Bald Eagle and Golden Eagle Mortalities at Wind Energy Facilities in the Contiguous United States

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SHORT COMMUNICATIONS

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BALD EAGLE AND GOLDEN EAGLE MORTALITIES AT WIND ENERGY FACILITIES IN THE CONTIGUOUS UNITED STATES

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KEY WORDS: *Bald Eagle*; Haliaeetus leucocephalus; *Golden Eagle*; Aquila chrysaetos; *mortality*; *United States*; *wind energy.*

Eagles are among the bird species that can be injured or killed by collision at wind energy facilities when the birds are flying at the same height above ground as the blades of horizontal-axis wind turbines (Drewitt and Langston 2006). Regions of the United States with wind resources adequate for wind energy development (National Renewable Energy Laboratory 2009) often overlap habitats important to Bald Eagles (*Haliaeetus leucocephalus;* Buehler 2000) and Golden Eagles (*Aquila chrysaetos*; Kochert et al. 2002). Golden Eagles, in particular, use open spaces and wind resources similar to those valuable for wind energy facilities. High levels of collision mortality are well documented for Golden Eagles at the Altamont Pass Wind Resource Area (APWRA) in California (Smallwood and Thelander 2008, Smallwood and Karas 2009), where published estimates of annual mortality ranged as high as 66.7 to 75.0 Golden Eagles per year in 2005–2007 (Smallwood and Thelander 2008; Drewitt and Langston 2006). Elsewhere, assessments of eagle mortality at commercial-scale and/or private wind energy facilities are either seldom conducted or in some cases not made available for public review. Meanwhile, terrestrial-based commercial wind energy (facilities where electrical power is produced for sale to the local or national power grid) installed in the contiguous United States reached an estimated 51 630 megawatts by September 2012, and likely will increase substantially by 2015 (U.S. Department of Energy 2011a, 2011b), suggesting potential for increased interaction between eagles and wind energy facilities.

Concerns over the effects of this trend on North America's Bald Eagles and Golden Eagles exist, but are weakly substantiated due to a lack of published documentation of mortalities. Our objective was to summarize documented cases of eagle mortality at wind energy facilities in the contiguous United States, excluding APWRA, during the last 15 years, as a starting point for future assessments.

METHODS

We retrieved information on eagle mortalities and injuries that occurred from 1997 to 30 June 2012 at wind energy facilities, by using public-domain sources, including documents from wind energy companies released to the U.S. Fish and Wildlife Service. We omitted anecdotal or unsubstantiated accounts and considered only cases with unambiguous physical evidence of mortality or injury. We did not include eagle mortalities from APWRA because of the availability of information reported from that location that has been published elsewhere. Although not all reports of mortality we reviewed included carcass necropsies, we considered collision as the likely cause of mortality for eagles discovered beneath operating wind turbines and/or which exhibited dismemberment or other gross external evidence of blunt force trauma. However, losses of eagles at wind energy facilities reported here included one eagle mortality attributed to electrocution on a power line. Last, we encountered six records of eagles injured by blunt force trauma at wind facilities and, due to the severity of their injuries, three were subsequently euthanized or deemed non-releasable. Of the remaining three, one injured eagle was released after extensive rehabilitation, and we are unaware of the final disposition of the remaining two. We included these as mortalities because the individuals were likely removed from the population. We only reported fatalities with strong and compelling information; we did not include 17 records where eagle mortality was not fully substantiated; i.e., the report lacked physical evidence or a reliable first-person source.

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Table 1. Mortalities of Bald Eagles and Golden Eagles associated with wind energy facilities in the contiguous United States during 1997 through June 2012, excluding Altamont Pass Wind Resource Area in California. These data underrepresent the total number of mortalities of eagles at wind energy facilities in the United States during this period; e.g., most were discovered incidentally during routine activities at facilities.

SPECIES	STATE	NUMBER OF FACILITIES WHERE MORTALITIES WERE REPORTED	NUMBER OF FATALITIES
Bald Eagle	Iowa	3	3
Bald Eagle	Maryland	1	1
Bald Eagle	Wyoming	2	2
Golden Eagle	California	13	27
Golden Eagle	Colorado	1	5
Golden Eagle	New Mexico	1	5
Golden Eagle	Oregon	2	6
Golden Eagle	Texas	1	1
Golden Eagle	Utah	1	1
Golden Eagle	Washington	2	5
Golden Eagle	Wyoming	7	29
Total		32[1]	85

[1] Both species were killed at two Wyoming facilities, yet each of the facilities is represented only once in the column total.

RESULTS AND DISCUSSION

We found a minimum of 85 eagle mortalities at 32 wind energy facilities in 10 states during 1997 through 30 June 2012 (Table 1, Appendix). Sixty-seven (78.8%) of these mortalities occurred during 2008–2012. Six (7.1%) mortalities were of Bald Eagles and 79 (92.9%) were of Golden Eagles. All but one mortality occurred at commercial-scale wind facilities; one dead adult Bald Eagle was discovered under a smaller-scale wind turbine with a blade radius of only 3.5 m. One Wyoming facility accounted for 12 Golden Eagle mortalities, the most for any single facility. Mortality of both species was recorded at two separate facilities in Wyoming. Adults made up 55.5% (20 birds) of the 36 Golden Eagle mortalities for which age class was reported. At APWRA, subadults composed 63.3% of 42 blade-strike mortalities of Golden Eagles (Hunt 2002); however, age class was unknown for more than half (54.4%) of the Golden Eagle mortalities (Appendix), so we could not make a clear comparison.

One possible explanation for limited records of Bald Eagle mortality is that this species may be less vulnerable than Golden Eagles to collisions at wind energy facilities. However, the White-tailed Eagle (*Haliaeetus albicilla*), a congener ecologically similar to the Bald Eagle, incurs substantial collision mortality at wind facilities in coastal Norway (Nygård et al. 2010). There may also be less overlap between the areas most important to Bald Eagles and current wind energy facilities in the contiguous United States than is the case for Golden Eagles. Another explanation is that discovery of carcasses of Bald Eagles, either incidentally or during surveys, at wind energy facilities east of the 100th meridian may be less likely because landscapes there are more heavily vegetated (row crops and forests) and thus carcasses are more likely to be concealed, particularly during spring and summer.

More than one-half (54.1%) of the eagle mortalities at wind energy facilities we report were discovered by a property owner or by facility employees during routine site operations. In contrast, less than one-fourth (18.8%) were found during surveys designed to document avian mortality (Appendix). One mortality (1.2%) was discovered via radiotelemetry, and one (1.2%) blade strike of an eagle from a territory near a turbine field was observed. Means of discovery of other mortalities (24.7%) were not evident from records we reviewed. Other than a sample of known-age individuals, records generally were too incomplete for us to assess biological or ecological factors associated with eagle mortality at wind energy facilities.

Designs of carcass surveys at wind energy facilities were either unknown to us or were such that inferences to total mortality could not be made. This, combined with the facts that most carcasses were discovered incidentally, and that reporting of mortalities was primarily voluntary with little or no effort directed toward finding the total number of eagles killed at a facility, suggest that the mortalities reported here underrepresent the actual number of eagle fatalities that have occurred at non-APWRA wind facilities in recent years.

More Golden Eagle strikes were reported in March–June than in any other months (Fig. 1), although sample sizes were too small for statistical analyses. Whether this reflected a seasonal shift in mortality or just a change in detection was unclear from the data available, but this should be investigated as part of future studies. Nygård et al. (2010) reported a surge in adult White-tailed Eagles killed at wind facilities in Norway during the spring season.

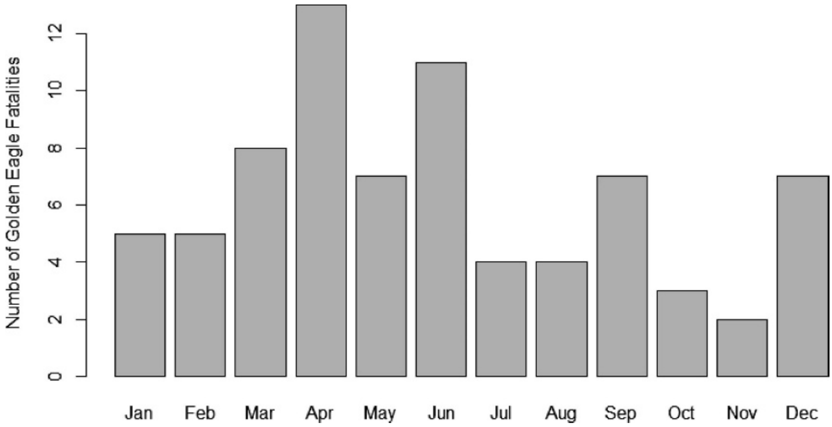

Figure 1. Seasonal distribution of Golden Eagle fatalities at wind facilities reported by month. Three of 79 Golden Eagle mortality records were not included due to lack of specificity of month of incident.

This summary likely conveys only a limited portion of eagles killed at non-APWRA wind energy facilities in the contiguous United States, considering the general lack of rigorous monitoring and reporting of eagle mortalities. Thus, our findings of the reported mortalities likely underestimate, perhaps substantially, the number of eagles killed at wind facilities in the United States. Even with this limitation, we report that blade-strike mortality of eagles is geographically widespread in the United States, and both Bald Eagles and Golden Eagles are killed. Given the projected growth in wind resource development in habitat frequented by Bald Eagles and Golden Eagles, estimation of total mortality and better understanding of factors associated with injury and death at wind facilities through robust and peer-reviewed research and monitoring should be a high priority.

MORTALIDAD DE *HALIAEETUS LEUCOCEPHALUS* Y *AQUILA CHRYSAETOS* EN INSTALACIONES DE ENERGÍA EÓLICA EN LA PARTE CONTINUA DE ESTADOS UNIDOS

RESUMEN.—Han muerto individuos tanto de *Haliaeetus leucocephalus* como de *Aquila chrysaetos* en instalaciones de energía eólica en Estados Unidos. Encontramos un mínimo de 85 águilas muertas, incluyendo 6 individuos de *H. leucocephalus* y 79 de *A. chrysaetos*, en 32 instalaciones de energía eólica en 10 estados desde 1997 hasta el 30 de junio de 2012. Probablemente nuestros resultados sub-representan, quizá substancialmente, los números de águilas muertas en Estados Unidos a causa de la producción de electricidad generada por el viento.

[Traducción del equipo editorial]

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LITERATURE CITED

BUEHLER, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). *In* A. Poole [ED.], The birds of North America online, No. 506. Cornell Laboratory of Ornithology, Ithaca, NY U.S.A. http://bna.birds.cornell.edu/bna/species/506 (last accessed 23 January 2012).

DREWITT, A.L. AND R.H.W. LANGSTON. 2006. Assessing the impacts of wind farms on birds. *Ibis* 148:29–42.

HUNT, G. 2002. Golden Eagles in a perilous landscape: predicting the effects of mitigation for wind turbine blade-strike mortality. California Energy Commission consultant report P500-02-043F. Sacramento, CA U.S.A.

KOCHERT, M.N., K. STEENHOF, C.L. MCINTYRE, AND E.H. CRAIG. 2002. Golden Eagle (*Aquila chrysaetos*). *In* A. Poole [ED.], The birds of North America online, No. 684. Cornell Laboratory of Ornithology, Ithaca, NY U.S.A. http://bna.birds.cornell.edu/bna/species/684 (last accessed 23 January 2012).

NATIONAL RENEWABLE ENERGY LABORATORY. 2009. U.S. wind resource map. U.S. Department of Energy, National Renewable Energy Laboratory, Washington, DC U.S.A. http://www.nrel.gov/gis/wind.html (last accessed 10 February 2011).

NYGÅRD, T.K., E.L. BEVANGER, E. DAHL, Ø. FLAGSTAD, A. FOLLESTAD, P.L. HOEL, R. MAY, AND O. REITAN. 2010. A study of White-tailed Eagle *Haliaeetus albicilla* movements and mortality at a wind farm in Norway. *In* D. Senapathi [ED.], Climate change and birds: adaptation, mitigation and impacts on avian populations. British Ornithologists' Union Proceedings, Peterborough, U.K. http://www.bou.org.uk/bouproc-net/ccb/nygard-etal.pdf (last accessed 9 October 2011).

SMALLWOOD, K.S. AND B. KARAS. 2009. Avian and bat fatality rates at old-generation and repowered wind turbines in California. *Journal of Wildlife Management* 73:1062–1071.

——— AND C. THELANDER. 2008. Bird mortality in the Altamont Pass Wind Resource Area, California. *Journal of Wildlife Management* 72:215–223.

U.S. DEPARTMENT OF ENERGY. 2011a. Current installed wind power capacity (MW). National Renewable Energy Laboratory, U.S. Department of Energy, Golden, CO U.S.A. http://www.windpoweringamerica.gov/pdfs/wind_maps/installed_capacity_current.pdf (last accessed 06 February 2013).

———. 2011b. U.S. DOE Forecast for U.S. Wind Energy growth for 2011–1013, relative to actual U.S. installations (2006–2010), and target path for 20% wind for U.S. by 2030. U.S. Department of Energy Wind Technologies Market Report. http://www1.eere.energy.gov/wind/pdfs/2010_wind_technologies_market_report_slides.pdf (last accessed 09 October 2011).

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Authors' Note: Between 30 June 2012 and the time of final acceptance of this manuscript, Bald and Golden eagles had been killed by wind-generated electricity production in three additional states: Idaho, Montana, and Nevada.

Appendix. Mortalities of Bald Eagles and Golden Eagles associated with wind energy facilities in the contiguous United States during 1997 through 30 June 2012, excluding Altamont Pass Wind Resource Area in California.

SPECIES	YEAR	STATE/SITE	SEX	AGE	HOW RECOVERED
Golden Eagle	1997	CA - 1	female	subadult	incidental
	1999	CA - 2	unknown	unknown	unknown
		CA - 3	unknown	unknown	unknown
	2000	CA - 3	unknown	unknown	unknown
		CA - 4	unknown	unknown	unknown
	2001	CA - 3	unknown	unknown	unknown
	2002	CA - 3	unknown	unknown	unknown
		CA - 5	unknown	unknown	unknown
		CA - 5	unknown	unknown	unknown
	2004	CA - 6	unknown	unknown	survey
		NM - 1	unknown	unknown	unknown
		NM - 1	unknown	unknown	unknown
	2005	CA - 6	unknown	unknown	incidental
		CA - 7	unknown	unknown	incidental
		NM - 1	unknown	adult	unknown
		NM - 1	unknown	unknown	unknown
	2007	CA - 8	unknown	unknown	unknown
		CA - 9	unknown	unknown	unknown
	2008	NM - 1	unknown	unknown	incidental
	2009	CA - 10	unknown	unknown	incidental
		CO - 1	unknown	unknown	survey
		CO - 1	unknown	unknown	incidental
		OR - 2	unknown	adult	incidental
		WA - 1	unknown	adult	survey
		WY - 3	unknown	unknown	incidental
		WY - 3	unknown	adult	survey
		WY - 3	unknown	unknown	survey
	2010	CA - 10	unknown	unknown	incidental
		CA - 11	unknown	juvenile	telemetry
		CO - 1	unknown	adult	incidental
		OR - 2	unknown	unknown	survey
		OR - 2	unknown	subadult	incidental
		OR - 2	unknown	juvenile	incidental
		WY - 1	unknown	adult	incidental

Appendix. Continued.

SPECIES	YEAR	STATE/SITE	SEX	AGE	HOW RECOVERED
		WY - 2	unknown	adult	incidental
		WY - 3	unknown	adult	incidental
		WY - 3	unknown	unknown	survey
		WY - 3	unknown	unknown	incidental
		WY - 3	unknown	subadult	survey
		WY - 3	unknown	unknown	incidental
		WY - 4	unknown	unknown	incidental
		WY - 5	unknown	unknown	survey
		WY - 5	unknown	unknown	survey
	2011	CA - 10	unknown	unknown	incidental
		CA - 10	unknown	unknown	incidental
		CA - 10	unknown	unknown	incidental
		CA - 10	unknown	adult	incidental
		CA - 12	male	juvenile	incidental
		CA - 12	unknown	adult	incidental
		CO - 1	male	adult	incidental
		CO - 1	unknown	unknown	incidental
		OR - 1	unknown	adult	incidental
		WA - 1	female	adult	incidental
		WA - 2	female	adult	incidental
		WA - 2	male	adult	observed
		WY - 1	unknown	unknown	incidental
		WY - 2	unknown	subadult	incidental
		WY - 3	unknown	subadult	incidental
		WY - 3	unknown	unknown	survey
		WY - 3	unknown	juvenile	survey
		WY - 4	unknown	unknown	incidental
		WY - 5	unknown	unknown	survey
		WY - 6	unknown	subadult	survey
		WY - 6	unknown	juvenile	incidental
		WY - 6	unknown	juvenile	incidental
		WY - 6	unknown	subadult	survey
		WY - 6	unknown	unknown	incidental
	2012	CA -10	unknown	adult	unknown
		CA - 10	unknown	adult	unknown
		CA - 10	unknown	subadult	unknown
		CA - 13	unknown	adult	unknown
		OR - 2	unknown	adult	incidental
		TX - 1	unknown	subadult	unknown
		UT - 1	unknown	adult	incidental
		WA - 2	unknown	unknown	unknown
		WY - 3	unknown	juvenile	incidental
		WY - 7	unknown	unknown	incidental
		WY - 7	unknown	unknown	incidental
		WY - 7	unknown	unknown	incidental
Bald Eagle	2010	WY - 4	unknown	adult	incidental
	2011	IA - 1	unknown	adult	incidental
		WY - 1	unknown	adult	survey
	2012	IA - 2	unknown	unknown	unknown
		IA - 3	male	adult	incidental
		MD - 1	male	adult	incidental

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COMMUNAL ROOSTING OF CHIMANGO CARACARAS (*MILVAGO CHIMANGO*) AT A SHALLOW LAKE IN THE PAMPAS, ARGENTINA

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KEY WORDS: *Chimango Caracara*; Milvago chimango; *abundance*; *land use*; *Pampean shallow lake*; *roosting site*.

Communal roosting behavior has been observed in a diversity of bird species (Eiserer 1984), is widespread among aquatic birds, and occurs in other groups including raptors (Beauchamp 1999). Many hypotheses have been proposed to explain communal roosting from the perspective of benefits to individuals in the group, including reduced risk of predation (Lack 1968), transfer of information and foraging efficiency (Ward and Zahavi 1973), reduced travel costs to and from daily activity centers (Caccamise and Morrison 1988), dispersion of foragers to reduce intraspecific competition (Chapman et al. 1991), conspecific attraction (Buckley 1996), and protection against inclement weather (Walsberg 1986).

In Falconiformes, communal roosting is common, particularly in Accipitridae (Sarasola et al. 2010) and in Cathartidae (vultures; McVey et al. 2008). Communal roosting has been little described in Falconidae; however, it has been recorded for the Lesser Kestrel (*Falco naumanni*; Olea et al. 2004) and some members of the subfamily Caracarinae; for example, the Crested Caracara (*Caracara cheriway*; Johnson and Gilardi 1996).

The Chimango Caracara (*Milvago chimango*, Falconidae, Caracarinae) is a common raptor with a geographic range that extends from southern Brazil and northern Chile south to southern Argentina (Tierra del Fuego) and includes Paraguay and Uruguay (Canevari et al. 1991). This species occupies a wide variety of natural and modified habitats such as grasslands, scrublands and woodlands, croplands, pasturelands, and suburban and urban areas (Morrison and Phillips 2000). Chimango Caracaras forage opportunistically, feeding on carrion and human refuse and on live prey such as insects, worms and other invertebrates (Biondi et al. 2005). This species is characterized by gregarious behavior and can be observed in groups while foraging and roosting (Canevari et al. 1991).

We observed Chimango Caracaras roosting in a wetland in the Los Padres Lake Reserve (37°57′S, 57°43′W), in Buenos Aires province, Argentina. This reserve covers 687 ha and contains a shallow lake with an area of 216 ha, which has a single influent stream and a single effluent stream (Pozzobon and Tell 1995). This area, within the southeastern Pampean region of Argentina, historically was dominated by permanent or temporary wetlands. In many areas, human activity has transformed natural grasslands and wetlands; currently much of the region exists as a highly fragmented agricultural matrix (Ghersa and León 2001). The landscape surrounding the reserve is subject to intensive human land uses and is characterized by small farms, cattle ranches, and semi-natural grasslands (Baccaro et al. 2006). Remnant wetlands are used by numerous bird species for foraging, reproduction, and resting (Josens et al. 2009).

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The littoral zone of Los Padres Lake, within the reserve, is dominated by the emergent marshy macrophyte *Schoenoplectus californicus* (Cyperaceae). We observed colonies of many species of birds roosting in an approximately 0.2-km^2 area of the littoral zone of the lake (Josens et al. 2009). This area of the littoral zone was the only place on the lake where Chimango Caracaras roosted. They congregated in large groups on the macrophytes, along with other species such as herons, ibis, and gulls (Josens et al. 2012).

METHODS

We conducted monthly counts of Chimango Caracaras roosting at this site from July 2006 to June 2009 (n = 36 counts). We counted while stationed in the area where the influent stream enters the lake, which was the best place to observe birds as they arrived at the roost. Counts began 2 hr before sunset and lasted approximately 2 hr, until birds stopped arriving, or when low ambient light precluded identifying birds. We used an analysis of variance (ANOVA) to explore seasonal and annual variation in numbers of Chimango Caracaras at the roost. We obtained daily rainfall data from the National Meteorological Service of Mar del Plata city station for the study period. Seasonal precipitation was calculated as the average rainfall for the corresponding months: winter (June, July, August); spring (September, October, November); summer (December, January, February); and autumn (March, April, May). Annual precipitation was calculated as the average rainfall for the four seasons. We considered a year from July to June. During our study, 2007 (defined as July 2007–June 2008) was a wetter than average year and 2008 (July 2008–June 2009) was a drier than average year (Fig. 1). A simple linear regression analysis was used to explore the relationship between Chimango Caracara abundance and monthly precipitation (Zar 1999). All values reported are (mean ± SE) unless otherwise indicated.

RESULTS AND DISCUSSION

Over the 36-month period, we recorded a monthly average of 1004 ± 689 Chimango Caracaras at the roost (range = 162–2790). Numbers of Chimango Caracaras counted at the roost differed between seasons ($F_{3,47}$ = 12.16, $P <$ 0.001). In all years, we recorded the highest numbers of individuals (1751 ± 555) during the austral winter months (June, July and August), and the lowest numbers (478 ± 326) in austral summer months (December, January and February). In autumn (March, April and May) and spring (September, October and November) an average of 980 ± 568 and 724 ± 473 individuals, respectively, were recorded. Pairwise comparisons (Tukey test) showed significant differences in numbers of Chimango Caracaras at the roost between winter and summer, winter and spring and between autumn and summer ($P <$ 0.05), for all years combined. Numbers of Chimango Caracaras counted at the roost also differed between years ($F_{2,23}$ = 7.3, P = 0.004), specifically between 2006 and 2008. We found no overall association between Chimango Caracara abundance at the roost and monthly precipitation, over the entire study period (r^2 = 0.05, P = 0.264; Fig. 2).

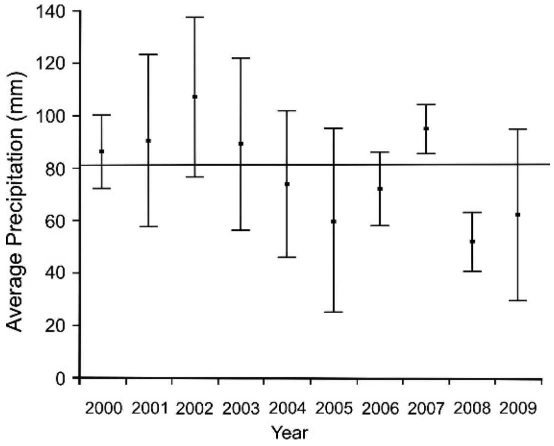

Figure 1. Annual (±SE) average precipitation (in mm) from 2000 to 2009 for the southeastern Buenos Aires province, Argentina. Also shown is the overall average precipitation for the period 2000–09.

Several factors may explain this aggregation and the fluctuating numbers of Chimango Caracaras at this communal roost. Variation in numbers of roosting Chimango Caracaras might reflect variation in seasonal foraging behaviors, which are linked to agricultural practices and the diet of this opportunistic species (Biondi et al. 2005). The Chimango Caracara is associated with farmlands where it feeds on insects, worms, and rodents, particularly during plowing and harvesting activities (Ghys and Favero 2004). These agricultural activities take place principally during winter, when several bird species congregate (Josens et al. 2009). Roosting communally may facilitate the acquisition of knowledge of patchily distributed food resources via one or more foraging-related mechanisms (Johnson and Gilardi 1996).

The observed decline in Chimango Caracara abundance at roosts in summer may be associated with commencement of the species' reproductive period rather than with weather conditions (e.g., precipitation). In our study region, Chimango Caracaras nest from November to January (spring–summer; Morrison and Phillips 2000). Thus, roost membership during the breeding season is likely to consist primarily of nonbreeders; this has been recorded for Crested Caracaras in Florida, U.S.A. (Dwyer et al. 2012). Although we do not know how precipitation may affect the Chimango Caracaras' behavior, changes in water levels may affect the availability of suitable environments for feeding, reproduction, and resting (Romano et al. 2005, Canepuccia et al. 2007), thereby influencing the abundance of this species at the roost.

Foraging theory proposes that transfer of information is favored in conspecific flocks, thereby allowing less successful

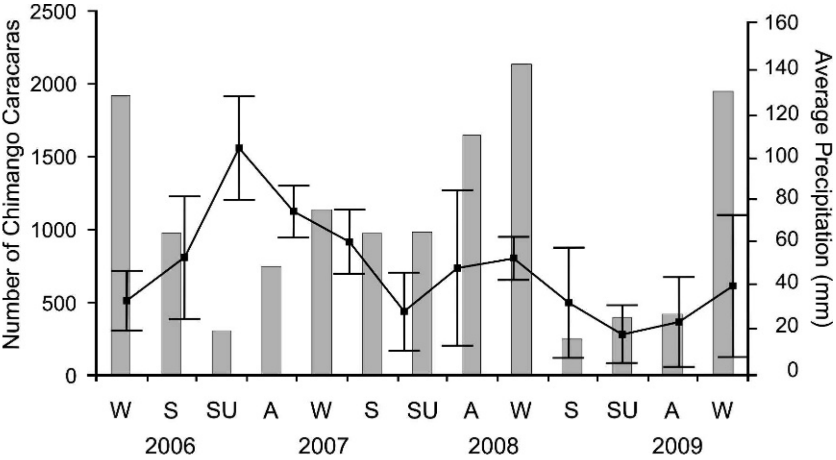

Figure 2. Seasonal variation in the average number of Chimango Caracaras and precipitation from July 2006 through June 2009, in Los Padres Lake Reserve, Buenos Aires province, Argentina. Seasons are: winter (June, July, and August), spring (September, October, and November), summer (December, January, and February) and autumn (March, April, and May). Seasonal Chimango Caracara abundance data are shown as vertical bars, and the points (±SE) show average seasonal precipitation.

individuals a better opportunity to learn of good foraging sites (Ward and Zahavi 1973). Recent research on Chimango Caracaras suggests that information related to the acquisition of cognitive knowledge, such as social behavior (e.g., learning a novel behavior for searching for food), is transmitted among conspecifics (Biondi et al. 2010). Hence, this roost site may also function as an ''information center'' where juvenile and adult Chimango Caracaras may acquire information about good foraging sites or learn foraging skills.

Combinations of factors, rather than one in particular, may explain communal roosting in some species (Chapman et al. 1991), and certainly, these hypotheses to explain the occurrence and variation in communal roosting behavior in Chimango Caracaras are not mutually exclusive. Further study is needed to understand the complex interplay of physical and biological factors associated with use of this roost site by Chimango Caracaras.

DORMIDEROS COMUNALES DE *MILVAGO CHIMANGO* EN UN LAGO POCO PROFUNDO EN LAS PAMPAS, ARGENTINA

RESUMEN.—*Milvago chimango* (Falconidae, Caracarinae) es una rapaz común con una extensa área de distribución geográfica en América del Sur. Esta especie se caracteriza por un comportamiento gregario y se puede observar en grupos mientras forrajea y descansa. Observamos dormideros de *M. chimango* en un humedal en la provincia de Buenos Aires, Argentina. En este sitio realizamos conteos mensuales de *M. chimango* durante tres años. Se utilizó un análisis de varianza (ANAVA) para explorar las variaciones estacionales y anuales en el dormidero, y se exploró la relación entre la abundancia de aves y la precipitación mensual. Se registró un promedio mensual de 1.004 ± 689 individuos de *M. chimango* en el dormidero. Se encontraron diferencias en la abundancia entre el invierno y el verano, el invierno y la primavera, y el otoño y el verano, y no se observó asociación entre la abundancia de aves y la precipitación mensual. La variación en el número podría reflejar variaciones en los comportamientos de alimentación de cada temporada, que están vinculados a las prácticas agrícolas y su dieta. Estas actividades agrícolas se llevan a cabo principalmente durante el invierno, cuando varias especies de aves se congregan. La disminución durante el verano podría estar asociada con el inicio del período reproductivo de la especie, y no con el régimen de precipitación. Este sitio dormidero también podría funcionar como un ''centro de información,'' donde jóvenes y adultos de *M. chimango* adquieren información sobre buenos sitios de alimentación o aprenden habilidades de forrajeo. Sin embargo, se necesitan más estudios para comprender la combinación de factores físicos y biológicos en la conducta de descanso comunal en esta especie.

[Traducción del equipo editorial]

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LITERATURE CITED

BACCARO, K., M. DEGORGUE, M. LUCCA, L. PICONE, E. ZAMUNER, AND Y. ANDREOLI. 2006. Calidad del agua para consumo humano y riego en muestras del cinturón hortícola de Mar del Plata. *Ria* 35:95–110.

BEAUCHAMP, G. 1999. The evolution of communal roosting in birds: origin and secondary losses. *Behavioral Ecology* 10:675–687.

BIONDI, L.M., M.S. BÓ, AND M. FAVERO. 2005. Dieta del chimango (*Milvago chimango*) durante el período reproductivo en el sudeste de la provincia de Buenos Aires, Argentina. *Ornitología Neotropical* 16:31–42.

———, G.O. GARCÍA, M.S. BÓ, AND A.I. VASSALLO. 2010. Social learning in the Caracara Chimango, *Milvago chimango* (Aves: Falconiformes): an age comparison. *Ethology* 116:722–735.

BUCKLEY, N.J. 1996. Food finding and the influence of information, local enhancement and communal roosting on foraging success of North American vultures. *Auk* 113:473–488.

CACCAMISE, F. AND D.W. MORRISON. 1988. Avian communal roosting implications of diurnal activity centers. *American Naturalist* 128:191–198.

CANEPUCCIA, A.D., J.P. ISACCH, D.A. GAGLIARDINI, A.H. ESCALANTE, AND O.O. IRIBARNE. 2007. Waterbird response to changes in habitat area and diversity generated by rainfall in a SW Atlantic coastal lagoon. *Waterbirds* 30:541–553.

CANEVARI, M., P. CANEVARI, G. CARRIZO, G. HARRIS, J. RODRÍGUEZ MATA, AND R. STRANECK. 1991. Nueva guía de las aves Argentinas. Vol. 2. Fundación Acindar, Buenos Aires, Argentina.

CHAPMAN, C.A., L.J. CHAPMAN, AND L. LEFEBVRE. 1991. Variability in parrot flock size: possible functions of communal roosts. *Condor* 91:842–847.

DWYER, J.F., J.D. FRASER, AND J.L. MORRISON. 2012. Within-year survival of nonbreeding Crested Caracaras. *Condor* 114:295–301.

EISERER, L. 1984. Communal roosting in birds. *Bird Behaviour* 5:61–80.

GHERSA, C.M. AND R.J.C. LEÓN. 2001. Ecología del paisaje pampeano: consideraciones para su manejo y conservación. Pages 471–512 *in* Z. Nave and A.S. Lieberman [EDS.], Ecología de Paisajes. Editorial Facultad de Agronomía, Universidad de Buenos Aires, Argentina.

GHYS, M.I. AND M. FAVERO. 2004. Espectro trófico de la gaviota capucho café (*Larus maculipennis*) en agroecosistemas de la Provincia de Buenos Aires, Argentina. *Ornitología Neotropical* 15:493–500.

JOHNSON, M.D. AND J.D. GILARDI. 1996. Communal roosting of the Crested Caracara in southern Guatemala. *Journal of Field Ornithology* 67:44–47.

JOSENS, M.L., A.H. ESCALANTE, AND M. FAVERO. 2009. Seasonal variability of waterbird assemblages in relationship to habitat characteristics in a Pampas wetland. *Waterbirds* 32:523–530.

———, ———, AND ———. 2012. Diversity, seasonality and structure of bird assemblages associated with three wetlands in the southeastern pampas, Argentina. *Ardeola* 59:93–109.

LACK, D. 1968. Ecological adaptations for breeding in birds. Methuen, London, U.K.

MCVEY, K.J., P.D.B. SKRADE, AND T.A. SORDAHL. 2008. Use of a communal roost by Turkey Vultures in northeastern Iowa. *Journal of Field Ornithology* 79:170–175.

MORRISON, J.L. AND L.M. PHILLIPS. 2000. Nesting habitat and success of the Chimango Caracara in southern Chile. *Wilson Bulletin* 112:225–232.

OLEA, P.P., R. VERA, A. DE FRUTOS, AND H. ROBLES. 2004. Premigratory communal roosts of the Lesser Kestrel in the boreal summer. *Journal of Raptor Research* 38:278–282.

POZZOBON, M.V. AND G. TELL. 1995. Estructura y dinámica de la comunidad perifítica sobre *Ricciocarpus natans* (Hepaticae) de la Laguna de Los Padres (Buenos Aires, Argentina). *Boletin de la Sociedad Argentina de Botanica* 30:199–208.

ROMANO, M.C., I.M. BARBERIS, F. PAGANO, AND J.I. MAIDAGAN. 2005. Seasonal and interannual variation in waterbird abundance and species composition in the Melincué saline lake, Argentina. *European Journal of Wildlife Research* 51:1–13.

SARASOLA, J.H., C. SOLARO, M.A. SANTILLAN, AND M.A. GALMES. 2010. Communal roosting behavior and winter diet of the White-tailed Kite (*Elanus leucurus*) in an agricultural habitat on the Argentine pampas. *Journal of Raptor Research* 44:202–207.

WALSBERG, G.E. 1986. Thermal consequences of roost-site selection: the relative importance of three modes of heat conservation. *Auk* 103:1–7.

WARD, P. AND A. ZAHAVI. 1973. The importance of certain assemblages of birds as ''information-centers'' for food-finding. *Ibis* 115:517–534.

ZAR, J.H. 1999. Biostatistical analysis. Prentice-Hall Inc., Englewood Cliffs, NJ U.S.A.

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INVERTEBRATES AS PREY OF SHORT-TOED SNAKE-EAGLES (*CIRCAETUS GALLICUS*)

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KEY WORDS: *Short-toed Snake-Eagle*; Circaetus gallicus; *diet*; *invertebrates*; *migration*; *stomach contents.*

The Short-toed Snake-Eagle (*Circaetus gallicus*), hereafter STE, is a medium-sized trans-Saharan migratory raptor present in Europe from March to November (Cramp and Simmons 1980, Migres Foundation unpubl. data). This species has a diet highly specialized on reptiles, as shown by diet analyses conducted during the breeding season using direct observations and the analysis of pellets and prey remains (Amores and Franco 1980, Vlachos and Papageorgiou 1994, Gil and Pleguezuelos 2001, Bakaloudis and Vlachos 2011). In addition to reptiles, these studies also found birds, amphibians, and small mammals as prey, all of them in small numbers and, therefore, considered as secondary food sources. The occurrence of insects in some of these studies (Gil and Pleguezuelos 2001, Bakaloudis and Vlachos 2011) was attributed to stomach content of prey (e.g., snakes and lizards). In the present study, our goal was to investigate the diet of individuals of all ages during the breeding season and autumn migration.

METHODS

From 2009 to 2011, during March to November, we studied Short-toed Snake-Eagles at the Strait of Gibraltar (35°45′ to 36°10′N and 5°10′ to 6°00′W), the shortest sea crossing between Europe and Africa, which acts as a major concentration point for soaring migrants from western Europe (Bernis 1980). During this period we examined live birds from recovery centers, and also dead eagles that had collided with power lines or wind farms, in order to determine biometry and molt patterns. For dead birds, we also collected the stomach contents for diet determination. We identified stomach contents, which were preserved in 95% ethanol and brought to the laboratory for further examination. We used a metal ruler (accuracy 0.1 cm) and digital scale to the nearest 0.1 g to measure and weigh prey in stomach contents. We used field guides to the reptiles (Mansó and Pijoan 2011) and invertebrates (Barrientos 2004) to identify prey at least to the genus level. Prey number was assigned by determining the lowest possible number of individuals (Morrison et al. 2008). Short-toed Snake-Eagles were classified according to Forsman (1999) as juveniles, immatures, or adults.

RESULTS

We analysed stomach contents of 14 birds, 7 of which contained invertebrates, such as centipedes (*Scolopendra cingulata*) and praying mantises (*Mantis religiosa*), in addition to more typical prey species. Two stomachs were empty, five contained only reptilian prey, four contained reptilian and non-reptilian prey and the remaining three stomachs contained only invertebrates (Table 1). Centipedes were the most abundant invertebrate prey, present in seven birds, with amounts varying from 1 to 44 individuals and an average size of 13.44 ± 1.95 cm (SD) and mass of 1.89 ± 0.73 g (SD). One of the stomachs with centipedes also contained three praying mantises. The stomachs of adults never contained invertebrates, which were present in the six juveniles and one immature eagle. The analysis of one pellet left in a rehabilitation center by another immature STE, collected alive at sea after a failed attempt to cross the Strait of Gibraltar, also contained centipedes (Table 1; see ''P'' in prey analysis).

The absence of any kind of prey other than centipedes, the fact that the centipedes were usually complete and undigested, and the large number found in some cases, indicated that invertebrates are a prey for non-adult STEs, at least during the portion of the migratory period when immature migrants join local breeding birds. Information

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Table 1. Prey items of 15 Short-toed Snake-Eagles near the Strait of Gibraltar (southern Spain) between 2009–2011. Prey items were found in the stomach (SC) or in pellets (P).

BIRD ID	AGE	DATE	YEAR	TYPE OF ANALYSIS	NO. OF PREY	CONTENT	
1	Adult	25 March	2011	SC	—	Empty	—
2	Adult	3 April	2011	SC	1	Snake	*Rhinechis scalaris*
3	Adult	19 April	2010	SC	1	Snake	*Hemorrhois hippocrepis*
4	Immature	21 April	2010	SC	1	Snake	*Hemorrhois hippocrepis*
5	Immature	15 August	2011	P	32	Centipede	*Scolopendra cingulata*
6	Adult	31 August	2010	SC		Scales	*Malpolon monspessulanus*
7	Immature	4 September	2011	SC	20	Centipede	*Scolopendra cingulata*
					1	Snake	*Rhinechis scalaris*
8	Juvenile	5 September	2009	SC		Scales	Natrix sp.
9	Juvenile	10 September	2009	SC	7	Centipede	*Scolopendra cingulata*
10	Juvenile	14 September	2009	SC	2	Centipede	*Scolopendra cingulata*
					1	Snake	*Rhinechis scalaris*
11	Juvenile	25 September	2011	SC	44	Centipede	*Scolopendra cingulata*
					3	Praying mantis	*Mantis religiosa*
12	Juvenile	30 September	2011	SC	1	Centipede	*Scolopendra cingulata*
13	Juvenile	17 October	2011	SC	—	Empty	—
14	Juvenile	25 October	2010	SC	2	Centipede	*Scolopendra cingulata*
						Scales	Natrix sp.
15	Juvenile	4 November	2010	SC	5	Centipede	*Scolopendra cingulata*
					1	Snake	*Hemorrhois hippocrepis*

about the feeding behavior of raptor migratory species *en route* is scarce (but see Yosef 1996), as is data on the use of foraging areas along migratory routes. The presence of invertebrates in the stomach contents of juvenile STEs could be an indicator of the challenge for these young birds to acquire more typical prey. The absence of the snake *Malpolon monspessulanus*, the most common prey species for STEs in the southern Iberian Peninsula (Gil and Pleguezuelos 2001, Pleguezuelos 2009a), in immature individuals was remarkable. This may be related to the juveniles' inexperience, as this snake is among the fastest of the Iberian reptiles according to Pleguezuelos (2009a). During migration, the concentration and roosting of thousands of raptors of different species in the area of the Straits of Gibraltar, a geographical barrier, may lead to competition for prey, especially when adverse weather conditions prevent the sea crossing and individuals of multiple species concentrate in the region for long periods (Bildstein 2006, Muñoz et al. 2010). In this scenario, juveniles, as inexperienced foragers, would have more difficulty finding food (Gorney and Yom-Tov 2008), or may be excluded from the best foraging habitats (Morrison et al. 2008). Despite the peak in snake activity in our study area from September until November (Feriche 2004, Pleguezuelos 2009a, 2009b), seven STEs (six juveniles and one immature) consumed invertebrates from September onwards. The use of invertebrates as a food source may also be due to their abundance in late summer (Kaltsas and Simaiakis 2012). During this period, eagles may shift their diet to invertebrates. As a caveat, we note that all the birds we studied, with the exception of one immature collected alive in the sea, were dead and hence their diet might not be typical of all STEs crossing through this region. These birds may have been starved and thus more likely to use a suboptimal food such as invertebrates. However, the cause of their deaths (collision) would seem to be nonselective, although this aspect should be studied in detail.

Some raptors, such as Black Kites (*Milvus migrans*), Montagu's Harriers (*Circus pygargus*), Broad-winged Hawks (*Buteo platypterus*) and Eleonora's Falcons (*Falco eleonorae*), change their feeding habits to become insectivorous or include larger amounts of invertebrates in their diet while migrating and at their wintering grounds (Shelley and Benz 1985, Arroyo et al. 1995, Zefania 2001, Ristow 2004, Bildstein 2006), mostly because of their high abundance and ease of capture (Mullié et al. 1992). The presence of invertebrates in the diet of the STEs agrees with published information in the general literature (Cramp and Simmons 1980) and with the suggestion that juveniles may use this kind of prey during adverse weather conditions, when it is more difficult to find reptiles (Campora and Cattaneo 2006). Centipedes are nocturnal predators that typically hide in cracks or under rocks unless disturbed. Hence, their presence in the diet suggests an active search to prey on them. Centipedes occur in the diet of Roadside Hawk (*Buteo magnirostris*), White-throated Hawk (*Buteo albigula*), Lesser Kestrel (*Falco naumanni*), Common Kestrel (*Falco tinnunculus*), Spotted Kestrel (*Falco moluccensis*), Greater Kestrel (*Falco rupicoloides*) and Eleonora's Falcon (Ferguson-Lees and Christie 2001, Ristow 2004, Souttou et al. 2007, Rodríguez et al. 2010), but rarely in a raptor as large as the STE.

Feeding ecology studies of the STE are based primarily on the diet of nestlings (Amores and Franco 1980, Vlachos and Papageorgiou 1994) and the limited available information for adults (Gil and Pleguezuelos 2001, Bakaloudis and Vlachos 2011) indicated that their diet did not differ from the nestlings', at least in the frequency of main prey consumed. However, there are no published data on the diet of the species outside the breeding period, such as during migration, in winter, or at nonbreeding staging areas in summer (Mellone et al. 2011). More research is needed to determine if invertebrates are also consumed outside the migratory period and by older individuals.

INVERTEBRADOS COMO PRESAS DE *CIRCAETUS GALLICUS*

RESUMEN.—*Circaetus gallicus* presenta típicamente una dieta especializada en reptiles. Sin embargo, el análisis del contenido estomacal durante el periodo de migración reveló la presencia de inverte, brados en la dieta de ejemplares jóvenes. La gran concentración de migrantes en la zona de estudio, el estrecho de Gibraltar, podría haber generado competencia por la presa principal, los reptiles, especialmente en el caso de los juveniles con poca experiencia. Nuestros resultados también podrían sugerir la explotación sistemática de un recurso trófico abundante, las escolopendras, coincidiendo con la finalización del verano.

[Traducción del equipo editorial]

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LITERATURE CITED

Amores, F. and A. Franco. 1980. Alimentation et écologie du Circaéte Jean le-Blanc dans le sud de l'Espagne. *Alauda* 49:59–61.

Arroyo, B.F., J.R. King, and L.E. Palomares. 1995. Observations on the ecology of Montagu's and Marsh harriers wintering in north-west Senegal. *Ostrich* 66:37–40.

Bakaloudis, D.E. and C.G. Vlachos. 2011. Feeding habits and provisioning rate of breeding short-toed eagles *Circaetus gallicus* in northeastern Greece. *Journal of Biological Research-Thessaloniki* 16:166–176.

Barrientos, J.A. [Ed.]. 2004. Curso práctico de entomología. Manuals de la Universitat Autònoma de Barcelona. 41. Asociación Española de Entomología, CIBIO-Centro Iberoamericano de Biodiversidad and Universitat Autònoma de Barcelona, Barcelona, Spain.

Bernis, F. 1980. La migración de las aves en el estrecho de Gibraltar. Vol. I. Aves planeadoras. Universidad Complutense de Madrid, Madrid, Spain.

Bildstein, K.L. 2006. Migrating raptors of the world: their ecology and conservation. Cornell University Press, Ithaca, NY U.S.A.

Campora, M. and G. Cattaneo. 2006. The short-toed eagle *Circaetus gallicus* in Italy. *Rivista Italiana di Ornitologia* 76:3–44.

Cramp, S. and K.E.L. Simmons. [Eds.]. 1980. Handbook of the birds of Europe, the Middle East and North Africa. Vol. 2. Oxford University Press, Oxford, U.K.

Ferguson-Lees, J. and D.A. Christie. 2001. Raptors of the world. Princeton University Press, Princeton, NJ U.S.A.

Feriche, M. 2009. Culebra de herradura *Hemorrhois hippocrepis*. *In* A. Salvador and A. Marco [Eds.], Enciclopedia virtual de los vertebrados Españoles. Museo Nacional de Ciencias Naturales, Madrid, Spain. http://www.vertebradosibericos.org (last accessed 14 December 2012).

Forsman, D. 1999. The raptors of Europe and the Middle East. T. and A.D. Poyser Ltd., London, U.K.

Gil, J.M. and J.M. Pleguezuelos. 2001. Prey and prey-size selection by the short-toed eagle (*Circaetus gallicus*) during the breeding season in Granada (southeastern Spain). *Journal of Zoology* 255:131–137.

Gorney, E. and Y. Yom-Tov. 2008. Fat, hydration condition, and moult of Steppe Buzzards *Buteo buteo vulpinus* on spring migration. *Ibis* 136:185–192.

Kaltsas, D. and S.M. Simaiakis. 2012. Seasonal patterns of activity of *Scolopendra cretica* and *S. cingulata* (Chilopoda, Scolopendromorpha) in East Mediterranean maquis ecosystems. *International Journal of Myriapodology* 7:1–14.

Mansó, A. and M. Pijoan. 2011. Anfibios y reptiles de la Península Ibérica, Baleares y Canarias. Nuevas guías de campo. Omega. Barcelona, Spain.

Mellone, U., B. Yáñez, R. Limiñana, A.-R. Muñoz, D. Pavón, J.M. Gonzalez, V. Urios, and M. Ferrer. 2011. Summering staging areas of non-breeding Short-toed Snake Eagles *Circaetus gallicus*. *Bird Study* 58:516–521.

Morrison, J.L., K.E. Pias, J. Abrams, I.G.W. Gottllieb, M. Deyrup, and M. McMillian. 2008. Invertebrate diet of breeding and nonbreeding Crested Caracaras (*Caracara cheriway*) in Florida. *Journal of Raptor Research* 42:38–47.

Mullié, W.C., J. Brouwer, and C. Albert. 1992. Gregarious behavior of African Swallow-tailed Kite *Chelictinia riocourii* in response to high grasshopper densities near Ouallam, western Niger. *Malimbus* 14:19–21.

Muñoz, A.-R., B. Toxopeus, J. Elorriaga, J.M. Gonzalez, and B. Yáñez. 2010. First record of a communal roost of short-toed eagles *Circaetus gallicus*. *Ibis* 152:173–175.

PLEGUEZUELOS, J.M. 2009a. Culebra bastarda *Malpolon monspessulanus. In* A. Salvador and A. Marco [EDS.], Enciclopedia virtual de los vertebrados Españoles. Museo Nacional de Ciencias Naturales, Madrid, Spain. http://www.vertebradosibericos.org. (last accessed 14 December 2012).

———. 2009b. Culebra de escalera *Rhinechis scalaris. In* A. Salvador and A. Marco [EDS.], Enciclopedia virtual de los vertebrados Españoles. Museo Nacional de Ciencias Naturales, Madrid, Spain. http://www.vertebradosibericos.org (last accessed 14 December 2012).

RISTOW, D. 2004. On the insect diet of Eleonora's Falcon *Falco eleonorae* and its importance for coloniality. Pages 705–712 *in* R.D. Chancellor and B.-U. Meyburg [EDS.], Raptors worldwide: Proceedings of the VI World Conference on Birds of Prey and Owls. World Working Group on Birds of Prey and Owls, Berlin, Germany, and MME/BirdLife Hungary, Budapest, Hungary.

RODRÍGUEZ, C., L. TAPIA, F. KIENY, AND J. BUSTAMANTE. 2010. Temporal changes in Lesser Kestrel (*Falco naumanni*) diet during the breeding season in southern Spain. *Journal of Raptor Research* 44:120–128.

SHELLEY, E. AND S. BENZ. 1985. Observations of aerial hunting, food carrying and crop size of migrant raptors. Pages 299–301 *in* I. Newton and R.D. Chancellor [EDS.], Conservation studies on raptors. International Council for Bird Preservation, Cambridge, U.K.

SOUTTOU, K., G. BAZIZ, S. DOUMANDJI, C. DENYS, AND R. BRAHIMI. 2007. Prey selection in the Common Kestrel, *Falco tinnunculus* (Aves Falconidae) in the Algiers suburbs (Algeria). *Folia Zoologica* 56:405–415.

VLACHOS, C.G. AND N.K. PAPAGEORGIOU. 1994. Diet, breeding success and nest-site selection of the short-toed eagle (*Circaetus gallicus*) in northeastern Greece. *Journal of Raptor Research* 28:39–42.

YOSEF, R. 1996. Raptors feeding on migration at Eilat, Israel: opportunistic behavior or migratory strategy? *Journal of Raptor Research* 30:242–245.

ZEFANIA, S. 2001. Observation of Sooty and Eleonora's falcons in Madagascar. Pages 151–159 *in* Y. Leshem, A. Froneman, P. Mundy, and H. Shamir [EDS.], Wings over Africa: proceedings of the International Seminar on Bird Migration: Research, Conservation, Education and Flight Safety. Society for Protection of Nature, Tel Aviv, Israel.

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