



PARENTAL DEPENDENCE OF A JUVENILE BLACK-AND-CHESTNUT EAGLE (*SPIZAETUS ISIDORI*) IN THE EASTERN ANDES, COLOMBIA

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Abstract · The Black-and-chestnut Eagle (*Spizaetus isidori*) is one of the least known Neotropical birds of prey, with scarce information about its basic biology throughout its entire distribution range. Information on the duration of its parental dependence is inexistent, although this is a key period in the natural history of birds which will impact the subsequent probability of survival, development of natal dispersion and finally reproduction. Here, we provide information on parental dependence, and report focal observation data describing behaviors, post-fledging movements and home range of a Black-and-chestnut Eagle fledgling in the eastern Andes of Colombia. We monitored fledgling development from ca. 6 to 32 weeks of age. The young eagle left the nest at 13 weeks and the dependence period lasts until at least 28 weeks old. The home range estimated (kernel 95) reached 48.1 ha and the intensively used area (kernel 50) reached 4.0 ha. Further studies, using new tracking technology and focal observations will be needed to improve our understanding of the species' post-fledging period.

Resumen · Dependencia parental de un juvenil de Águila Crestada (*Spizaetus isidori*) en la cordillera oriental de los Andes de Colombia

El Águila Crestada (*Spizaetus isidori*) es una de las rapaces menos conocidas del Neotrópico, con escasa información sobre aspectos básicos de su biología a través de todo el rango de distribución. Entre otras cosas, se desconoce información relacionada con la dependencia parental de los juveniles de la especie. La dependencia parental se considera clave en la historia de vida de las aves, ya que su desarrollo en este estado puede afectar subsecuentemente su probabilidad de supervivencia y el desarrollo de los procesos asociados a la dispersión natal y la reproducción. En este trabajo proveemos información relacionada con el tiempo de duración de la dependencia parental de un juvenil de la especie, además de datos de observaciones focales sobre comportamiento, movimientos y rango de acción. Se monitoreó el desarrollo de un juvenil entre las 6–32 semanas de edad aproximadamente. El volantón abandonó del nido a las 13 semanas y la dependencia parental se prolongó, por lo menos, hasta las 28 semanas de edad. El rango de acción estimado (kernel 95) fue de 48.1 ha y el área núcleo (kernel 50) fue de 4.0 ha. Es necesario que se realicen futuros estudios usando tecnologías de telemetría y observaciones focales para obtener una mejor comprensión del periodo de dependencia parental de los juveniles de la especie.

Key words: Andes · Black-and-chestnut Eagle · Colombia · Fledging · Home range · Movements · Post-fledging

INTRODUCTION

The Black-and-chestnut Eagle (*Spizaetus isidori*) is one of the least known Neotropical birds of prey (Valdez & Osborn 2004). This large eagle occupies montane forests across a broad latitudinal but narrow longitudinal range from northern Venezuela and Colombia through Ecuador, Peru, and Bolivia to north-western Argentina (Ferguson-Lees & Christie 2001). It is considered to be very sensitive to habitat fragmentation and degradation because it breeds at low densities (between 50 and 100 km² per pair, Thiollay 1991) and requires large tracts of relatively undisturbed montane forests. It was categorized as Endangered in the Red List of Threatened Species,

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Table 1. Time allocation to different behaviours by a juvenile Black-and-chestnut Eagle (*Spizaetus isidori*) during its fledging (from 14 March to 30 April 2014), post-fledging (from 1 May to 15 September 2014) and in the total parental dependence period, in a nest in Gachalá, Cundinamarca, Colombia.

| Activity | Fledging period (%) | Post-fledging period (%) | Parental dependence (%) |
|-----------------------------|---------------------|--------------------------|-------------------------|
| Preening | 9 | < 0.6 | 2 |
| Feeding | 19 | 2 | 6 |
| Flapping | 4 | 0 | 1 |
| Flying | 0 | 40 | 31 |
| Perched | 58 | 38 | 43 |
| Walking | 9 | 0 | 2 |
| Vocalizing perched | < 0.6 | 18 | 14 |
| Vocalizing flying | 0 | 1 | 1 |
| Hours of observation | 39 | 130 | 169 |

because of its small population size, with an estimated population size between 250 and 999 individuals and a declining population trend (BirdLife International 2016).

Juvenile Black-and-chestnut Eagles are known to stay near the nest for several months, suggesting a prolonged time of parental dependence, during which fledglings are dependent on their parents for food (Lehmann 1961). The parental dependence comprehends two periods: the fledging period, the time after hatching until the age when a fully-feathered offspring voluntarily leaves the nest for the first time; and the post-fledging period, which starts when the young leave the nest and finished when it becomes independent of its parents (Steenhof & Newton 2007). Information on fledging and post-fledging in the Black-and-chestnut Eagle is almost inexistent. This is a cause for concern because these are critical periods in bird's life (Penteriani et al. 2005) that will impact the subsequent probability of survival and natal dispersion, and may even impact adult performance through chronic effects (Ferrer 1992, 1993; Green & Cockburn 2001, Reid et al. 2003). During the post-fledging, juveniles complete their physical development (particularly feather growth and muscular strengthening), and learn essential flight and foraging skills that eventually will allow them to survive to adulthood (Weathers & Sullivan 1989, Mock & Parker 1997). This period is often overlooked in conservation efforts because most attention is focused on the immediate surroundings of the nest-site (Penteriani et al. 2005). The goal of this study was to describe the duration of the parental dependence, with observations of behaviors, movements, and home range of a juvenile Black-and-chestnut Eagle in a remnant forest in the eastern Andes of Colombia.

METHODS

Study area. A Black-and-chestnut Eagle nest was found on 14 March 2014. The nest was located in

a remnant forest patch of 309 ha, almost completely surrounded by pastures for livestock grazing, that was connected by three thinner forested corridors to a larger patch of continuous dense natural forest approximately 52,287 ha in size (4°49'36.2"–4°39'30"N; 73°28'33.2"–73°28'15"W). The nesting tree was located within the buffer zone of the Chingaza National Natural Park and the Tolima Regional Protective Forest Reserve. It was located in the biological corridor "Farallones de Gachalá y Medina" in the Department of Cundinamarca, Colombia, within the jurisdiction of the Corporación Autónoma Regional del Guavio (CORPOGUAVIO).

Observations. When we found the nest, the nestling was roughly six weeks old and covered in white downy feathers, with dark remiges starting to emerge. From 14 March to 15 September 2014, we performed focal observations for three consecutive days every 10 days. All observations were made using binoculars (10x50) and a spotting scope (20–60x). We identified the fledgling by its plumage. During the fledging (March 2014 to April 2014), we monitored the nest from a vantage point at a distance of ca. 60 m, to follow nestling development. From May (the first month after fledging) to September 2014 we estimated home range and movements by recording the exact location of the fledgling taking notes on landmarks and later collecting GPS coordinates of each landmark (Garmin GPSMAP 60CSx). Localizations of the juvenile were taken every 25 min when possible, and observation periods started at 07:00–08:00h and ended at 17:00–18:00h. We obtained an average of 6 d (SD ± 4.1) per month and 17 (SD ± 5.9) locations of the fledgling per day of observation. The plumage of juveniles is mostly white with a dark grey brown mantle and dark lines in the flight feathers. This differs clearly from that of the adults, which are mostly black with dark reddish brown in the belly (see Ferguson-Lees & Christie 2001). We assumed that the juvenile we observed

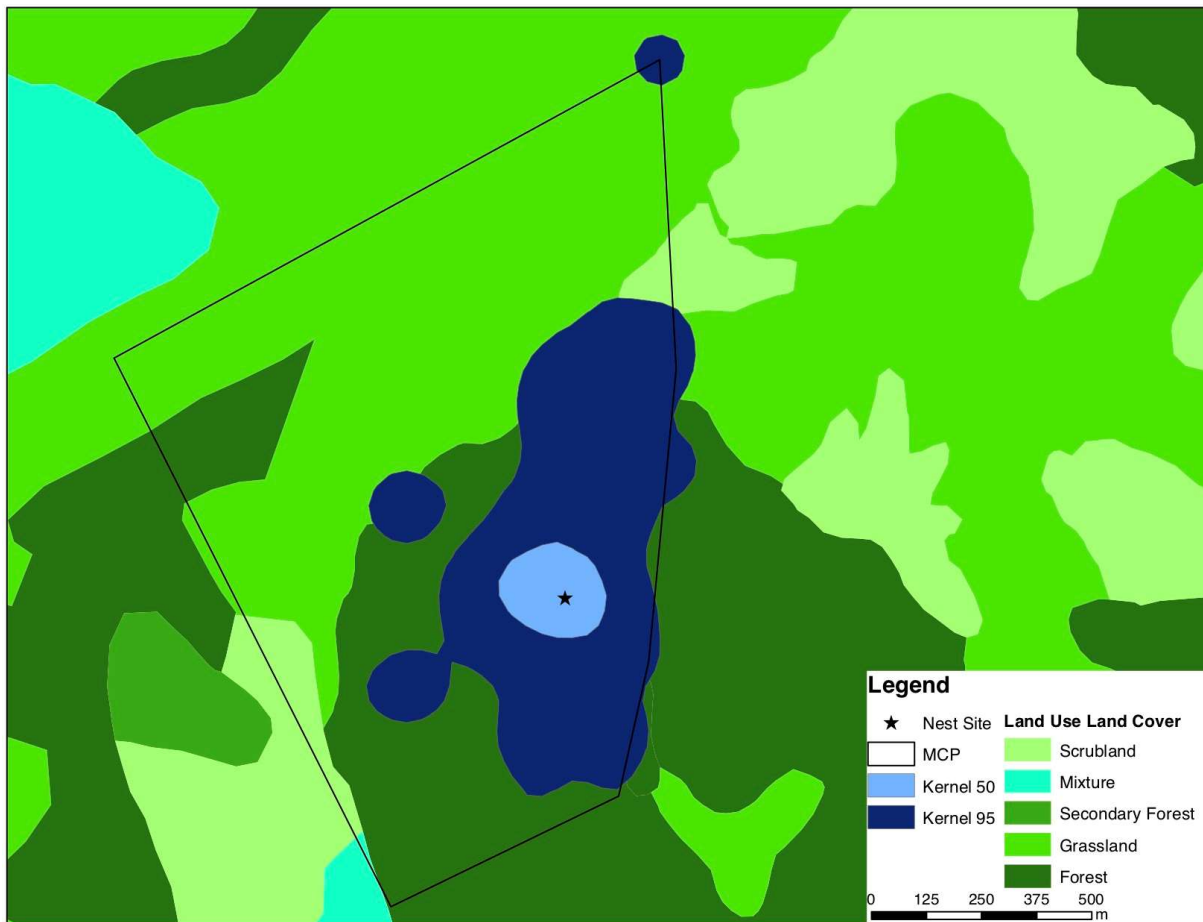


Figure 1. Home range (kernel 95) of a juvenile Black-and-chestnut Eagle (*Spizaetus isidori*) during its post-fledging period (from 1 May to 15 September 2014), kernel 50 represents the intensively used area, in Gachalá, Cundinamarca, Colombia.

during each observation session was the same individual because adult Black-and-chestnut Eagles are extremely territorial (SZ pers. obs.) and most likely would not allow another juvenile to intrude in their nesting tree. Once the fledgling was located, we recorded the time of day, date, distance to the nest, type of habitat used, and its behavior (e.g., perching, flying, feeding, preening, flapping, vocalizing, or walking; Table 1).

Data analysis. We estimated the time of parental dependence, the fledging and post-fledging periods (in days and weeks), and the percentage of time of the post-fledging in the completed parental dependence, as well as the percentage of time spent performing different behaviours. We also estimated the size of the home range used by the juvenile eagle between 3 May and 15 September 2014, when the juvenile was between ca. 13–32 weeks old. Kernel 95% was used to calculate the size of the home range and 50% kernel density contours were calculated to estimate the core (intensively used) areas (Hayne 1949, Fieberg 2007). Furthermore, we used a minimum convex polygon for 100% of the locations (MCP 100) (Mohr 1947) to compare the size of the home range with other eagle species (Table 2). Finally, we used Geographic Information System (GIS,

ArcGIS 10.1 (ESRI, Redlands, USA)) to combine fledgling GPS locations with a land use and land cover map (with 1:10,000 resolution) provided by CORPO-GUAVIO.

RESULTS

We obtained the last evidence of parental dependence at 12 August 2014, when an unidentified prey was delivered by an adult to the 28 weeks old juvenile. The fledging period finished when the chick reached approximately 13 weeks old (ca. 2 May 2014) and the post-fledging period lasted until it was at least 32 weeks old. We observed the juvenile for a total of 168.5 hours. We failed to see the juvenile for less than 10% of the time of observation (16.3 hours) although we could hear its calls for most of this time, and only during 1.5 hour of observation time (1%) was it neither seen nor heard. During the fledging period, the fledgling spent most of the time perched (58%), followed by feeding (19%). During the post-fledging period the fledgling spent more time flying (40%), although the time spent perching was also important (38%). During the total parental dependence, the fledgling spent more time perching (43%) followed by flying (31%) and vocalizing (15%) (Table 1).

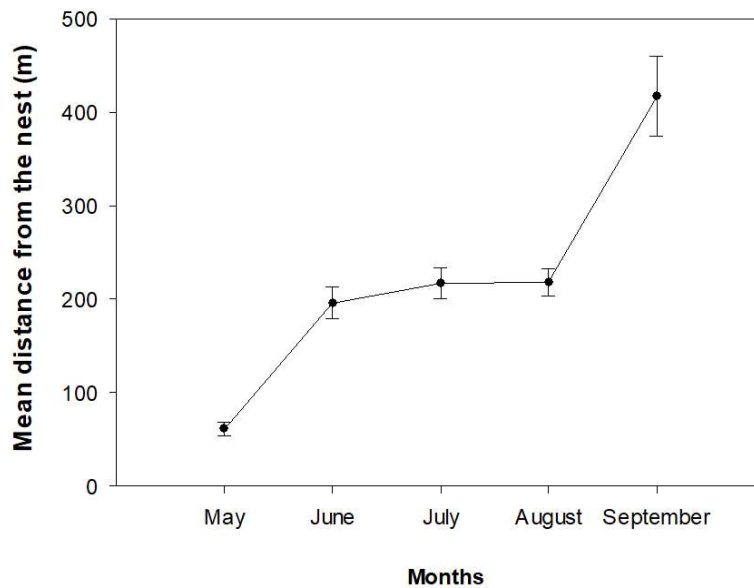


Figure 2. Mean distance to the nest ($m \pm SE$) of a juvenile Black-and-chestnut Eagle (*Spizaetus isidori*) during 5 months of its post-fledging period (May 2014 was the first month after fledging) in a nest in Gachalá, Cundinamarca, Colombia.

We obtained 703 locations of the juvenile during the post-fledging dependence period (between 3 May and 15 September 2014). The home range (kernel 95) reached 48.1 ha, the intensively used area (core area; kernel 50) reached 4.0 ha and the MCP 100 reached 148.6 ha (Figure 1). The month with the maximum number of fledgling locations was August 2014 ($n = 243$) and the month with fewer locations was September 2014 ($n = 35$). The average number of locations per month ($\pm SD$) was $100.4 (\pm 63.7)$. The home range (kernel 95) was 82% dense forest, 16% pastures and 2% scrublands, while the core area (kernel 50) was 100% dense forest (Figure 1).

The distance moved during the post-fledging dependence period increased progressively with age (Figure 2). When the fledgling was 28 and 32 weeks old, we registered the maximum distances between the fledgling and the nest, at 1032 and 1140 m, respectively. The monitoring ended on 15 September 2014 when the 32 weeks old fledgling could not be detected for two consecutive days, but we are not sure if we failed to find the fledgling or if the fledgling had already dispersed from the nesting-site. Therefore, it is possible that the monitoring ceased before the juvenile dispersed from the nest site.

DISCUSSION

We describe for the first time the fledging and post-fledging dependence periods of a juvenile Black-and-chestnut Eagle. Our observations indicate that the parental dependence was at least 32 weeks, the young eagle left the nest at about 13 weeks of age and remained near the nest for at least 19 weeks more. This suggests a total parental dependency of more than seven months. The long nestling period

and prolonged post-fledging dependence period seems to be a common characteristic of tropical forest eagles, and particularly of other Neotropical forest eagles, such as Harpy Eagle (*Harpia harpyja*), Crested Eagle (*Morphnus guianensis*), Ornate Hawk-Eagle (*Spizaetus ornatus*), and Black Hawk-Eagle (*Spizaetus tyrannus*) (Table 2). The fledglings of all these eagles tend to stay close to the nest longer than the Black-and-chestnut Eagle. These long post-fledging dependence periods probably preclude those eagle species to breed yearly (Table 2; Newton 1979, Whitacre & Jenny 2012, Muñiz-López et al. 2012). In contrast, the length of the post-fledging dependence period of the Black-and-chestnut Eagle would allow yearly breeding (JMG pers. obs.).

The post-fledging dependence period in the Black-and-chestnut Eagle comprised ca. 59% of the total dependency period of the young after hatching. This percentage is higher than the 40% found in most small- and medium-sized temperate raptors (kestrels, harriers, and kites; Bustamante 1993, 1995; Bustamante & Hiraldo 1989, Arroyo et al. 2002, Boileau & Bretagnolle 2014) and some large temperate eagles (Spanish Imperial Eagle *Aquila adalberti*), some Golden Eagle (*Aquila chrysaetos*) populations (Alonso et al. 1986, Ferrer 1992, Soutullo et al. 2006), and similar to, or slightly longer than, other medium-large temperate eagles (Bonelli's Eagle *Aquila fasciata*; O'toole et al. 1999, Minguez et al. 2001). However, this proportion is much smaller than that in other large Neotropical eagles, where it is always $> 75\%$ (Table 2).

The characteristics of the Black-and-chestnut Eagle post-fledging dependence period seem to be different from other tropical and temperate raptors (although closer to the first group). These charac-

Table 2. Age at fledging and post-fledging, dependence period length, maximum distance travelled from nest and home range (minimum convex polygon for 100% of the locations) in some tropical and temperate eagles. Monitoring ceased before the juveniles dispersed from the nest site (*).

| Species | Age at fledging (in days) | Post-fledging dependence period (in days) | Post-fledging dependence period in the parental dependence (%) | Maximum distance in the post-fledging dependence period (home range, ha) | Reference |
|---|---------------------------|---|--|--|-------------------------|
| Tropical eagles | | | | | |
| Crested Eagle (<i>Morphnus guianensis</i>) | 114 | 365* | 76 | 600 m (37.5) | Whitacre et al. 2012a |
| Harpy Eagle (<i>Harpia harpyja</i>) | 140 | 590* | 81 | 1300 m | Muñiz-López et al. 2012 |
| Ornate Hawk-Eagle (<i>Spizaetus ornatus</i>) | 77 | 372 | 83 | 300–1000 m (males–females) | Whitacre et al. 2012b |
| Black Hawk-Eagle (<i>Spizaetus tyrannus</i>) | 75 | 285 | 79 | 50–150 m mostly | Whitacre et al. 2012c |
| Black-and-chestnut Eagle (<i>Spizaetus isidori</i>) | 92 | 133* | 59 | 1140 m (149) | This study |
| Temperate eagles | | | | | |
| Spanish Imperial Eagle (<i>Aquila adalberti</i>) | 72 | 67 | 48 | - | Alonso et al. 1986 |
| Spanish Imperial Eagle (<i>Aquila adalberti</i>) | 79 | 51 | 40 | - | Ferrer 1992 |
| Bonelli's Eagle (<i>Aquila fasciata</i>) | 60 | 90 | 60 | 2000 m | Minguez et al. 2001 |
| Bonelli's Eagle (<i>Aquila fasciata</i>) | 60 | 88 | 53 | - | Balbotín & Ferrer 2009 |
| Golden Eagle (<i>Aquila chrysaetos</i>) | 70 | 86 | 55 | 5000 m | O'toole et al. 1999 |
| Golden Eagle (<i>Aquila chrysaetos</i>) | 70 | 70 | 50 | 6200 m | Soutullo et al. 2006 |

teristics are consistent with a slow breeding strategy traditionally considered a result of the relative stability of tropical environments (Martin 1996). The differences could be the result of a more marked environmental variation in the mountain-tropical and subtropical forests where the Black-and-chestnut Eagle lives.

The home range of the Black-and-chestnut Eagle juvenile estimated in this study has already lost 16% (ca. 8 ha) of its original montane forest. The species is considered to be extremely sensitive to deforestation and habitat loss (Thiollay 1991). Colombia has lost more than 60% of the Black-and-chestnut Eagle's original natural habitat through fragmentation and deforestation (Renjifo et al. 2014). Future studies will be needed to improve our understanding of how this species deals with habitat loss and fragmentation.

Finally, current observations in nests from Colombia, Ecuador, and Argentina suggest the fledglings could remain in the vicinity of the nest site for a total of ten months or more (SZ pers. obs.). Further studies using new tracking technology (i.e., GPS/GSM loggers) and focal observations will be needed to

improve our understanding of the species post-fledging dependence period as well as to understand when the fledgling starts its natal dispersion.

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