Discovery of an Austral Migratory Corridor for Raptors in South America

Author(s): Javier Medel Hidalgo, Keith L. Bildstein, Roberto P. Schlatter and Juan G. Navedo

Source: Journal of Raptor Research, 52(1):89-93.
Published By: The Raptor Research Foundation
https://doi.org/10.3356/JRR-16-110.1
URL: http://www.bioone.org/doi/full/10.3356/JRR-16-110.1

Short Communications

J. Raptor Res. 52(1):89–93

Discovery of an Austral Migratory Corridor for Raptors in South America

Javier Medel Hidalgo[1]
Universidad Austral de Chile, Valdivia, Chile
and
Centre for Ecology and Conservation, Sensory Ecology and Evolution Lab, University of Exeter, Penryn, Cornwall, U.K.

Keith L. Bildstein
Acopian Center for Conservation Learning, Hawk Mountain Sanctuary, Orwigsburg, PA 17961 U.S.A.

Roberto P. Schlatter[2]
Instituto de Ciencias Marinas y Limnológicas, Universidad Austral de Chile, Valdivia, Chile

Juan G. Navedo
Bird Ecology Lab, Instituto de Ciencias Marinas y Limnológicas, Universidad Austral de Chile, Valdivia, Chile

Key Words: *White-throated Hawk*; Buteo albigula; *Variable Hawk*; Geranoaetus polyosoma; *Andes foothills*; *Andes Mountains*; *Atacama Desert*; *austral migration*; *migration watchsites.*

The movements and distribution of birds are of international conservation interest, as many populations worldwide are characterized by their migratory behavior (Newton 2008). Some species travel relatively short distances between breeding and wintering grounds, whereas others travel hundreds or thousands of kilometers, crossing entire oceans, deserts, or mountain ranges, sometimes without stopping to rest or feed (Newton 2008). Migratory corridors play a crucial role for these species to successfully reach breeding and wintering areas (Tewksbury et al. 2002, Sawyer et al. 2009). Because of accelerated land-use changes (Newbold et al. 2015), there is currently an urgent need to identify and protect migratory corridors to ensure the conservation of several species (Joshi et al. 2011, Runge et al. 2015), especially those species whose migratory ecology is poorly known (Wilcove and Wikelski 2008).

Compared to other avian taxa, raptors are often underrepresented by monitoring programs, because of their low population densities and evasive behavior (Bednarz 2007). Monitoring migratory corridors at key concentration points represents an effective and low-cost method for evaluating raptor populations and migratory behavior (Oppel et al. 2014). Yet, only in North America are there more than 1800 short-term or permanent raptor migration watchsites (McCarty et al. 2000). Even though many raptors make important migrations in South America, relatively few monitoring programs exist on this continent, and only 12 of 35 watchsites occur along the Andes Mountains (Juhant 2011, Bayly et al. 2014).

"South America has the world's richest avifauna" (Chesser 1994); however, overall scarce academic development and a historically unstable political situation have made access to South American sites inconsistent (Jahn et al. 2004). Furthermore, the migratory patterns of austral migratory birds are largely unknown, because physical barriers to migration and distinct leading lines that could concentrate migrants *en route* are almost nonexistent (Juhant and Seipke 2009). There are no wide lakes to avoid and the north–south orientation of the Atacama Desert and the Andes Mountains do not act as barriers to latitudinal migration (Chesser 1994). In addition, although the north–south orientation of the Andes Mountains may serve as a continental-scale leading line, their overall high altitude and complexity probably precludes concentrating migrants at specific points.

Here we report count data for migratory raptors systematically collected during austral autumn migration in extreme northern Chile. Our aim was to identify and

[1] Email address: javierantoniomedelhidalgo@gmail.com
[2] Deceased.

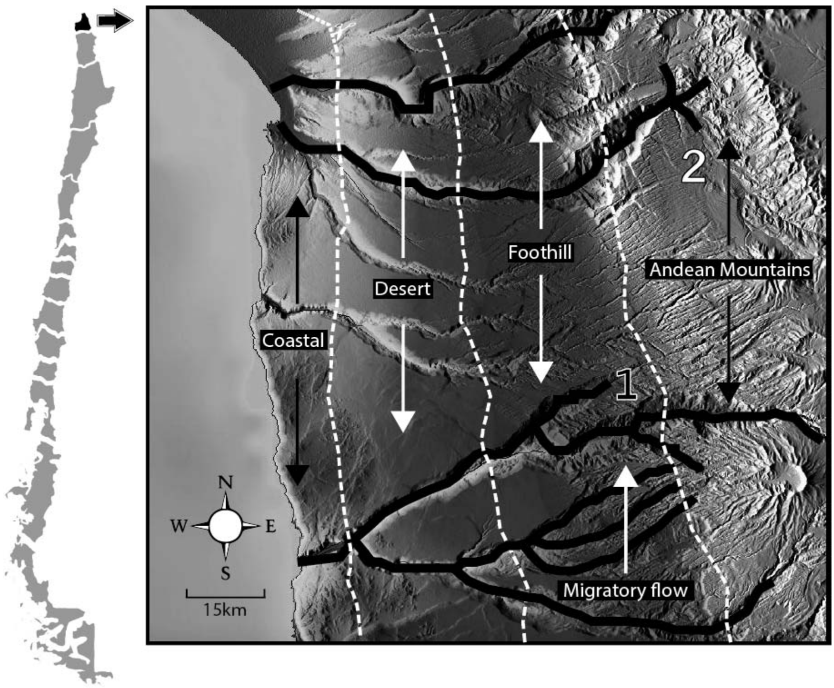

Figure 1. Study area in the Arica and Parinacota region of northern Chile. Sites 1 and 2 correspond to observation points in the Andes foothills and mountains. Dotted white lines represent the approximate bounds of coast, desert, foothill, and Andes Mountains areas. Migratory flow shows the flight orientation during austral autumn migration. Main canyon systems that connect the narrowest area between the widest section of the high Andes Mountains and the Pacific Ocean are outlined in black.

describe a movement corridor for migrating Neotropical raptors in South America.

METHODS

Study Area. The Andes foothills are located along the western slopes of the Andes Mountains (elevation 1800–3800 m; Caldentey 2016). In extreme northern Chile, the geomorphology of the Arica and Parinacota region (18°35.65′S, 69°28.71′W) is defined by a series of small valleys running east to west, feeding four large canyon systems (Lluta, Azapa, Codpa, and Camarones; Chacama 2005), between the Pacific Coast and the highest and widest area of the Andes Mountains (Beck and Zandt 2002; Fig. 1). The study area corresponds to a marginal high-desert climate (average annual temperature 15°C) with daily temperature fluctuations of 25°C (Caldenty 2016). Occasional rainfall increases over the western slope of the Andes, reaching 100–200 mm/yr at the height of the Western Cordillera (Garreaud 2009). We selected two observation points in the Arica and Parinacota region based on their position in the narrowest area between the Pacific Ocean and the widest section of the high Andes Mountains, where the probability of austral migratory raptors concentrating in specific areas was highest (Fig. 1). Site 1 was divided into two points at the top of the Camarones canyon system in the Andes foothils, near the villages of Codpa (18°51.832′ S, 69°41.668′ W) and Pachica (18°54.776′ S, 69°36.866′ W), along the migration route followed by one of three White-throated Hawks (*Buteo albigula*) captured in San Carlos de Bariloche, Argentina, and tracked using GPS transmitters (M. Bechard unpubl. data). We selected Site 2 at the top of Copaquilla Valley of the Azapa Canyon system (18°23.493′ S, 69°38.521′ W), based on one documented observation of a White-throated Hawk in the Andes Mountains (González et al. 2015). We compared counts and species composition at the two sites to determine whether raptors migrate through this region of the western Andes in a wide corridor and use different geographic zones in a similar manner. The distance between the two sites was 50 km.

Sampling and Analyses. Observations were made in April 2015 during the austral autumn, between 0900 and 1800 H on 18 consecutive days. Each day's observations were made from a single observation point by JMH. Counts occurred daily from 8–17 April at Site 1 and from 18–26 April at Site 2. Birds were identified using binoculars (10 ×

Table 1. Records of migrating White-throated Hawks (*Buteo albigula*) and Variable Hawks (*Geranoaetus polyosoma*) in South America during austral autumn, based on observations that spanned a minimum of two consecutive days.

GEOGRAPHIC AREA	SAMPLING EFFORT (hr)	PASSAGE RATE (BIRDS/hr)[1]	REFERENCE
Southern Argentina	93	B: 1.0, G: 0.3	Juhant and Seipke 2009
Central Chile	236	B: 1.0	Pavez 2000
Northern Chile	162	B: 1.8, G: 2.6	This study

[1] B: White-throated Hawk (*Buteo albigula*); G: Variable Hawk (*Geranoaetus polyosoma*).

45) and a spotting scope (20–60×). Migrants were spotted by regularly scanning the sky toward the south, 180° from east to west. Raptors were counted as migratory only if they occurred in groups of two or more individuals or were observed actively flying northward. When possible, birds were aged based on plumage (Ferguson-Lees and Christie 2001) and previous observer experience. Migratory individuals were grouped by time of day: morning (0900–1200 H), midday (1200–1500 H), and afternoon (1500–1800 H).

Because the gathered count data did not meet assumptions of normality for parametric analysis, we used species-specific Kruskal-Wallis tests to evaluate whether the observed migratory flow varied among the three diel periods. All values are presented as means ± SE.

RESULTS

We identified and counted 719 individuals of two raptor species exhibiting migratory behavior (i.e., flying northward), including 10 individuals that we could not identify to species because of their high flight altitude. We saw no other species exhibiting migratory behavior. Most (98%) of the identified individuals of both species were adults. Observations included individual birds and 14 groups of two or more individuals, including three mixed-species groups. The Variable Hawk was the more frequent species, representing 58% of the individuals ($n=415$; $n=6$ groups), with an average passage rate of 2.6 ± 0.6 birds/hr throughout the study period. The White-throated Hawk was the less frequent species ($n=294$; $n=6$ groups), with an average passage rate of 1.8 ± 0.5 birds/hr. We also observed resident individuals of eight other raptor species exhibiting non-migratory movement behavior (i.e, not flying in a clear orientation from south to north). Most of the migrants (94%) at Site 1 flew across canyon systems (Fig. 1). When crossing below the top of a canyon, hawks used soaring flight to ascend above the northern edge of the canyon. Most birds then proceeded northward using gliding flight, but a few (2–4) individuals of both species used powered flight to continue.

We observed individuals of both species throughout the day. Our statistical analyses revealed no significant differences in counts of the two focal species among the three diel periods (White-throated Hawk: $\chi^2 = 4.26$; $P = 0.12$; Variable Hawk: $\chi^2 = 0.87$; $P = 0.65$); however, White-throated Hawks tended to be more common in the morning and Variable Hawks in the afternoon. The maximum daily passage rates for White-throated Hawks (15.2 birds/hr) and Variable Hawks (13.4 birds/hr) occurred on the same day (13 April). Birds flew at variable altitudes near to the ground (10–30 m), and generally remained below 30 m altitude during the first and last hour of observations (0900–1000 H, 1700–1800 H). We observed only a few individual White-throated Hawks actively hunting, primarily in vegetated areas at higher elevations.

DISCUSSION

Our results suggest that extreme northern Chile is a migratory corridor for White-throated Hawks and Variable Hawks. Previous locations of a GPS-tracked individual (M. Bechard unpubl. data) support our results. Based on available population estimates (Ekstrom et al. 2016, Symes 2016), this corridor is used by 3–30% of the White-throated Hawk biogeographic population (1000–10,000 individuals), and by an unknown percentage, but >4%, of the Variable Hawk population (<10,000 mature individuals). These results demonstrate the importance of the corridor and provide conservative estimates of the numbers of birds that use it, given that: (1) surveys did not last for the entire migratory period; and (2) the 9-d period spent at Site 2, where flight activity was lower, reduced the count averages. Because our monitoring at Site 2 probably did not occur during peak migration, our results may underestimate the importance of this area.

We also documented a higher migration flow compared to other systematic studies in this region (Table 1), and present the northernmost migration records in Chile for both White-throated Hawk and Variable Hawk. Our study area fell within the elevation range previously described for both species observed migrating along a common corridor (range: 1788–2865 m; Trejo et al. 2007, Juhant and Seipke 2009). The observed differences in migration flow could be associated with geographic and climatic variation between the central and extreme northern regions of Chile. Peak migratory flow has been observed during March in southern areas (Pavez 2000, Trejo et al. 2007, Juhant and Seipke 2009). Thus, given the long distances between southern and central Chile and our study area (2000–4500 km), we may have observed the same annual migratory flow passing later in northern Chile. Another possibility is that the food supply may be greater in the Andes foothills where the summer precipitation pattern in the Altiplano increases the water supply (Caldentey 2016), and this may affect arrival dates in the extreme north.

The scarcity of White-throated Hawk juveniles, previously reported by Juhant and Seipke (2009), could be explained by temporal segregation of age classes on migration or of individuals destined for different wintering grounds (Trejo et al. 2007). Another possibility is that some juveniles migrate shorter distances than adults. The low reproductive rate of White-throated Hawks also may be a contributing factor; in raptors that breed in Chile, the species is the only trans-equatorial migratory raptor with an annual reproductive rate of only one juvenile per breeding pair (Medel Hidalgo 2014).

Because of its influence over the main Andes foothill migration corridor, the extremely arid Atacama Desert likely has profound effects on the survival rates and evolution of migratory strategies among austral migratory birds. Unlike other migratory corridors that pass through large desert expanses (Newton 2008, Strandberg et al. 2010), the Atacama Desert is flanked by the Andes along its entire length. Therefore, the Andes foothills provide inland migratory raptors the option of avoiding the extreme conditions present in both the lowland Atacama Desert and the widest and highest area of the Andes Mountains, providing an essential corridor for latitudinal migratory movements (Fig. 1).

Based on our passage rate results, the Andes foothills in the Arica and Parinacota region in extreme northern Chile should be considered the major migration corridor for the White-throated Hawk and Variable Hawk and, therefore, should be the focus for developing long-term research and migration monitoring to evaluate the status of these species' populations. In addition, given the associated topography, geography, and possibly favorable winds and thermal conditions, canyon systems that run across foothills and connect the Andes Mountains and Pacific Ocean, should be considered potential strategic observation points for future studies of austral raptor migration through this region. Further research should expand the sampling effort to include the entire autumn migration cycle (March to May) in the Andes foothills.

DESCUBRIMIENTO DE UN CORREDOR MIGRATORIO AUSTRAL DE AVES RAPACES EN SUDAMÉRICA

RESUMEN.—En Sudamérica, los corredores migratorios que utilizan las aves rapaces son en gran parte desconocidos, lo que obstaculiza el estudio y la conservación eficientes de estas especies. Realizamos un esfuerzo sistemático diurno para estimar el flujo migratorio durante el otoño austral en la pre-cordillera y cordillera de los Andes en el extremo norte de Chile. Elegimos esta región debido a que es el área más estrecha entre la costa del Océano Pacífico y la sección más ancha de la parte alta de la cordillera de los Andes y en base a datos de ubicación precisos de un individuo de *Buteo albigula* proporcionados por transmisores satelitales GPS. En este estudio documentamos la composición de especies, la fenología, y la abundancia promedio de aves rapaces migratorias, usando dos puntos de observación diferentes, registrando un total de 719 individuos de dos especies principales. *Geranoaetus polyosoma* representó el 58% de todos los individuos, migrando a una tasa promedio de 2.6 ± 0.6 aves/h. *B.albigula* fue menos común, con un promedio de 1.8 ± 0.5 aves/h. Empleando estimaciones conservadoras, este corredor es utilizado por 3-30% de la población biogeográfica estimada a nivel global de *B. albigula* y un porcentaje desconocido, pero superior al 4% de la población de *G. polyosoma*. Nuestros resultados documentan un mayor flujo migratorio de aves rapaces en comparación con estudios previos de conteos migratorios australes, lo que apoya la importancia de este corredor, al menos para estas dos especies.

ACKNOWLEDGMENTS

This manuscript is dedicated to the memory of our friend Roberto P. Schlatter, who dedicated his life to study the avifauna as surrogates to protect natural resources in South America. This study was possible thanks to a Hawk Mountain Sanctuary grant provided to Javier Medel. We also thank Fernando Medel, Conchita Hidalgo, Javiera Salazar, Jorge Ruiz, Mauricio Cano, Enzo Basso, Irene Bueno, Tyler McFadden, Ricardo Figueroa, and Pablo Oyarzún for fruitful comments on an earlier version of this manuscript.

LITERATURE CITED

BAYLY, N.J., C. GOMEZ, L. CARDENAS, AND M. RUBIO. 2014. Migration of raptors, swallows and other diurnal migratory birds through the Darien of Colombia. *Ornitologia Neotropical* 25:63–71.

BECK, S.L. AND G. ZANDT. 2002. The nature of orogenic crust in the central Andes. *Journal of Geophysical Research* 107:7–16.

BEDNARZ, J.C. 2007. Study design, data management, analysis, and presentation. Pages 73–88 *in* D.M. Bird and K.L. Bildstein [EDS.]. Raptor research and management techniques. Hancock House Publishers, Blaine, WA, U.S.A, and Surrey, British Columbia, Canada.

CALDENTEY, J. 2016. Climas en la región de Arica y Parinacota. Pages 43–62 *in* J.P. Hernández, C.F. Estades, L.F. Yancas, and J.H. De Lartundo [EDS.], Biodiversidad terrestre de la región de Arica y Parinacota. Maval Press, Santiago, Chile.

CHACAMA, R. 2005. Patrón de asentamiento y uso del espacio. Precordillera de Arica, extremo norte de Chile, siglos X–XV. *Bulletin de l'Institut Français d'Études Andines* 34:357–378.

CHESSER, R.T. 1994. Migration in South America: an overview of the austral system. *Bird Conservation International* 4:91–107.

EKSTROM, J., M. HARDING, AND S. BUTCHART. 2016. *Buteo albigula*. The IUCN Red List of Threatened Species 2016:e.T22695900A93533006. BirdLife International, Cambridge, U.K. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22695900A93533006.en (last accessed 25 August 2017).

FERGUSON-LEES, J. AND D.A. CHRISTIE. 2001. Sex and age differences in sizes and shapes of raptors. Pages 35–43 *in* Raptors of the world. Houghton Mifflin Company, New York, NY U.S.A.

GARREAUD, R.D. 2009. The Andes climate and weather. *Advances in Geosciences* 22:3–11.

GONZÁLEZ, B.A., M.A. VUKASOVIC, AND C. ESTADES. 2015. Presence of the White-throated Hawk *Buteo albigula* at the northernmost Chile. *Boletín Chileno de Ornitología* 21:128–130.

JAHN, A.E., D.J. LEVEY, AND K.G. SMITH. 2004. Reflections across hemispheres: a system-wide approach to New World bird migration. *Auk* 121:1005–1013.

JOSHI, P.K., K. YADAV, AND V.S.P. SINHA. 2011. Assessing impact of forest landscape dynamics on migratory corridors: a case study of two protected areas in Himalayan foothills. *Biodiversity and Conservation* 20:3393–3411.

JUHANT, M.A. 2011. Where to watch raptor migration in South America. *Neotropical Birding* 9:8–16.

——— AND S.H. SEIPKE. 2009. Austral autumn migration counts of raptors in Argentinean Patagonia. *Hawk Migration Studies* 35:7–10.

MCCARTY, K., K. ARNOLD, J. OTTINGER, AND K.L. BILDSTEIN. 2000. HMANA data at Hawk Mountain Sanctuary: an update through January 2000. *Hawk Migration Studies* 25:30–39.

MEDEL HIDALGO, J. 2014. Breeding behavior of the White-throated hawk *Buteo albigula* in the ecoregion of Valdivian temperate rainforest, Valdivia, Chile. B.S. thesis, Universidad Austral de Chile, Valdivia, Chile.

NEWBOLD, T., L.N. HUDSON, S.L. HILL, S. CONTU, I. LYSENKO, R.A. SENIOR, L. BÖRGER, D.J. BENNETT, A. CHOIMES, B. COLLEN, J. DAY, A. DE PALMA, S. DÍAZ, S. ECHEVERRIA-LONDOÑO, M.J. EDGAR, A. FELDMAN, M. GARON, M.L.K. HARRISON, T. ALHUSSEINI, D.J. INGRAM, Y. ITESCU, J. KATTGE, V. KEMP, L. KIRKPATRICK, M. KLEYER, D.L. CORREIA, C.D. MARTIN, S. MEIRI, M. NOVOSOVOLOV, Y. PAN, H.P. PHILLIPS, D.W. PURVES, A. ROBINSON, J. SIMPSON, S.L. TUCK, E. WEIHER, H.J. WHITE, R. EWERS, G.M. MACE, J.P. SCHARLEMANN, AND A. PURVIS. 2015. Global effects of land use on local terrestrial biodiversity. *Nature* 7545:45–50.

NEWTON, I. 2008. The migration ecology of birds. Academic Press, London, U.K.

OPPEL, S., P. IANKOV, S. MUMUN, AND G. GERDZHIKOV. 2014. Identification of the best sites around the gulf of Iskenderun, Turkey, for monitoring the autumn migration of Egyptian Vultures. *Sandgrouse* 36:240–249.

PAVEZ, E. 2000. Migratory movements of the White-throated Hawk. *Journal of Raptor Research* 34:143–147.

RUNGE, C.A., J.E. WATSON, S.H. BUTCHART, J.O. HANSON, H.P. POSSINGHAM, AND R.A. FULLER. 2015. Protected areas and global conservation of migratory birds. *Science* 350:1255–1258.

SAWYER, H., M.J. KAUFFMAN, R.M. NIELSON, AND J.S. HORNE. 2009. Identifying and prioritizing ungulate migration routes for landscape-level conservation. *Ecological Applications* 19:2016–2025.

STRANDBERG, R., R.H. KLAASEN, M. HAKE, AND T. ALERSTAM. 2010. How hazardous is the Sahara Desert crossing for migratory birds? Indications from satellite tracking of raptors. *Biology Letters* 6:297–300.

SYMES, A. 2016. *Geranoaetus polyosoma*. The IUCN Red List of Threatened Species. BirdLife International, Cambridge, U.K. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22735520A95113871.en (last accessed 26 August 2017).

TEWKSBURY, J.J., D.J. LEVEY, N.M. HADDAD, S. SARGENT, J.L. ORROCK, A. WELDON, B.J. DANIELSON, J. BRINKERHOFF, E.I. DAMSCHEN, AND P. TOWNSEND. 2002. Corridors affect plants, animals, and their interactions in fragmented landscapes. *Proceedings of the National Academy of Sciences of the United States of America* 99:12923–12926.

TREJO, A., P. CAPLLONCH, AND L. SYMPSON. 2007. Migratory status of the White-throated Hawk (*Buteo albigula*): what do we know up to now? *Ornitologia Neotropical* 18:11–19.

WILCOVE, D.S. AND M. WIKELSKI. 2008. Going, going, gone: is animal migration disappearing. *PLOS Biology* 6(7):e188. https://doi.org/10.1371/journal.pbio.0060188 (last accessed 26 September 2017).

Received 21 December 2016; accepted 18 September 2017
Associate Editor: Jeff P. Smith