SEASONAL DISTRIBUTION OF THE STRIATED HERON (*BUTORIDES STRIATA*) IN SOUTHERN SOUTH AMERICA: EVIDENCE FOR PARTIAL MIGRATION

FLOYD E. HAYES [1,2], BRETT D. HAYES [1] AND PETER LECOURT [1]

[1] *Department of Biology, Pacific Union College. 1 Angwin Ave., Angwin, CA 94508, USA.*
[2] *floyd_hayes@yahoo.com*

ABSTRACT.— The nominate subspecies of the Striated Heron (*Butorides striata striata*) inhabits most of South America. Previous authors suggested that the southernmost populations are partially migratory based on anecdotal evidence. An analysis of 9352 eBird records from south of 20°S reveals that the proportion of Striated Heron records during the austral winter months (June–August) decreases south of 24°S. Breeding occurs as far south as 37°S, whereas individuals have wintered as far south as 39°S. The seasonal distribution data strongly suggest that populations south of 24°S are partially migratory, with most individuals departing during the winter period in southern Paraguay, southeastern Brazil, Uruguay, and most of Argentina. Given the absence of band recovery, geolocator recovery, or satellite tracking data, it is unknown how far north the southernmost populations migrate, but heat maps of 35304 eBird records in South America suggest most individuals winter in eastern Bolivia and central Brazil. Further studies are needed to elucidate the migratory pathways and destinations of migrant individuals of the Striated Heron.

KEY WORDS: *Argentina, Brazil,* Butorides striata*, Chile, eBird, migration, Paraguay, seasonality, Uruguay.*

RESUMEN. DISTRIBUCIÓN ESTACIONAL DE LA GARCITA AZULADA (*BUTORIDES STRIATA*) EN EL SUR DE AMÉRICA DEL SUR: EVIDENCIA DE MIGRACIÓN PARCIAL.— La subespecie nominal de la Garcita Azulada (*Butorides striata striata*) habita la mayor parte de América del Sur. Se ha sugerido en base a evidencias anecdóticas que las poblaciones más australes son parcialmente migratorias. Un análisis de 9352 registros obtenidos de eBird al sur de los 20°S revela que la proporción de registros de Garcita Azulada durante los meses del invierno austral (junio–agosto) disminuye al sur de los 24°S. La especie se reproduce al menos hasta los 37°S, mientras que los individuos pasan el invierno al menos hasta los 39°S. Los datos de distribución estacional sugieren fuertemente que las poblaciones al sur de los 24°S son parcialmente migratorias y que la mayoría de los individuos abandonan el sur de Paraguay, el sudeste de Brasil, Uruguay y la mayor parte de Argentina durante el período invernal. Debido a la ausencia de datos de recuperación de anillos, geolocalizadores o de seguimientos satelitales, se desconoce qué tan al norte migran las poblaciones más australes, pero los mapas de calor de 35304 registros de eBird de América del Sur sugieren que la mayoría de los individuos pasan el invierno en el este de Bolivia y el centro de Brasil. Se necesitan más estudios para dilucidar las rutas migratorias y los destinos de los individuos migrantes de Garcita Azulada.

PALABRAS CLAVE: *Argentina, Brasil,* Butorides striata*, Chile, eBird, estacionalidad, migración, Paraguay, Uruguay.*

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In temperate latitudes of southern South America many species of birds, collectively referred to as austral migrants, Neotropical migrants, or Neotropical austral migrants, migrate northward toward the tropics during the colder winter period (e.g., Chesser 1994, 1997, 2005, Hayes et al. 1994, Hayes 1995a, Jahn et al. 2004, Capllonch 2007, Capllonch et al. 2008, 2009, Cueto and Jahn 2008, Cueto et al. 2008). However, much remains to be learned about which species migrate, the timing of their migration, and their migratory routes and destinations. Studying the seasonal distribution of birds in southern South America previously required extensive data sets of specimen and sight records (e.g., Chesser 1994, Hayes et al. 1994, Capllonch 2007, Capllonch et al. 2009). In recent years eBird, an innovative and rapidly growing citizen science project, has provided researchers with

access to an unprecedented quantity of observational data useful for analyzing the seasonal distribution of birds, which can be used to infer their migratory patterns or lack thereof (Sullivan et al. 2009, 2014, Wood et al. 2011).

The Striated Heron (*Butorides striata*) is a relatively cosmopolitan species of heron occurring throughout South America, Africa, Madagascar, many Indian Ocean islands, southern and eastern Asia, the East Indies, Australia, and many Pacific Ocean islands (Hancock and Kushlan 1984, Martínez-Vilalta and Mottis 1992, Kushlan and Hancock 2005). The nominate subspecies *Butorides striata striata* occurs throughout all but the southernmost part of South America and hybridizes with the closely related Green Heron (*Butorides virescens*) of North America and the Caribbean where their ranges meet in central Panama and Tobago (Payne 1974, Hayes 2002, 2006, Hayes et al. 2013). Although migratory movements are well documented in breeding populations of the Striated Heron in northern Asia and Green Heron in North America, most subspecies of the Striated Heron and Green Heron (including those of Striated Heron in temperate latitudes of the Southern Hemisphere) are thought to be relatively sedentary despite erratic seasonal movements and vagrancy to offshore islands (Urban 1982, Hancock and Kushlan 1984, Marchant and Higgins 1990, Martínez-Vilalta and Mottis 1992, Hayes 2002, Kushlan and Hancock 2005, McKilligan 2005). However, numerous authors have casually stated, although with very few if any supporting data, that the Striated Heron is migratory or partially migratory in southern South America (Chesser 1994) and, more specifically, in Paraguay (del Castillo and Clay 2004), southern Brazil (Belton 1984, Sick 1993, Bencke 2001, Nunes and Tomas 2004, Accordi and Hartz 2006, Scherer et al. 2011, Müller and Barros 2013), Uruguay (Gerzenstein 1965), and Argentina (Mazar Barnett and Pearman 2001, Bodrati et al. 2006, 2010, 2012, Torres and Michelutti 2006, Alonso and Ronchi Virgolini 2008, Ronchi-Virgolini et al. 2008, Chatellenaz et al. 2010, Fandiño and Giraudo 2010, Echevarria et al. 2014, Capllonch 2018).

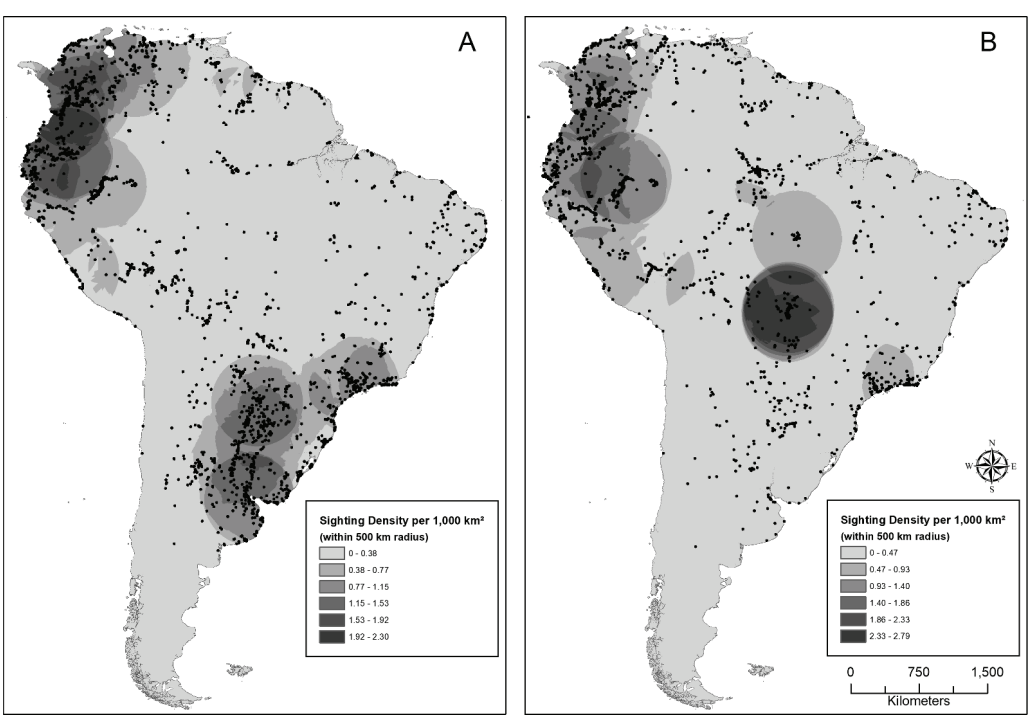

Figure 1. Heat maps illustrating the distribution and density of records (based on eBird data) of the Striated Heron (*Butorides striata*) in South America during (A) the austral summer months (December–February, 8895 records), and (B) the austral winter months (June–August, 8671 records).

Table 1. Percentage of records (based on eBird data) of the Striated Heron (*Butorides striata*) per month for each degree of latitude (°S) south of 20°S in southern South America. Because of the low sample size for 39°S, monthly records are indicated by a + sign.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	*n*
20°	7	2	13	9	6	3	3	4	9	27	11	5	325
21°	12	8	3	7	7	6	6	<1	7	12	19	12	122
22°	10	11	6	7	9	6	8	4	8	14	12	6	1417
23°	10	9	7	8	10	5	7	6	6	15	10	9	998
24°	9	12	13	6	6	1	6	2	4	21	14	8	375
25°	12	10	8	3	2	1	3	4	6	20	18	13	1283
26°	11	8	6	5	4	<1	<1	2	5	25	22	12	413
27°	15	12	6	4	4	1	5	3	5	22	15	9	714
28°	11	10	7	4	5	<1	2	2	5	19	26	11	519
29°	9	11	7	4	10	4	3	1	2	18	15	16	169
30°	12	16	10	5	5	1	<1	2	5	14	20	11	447
31°	13	10	7	4	4	<1	<1	1	2	19	25	14	481
32°	7	14	6	4	2	<1	<1	<1	5	19	25	16	253
33°	13	11	16	3	2	-	1	2	2	15	20	16	314
34°	15	16	9	4	2	1	<1	<1	2	14	22	14	1198
35°	15	8	7	1	4	1	2	-	4	10	33	16	102
36°	23	6	5	-	-	1	1	-	1	17	32	14	84
37°	13	8	18	3	-	-	5	-	-	23	15	18	40
38°	24	8	6	2	1	-	3	-	-	19	18	17	95
39°	-	+	-	-	-	-	-	-	+	+	-	-	3

In this study we quantitatively analyze the seasonal distribution of the Striated Heron in southern South America based on data submitted to eBird. We provide evidence that it is a partial Neotropical austral migrant (Jahn et al. 2004, 2012), with most individuals in temperate latitudes migrating northward during the colder winter period.

METHODS

We obtained all records submitted to eBird of the Striated Heron in South America (excluding the Galapagos Islands) up through 30 November 2017. Each record was defined as an observation of one or more individuals of the Striated Heron at a given locality (area size highly variable) on a given date. To compare the summer and winter distributions of the Striated Heron, all records from December–February (austral summer) and June–August (austral winter) were plotted on heat maps using the ArcGIS platform. Shading matrices for the density of records within a 500 km radius of each locality were superimposed on the maps. We also calculated the percentage of records for each month of the year for each degree of latitude south of 20°S, and the percentage of records occurring only during June–August at each degree of latitude south of 20°S.

RESULTS

We obtained 35304 records of Striated Heron in South America. Of these, 9352 were from south of 20°S, ranging from 26 March 1983 to 30 November 2017, with one older outlier on 13 December 1937. Maps plotting the summer and winter distributions of the Striated Heron were similar, revealing that individuals occur at southern latitudes throughout the year, but winter records at southern latitudes were fewer and more scattered (Fig. 1). Shading matrices illustrating the density of records revealed a shift in high density areas from southern South America during the summer to central South America during the winter (Fig. 1). The proportion of records during the winter months decreased as latitude increases (Table 1, Fig. 2). South of 24°S, fewer than 10% of the records were from the winter months (Fig. 2), whereas south of 30°S only 2.6% of the records were from these months.

In northern and central Argentina the Striated Heron nests from October–March in the provinces of Chaco, Corrientes, Córdoba, Entre Ríos, Santa Fe, and Buenos Aires, as far south as Azul, Buenos Aires Province (37°S, 60°W; see de la Peña and Montalti 2014). Nesting may occur farther south: on 17 November 2015, an adult carrying nest material was observed at Lago de los Cisnes, Parque Miguel Lillo (39°S, 59°W) (record from R Doumecq Milieu in eBird). The southernmost eBird records of the Striated Heron are of possibly the same bird observed repeatedly at Hilario Ascasubi, Villarino Department, Buenos Aires Province, Argentina (39°S, 62°W), on 29 September 2014, 17 October 2014, and 26 February 2015 (record from R Scoffield). The southernmost winter record is from Lago Pellegrini, Neuquén Province, Argentina (39°S, 68°W), on 15 July 2015 (record from MJ Huc), with another individual slightly farther north at Ruta 228-Lagunita km 12, Buenos Aires Province, Argentina (39°S, 59°W), on 6 and 31 July 2016 (record from R Doumecq Milieu).

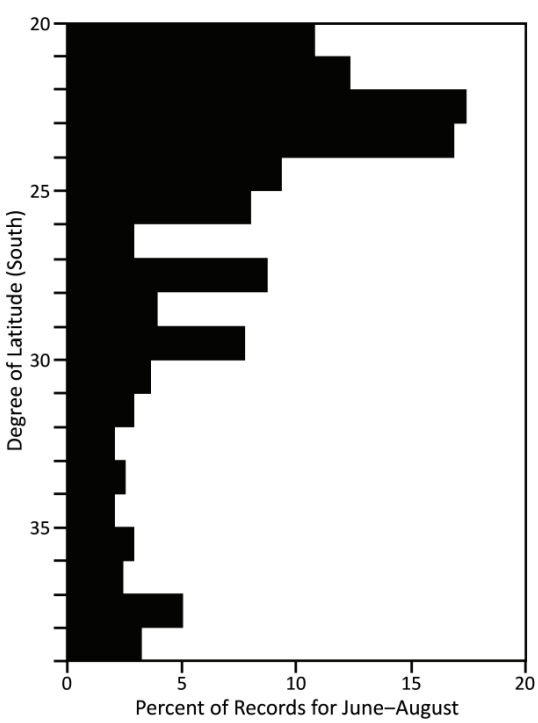

Figure 2. Percentage of annual records (based on eBird data) of the Striated Heron (*Butorides striata*) occurring only during the austral winter months (June-August) at each degree of latitude south of 20°S in southern South America.

West of the Andes, the Striated Heron is a non-breeding vagrant in northern Chile (Jaramillo 2005). The southernmost records are from the mouth of the Elqui River in Coquimbo, Elqui Province (30°S, 71°W), during 11-12 December 2010 and 31 March to 17 September 2012 (records from many observers).

DISCUSSION

The proportion of Striated Heron records during the winter months decreases as latitude increases, providing evidence that this species is a Neotropical austral migrant in which populations south of 24°S are partially migratory, with most individuals departing during the colder winter months in southern Paraguay, southeastern Brazil, Uruguay, and most of Argentina.

Breeding has been confirmed as far south as 37°S, whereas individuals have wintered as far south as 39°S. Presumably most individuals of the southernmost populations migrate northward during winter because resources dwindle during cold weather, but movements may also be influenced by hydrological regimes, at least on a local scale (Beltzer and Neiff 1992, Hayes 1996, Torres and Michelutti 2006). For example, the abundance of the Striated Heron is inversely correlated with water level along the Paraguay and Parana rivers (Beltzer and Neiff 1992, Hayes 1996), indicating that herons disperse away from major rivers during flood pulses.

Given the absence of published band recovery, geolocator recovery, or satellite tracking data for the Striated Heron, it is unknown how far north the southernmost populations migrate. The Striated Heron occurs year-round in Paraguay, where it was not suspected of being an austral migrant by Hayes et al. (1994) and Hayes (1995b), but del Castillo and Clay (2004) noted that it was most common during summer. Although several authors considered the Striated Heron migratory in southern Brazil (Belton 1984, Sick 1993, Bencke 2001, Nunes and Tomas 2004, Accordi and Hartz 2006, Scherer et al. 2011, Müller and Barros 2013), it was not included in a recent compilation of migratory birds in Brazil (Somenzari et al. 2018). Our data indicate that some migrants from Argentina likely winter

in Paraguay and southern Brazil or pass through as migrants, and some breeding residents from southern Paraguay and southern Brazil likely migrate northward. The heat map obtained in this study suggests that most migrants from southern latitudes winter farther north in eastern Bolivia and central Brazil, but some may migrate to northern South America.

The Striated Heron occasionally strays across short stretches of ocean to the islands of Bonaire (Prins et al. 2009), Curaçao (Prins et al. 2009), and Tobago (Payne 1974, Hayes 2006) off the coast of northern South America. Vagrants have wandered hundreds of kilometers westward to Cocos (Slud 1967) in the eastern Pacific, and northward to Nicaragua (Sandoval and Arendt 2010) in Central America, St. John in the Greater Antilles (Hayes and Hayes 2006), and St. Vincent in the Lesser Antilles (Bond 1964). Such vagrants probably disperse from relatively sedentary populations in tropical latitudes, but it is possible that some disperse as long-distance migrants from southern South America. Further studies, especially of band recovery, geolocator recovery, or satellite tracking data, are needed to elucidate the migratory pathways and destinations of migrant individuals of the Striated Heron.

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