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# ELECTROCUTION ON POWER LINES IS AN IMPORTANT THREAT FOR THE ENDANGERED CHACO EAGLE (*BUTEOGALLUS CORONATUS*) IN ARGENTINA

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ABSTRACT.—Electrocution is a widespread conservation problem for birds of prey that has received little attention in the Neotropics. Here we present electrocution records involving the endangered Chaco Eagle (*Buteogallus coronatus*) in central Argentina, and we provide information on the power pole structural characteristics associated with electrocutions. Nine Chaco Eagles were recorded electrocuted during the period 2012–2019 over an area of 9000 km$^2$. Chaco Eagles were found electrocuted in association with five types of power poles, but more than half the electrocutions (55%) were on poles made of steel-reinforced concrete and with jumper wires above the crossarms. With the addition of four previous electrocution reports in this region during the same time period, the annual rate of Chaco Eagle electrocutions was similar to the rate of mortality by other human-related factors such as direct persecution. Future conservation actions and research should focus on retrofitting the small fraction of poles that pose the highest electrocution risks for Chaco Eagles, and on assessing the demographic effects of electrocution mortality for this species and other endangered raptors in Argentina.

KEY WORDS: *Chaco Eagle*; Buteogallus coronatus; *conservation*; *electrocution*; *endangered species*; *mortality*.

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LA ELECTROCUCIÓN EN LÍNEAS ELÉCTRICAS ES UNA AMENAZA IMPORTANTE PARA *BUTEOGALLUS CORONATUS*, UNA ESPECIE EN PELIGRO DE EXTINCIÓN EN ARGENTINA

RESUMEN.—La electrocución es un problema de conservación muy extendido para las aves de presa que ha recibido poca atención en el Neotrópico. Aquí presentamos registros de electrocución que involucran a la especie *Buteogallus coronatus*, considerada en peligro de extinción en el centro de Argentina, y proporcionamos información sobre las características estructurales de los postes eléctricos asociados con

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las electrocuciones. Nueve individuos de *B. coronatus* fueron registrados electrocutados durante el período 2012–2019 en un área de 9000 km$^2$. Los individuos fueron hallados electrocutados en asociación a cinco tipos de postes eléctricos, pero más de la mitad de las electrocuciones (55%) fueron en postes de hormigón armado y con cables puente sobre las crucetas. Con la adición de cuatro registros previos de electrocución en esta región durante el mismo período de tiempo, la tasa anual de electrocución de *B. coronatus* fue similar a la tasa de mortalidad de otros factores antropogénicos como la persecución directa. Las futuras acciones de conservación e investigación deberían enfocarse en reacondicionar la pequeña fracción de postes que plantean los mayores riesgos de electrocución para *B. coronatus*, y en evaluar los efectos demográficos de la mortalidad por electrocución para esta especie y otras rapaces en peligro en Argentina.

[Traducción del equipo editorial]

Electrocution is an important threat for many birds of prey worldwide. This mortality source is responsible for declines in raptor populations on most continents (Eccleston and Harness 2018, Slater et al. 2020). However, this threat from human infrastructure has received little attention in the Neotropics despite the high raptor species diversity in the region (but see Ibarra and De Lucca 2015, Galmes et al. 2018a), and the critical conservation status of many of those species (Sarasola et al. 2018). Compared to other regions, systematic studies of raptor electrocution are lacking (Lehman et al. 2007).

Most avian electrocution is associated with electrical distribution lines of low- to medium-voltage (i.e., 1–60 kV; Lehman et al. 2007) due to narrow clearances between energized and grounded components. Contributing factors associated with higher avian electrocution risks include species-specific traits such as body size and behavior (Ferrer and Hiraldo 1992, Ledger and Hobbs 1999), and environmental factors such as the proximity of lines to activity areas (Watts et al. 2015), local prey abundance (Dixon et al. 2017), nest sites (Dwyer and Mannan 2007), and the availability of non-power-pole perching sites (Donázar et al. 2002, Lehman et al. 2010). However, the risk of avian electrocution is mainly the result of the combination of two crucial features of power poles in the lines: the design of the poles and the materials with which they are built (Avian Power Line Interaction Committee [APLIC] 2006). Poles built with conductive materials such as steel-reinforced concrete may significantly increase avian electrocution risk relative to poles made of nonconductive material such as wood.

The Chaco Eagle (*Buteogallus coronatus*) is one of the largest and most endangered raptor species in the Neotropics, with an estimated global population of fewer than 1000 reproducing individuals and a decreasing population trend (BirdLife International 2016). The most important threats documented for the species are human-related, including habitat loss (Fandiño and Pautasso 2013) and direct persecution (Sarasola and Maceda 2006, Sarasola et al. 2010, Barbar et al. 2016). Recently, Galmes et al. (2018a) documented four Chaco Eagle electrocutions in central Argentina, and asserted that the observed level of mortality is important given the small population of the species.

Here we present new electrocution records involving Chaco Eagles in central Argentina and discuss the relative effect this source of mortality has on their populations in comparison with previously identified threats. We also provide information on the structural characteristics of the poles associated with the electrocutions as a way to identify poles posing a high risk of electrocution for Chaco Eagles.

## METHODS

We documented electrocutions involving Chaco Eagles across an area of ca. 90,000 km$^2$ in the southernmost extreme of the species' range in central Argentina (Fig. 1). This region is characterized by a semiarid landscape and includes two habitat types, the Espinal and the Monte desert biomes, that appear critical to the Chaco Eagle.

We gathered information on electrocutions of Chaco Eagles from 2012 to 2019 from two main sources. First, Chaco Eagles equipped with transmitters as nestlings were discovered electrocuted after transmission ceased. Second, we investigated reports of Chaco Eagle mortalities made by local farmers and conservation nongovernmental organizations. For each carcass found under a power pole, we established the cause of death by external examination of the body and we diagnosed electrocution based on and the presence of burns on the feathers and skin (Kagan 2016). When possible, we classified electrocuted birds based on plumage as juvenile (<1 yr old), immature (1–4 yr old), or adult (>4 yr old); and as male or female based on molecular determination or morphometric characteristics (females are larger; Galmes et al. 2018b).

For every electrocution, we identified the pole responsible and we classified poles based on their structural characteristics, including the design and material of the pole. Poles were classified according to the number of phases (i.e., one or three long wires between poles) on the line, the presence of jumper wires (short wires connecting equipment on poles) above the crossarms, and the material with which the pole was built (steel-reinforced concrete or wood) following Galmes et al. (2018a).

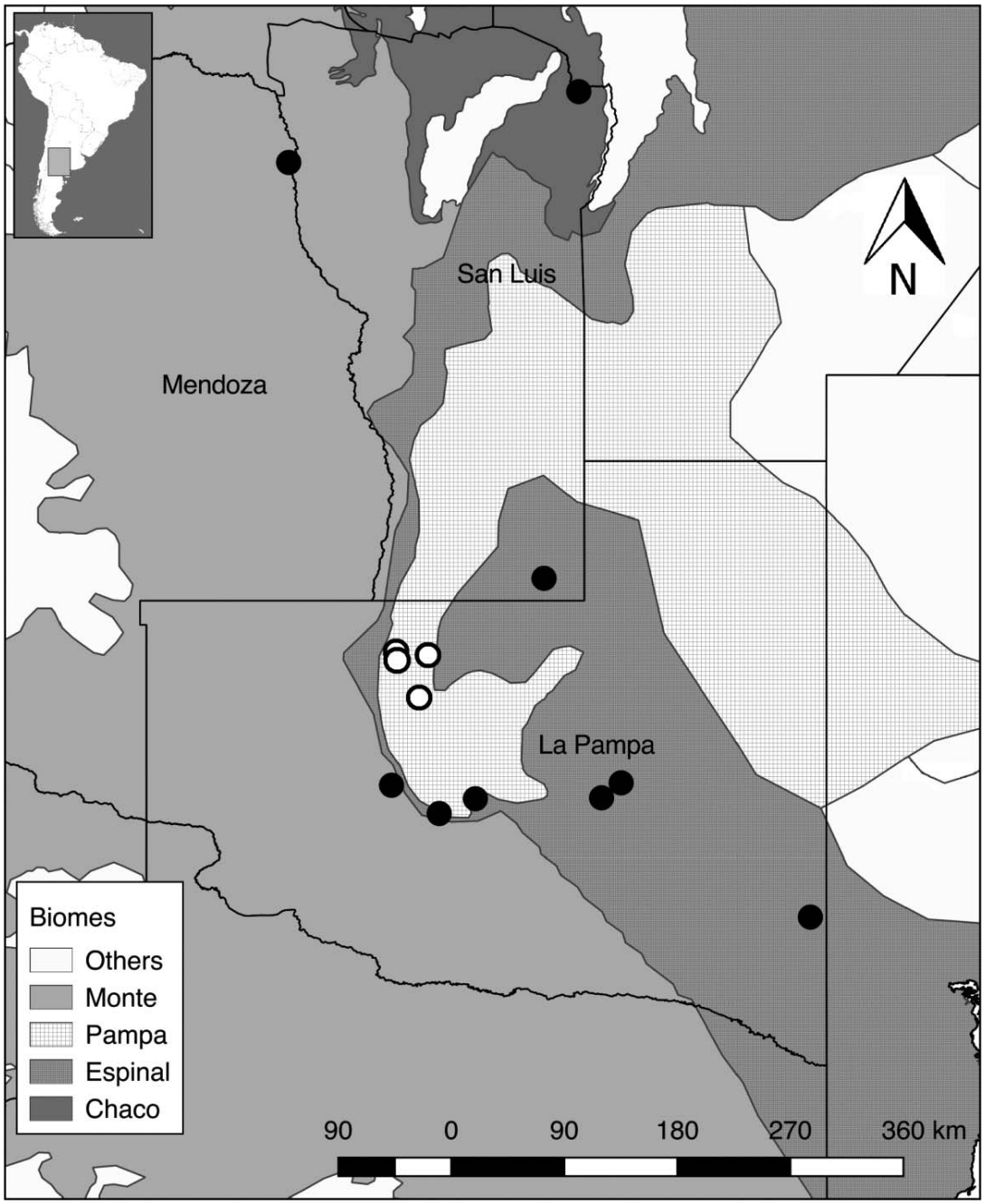


Figure 1. Locations of the electrocutions of Chaco Eagles across semiarid biomes in central Argentina from 2012 to 2019. Filled circles indicate the nine electrocutions reported in this study. Open circles indicate four electrocutions reported by Galmes et al. (2018).

Table 1. Number of electrocuted Chaco Eagles in association with power pole features (material of the pole, number of phases, and presence/absence of suspended jumper wires).

| NUMBER OF CHACO EAGLES ELECTROCUTED | POWER POLE FEATURES | | |
|---|---|---|---|
| | POLE MATERIAL | NUMBER OF PHASES | JUMPER WIRES |
| 1 | Wood | 3 | Present |
| 1 | Wood | 1 | Present |
| 2 | Concrete | 3 | Absent |
| 2 | Concrete | 3 | Present |
| 3 | Concrete | 1 | Present |

## RESULTS

We recovered nine electrocuted Chaco Eagles from 2012 to 2019. Of these nine, six were found in La Pampa province, and three in southern and northern San Luis and in eastern Mendoza provinces (Fig. 1). Of the nine electrocuted eagles, three were tagged with satellite transmitters as nestlings. The remaining individuals were found electrocuted during field surveys, or reported by local farmers or nongovernmental organizations.

We found Chaco Eagles electrocuted in association with five types of poles (Table 1). Most of the electrocutions were associated with three-phase, 13.2-kV power lines (55.5% of the casualties), with poles built of steel-reinforced concrete (77.7%), or with poles with jumpers above the crossarms (77.7%; Table 1). 55.5% of the Chaco Eagles were found electrocuted on concrete poles with jumpers above the crossarms. Single-phase poles also accounted for a considerable number of the electrocuted eagles (44.4%), even though these lower-voltage lines (i.e., 7.62 kV) were less common in the area (approximately 13% of the lines; Ministerio de Energía y Minería de Argentina 2019). Single-phase poles associated with Chaco Eagle mortalities were built of steel-reinforced concrete with jumper wires above the top of the pole. Two Chaco Eagles were found electrocuted in association with wooden poles, one each with a three-phase and a single-phase pole.

Six of seven electrocuted Chaco Eagles that could be aged were juveniles ($n=1$) or immatures ($n=5$). One other bird was an adult eagle of unknown sex, and the remaining two could not be aged. All birds for which sex could be determined ($n=5$) were female.

## DISCUSSION

Electrocution on power lines is likely an important threat for the Chaco Eagle in central Argentina, and for other large raptor species in the region (Ibarra and De Lucca 2015, Sarasola and Zanón-Martínez 2017). Even considering that information was gathered opportunistically, it appeared that mortality of Chaco Eagles by electrocution was similar to mortality attributed to other human-related factors previously identified for the species and assessed in a similar way. For example, the mortality of Chaco Eagles by electrocution in our study area was 1.2 eagles/yr but increased to 1.6 eagles/yr when four additional reports for the same area and time period are included. These values are slightly lower than the annual rate of persecution for the period 2010–2014 of two eagles/yr (Barbar et al. 2016). However, this last value was derived from both field data and reports from rehabilitation centers in seven provinces all over the country, whereas the electrocution reports involving Chaco Eagles come from a comparatively small area comprising three provinces in central Argentina (Fig. 1). In addition, electrocution was responsible for a third of the deaths of Chaco Eagles tagged with satellite transmitters during the period 2012–2016 (J. Sarasola unpubl. data). Other than direct persecution, vehicle collisions (Maceda et al. 2003) and drowning in reservoirs (J. Sarasola unpubl. data) are other human-related mortality factors not yet quantified or properly assessed for the species.

Although our sample size was limited, the sex ratio of Chaco Eagles electrocuted in our study area seemed to be skewed toward nonreproductive females. Biased electrocution mortality toward large-bodied females or non-adult age classes has been previously reported for other eagle species (Ferrer and Hiraldo 1992, González et al. 2007), and other raptors (Dwyer and Mannan 2007) elsewhere. Differences in electrocution mortality between sexes may be explained by sexual size dimorphism, as the probability of electrocution increases with wingspan, which would make the risk of electrocution higher for females (Ferrer and Hiraldo 1992, Dwyer and Mannan 2007). Dispersal and exploratory movements of non-territorial immature individuals toward new areas may also result in higher electrocution risk. However, further research is required to determine the relationship between size and behavior, and differential electrocution risk among ages and sexes, as well as on the implications that such differences could have for the demography of this endangered species.

The most dangerous power line designs were those where concrete poles were coupled with jumper wires above the crossarms. Poles with both these features were responsible for the electrocution of more than half of the Chaco Eagles reported herein. Steel-reinforced concrete poles with jumper wires were also the riskiest poles in single-phase, lower-voltage distribution lines. On these lines, birds perch directly on the top of the grounded pole with a narrow clearance between themselves and a jumper wire attached to the top of the pole. Our findings were consistent with those reported for high-risk power line designs for seven avian species found electrocuted, including the Chaco Eagle (Galmes et al. 2018a). Power poles with these characteristics, either single- or three-phase, represent only a small fraction of the total poles of

power lines in the area. Galmes et al. (2018a), for example, reported that <1% of the poles in the 355-km power lines surveyed had these features, which was similar to the 2% found in a sample of 150 km of power lines also in La Pampa province (J. Sarasola unpubl. data). Thus, the number of poles posing the highest electrocution risk for the Chaco Eagle, and probably for other raptor species, is a very small proportion of the poles in the region. Consequently, retrofitting a relatively small number of poles would likely have an outsized positive effect on the Chaco Eagle population.

Of note is that among the many human-related threats that endangered raptors face in the Neotropics (Sarasola et al. 2018), mortality by electrocution has not been highlighted as one of the most significant, and has been documented only for the Chaco Eagle (Galmes et al. 2018a, this study) and for the Ridgway's hawk (*Buteo ridgwayi*) to date (Dwyer et al. 2019). Although power lines may not pose a risk to all raptor species, the lack of reports of electrocutions for other endangered or critically endangered species is likely a consequence of inadequate survey efforts at a regional scale. Future research should be focused on adequately assessing the demographic effects of electrocution mortality for the Chaco Eagle and other endangered raptors in this region.

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LITERATURE CITED

Avian Power Line Interaction Committee (2006). Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission, Washington, DC, and Sacramento, CA, USA.

Barbar, F., A. Capdevielle, and M. Encabo (2016). Direct persecution of Crowned Eagles (*Buteogallus coronatus*) in Argentina: A new call for their conservation. Journal of Raptor Research 50:115–120.

BirdLife International (2016). *Buteogallus coronatus*. The IUCN Red List of Threatened Species. Version 2016.3. http//www.iucnredlist.org.

Dixon, A., M. L. Rahman, B. Galtbalt, A. Gunga, B. Sugarsaikhan, and N. Batbayar (2017). Avian electrocution rates associated with density of active small mammal holes and power-pole mitigation: implications for the conservation of threatened raptors in Mongolia. Journal for Nature Conservation 36:14–19.

Donázar, J. A., C. J. Palacios, L. Gangoso, O. Ceballos, M. J. González, and F. Hiraldo (2002). Conservation status and limiting factors in the endangered population of Egyptian Vulture (*Neophron percnopterus*) in the Canary Islands. Biological Conservation 107:89–97.

Dwyer, J. F., T. I. Hayes, R. Thorstrom, and R. E. Harness (2019). Retrofitting power poles to prevent electrocution of translocated Ridgway's Hawks (*Buteo ridgwayi*). Journal of Caribbean Ornithology 32:4–10.

Dwyer, J. F., and R. W. Mannan (2007). Preventing raptor electrocutions in an urban environment. Journal of Raptor Research 41:259–267.

Eccleston, D. T., and R. E. Harness (2018). Raptor electrocutions and power line collisions. In Birds of Prey: Their Biology and Conservation in the XXI Century (J. H. Sarasola, J. M. Grande, and J. J. Negro, Editors). Springer, Cham, Switzerland. pp. 273–302.

Fandiño, B., and A. Pautasso (2013). Distribución, historia natural y conservacion de *Harpyhaliaetus coronatus* (Aves: Accipitridae) en el centro-este de Argentina. Natura Neotropicalis 44:41–59.

Ferrer, M., and F. Hiraldo (1992). Man-induced sex-biased mortality in the Spanish Imperial Eagle. Biological Conservation 60:57–60.

Galmes, M. A., J. H. Sarasola, J. M. Grande, and F. H. Vargas (2018a). Electrocution risk for the endangered Crowned Solitary Eagle and other birds in semiarid landscapes of central Argentina. Bird Conservation International 28:403–415.

Galmes, M. A., J. H. Sarasola, J. M. Grande, and F. H. Vargas (2018b). Parental care of the endangered Chaco Eagle (*Buteogallus coronatus*) in central Argentina. Journal of Raptor Research 52:316–325.

González, L. M., A. Margalida, S. Mañosa, R. Sánchez, J. Oria, J. I. Molina, J. Caldera, A. Aranda, and L. Prada (2007). Causes and spatio-temporal variations of non-natural mortality in the vulnerable Spanish Imperial Eagle *Aquila adalberti* during a recovery period. Oryx 41:495–502.

Ibarra, J., and E. R. De Lucca (2015). Águilas moras (*Geranoaetus melanoleucus*), víctimas de electrocución en Luján de Cuyo, Mendoza, Argentina. Nótulas Faunísticas 176:1–7.

Kagan, R. A. (2016). Electrocution of raptors on power lines: a review of necropsy methods and findings. Veterinary Pathology 53:1030–1036.

Ledger, J. A., and C. A. Hobbs (1999). Raptor use and abuse of powerlines in southern Africa. Journal of Raptor Research 33:49–52.

Lehman, R. N., P. L. Kennedy, and J. A. Savidge (2007). The state of the art in raptor electrocution research: a global review. Biological Conservation 135:459–474.

Lehman, R. N., J. A. Savidge, P. L. Kennedy, and R. E. Harness (2010). Raptor electrocution rates for a utility in the intermountain Western United States. Journal of Wildlife Management 74:459–470.

Maceda, J. J., J. H. Sarasola, and M. E. M. Pessino (2003). Presas consumidas por el águila coronada (*Harpyhaliaetus coronatus*) en el límite sur de su rango de distribución en Argentina. Ornitologia Neotropical 14:419–422.

Ministerio de Energía y Minería de Argentina (2019). Energía Eléctrica. https://www.argentina.gob.ar/energia.

Sarasola, J. H., J. M. Grande, and M. J. Bechard (2018). Conservation status of Neotropical raptors. In Birds of Prey: Their Biology and Conservation in the XXI Century (J. H. Sarasola, J. M. Grande, and J. J. Negro, Editors). Springer, Cham, Switzerland. pp. 293–326.

Sarasola, J. H., and J. J. Maceda (2006). Past and current evidence of persecution of the endangered Crowned Eagle *Harpyhaliaetus coronatus* in Argentina. Oryx 40:347–350.

Sarasola, J. H., M. Á. Santillán, and M. A. Galmes (2010). Crowned Eagles rarely prey on livestock in central Argentina: persecution is not justified. Endangered Species Research 11:207–2013.

Sarasola, J. H., and J. I. Zanón-Martínez (2017). Electrocución de aves en líneas eléctricas: la muerte silenciosa de las grandes rapaces. In Informe Ambiental 2017 (A. Di Pangracio, A. Nápoli, and M. E. Garro Vidal, Editors). Fundación Ambiente y Recursos Naturales FARN, Buenos Aires, Argentina. pp. 219–230.

Slater, S. J., J. F. Dwyer, and M. Murgatroyd (2020). Conservation letter: raptors and overhead electrical systems. Journal of Raptor Research 54:109–203.

Watts, B. D., E. K. Mojica, and B. J. Paxton (2015). Using Brownian bridges to assess potential interactions between Bald Eagles and electrical hazards within the Upper Chesapeake Bay. Journal of Wildlife Management 79:435–445.

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