

# Short Communications

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## First Documented Migration of Individual White-Crested Elaenias (*Elaenia albiceps chilensis*) in South America

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**ABSTRACT.**—Few details are available on the migration (rates, routes, dates) of Neotropical austral migrant birds, which breed and migrate wholly within South America. Only one long-distance austral migrant breeds in the South American temperate forest biome: the White-crested Elaenia (*Elaenia albiceps chilensis*). However, the migratory dates, routes, and wintering locations are poorly known. During the austral summers of 2011–2013, we attached light level geolocators to breeding White-crested Elaenias at the world’s southernmost forests, on Navarino Island, Chile. The duration of fall migration of three Elaenias to the Amazonian wintering grounds was 64–96 days, while spring migration was 45–60 days. The average distance between breeding and wintering grounds was 5,932 km, which constitutes the longest migration of a Neotropical austral migrant studied to date. A better understanding of the annual cycle of Elaenias could offer new opportunities to examine the evolution of migration and population regulation of one of Patagonia’s most common birds. Received 5 March 2015. Accepted 28 November 2015.

Key words: Amazonia, Brazil, Chile, migratory birds, Omora Ethnobotanical Park, sub-Antarctic.

White-crested Elaenias (*Elaenia albiceps chilensis*, hereafter, “Elaenias”) breed in South American temperate and sub-Antarctic forests and are migratory (Fitzpatrick et al. 2004, Rozzi and Jiménez 2014), wintering in tropical South America (Zimmer 1941, Pinto and de Camargo 1961, Fitzpatrick et al. 2004). Elaenias are among the most abundant bird species in the South American temperate forest community during the breeding season (Jiménez 2000, Brown et al.

2007, Ippi et al. 2009). However, little is known about their migration dates and routes (i.e., the degree of migratory connectivity), in large part because, until recently, the necessary technology to track small passerine migrants throughout the year has not been available. Today, we have more information on the overwintering locations of individual birds than in 1941, when Zimmer stated that Elaenias “...spend the southern winter in an extensive area from Perú to the eastern coast of Brazil and north to the Amazon...” (Zimmer 1941:9).

Past research suggested that Elaenias migrate northward in fall along the southwestern South American coast (Traylor 1958). Other authors suggested a fall route on the eastern side of the Andes Mountains (Zimmer 1941), then a turn eastwards to the Atlantic coast (Pinto and de Camargo 1961, Olog 1979, Sick 1984, reviewed by Capllonch et al. 2011). The most recent researchers propose that populations that overwinter in Brazil start their fall migratory flights northwards along the Andes Mountains, turning northeast across Argentina towards Uruguay and Brazil, returning southwest in spring across northern Argentina, then southwards along the Andes (Marini and Calvalcanti 1990, Capllonch et al. 2011). Within Brazil, Marini and Calvalcanti (1990) proposed that Elaenias migrate in fall along the Atlantic coast to eastern Amazonian wintering grounds, returning south in spring through central Brazil along the basin of the Paraguay River. Here, we report the first tracked migration dates, routes, distances, and wintering locations of three White-crested Elaenias from a breeding population in the world’s southernmost forests on Navarino Island in the Cape Horn Biosphere Reserve, Chile.

### METHODS

**Study Area and Studied Species.**—We studied breeding Elaenias at the Omora Ethnobotanical Park on Navarino Island, Chile (54° 57' S, 67° 39' W), within the Cape Horn Biosphere Reserve.

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Along the coast, vegetation is composed of old-growth and secondary evergreen forests dominated by *Nothofagus betuloides* and *Drimys winteri* at lower elevations (0–200 m), and by deciduous forests dominated by *N. pumilio* and *N. antarctica* at higher elevations (200–500 m). At Omora Park, we have maintained an uninterrupted monthly mist-netting program for over a decade. From January 2000 to December 2010, we captured 1,018 different Elaenias, of which we recaptured 10.4% in the years to follow (Rozzi and Jiménez 2014). On average, captured Elaenias had a weight of 15.9 g, wing length of 75 mm, and a tail length of 63 mm.

**Geolocator Deployment and Recovery.**—From 14 January 2011 to 24 January 2013, we attached 128 light-level geolocators manufactured by Eli Bridge (University of Oklahoma, Norman, USA) to Elaenias captured with mist nets (12 × 2.6 meters, 30 mm mesh). Geolocators weighed 0.7 g (including harness) representing ~4.4% of the Elaenia's body mass. Geolocators measured light intensity every minute and recorded the average intensity every 10 mins on a scale from 0–127 (Contina et al. 2013). Geolocators were attached using a silicon or Kevlar thread leg harness (Rappole and Tipton 1991).

**Statistical Analyses.**—We processed light-level data with the R-packages BASTag (Wotherspoon et al. 2013) and GeoLight 2.0 (Lisovski and Hahn 2012). We first log-transformed the light values, then on the log-scale we used a light threshold of 5.1 to identify sunrise and sunset times. We eliminated outlier sunrise and sunset times by using the loessFilter function to delete twilight transitions that were >2 times the interquartile range of residuals from a smoothed line, a filtering value that has been used in other geolocation studies (e.g., Lislevand and Hahn 2015). We conducted an on-bird calibration using the first 10 days of February, during which times birds were still on the breeding grounds. The calibrated sun elevation angle for the three tags was 0.31, 1.12, and -0.91. We used the sun elevation that was generated for each tag to calculate all subsequent locations for that tag. We then calculated the latitude and longitude for each twilight event. During the calibration period, the mean error for all three tags combined was 247 km (regardless of direction). Longitude could not be calculated from a period from mid-February to mid-April, and mid-August to mid-October because of the equinoxes.

We identified spring migration departure and arrival dates by combining information about movement and residency periods generated from the twilight times and from the latitude and longitude data. Movement and residency periods were generated with the changeLight function (sunrise probability = 0.04, sunset probability = 0.04, minimum stationary period = 5 days). These values were picked because they captured movement and stationary periods that were generally consistent with the known migratory phenology of the species. Our ability to track migration routes was limited by the lack of latitude estimates around the equinox. As a result, our inferences during these times were primarily based on longitude. We identified wintering locations by averaging the latitude and longitude during the period from 1 July to 31 August, because it was a period during which there was little evidence of movement and was far enough from the equinox that both latitude and longitude could be calculated.

We define distance of fall and spring migration as the straight-line great circle distance between breeding site and wintering area. Therefore, reported migration distances are minimum distances, because Elaenias do not migrate in a straight line between sites. Similar to previous studies on bird migration in South America (Jahn et al. 2013), we define migration rate as the distance of migration divided by the duration in days of fall or spring migration. The migration rates we report, therefore represent minimum rates.

## RESULTS

**Migration Recorded by Geolocators.**—During November 2012 and December 2013, we recovered nine geolocators at the breeding site. Of these, three had usable data; the data from the others could not be processed because of multiple errors in recording, storing light data, or battery drainage. Hereafter, we refer to the three birds for which tags were recovered as A, B, and C.

Birds A, B, and C departed from Omora Park on 29, 18, and 22 February 2012, respectively (Fig. 1). On their northward migration, all three birds moved northwestwards up to ~43°S, 71°W, and then northeastwards to an area of ~13°S, 40°W, then again to the northwest reaching sites located at 6–8°S, 60°W, where the longitude stabilized for much of the winter (Fig. 2). The

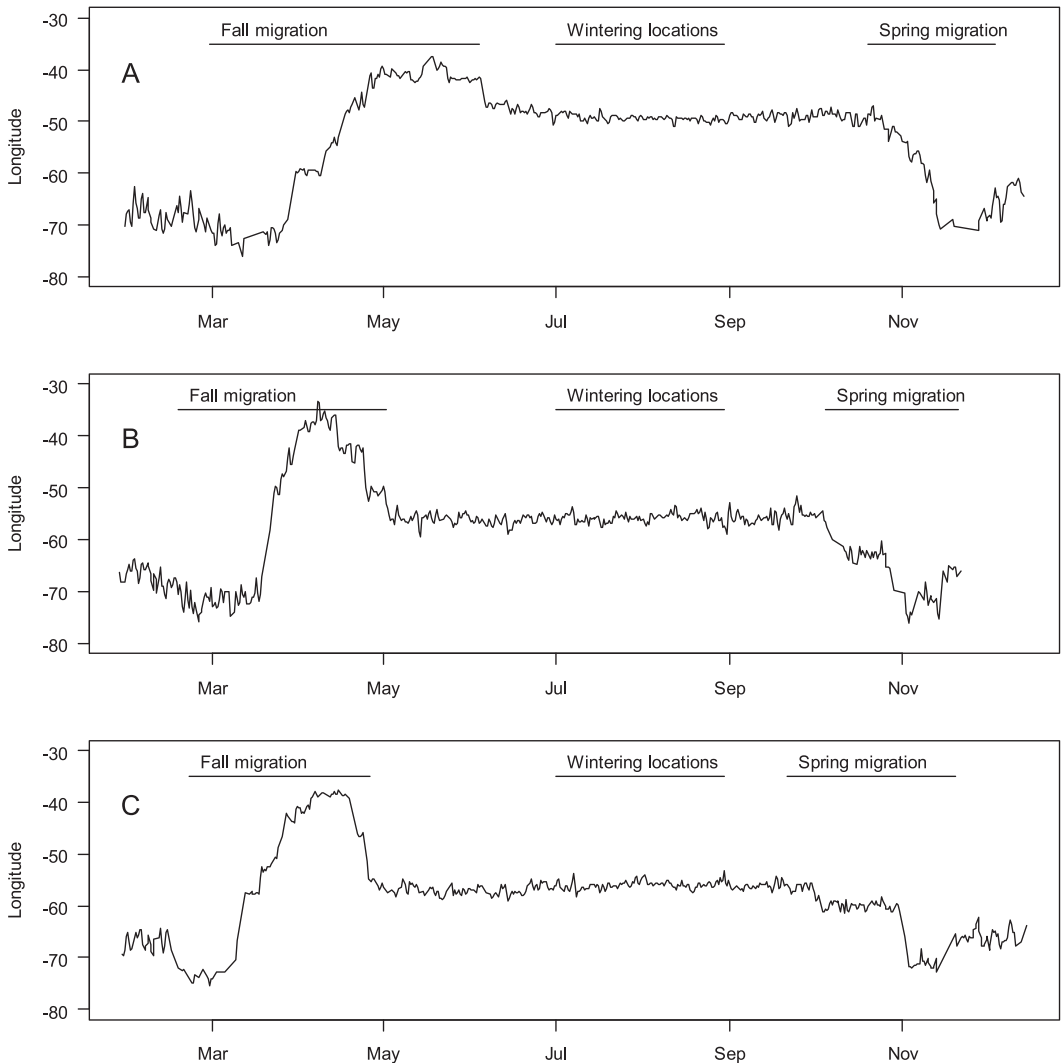


FIG. 1. The migratory phenology of three White-crested Elaenias tagged in January 2012 and recovered the following spring. Lines for fall and spring migration indicate estimates of the duration of spring and fall migration; lines for the wintering location identify the date range used to estimate wintering locations in Fig. 2; letters in each panel identify the three individual birds.

migratory paths of the three Elaenias indicate that they moved northward along the east coast of South America, before moving westward to arrive at the wintering area on 4 June (bird A), 2 May (bird B), and 26 April (bird C; Fig. 1). Birds A, B, and C departed the wintering area on 20 October, 5 October, and 21 September, respectively, and arrived back at their breeding site in Omora Park on 4 December, 21 November, and 20 November 2012, respectively (Fig. 1).

Thus, for these three Elaenias, fall migration lasted 96, 74, and 64 days, respectively.

It also appeared to include a stopover period of >10 days in eastern Brazil, near the coast (Fig. 1). In contrast, spring migration lasted only 45, 47, and 60 days, during which the birds flew directly south to the breeding grounds (Figs. 1 and 2).

*Overwintering Locations.*—The overwintering location of bird A was in eastern Amazonia (Fig. 2); the center location was off the northeastern Brazilian coast, likely because of errors in light-level readings by the geolocator). Birds B and C overwintered in central Amazonia (Fig. 2).

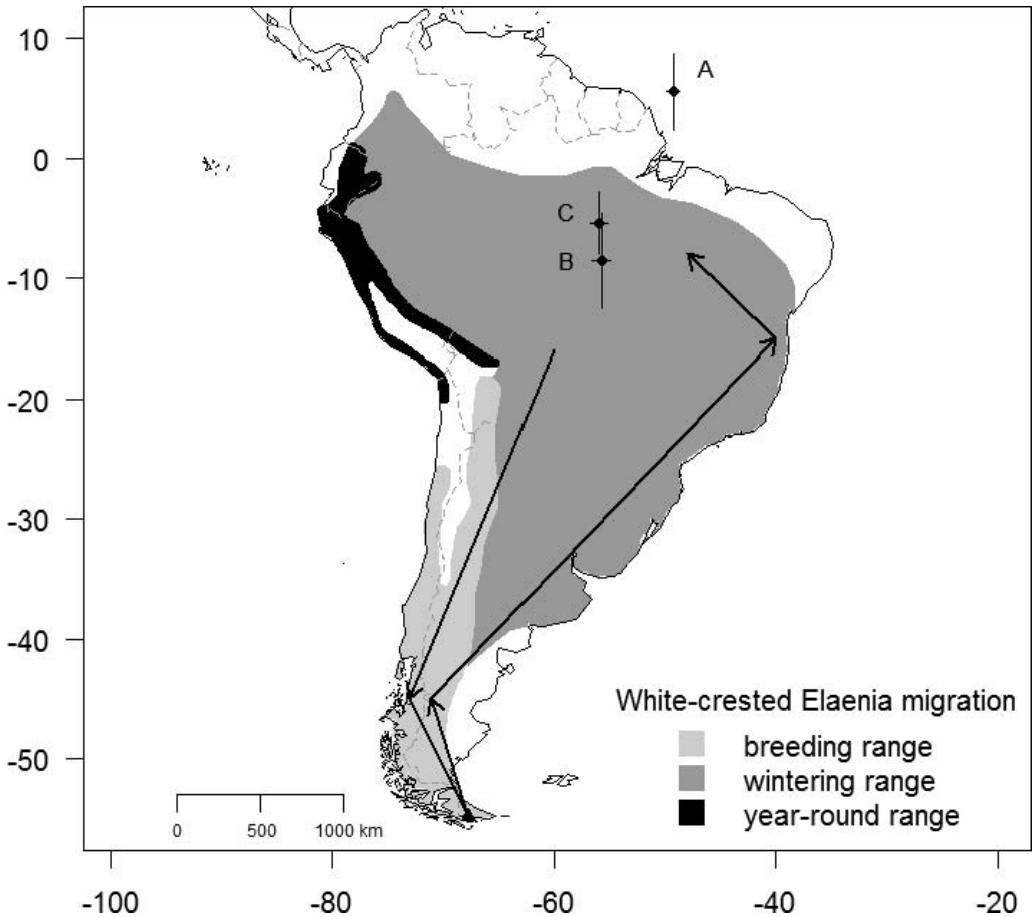


FIG. 2. Average wintering locations (mean and standard error bars) are given for three White-crested Elaenias. The arrows represent approximate migration routes during fall (northward) and spring (southward). Plotting migration routes or stopover locations was not possible, because a significant portion of this movement occurred during the equinox period when only longitude could be estimated reliably. Distributional data are from NatureServe (2012).

The straight-line distances from the breeding locations to the overwintering locations were 6,930 (for bird A), 5,265 (for bird B) and 5,601 km (for bird C; Fig. 2). Thus, the birds migrated at rates ranging from 71–88  $\text{km}\cdot\text{day}^{-1}$  during fall, and at 93 to 154  $\text{km}\cdot\text{day}^{-1}$  during spring.

#### DISCUSSION

The migration of Elaenias between Navarino Island and Amazonia constitutes the longest known migration among Neotropical austral migrants (i.e., which migrate wholly within South America; Cueto and Jahn 2008). Similar to passerine migrants on other continents, spring

migration of Elaenias is faster than fall migration (e.g., Tøttrup et al. 2012, McKinnon et al. 2013). In contrast to migration patterns in other continents, such as between North and Central America, as well as between Europe and Africa, where numerous forest passerines migrate to breed at higher latitudes (McKinnon et al. 2013), in South America, White-crested Elaenia is the single long-distance migrant that moves between tropical and temperate forest (Rozzi et al. 1996). It is important to note that tropical and temperate forests in South America are separated by extensive non-forested arid and semiarid zones (Armesto et al. 1998), which Elaenias manage to cross.

The migration tracks of our three study birds support the hypothesis that at least the southernmost population of *Elaenias* migrates northwards along the eastern side of the Andes Mountains, then northeast across Argentina towards Uruguay and Brazil, returning southwest in spring across northern Argentina, then southwards along the Andes (Marini and Calvalcanti 1990, Capllonch et al. 2011). Specifically, our longitude data suggest that the three birds spent from a week to a month in eastern Brazil. The stopover in eastern Brazil during fall migration coincides with a peak in abundance of *Elaenias* and with the rainy season in that region (Ruiz-Esparza et al. 2011). Further research is needed to evaluate whether the timing and route of White-crested *Elaenias*' migration allow the birds to track rainfall, as has been suggested for other Neotropical austral migrants that overwinter in tropical South America (Jahn et al. 2013) and was demonstrated for migratory birds on other continents (Pyle et al. 2009).

The wintering location of bird A was outside of the known species' range (Natureserve 2012), and indeed fell over the ocean. Such an offset can occur when the light environment of the wintering area is substantially different from that on the breeding ground where the calibration was performed (Ryder et al. 2011, Fudickar et al. 2012). However, it is also conceivable that this bird could have wintered along the coast, which would have put the wintering location outside of the mapped distribution. For relatively cryptic species that have not been extensively studied, the results of new tracking technology may offer us the opportunity to revisit our assumptions about their distribution.

The three birds stayed ~4 months within the winter range. Interestingly, there was a positive relationship between the dates of arrival on the wintering grounds after fall migration and the dates of arrival at the breeding site the following spring. The migration rates of the *Elaenias* were higher than those reported for another Tyrannid, the Fork-tailed Flycatcher (*Tyrannus savana*; 45–66 km/day; Jahn et al. 2013), and lower than that of larger migratory birds (McKinnon et al. 2015).

Although the recapture rate of tagged birds was low, we do not believe that geolocators affected the survival and recapture rate of the *Elaenias*, given that the recapture rates of birds with geolocators was similar to those banded and having no geolocators (10.4%; Rozzi and Jiménez 2014). While the survival of tagged birds has been raised as a concern in other geocator studies (Bowlin

et al. 2010), it does not appear to be a concern in this species. In addition, geocator technology has improved substantially lately (Hobson et al. 2015), and failure rates have decreased dramatically compared to that of the prototypes we used in this study (JEJ, unpubl. data).

Our results demonstrate that geolocators can improve our knowledge of the ecology, habitat requirements, and challenges to survival during migration and winter of small migrants such as *Elaenias*. Furthermore, by combining geocator data (i.e., to evaluate migratory connectivity; Webster et al. 2002) with other ecological and physiological data, potential carry-over effects from the birds' wintering period in Amazonia may be detected during their breeding season in Patagonia (Hostetler et al. 2015).

*Elaenias* are the dominant breeding passerines in the temperate forests of South America, where they play important ecological roles, such as seed dispersers in sub-Antarctic forests (Brown et al. 2007, Cavallero et al. 2013). Therefore, understanding the annual cycle of migratory birds such as *Elaenias* should be a priority to understand ecological interactions and conservation of interconnected tropical, temperate, and sub-Antarctic forest ecosystems in South America.

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#### LITERATURE CITED

- ARMESTO, J. J., R. ROZZI, C. SMITH-RAMÍREZ, AND M. T. K. ARROYO. 1998. Conservation targets in South American temperate forests. *Science* 282:1271–1272.
- BOWLIN, M. S., P. HENNINGSSON, F. T. MUIJRES, R. H. E. VLEUGELS, F. LIECHTI, AND A. HEDENSTRÖM. 2010. The effects of geocator drag and weight on the flight ranges of small migrants. *Methods in Ecology and Evolution* 1:398–402.

- BROWN, C. E., C. B. ANDERSON, S. IPPY, M. F. SHERRIFFS, R. CHARLIN, S. MCGEEHEE, AND R. ROZZI. 2007. The autecology of the Fío-fío (*Elaenia albiceps* Lafresnaye & D'Orbigny) in subantarctic forests of the Cape Horn Biosphere Reserve, Chile. *Anales del Instituto de la Patagonia* 35:29–40.
- CAPLONCH, P., M. E. ALVAREZ, AND P. G. BLENDINGER. 2011. On the migration of *Elaenia albiceps chilensis* (Aves: Tyrannidae) in Argentina. *Acta Zoológica Lilloana* 55:229–246.
- CAVALLERO, L., E. RAFFAELE, AND M. A. AIZEN. 2013. Birds as mediators of passive restoration during early post-fire recovery. *Biological Conservation* 158: 342–350.
- CONTINA, A., E. S. BRIDGE, N. E. SEAVY, J. M. DUCKLES, AND J. F. KELLY. 2013. Using geologgers to investigate bimodal isotope patterns in Painted Buntings (*Passerina ciris*). *Auk* 130:265–272.
- CUETO, V. R. AND A. E. JAHN. 2008. On the need for a standardized name for birds that migrate within South America. *Hornero* 23:1–4.
- FITZPATRICK, J. W., J. M. BATES, K. S. BOSTWICK, I. C. CABALLERO, B. M. CLOCK, A. FARNSWORTH, P. A. HOSNER, L. JOSEPH, G. M. LANGHAM, D. J. LEBBIN, J. A. MOBLEY, M. B. ROBBINS, E. SCHOLES, J. G. TELLO, B. A. WALTHER, AND K. J. ZIMMER. 2004. Family Tyrannidae (tyrant-flycatchers). Pages 170–462 in *Handbook of the birds of the world. Volume 9. Cotingas to pipits and wagtails* (J. del Hoyo, A. Elliott, and D. A. Christie, Editors). Lynx Edicions, Barcelona, Spain.
- FUDICKAR, A. M., M. WIKELSKI, AND J. PARTECKE. 2012. Tracking migratory songbirds: accuracy of light-level loggers (geolocators) in forest habitats. *Methods in Ecology and Evolution* 3:47–52.
- HOBSON, K. A., K. J. KARDYNAL, S. L. VAN WILGENBURG, G. ALBRECHT, A. SALVADORI, M. D. CADMAN, F. LIECHTI, AND J. W. FOX. 2015. A continent-wide migratory divide in North American breeding Barn Swallows (*Hirundo rustica*). *PLoS One* 10:e0129340.
- HOSTETLER, J. A., T. S. SILLETT, AND P. P. MARRA. 2015. Full-annual-cycle population models for migratory birds. *Auk: Ornithological Advances* 132: 433–449.
- IPPY, S., C. B. ANDERSON, R. ROZZI, AND C. S. ELPHICK. 2009. Annual variation of abundance and composition in forest bird assemblages on Navarino Island, Cape Horn Biosphere Reserve, Chile. *Ornitología Neotropical* 20:231–245.
- JAHN, A. E., D. J. LEVEY, V. R. CUETO, J. P. LEDEZMA, D. T. TUERO, J. W. FOX, AND D. MASSON. 2013. Long-distance bird migration within South America revealed by light-level geolocators. *Auk* 130:223–229.
- JIMÉNEZ, J. E. 2000. Effect of sample size, plot size, and counting time on estimates of avian diversity and abundance in a Chilean rainforest. *Journal of Field Ornithology* 71:66–87.
- LISLEVAND, T. AND S. HAHN. 2015. Skipping-type migration in a small Arctic wader, the Temminck's Stint *Calidris temminckii*. *Journal of Avian Biology* 46:419–424.
- LISOVSKI, S. AND S. HAHN. 2012. GeoLight—processing and analysing light-based geocator data in R. *Methods in Ecology and Evolution* 3:1055–1059.
- MARINI, M. Â. AND R. B. CAVALCANTI. 1990. Migrações de *Elaenia albiceps chilensis* e *Elaenia chiriquensis albivertex* (Aves: Tyrannidae). *Boletim do Museu Paraense Emílio Goeldi, Série Zoológica* 6:59–67.
- MCKINNON, E. A., K. C. FRASER, AND B. J. M. STUTCHBURY. 2013. New discoveries in landbird migration using geolocators, and a flight plan for the future. *Auk* 130:211–222.
- NATURESERVE. 2012. NatureServe web service. Arlington, Virginia, USA. [services.natureserve.org/](http://services.natureserve.org/) (accessed 14 Nov 2013).
- OLROG, C. C. 1979. Nueva lista de la avifauna argentina. *Opera Lilloana* 27:1–324.
- PINTO, O. M. O. AND E. A. DE CAMARGO. 1961. Resultados ornitológicos de quatro recentes expedições do Departamento de Zoologia ao nordeste do Brasil, com a descrição de seis novas subespécies. *Arquivos de Zoologia do Estado de São Paulo* 11:193–284.
- PYLE, P., W. A. LEITNER, L. LOZANO-ANGULO, F. AVILEZ-TERAN, H. SWANSON, E. G. LIMÓN, AND M. K. CHAMBERS. 2009. Temporal, spatial, and annual variation in the occurrence of molt-migrant passerines in the Mexican monsoon region. *Condor* 111:583–590.
- RAPPOLE, J. H. AND A. R. TIPTON. 1991. New harness design for attachment of radio transmitters to small passerines. *Journal of Field Ornithology* 62:335–337.
- ROZZI, R. AND J. E. JIMÉNEZ. 2014. Magellanic sub-Antarctic ornithology: first decade of long-term bird studies at the Omora Ethnobotanical Park: Cape Horn Biosphere Reserve, Chile. University of North Texas Press, Denton, USA and -Universidad de Magallanes Punta Arenas, Chile.
- ROZZI, R., D. MARTÍNEZ, M. F. WILLSON, AND C. SABAG. 1996. Avifauna de los bosques templados de Sudamérica. Pages 135–152 in *Ecología de los bosques nativos de Chile* (J. J. Armesto, C. Villagrán, and M. T. K. Arroyo, Editors). Editorial Universitaria, Santiago, Chile.
- RUIZ-ESPARZA, J., P. A. DA ROCHA, D. P. B. RUIZ-ESPARZA, A. DE SOUZA RIBEIRO, AND S. F. FERRARI. 2011. Migratory birds in the semi-arid Caatinga scrublands of northeastern Brazil: diversity and seasonal patterns. *Ornitología Neotropical* 22:15–24.
- RYDER, T. B., J. W. FOX, AND P. P. MARRA. 2011. Estimating migratory connectivity of Gray Catbirds (*Dumetella carolinensis*) using geocator and mark-recapture data. *Auk* 128:448–453.
- SICK, H. 1984. *Ornitología brasileira: uma introdução*. Editora Universidade de Brasília, Brasília, Brazil.
- TØTTRUP, A. P., R. H. G. KLAASSEN, R. STRANDBERG, K. THORUP, M. W. KRISTENSEN, P. S. JØRGENSEN, J. FOX, V. AFANASYEV, C. RAHBK, AND T. ALERSTAM. 2012. The annual cycle of a trans-equatorial Eurasian–African passerine migrant: different spatio-temporal strategies for autumn and spring migration. *Proceedings of the Royal Society of London, Series B* 279:1008–1016.

- TRAYLOR, M. A. 1958. Birds of northeastern Peru. *Fieldiana Zoology* 35:87–141.
- WEBSTER, M. S., P. P. MARRA, S. M. HAIG, S. BENSCH, AND R. T. HOLMES. 2002. Links between worlds: unraveling migratory connectivity. *Trends in Ecology and Evolution* 17:76–83.
- WOTHERSPOON, S., M. SUMNER, AND S. LISOVSKI. 2013. BASTag: basic data processing for light based geolocation archival tags. Version 0.1–3.
- ZIMMER, J. T. 1941. Studies of Peruvian birds. Number 36. The genera *Elaenia* and *Myiopagis*. *American Museum Novitates* 1108:1–23.

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## Assessing Nest Success of Black-Capped Chickadees (*Poecile atricapillus*) in an Urban Landscape Using Artificial Cavities

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**ABSTRACT.**—Native bird diversity is compromised in urban areas partially because of the lack of available habitat for some species. As urbanization continues to increase, it is important to understand the behavioral dynamics of bird species located in cities. The Black-capped Chickadee (*Poecile atricapillus*), as a generalist species, offers an opportunity to investigate how common native birds use urban areas that lack natural habitat features while additionally competing with non-native, invasive species (e.g., House Sparrows, *Passer domesticus*). Our objectives were to determine nest box use and nesting success rate of Black-capped Chickadees and House Sparrows using artificial nest boxes in natural habitats located in an urban area, specifically a recently restored 5.66-ha area of pond sedge surrounded by oak (*Quercus* spp.) savannah located south of Lincoln Park Zoo in Chicago, Illinois, USA. Artificial nest cavities with 3 cm diameter entrance holes, intended to exclude House Sparrows, were installed on trees around the study site and monitored for activity. We found that Black-capped Chickadees will readily use artificial cavities; seven of the 20 boxes were excavated and four produced nests. The artificial nesting cavities successfully excluded House Sparrows from nest building and raising young. Received 8 September 2015. Accepted 22 November 2015.

**Key words:** artificial cavity, Black-capped Chickadee, House Sparrow, invasive species, nest success, urban ecology, wildlife management.

Cavity nesting birds depend on standing dead trees (snags) or dead limbs of sufficient size to successfully fledge their young. The abundance of these species is in part related to the density of snags within a habitat patch. In urban centers, snags and dead tree limbs are often removed for

aesthetic or safety reasons which can lead to an overall decrease in cavity nesting species (Blewett and Marzluff 2005). Additionally, the high density of invasive House Sparrows (*Passer domesticus*) in urban areas may increase competition for available nesting habitat because the sparrows are strong competitors that often choose nest sites indiscriminately (Anderson 2006, Lowther and Cink 2006).

Artificial cavities, or nest boxes, can provide alternative nest sites for cavity nesting species (May 2001). The use of these nest boxes has been shown to increase the abundance of cavity nesting bird species in the vicinity (Newton 1994), while providing the opportunity for smaller species to breed at a higher frequency prior to the implementation of nest boxes (May 2001, Charter et al. 2010). Although artificial nest cavities have been shown to benefit native species in natural environments (Newton 1994), this has yet to be quantified in urban areas where snags are less abundant and non-native nest site competitors are more common. Thus, we investigated how artificial nest boxes influence the abundance of a native cavity nesting species known to readily use urban areas without providing nesting habitat for the invasive House Sparrow.

The Black-capped Chickadee (*Poecile atricapillus*) is an ideal study candidate because of its high relative abundance in urban areas compared to other native cavity nesting species, and its smaller size in relation to the House Sparrow (Melles et al. 2003). We hypothesized that Black-capped Chickadees would nest in artificial cavities with an entrance size larger than the body size of adult Black-capped Chickadees but smaller than the body size of adult House Sparrows, while House Sparrows would not be able to fit because of the entrance size. Therefore, the goal of this

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