaciones de cernícalo primilla *Falco naumanni*, se han llevado a cabo numerosos proyectos de reintroducción y refuerzo de sus poblaciones en varios países mediterráneos. Aprovechando la experiencia de proyectos previos, intentamos establecer una colonia de *F. naumanni* en la cubierta de la sede central de la Estación Biológica de Doñana, un edificio moderno y recientemente construido en Sevilla, sur de España. Nuestro objetivo es obtener un acceso fácil a una población urbana y silvestre de esta especie modelo con fines científicos. Después de la liberación de los primeros individuos mediante el método de crianza campestre hace cinco años, nuestra colonia experimental parece haberse establecido. Tres, seis y tres parejas intentaron reproducirse en los años 2010, 2011 y 2012, respectivamente.

[Traducción de los autores editada]

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LITERATURE CITED

ALCAIDE, M., J.J. NEGRO, D. SERRANO, J.L. ANTOLÍN, S. CASADO, AND M. POMAROL. 2010. Captive breeding and reintroduction of the Lesser Kestrel *Falco naumanni*: a genetic analysis using microsatellites. *Conservation Genetics* 11:331–338.

ANTOLÍN, J. 2001. Liberación de cernícalos primilla (*Falco naumanni*) nacidos en cautividad, creando ambiente de colonia: Método DEMA. Pages 372–376 *in* J.F.G. Toledano and M.C. Matesanz [EDS.], Biología y conservación del cernícalo primilla: Actas del IV Congreso Nacional sobre el Cernícalo Primilla. Consejería de Medio Ambiente, Dirección General Promoción y Disciplina Ambiental/GREFA, Madrid, Spain.

BARDO, L. AND D.M. BIRD. 2009. The use of captive American Kestrels (*Falco sparverius*) as wildlife models: a review. *Journal of Raptor Research* 43:345–364.

BIRDLIFE INTERNATIONAL. 2011. Species factsheet: *Falco naumanni.* http://www.birdlife.org/datazone/speciesfactsheet.php?id=3589 (last accessed 15 December 2011).

BUX, M., G. GIGLIO, AND M. GUSTIN. 2008. Nest box provision for Lesser Kestrel *Falco naumanni* populations in the Apulia region of southern Italy. *Conservation Evidence* 5:58–61.

CATRY, I., R. ALCAZAR, A.M.A. FRANCO, AND W. SUTHERLAND. 2009. Identifying the effectiveness and constraints of conservation interventions: a case study of the endangered Lesser Kestrel. *Biological Conservation* 142:2782–2791.

DE LA RIVA, M. AND D. SERRANO. 2004. Restauración de edificios y conservación de colonias. Pages 82–90 *in* Junta de Andalucía [ED.], El cernícalo primilla en Andalucía. Manuales de Conservación de la Naturaleza No. 2. Consejería de Medio Ambiente, Seville, Spain.

FORERO, M.G., J.L. TELLA, J.A. DONÁZAR, AND F. HIRALDO. 1996. Can interspecific competition and nest site availability explain the decrease of Lesser Kestrel *Falco naumanni* populations? *Biological Conservation* 78:286–293.

FRANCO, A.M.A., J.T. MARQUES, AND W. SUTHERLAND. 2005. Is nest-site availability limiting Lesser Kestrel populations? A multiple scale approach. *Ibis* 147:657–666.

JONES, C.G. 2004. Conservation management of endangered birds. Pages 269–303 *in* W.J. Sutherland, I. Newton, and R.E. Green [EDS.], Bird ecology and conservation: a handbook of techniques. Oxford Univ. Press, New York, NY U.S.A.

NEGRO, J.J. 1997. Lesser Kestrel *Falco naumanni. Birds of the Western Palearctic Update* 1:49–56.

———, J. BUSTAMANTE, C. MELGUIZO, J.L. RUIZ, AND J.M. GRANDE. 2000. Nocturnal activity of Lesser Kestrel under artificial illumination in Seville, Spain. *Journal of Raptor Research* 34:327–329.

PÉREZ, I., J.C. NOGUERA, AND E. MÍNGUEZ. 2011. Is there enough habitat for reintroduced populations of the Lesser Kestrel? A case study in eastern Spain. *Bird Conservation International* 21:228–239.

POMAROL, M. 1993. Lesser Kestrel recovery project in Catalonia. Pages 24–28 *in* M.K. Nicholls and R. Clarke [EDS.], Biology and conservation of small falcons: Proceedings of the 1991 Hawk and Owl Trust Conference. The Hawk and Owl Trust, London, U.K.

———. 1996. Artificial nest structure design and management implications for the Lesser Kestrel (*Falco naumanni*). *Journal of Raptor Research* 30:169–172.

———, J. BONFIL, F. CARBONELL, F. PONT, AND G. MAS. 2009. Conservación del cernícalo primilla en Catalunya. Pages 46–51 *in* LPO [ED.], Actas del VII Congreso Internacional sobre el Cernícalo Primilla. LPO, Almendralejo, Spain.

———, G. HEREDIA, J. BONFIL, AND C. PIÑO. 2001. Recuperación del cernícalo primilla (*Falco naumanni*) en Catalunya: cría en cautividad, reintroducción y seguimiento de la población. Pages 349–360 *in* J.F.G. Toledano and M.C. Matesanz [EDS.], Biología y conservación del cernícalo primilla: Actas del IV Congreso Nacional sobre el Cernícalo Primilla. Consejería de Medio Ambiente, Dirección General Promoción y Disciplina Ambiental/GREFA, Madrid, Spain.

RODRÍGUEZ, A., J.J. NEGRO, M. MULERO, C. RODRÍGUEZ, J. HERNÁNDEZ-PLIEGO, AND J. BUSTAMANTE. 2012. The eye in the sky: combined used of unmanned aerial systems and GPS data-loggers for ecological research and conservation of small birds. *PLoS ONE* 7(12): e50336.

RODRÍGUEZ, C., K. JOHST, AND J. BUSTAMANTE. 2006. How do crop types influence breeding success in Lesser Kestrels through prey quality and availability? A modelling approach. *Journal of Applied Ecology* 43:587–597.

SERRANO, D., M.G. FORERO, J.A. DONÁZAR, AND J.L. TELLA. 2004. Dispersal and social attraction affect colony selection and dynamics of Lesser Kestrels. *Ecology* 85:3438–3447.

——— AND J.L. TELLA. 2003. Dispersal within a spatially structured population of Lesser Kestrels: the role of spatial isolation and conspecific attraction. *Journal of Animal Ecology* 72:400–410.

——— AND ———. 2007. The role of despotism and heritability in determining settlement patterns in the colonial Lesser Kestrel. *American Naturalist* 169:E53–E67.

———, ———, J.A. DONÁZAR, AND M. POMAROL. 2003. Social and individual features affecting natal dispersal in the colonial Lesser Kestrel. *Ecology* 84:3044–3054.

TELLA, J.L., F. HIRALDO, J.A. DONÁZAR, AND J.J. NEGRO. 1996. Costs and benefits of urban nesting in the Lesser Kestrel. Pages 53–60 *in* D. Bird, D. Varland, and J.J. Negro [EDS.], Raptors in human landscapes: adaptations to built and cultivated environments. Academic Press, London, U.K.

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