ORNITOLOGIA NEOTROPICAL 25: 55–61, 2014

POST-FLEDGING SURVIVAL OF BLUE-FRONTED PARROTS (*AMAZONA AESTIVA*)

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Resumen. – Supervivencia de volantones en el Loro Hablador (*Amazona aestiva*). – El Loro Hablador (*Amazona aestiva*) se encuentra bajo una intense presión producto de la destrucción de su hábitat y la remoción de adultos y pichones para el comercio de mascotas. Mientras que estimaciones de éxito reproductivo y supervivencia de pichones han sido producidas en estudios previos, la supervivencia de los volantones es desconocida. Entre enero y abril de 2007, equipamos con radio-collares y monitoreamos 18 volantones correspondientes a ocho nidos de Loro Hablador. Monitoreamos las aves con transmisores por un promedio de 33 ± 20.9 (SD) días (rango: 11–87) desde que abandonaron exitosamente el nido hasta que murieron, desaparecieron del área de estudio o falló el transmisor. La supervivencia durante este período fue 94% (n = 18) y la única muerte, que ocurrió 11 días posteriores al abandono del nido, fue causada por un ave rapaz. Durante febrero, perdimos la señal de 15 de los 17 volantones supervivientes a un promedio de 27.3 ± 7.3 (SD) días (rango: 16–37) posteriores al abandono del nido. Perdimos las señales de los hermanos al mismo tiempo, indicando una dispersión de los grupos familiares desde el área de estudio. Las señales perdidas no pudieron ser relocalizadas durante el resto del período de estudio. Estudios adicionales se necesitan para definir la supervivencia de los juveniles sobre un periodo de tiempo mayor, asi como elucidar la dirección y distancia de viaje de las aves que abandonan el área natal después de la temporada reproductiva.

Abstract. – Blue-fronted Parrots (*Amazona aestiva*) are under intense pressure from habitat destruction and removal of adults and chicks for the pet trade. While estimates of nesting success and nestling survival of Blue-fronted Parrots have been produced in previous studies, the survival of fledglings is unknown. During January–April 2007, we monitored 18 radio-collared Blue-fronted Parrots from eight wild nests. We monitored radio-collared birds for an average of 33 ± 20.9 (SD) days (range: 11–87) post-fledging, until death, disappearance from the study area, or failure of the collar. Survival during this period was 94% (n = 18) and the single mortality, which occurred 11 days post-fledging, was due to predation by a raptor. During February, we lost the signals for 15 of 17 surviving fledglings at an average of 27.3 ± 7.3 (SD) days (range: 16-37) post-fledging. We lost the signals for siblings concurrently, indicating a dispersal of family groups from the study area. The lost signals could not be relocated during the remainder of the study period. Additional studies are needed to define the survival of juveniles over a longer period as well as to elucidate the direction and distance of travel for birds that leave the natal area after the breeding season. *Accepted 23 May 2014.*

Key words: Blue-fronted Parrot, *Amazona aestiva*, Argentina, Chaco, parrots, post-fledging movements, survival, telemetry.

INTRODUCTION

Two important and little-studied aspects of parrot conservation biology include seasonal movements and mortality (Snyder *et al.* 2000). While data describing the breeding range and nest success of many species, including Blue-fronted Parrots (*Amazona aestiva*) have been published (Fernandes-Seixas 2002, Berkunsky & Reboreda 2009, Berkunsky *et al.* 2009), information on seasonal movements and fledgling mortality are lacking. In many psittacines, the first two to eight weeks after fledging are characterized by limited mobility and high mortality (Snyder *et al.* 1987, Lindsey *et al.* 1991, Smith & Moore 1992, Myers & Vaughan 2004, Salinas-Melgoza & Renton 2007). Post-fledging survival estimates are important because they increase the accuracy of population viability analyses and improve the ability of managers to target conservations efforts to the most vulnerable life stages (Holdsworth *et al.* 2011).

Due to habitat destruction and capture for the pet trade, 19 of 30 *Amazona* species are considered threatened (Critically Endangered, Endangered, or Vulnerable; IUCN 2013). Other *Amazona* species remain relatively widespread and abundant but many, including the Blue-fronted Parrot, are experiencing local population declines (del Hoyo *et al.* 1997, Berkunsky *et al.* 2012). The primary causes of the decline of Blue-fronted Parrots in Argentina are habitat destruction and direct persecution by humans, including the removal of chicks for the pet trade and capture or hunting of juvenile and adult parrots at citrus orchards (Bucher *et al.* 1992, Berkunsky *et al.* 2012).

Blue-fronted Parrots inhabit the tropical and sub-tropical dry forests and savannahs of Argentina, Brazil, Paraguay, and Bolivia (Forshaw 2006). The majority of Argentina's Blue-fronted Parrots breed in mature Chaco forests (Berkunsky *et al.* 2012). Northern Argentina's Chaco province provides some of the largest remaining areas of this threatened habitat (Boletta *et al.* 2006). The regular, seasonal fluctuation in abundance of individuals in these forests between the breeding and non-breeding seasons has led researchers to suggest that a partial migration could be occurring (Bucher *et al.* 1992). It is likely that Blue-fronted Parrots leave the dry Chaco habitat, where their foods become scarce during the non-breeding season, possibly traveling north or northwest to riparian and transitional forests where other fruits and seeds are available (Berkunsky *et al.* 2012).

From January to April of 2007 we estimated post-fledging survival of fledglings in their natal area and collected evidence for the hypothesis of partial migration of Blue-fronted Parrots breeding in mature, dry Chaco forests.

METHODS

Study area and study subjects. The Loro Hablador Provincial Park (25°28.19'S, 61°54.70'W, 173 m a.s.l.) occupies 300 km^2 of dry Chaco forest and savannah in Chaco province, northern Argentina. The dry Chaco forests of South America are considered a high priority for conservation in the Neotropics (Dinerstein *et al.* 1995), and the Park was created to protect the breeding habitat of Blue-fronted Parrots in Argentina. The climate is subtropical, with distinct wet and dry seasons and the highest maximum temperatures on the continent, reaching 52 degrees Celsius (Rabinovich 2004). The annual precipitation averages 590 mm, of which 75% falls between November and March (Berkunsky & Reboreda 2009). The flat, dry landscape is dominated by xerophilic forest with a dense, thorny understory. Canopy vegetation averages 15 meters and is predominately composed of hardwoods such the White Quebracho (*Aspidosperma quebracho-blanco*, Apocynaceae) and Red Quebracho (*Schinopsis lorentzii*, Anacardiaceae), which provide nesting cavities for Blue-fronted Parrots (Berkunsky & Reboreda 2009).

We chose to study nests for their proximity to an 18-meter tower, which we climbed to locate distant radio signals. The tower was located about 1 km from the Park Ranger Headquarters. In December 2006, 19 chicks from nine nests within a 7 km radius of the tower were fitted with radio collars shortly before fledging. One chick was depredated by a boa constrictor (*Boa constrictor occidentalis*) before fledging, which reduced the sample size to 18 chicks from eight nests. The chicks from these eight nests consisted of two 1-chick nests, two 2-chick nests, and four 3-chick nests. Most chicks were collared when their primaries had fully emerged from the sheath or upon reaching a wing chord (flattened) of 200 mm. Two chicks were collared 1 week earlier because of their tendency to climb up the nest cavity, avoiding capture. All chicks had a mass of at least 350 g when they were fitted with collars.

Between 10 January and 28 April 2007 we tracked radio-collared fledglings in the Park and surrounding private properties. During March 2007, we also conducted searches in four areas outside of the Park area, where flocks of Blue-fronted Parrots were larger and more common during the non-breeding season (IB pers. observ.). These areas included sites near: 1) The towns of Pompeya (24º55'S, 61º28'W) and Wichi (24º36'S, 61º27'W), along the Bermejito and Bermejo rivers, 75 and 110 km northeast of the Park; 2) The Ingenio Tabacál (23º15'S, 64º18'W), Salta province, 340 km northwest of the Park; 3) Finca Las Varás (23º21'S, 64º05'W) Salta province, 320 km northwest of the Park and 4) Cachipunco and the citrus orchards of Santa Clara (24º16'S, 64º38'W), Jujuy province, 307 km west-northwest of the Park.

Telemetry equipment. Birds were tracked using R-1000 receivers (Communications Specialists Inc.) and 3-element collapsible yagi antennas (Telenax Inc.). Our radio-collars, TX-203C (Telenax Inc.), weighed 13.5 g, approximately 4% of an adult parrot's body mass. Each collar was equipped with activity/inactivity and mortality sensors. The mortality sensors were programmed to give a double-beep after four hours of inactivity. Our order was custom made to maximize detection range and thus the battery life of our transmitters was only 3.5 months. The detection range was 1–3 km from the ground and 3–6 km from the top of the 18-m tower. The reception range was strongly affected by the height of parrots in the vegetation and varying density of foliage.

Search techniques. Once the collars were in place, we determined the status of each chick daily until fledging. The signals of fledged chicks were checked at least once per day, when weather conditions allowed, by noting the strongest bearing from the closest, accessible ground location. We searched for signals from access points on roads and trails, or from the nest tree and/or from the top of the tower. Daily searches were confined to a 7 km radius around the tower. On four occasions we were able to physically locate fledglings during the first week post-fledging however, unless otherwise noted, our discussion of movements is based on radio signal locations. Radio signal locations were plotted as occupancy of a semi-circular plot, created using the maximum possible detection distance of the signal from the observer (3 km) and our maximum directional error (± 15 degrees). Location plots were not detailed enough to employ meaningful statistical calculations and thus we limit our discussion of the movements of tagged birds to anecdotal observations.

We conducted vehicle searches from 14–26 March 2007 to search for lost signals in a larger area. The first week was spent searching systematically along all drivable roads within a 20 km radius of the tower. We stopped every 2 km and conducted a search for each frequency with the antenna held approximately 3 m above the ground. We scanned individual frequencies for 30-45 s each by holding the antenna steady for 5 s before moving it 45 degrees and waiting another 5 s. After concluding the vehicle searches in the vicinity of the Park, we conducted final searches in areas that have been suggested as likely wintering grounds for the Blue-fronted Parrots breeding in the Park. These areas where chosen because they have historically shown a seasonal increase in numbers of parrots, with large flocks appearing in the winter (IB pers. observ.).

We tracked all birds until death, disappearance of the signal from the study area, or battery failure of the collar. Upon detecting a mortality signal, we located the bird and determined the cause of death. When a signal was not found we commenced a search, stopping to scan for the signal every 500–1000 meters on roads within a 7 km radius of the tower, or by scanning for the signal from the top of the tower. A signal was considered to have disappeared from the study area after it had been missing for a minimum of 29 days. We scanned for the frequencies of missing signals from the top of the tower and from roads within 7 km of the tower on most days during this 29-day period. The last 7 days of this period included intensive searching from all roads within a 20 km radius of the tower. Battery failure of the collar was considered a possible outcome only in the cases where individuals had collars in place for close to 3 months before disappearance of the signal.

RESULTS

For the population of Blue-fronted Parrots breeding in the vicinity of the Park we found a 94% survivorship of birds during the 33 ± 20.9 (SD) days (range: 11–87) over which the birds were tracked. Six of eight family groups disappeared from the study area before battery failure of the collar. Only one fledgling died before radio signals were lost. This mortality occurred 11 days after fledging and approximately 1 km from the nest. The feathers surrounding the plucked remains lacked teeth marks, indicating a raptorial predator. The signals from 15 of 17 surviving parrot chicks (six of the eight family groups) disappeared from the study area between 7 February and 20 February 2007, at an average 27.3 ± 7.3 (SD) days after fledgling (range: 16–37 days), and could not be re-located. The remaining chicks, two single chicks from different nests, were tracked for 86 and 87 days. They remained within 5 km of their nests for the duration of the study.

Post-fledging mobility varied considerably among family groups. Two chicks from one family group moved more than a kilometer within 1 hour of fledgling; three chicks from another family group remained within 200 meters of their nest for two weeks after fledging. Of three chicks that were observed on the day that they fledged, two were found on the ground. They did not fly during our observations, however they were active and climbed into nearby vegetation. The third was in a small tree, about 2 meters off the ground, and remained still throughout the observation. All of these fledglings survived without intervention and we do not believe that the radio collars significantly affected their mobility. Siblings generally stayed close together after fledging and were often found near to fledglings of one or more other family groups. Each family disappeared from the study area as a separate unit, even when leaving from a local area shared by multiple families. No two family groups disappeared on the same day, and all chicks of each family group disappeared on the same day.

After the disappearance of all but two of the collared fledglings, we conducted searches by vehicle in an attempt to locate the lost signals. None of the missing subjects were detected during searches conducted from all roads within a 20 km radius of the tower. From the roof of the vehicle, the detection range for our radio-collars was 3 km. This range, combined with the 5 km average range from the top of the tower, allowed us to be certain that the radio-collared individuals were not present in approximately 35% of the area searched.

After our local searches, we attempted to locate the lost signals among flocks of parrots on their suggested wintering grounds. During the searches at Finca Las Varás in northern Salta province, a flock of approximately 200 Blue-fronted Parrots was located, roosting near citrus orchards, however the radio-collared individuals from Chaco were not among them. We were unable to locate any Blue-fronted Parrots at the three other sites we searched.

DISCUSSION

In many psittacines, the first two to eight weeks after fledging are characterized by limited mobility and high mortality (Snyder *et al.* 1987, Lindsey *et al.* 1991, Smith & Moore 1992, Myers & Vaughan 2004, Salinas-Melgoza & Renton 2007). During this stage of development fledglings usually remain in a secure location, either with siblings or with fledglings from other family groups, while the adults forage nearby, returning periodically to feed their young.

In Lilac-crowned Parrots (*Amazona finschi*), first year survivorship was 73% (n = 68) and all mortalities occurred during the first five weeks post-fledging; mortality was the highest during the first two weeks post-fledgling when chick mobility was limited (Salinas-Melgoza & Renton 2007). A study of Puerto Rican Parrots (*Amazona vittata*) found an 87% survivorship of fledglings during the first four weeks (n = 15; Lindsey *et al.* 1994). A six-year study of Western Long-billed Corellas (*Cacatua pastinator*) and Major Mitchell Cockatoos (*Cacatua leadbeateri*) found respective survival rates of 83% (n = 164) and 80% (n = 155) during the first month post-fledging (Smith & Rowley 1995). In comparison, while our radio-collared Blue-fronted Parrot fledglings showed a trend of limited movements during the first weeks post-fledgling, they did not suffer high mortality during this period.

In the present study, 17 of 18 Blue-fronted Parrot fledglings survived during the 33-day mean tracking period. However, the multi-year studies described above found significant differences in survival rates between years. For example, the first-month survival rates of *Cacatua pastinator* and *Cacatua leadbeateri* varied from 56% (n = 18) to 93% (n = 29) and from 55% (n = 11) to 93% (n = 30), respectively, over the six-year period (Smith & Rowley 1995). Consequently, while the difference in first-month survivorship between Blue-fronted Parrots and other psittacine species may be biologically significant, more years of survivorship data for Blue-fronted Parrots will be needed before conclusions can be drawn. Furthermore, while survivorship data for any discrete life stage, such as a "limited mobility fledgling period", can illuminate age-specific vulnerabilities, survivorship data from other life stages is needed to create an accurate projection of population trends.

Expansive home ranges, nomadic behavior, and the difficulties of capturing and re-sighting marked individuals have kept the seasonal movements of forest-dwelling parrots largely illusive. Only two of 356 parrot species, both Australian, are known to be completely migratory (IUCN 2013), while several other Australian species are partially migratory. Among New World parrots, long-distance, seasonal migration has been documented only in Thick-billed Parrots (*Rhynchopsitta pachyrhyncha*) in Mexico (Snyder *et al.* 1999) and Mealy Parrots (*Amazona farinosa*) in Guatemala (Bjork 2004). While seasonal altitudinal movements and nomadic wanderings have been documented in many *Amazona* parrots, only Mealy Parrots, among the 30 *Amazona* species, are known to make long-distance migratory movements of up to 190 kilometers from their breeding grounds (Bjork 2004). The discovery of long-distance migration of Mealy Parrots in a lowland forest habitat highlights the need for increased research on seasonal movements of other lowland *Amazona* parrots, especially where seasonal fluctuations in populations are observed.

In the present study, the signals from 75% (6 of 8) of the radio-collared Blue-fronted Parrot family groups disappeared from the study area during February. It is possible that these individuals dispersed locally and were concentrated in the portions of the study area that we could not reach. However, the dispersal of family groups to a more distant location is also likely, considering the observational evidence that very few Blue-fronted Parrots occur anywhere along the perimeter or interior of the 300 km^2 Park between late-February and August (the non-breeding season). Our data are consistent with observations that each year most of the Blue-fronted Parrots in and surrounding the Loro Hablador Natural Park depart at the end of the breeding season, during February and March (IB pers. observ.). Future efforts should employ the use of aircraft or satellite telemetry to discriminate between the occurrence of discrete, long-distance migrations and the ranging, nomadic movements that are more typical of the *Amazona* genus. Since the long term survival of this species can only be ensured through the protection of habitat used during both breeding and non-breeding seasons, the seasonal movements of Blue-fronted Parrots breeding in the dry Chaco continues to be an important area for future study.

ACKNOWLEDGMENTS

This study would not have been possible without the financial support of The Amazona Society (U.S. and U.K. divisions), Parrots International, The World Parrot Trust, and numerous private donors. I.B. was supported by fellowships from Consejo Nacional de Investigaciones Científicas y Técnicas de Argentina (CONICET). We thank R. Rojas, R. Ruggera, K. Jones, and J. Carrera for their assistance in monitoring nests, and James Melton, Wilson Morales, and Alberto Cordoba for their assistance in monitoring radio-collared parrots. We also thank the Dirección de Fauna, Parques y Ecologia of Chaco Province for granting permission for research. We are grateful to Donald Kroodsma and Steve Seibel for their constructive comments on early drafts of this manuscript.

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