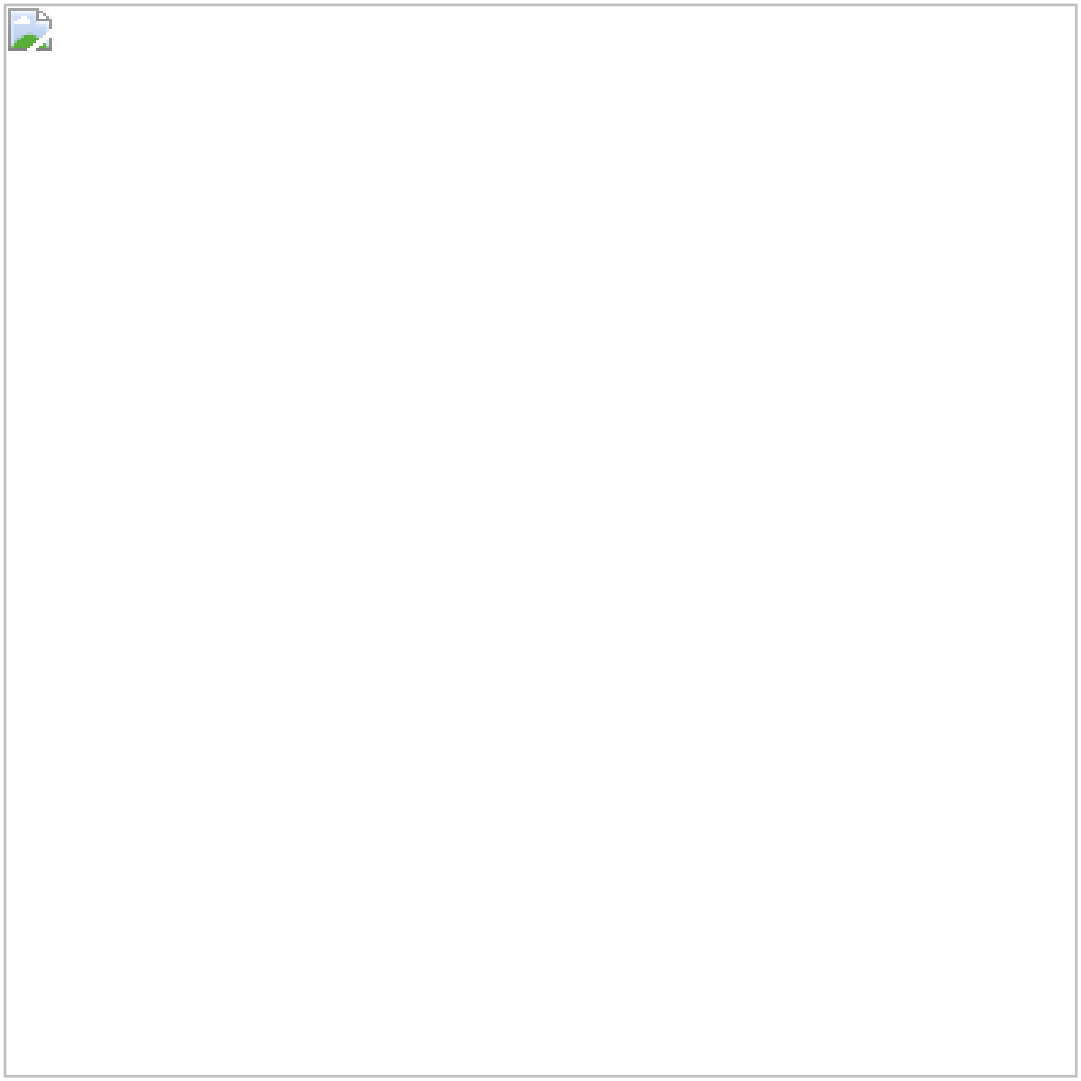

Human Persecution is An Important Threat to the Conservation of the Endangered Black-and-Chestnut Eagle in Northern Andes

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Human Persecution is An Important Threat to the Conservation of the Endangered Black-and-Chestnut Eagle in Northern Andes

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Abstract

Background and Research Aims: The Black-and-chestnut Eagle (*Spizaetus isidori*) has a total population of fewer than 1000 adult individuals, and is categorized as Endangered at the global level. The northern Andes (Ecuador and Colombia) represent one of the last population strongholds of the species. In this study, we analyzed human persecution of the Black-and-chestnut Eagle as retaliation or as a preventive measure against poultry predation, as well as other threats that have affected the species in this geographical region between 2000 and 2022.

Methods: In order to understand the human persecution and other threats faced by the Black-and-chestnut Eagle in the northern Andes, we compiled records of immature and adult individuals of the species that had been shot, captured, or had presented evidence of any other affectations during the last 23 years.

Results: We found a total of 96 Black-and-chestnut Eagles affected by different threats. Human persecution of the species to prevent poultry predation was the motive in 81% (46 of 57) of the cases of shot eagles, 67% (10 of 15) of those captured illegally, 30% (3 of 10) of those in which the cause of affectation was undetermined and for one individual that had been stabbed. Immature eagles were more affected than adult eagles by human persecution. Black-and-chestnut Eagles were also affected by electrocution, illegal trafficking and collision with vehicle.

Conclusion: Human persecution as retaliation or as a preventive measure against poultry predation is an important threat to the conservation of the Black-and-chestnut Eagle in northern Andes.

Implications for Conservation: Strict application of laws at human persecution sites, identification and monitoring of areas with high risk of human-eagle conflict, development of environmental educational programs, strengthening of the technical capacities of rural communities, maintaining or even increasing forest cover, and reducing the exposure of poultry by using enclosures are key for Black-and-chestnut Eagle conservation in the northern Andes.

Keywords

Threats, human-wildlife conflict, raptors, shooting, electrocution

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Introduction

Conflicts over wildlife, often called human-wildlife conflicts, are complex, particular, and widely distributed (Zimmermann et al., 2020). These are of great concern in the case of threatened species and those with declining populations that could be rapidly eliminated at the landscape scale as a result of these conflicts (Zimmermann et al., 2021). Human persecution to mitigate or prevent the predation of domestic animals is an important threat to Neotropical eagles, especially those of larger size (Sarasola et al., 2018). For example, human persecution of the Harpy Eagle (*Harpia harpyja*) in Brazil is an important threat to the species (Miranda et al., 2021) and such persecution constitutes a relevant threat to the Chaco Eagle (*Buteogallus coronatus*) in Argentina (Barbar et al., 2016).

The Black-and-chestnut Eagle (*Spizaetus isidori*) inhabits dense mountain forests throughout the Andes, as well as in the Sierra Nevada de Santa Marta (Ferguson-Lees & Christie 2001). Despite this wide latitudinal distribution, studies of the diet of this species have only been published in Colombia and Argentina (Zuluaga & Echeverry-Galvis 2016; Aráoz et al., 2017; Restrepo-Cardona et al., 2019). It feeds on a wide variety of prey, including arboreal mammals and large birds. Poultry is a relatively important prey in its diet, with frequency ranges of 9 to 31% and biomass contributions of 12 to 47% of the total prey consumed (Zuluaga & Echeverry-Galvis 2016; Restrepo-Cardona et al., 2019).

With a total population of fewer than 1000 adult individuals, the Black-and-chestnut Eagle is listed as an Endangered species at the global level (BirdLife International, 2022a). However, despite its concerning conservation status, there have been no quantitative evaluations of the threats faced by the species throughout its distribution. Recent data in Colombia indicate that human persecution as retaliation or as a preventive measure against poultry predation is a relevant cause of mortality in the species (Restrepo-Cardona et al., 2020). In Ecuador, it is unknown whether the underlying causes for human persecution of the Black-and-chestnut Eagle are similar to those found in Colombia, although one recent study suggests that the situation could be very similar in the two countries (Zuluaga et al., 2021b).

Threat evaluation is a central planning component for biodiversity conservation (Groom et al., 2006). As part of the management of conflicts between humans and the Black-and-chestnut Eagle, it is important to quantitatively examine human persecution of the species (Restrepo-Cardona et al., 2020). The purpose of this study was to analyze the human persecution of the Black-and-chestnut Eagle as retaliation or as a preventive measure against poultry predation, as well as other threats that were found to affect the species in Ecuador and Colombia in the period 2000 to 2022. In addition, we explore the age differences among affected eagles. Our hypothesis is that human persecution prevails in the northern Andes as an important threat to the conservation of the Black-and-chestnut Eagle. This paper presents the first records for Ecuador, as well as new records for Colombia and cases published in the literature.

Methods

Study area

In the northern Andes (Ecuador and Colombia), estimates suggest that the Black-and-chestnut Eagle population ranges from 285 to 485 pairs (Renjifo et al., 2014; Freile et al., 2019), although these estimates are not supported by quantitative data obtained from field sampling. In Colombia, human persecution constitutes an important threat to the species (Restrepo-Cardona et al. 2020; Zuluaga et al., 2022), as well as other threats such as habitat loss (61%, Renjifo et al., 2014), electrocution and illegal trafficking (Restrepo-Cardona et al., 2020). While in Ecuador, there have been no quantitative evaluations conducted regarding the threats that can affect the Black-and-chestnut Eagle.

Data collecting

In order to understand the human persecution and other threats faced by the Black-and-chestnut Eagle in Ecuador and Colombia, we compiled records of immature and adult individuals of the species that had been shot, captured, electrocuted, or had presented evidence of any other affectations between 2000 and 2022. To determine the type and causes of injury of the eagles, information was obtained from reports of veterinary diagnoses, necropsies, and radiography, as well as through interviews conducted with experts in the field of the Black-and-chestnut Eagle, officers of public and private agencies and farmers.

This information was compiled through cases of Black-and-chestnut Eagles reported by the Fundación Cóndor Andino, the Quito Zoo, the Eduadorian Ministry of Environment, Water and Ecological Transition (MAATE, by its Spanish acronym), Bioparque Amaru, the Fundación Jocotoco, ALTRÓPICO, the Fundación Zoológica del Ecuador, the Fundación Proyecto Águila Crestada – Colombia (PAC-C), the Instituto de Ciencias Naturales de la Universidad Nacional (ICN-UN) and CORTOLIMA. We also included data published by Restrepo-Cardona et al. (2020) and Zuluaga et al. (2021a) regarding threats to the species in Ecuador and Colombia. It was not possible to determine if incidents resulted in the death or recovery of the eagles due to lack of systematic data.

Data analysis

To evaluate whether there were significant differences among the number of Black-and-chestnut Eagles affected by the

different threats and according to age classes (adults and immatures), we performed Chi-squared independence tests. All analyses were performed using the program R Project version 2.1 (R Core Team, 2020) and statistical significance was considered where $p < 0.05$.

Results

We found a total of 96 Black-and-chestnut Eagles affected by different threats in the northern Andes in the period 2000 to 2022. The unpublished records included 50 cases (38 in Ecuador and 12 in Colombia). The published records comprised 46 cases of Black-and-chestnut Eagles affected by different threats (1 in Ecuador and 45 in Colombia) (Table 1).

Immature eagles were affected by the different threats to a greater extent than adult individuals (70 immatures and 23 adults) ($X^2 = 23.75$, df = 1, $p < 0.05$; n = 93). Age of three individuals was undetermined. Sex was not determined in the majority of the eagles affected by the different threats (80 of 96). In cases where it was possible to determine this parameter, nine females and seven males were found. The eagles were affected to the greatest extent by shooting with firearms (57 of 96) ($X^2 = 9.11$, df = 1, $p < 0.05$; n = 86), followed by illegal capture (15 of 96) and electrocution (9 of 96). In addition, we found that two chicks had fallen from the nest, one eagle had been stabbed with a sharp weapon, one had been hit by a vehicle and another had been killed by an adult Black-and-chestnut Eagle. For 10 individuals, the cause of affectation was not determined (Table 1).

Human persecution as retaliation or as a preventive measure against poultry predation was the motive in 81% (46 of 57) of the cases of Black-and-chestnut Eagles that had been shot, 67% (10 of 15) of those captured illegally, 30% (3 of 10) of those for which the cause of affectation could not be determined and for one individual that had been stabbed. Illegal trafficking was the motive in 20% (3 of 15) of the cases of captured Black-and-chestnut Eagles. A total of 73% of the cases (70 of 96, mean: 8 eagles per year) of Black-and-chestnut Eagles suffering different threats occurred between 2014 and 2022, while the remaining cases occurred between 2000 and 2013 (27%, mean: 1.8 eagles per year) (Table 1).

Forty-one percent (39 of 96) of the total number of Black-and-chestnut Eagles affected by different threats was reported in Ecuador. Among these, 51% were shot, 31% were affected by other threats and for seven eagles it was not possible to determine the cause of affectation. The 39 records come from five provinces, mainly Morona Santiago (18 cases, 46%), followed by Napo (10 cases, 26%), Pichincha and Tungurahua (5 cases in each province), and a single case in Carchi. In 61% of the cases, the cause was human persecution of the Black-and-chestnut Eagle as retaliation or as a preventive measure against poultry predation (Table 1; Figure 1).

Fifty-nine percent (57 of 96) of the total number of Black-and-chestnut Eagles affected by different threats was reported in Colombia. Among these, 64.9% were shot, 31.5% were affected by other threats and for two eagles it was not possible to determine the cause of affectation. The 57 records came from 13 departments, mainly Huila (15 cases, 26.3%), followed by Cundinamarca (7 cases, 12.2%), Boyacá and Tolima (5 cases in each department), Antioquia, Quindío and Putumayo (4 cases in each department), Meta and Cesar (3 cases in each department), Norte de Santander, Magdalena and Risaralda (2 cases in each department), and a single case in Cauca. In 63% of the cases, the cause was human persecution of the Black-and-chestnut Eagle to mitigate or prevent predation of poultry (Table 1; Figure 1).

Discussion

We analyzed records of 96 Black-and-chestnut Eagles affected by different threats in the northern Andes in the period 2000 to 2022. Human persecution of the Black-and-chestnut Eagle as retaliation or as a preventive measure against poultry predation was the motive in 81% of the cases of shot eagles and 67% of those captured illegally. The proportion of cases of Black-and-chestnut Eagles affected by different threats differed among ages. Seventy-three percent of the cases of eagles suffering different threats occurred between 2014 and 2022 (Table 1).

Human persecution is a critical problem for the conservation of raptors worldwide, which can cause declines in their populations and even the extinction of species (Madden et al., 2019; Newton, 2020; BirdLife International 2022b). It is of great concern that, from 2000 to 2022, at least 72 Black-and-chestnut Eagles were hunted or captured illegally in the northern Andes (Table 1). Studies exploring the impact of human persecution on raptors indicate that even relatively low rates of hunting can slow down the rate of population growth, rendering the species more susceptible to other potential threats (Newton, 2020). As forest cover decreases in the breeding territories of the Black-and-chestnut Eagle, the importance of poultry, mainly chickens (*Gallus gallus*), in their diet increases (Restrepo-Cardona et al. 2019) and, thus, the likely of eagles to be hunted in retaliation by poultry predation too (Restrepo-Cardona et al., 2020; Zuluaga et al., 2021a,b). The high levels of deforestation in the northern Andes (e.g., Etter et al., 2006; Sierra et al., 2021), combined with human persecution of the species, could therefore cause the rapid loss of population of the Black-and-chestnut Eagle in this geographical region.

Human persecution to mitigate or prevent predation of poultry affects Black-and-chestnut Eagles differentially according to age. We found a higher proportion of immature eagles shot or illegally captured in the northern Andes, compared to adult eagles (Table 1). This could translate into lower rates of recruitment of reproductive adults. The higher proportion of immature shot and captured Black-and-chestnut Eagles may be a consequence of the fact that, in the nests of this species in Andean mountains of Colombia, poultry was a prey frequently given by the parent eagles to their chicks

Table 1. Records of Black-and-Chestnut Eagles (*Spizaetus isidori*) Affected by Several Threats in the Northern Andes (Ecuador and Colombia), in Chronological Order Between 2000 and 2022.

Date	N. de birds	Sex	Age	Type of incident	Main cause	Department or province	Country	Source	Reference
2000	1	Unknown	Adult	Gunshot	Unknown	Norte de Santander	Colombia	CORPONOR	Restrepo-Cardona et al. 2020
2000	1	Unknown	Adult	Gunshot	Poultry predation	Boyacá	Colombia	César Márquez	Restrepo-Cardona et al. 2020
2002	1	Unknown	Immature	Illegal capture	Unknown	Cundinamarca	Colombia	CORPOGUAVIO	Restrepo-Cardona et al. 2020
2002	1	Unknown	Adult	Gunshot	Poultry predation	Cundinamarca	Colombia	Santiago Zuluaga	Restrepo-Cardona et al. 2020
Mar. 2002	1	Female	Immature	Gunshot	Unknown	Norte de Santander	Colombia	IAvH	Restrepo-Cardona et al. 2020
2003	1	Unknown	Immature	Gunshot	Poultry predation	Boyacá	Colombia	César Márquez	Restrepo-Cardona et al. 2020
2004	1	Unknown	Immature	Illegal capture	Illegal trafficking	Cundinamarca	Colombia	CORPOGUAVIO	Restrepo-Cardona et al. 2020
2005	1	Female	Adult	Unknown	Unknown	Napo	Ecuador	Zoológico de Quito	This study
2005	1	Unknown	Adult	Gunshot	Poultry predation	Huila	Colombia	Joaquín Sánchez	Restrepo-Cardona et al. 2020
2005	1	Unknown	Adult	Gunshot	Poultry predation	Boyacá	Colombia	César Márquez	Restrepo-Cardona et al. 2020
2006	1	Unknown	Immature	Unknown	Unknown	Quindío	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
Mar. 2006	1	Unknown	Immature	Illegal capture	Poultry predation	Antioquia	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
2008	1	Unknown	Immature	Gunshot	Poultry predation	Boyacá	Colombia	César Márquez	Restrepo-Cardona et al. 2020
2009	1	Unknown	Immature	Gunshot	Poultry predation	Cundinamarca	Colombia	CORPOGUAVIO	Restrepo-Cardona et al. 2020
2009	1	Unknown	Immature	Illegal capture	Poultry predation	Cundinamarca	Colombia	Carmen Rincón	Restrepo-Cardona et al. 2020
2010	1	Unknown	Immature	Illegal capture	Illegal trafficking	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
2010	1	Unknown	Immature	Gunshot	Poultry predation	Cundinamarca	Colombia	César Márquez	Restrepo-Cardona et al. 2020
2010	1	Unknown	Immature	Gunshot	Poultry predation	Magdalena	Colombia	CAR	Restrepo-Cardona et al. 2020
2011	1	Unknown	Adult	Unknown	Unknown	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study

(continued)

Table 1. (continued)

Date	N. de birds	Sex	Age	Type of incident	Main cause	Department or province	Country	Source	Reference
2011	1	Unknown	Immature	Illegal capture	Unknown	Meta	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
2012	1	Unknown	Immature	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
2012	1	Male	Immature	Gunshot	Poultry predation	Napo	Ecuador	Andrés Ortega	This study
2012	1	Unknown	Immature	Gunshot	Poultry predation	Pichincha	Ecuador	PAC-C	Zuluaga et al. 2021a
2013	1	Unknown	Immature	Illegal capture	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
2013	1	Unknown	Immature	Accident	Electrocution	Morona Santiago	Ecuador	Bioparque Amaru	This study
Oct. 2013	1	Unknown	Immature	Stabbing	Poultry predation	Morona Santiago	Ecuador	MAATE	This study
2014	1	Male	Immature	Gunshot	Poultry predation	Morona Santiago	Ecuador	Bioparque Amaru	This study
2014	1	Unknown	Unknown	Gunshot	Poultry predation	Napo	Ecuador	Fundación Cóndor Andino	This study
2014	2	Unknown	Adult	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
2014	1	Unknown	Immature	Gunshot	Poultry predation	Huila	Colombia	Erik Gaitán	Restrepo-Cardona et al. 2020
Sep. 2014	1	Unknown	Immature	Accident	Electrocution	Risaralda	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
Nov. 2014	1	Unknown	Adult	Illegal capture	Poultry predation	Quindío	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
Dec. 2014	1	Unknown	Immature	Gunshot	Poultry predation	Cauca	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
2015	1	Unknown	Immature	Accident	Electrocution	Carchi	Ecuador	ALTROPICO	This study
2015	1	Unknown	Immature	Unknown	Poultry predation	Tungurahua	Ecuador	Juan P. Reyes	This study
2015	1	Unknown	Immature	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
2015	1	Unknown	Immature	Unknown	Poultry predation	Pichincha	Ecuador	Fundación Cóndor Andino	This study
2015	1	Unknown	Immature	Gunshot	Poultry predation	Putumayo	Colombia	Brayan Coral	Restrepo-Cardona et al. 2020
Jul. 2015	1	Unknown	Immature	Gunshot	Poultry predation	Meta	Colombia	Iván Sánchez	Restrepo-Cardona et al. 2020
Nov. 2015	1	Unknown	Immature	Gunshot	Unknown	Huila	Colombia	CAM	Restrepo-Cardona et al. 2020
2016	1	Unknown	Adult	Gunshot	Poultry predation	Putumayo	Colombia	Alvaro Cardenas	Restrepo-Cardona et al. 2020
2016	2	Unknown	Unknown	Gunshot	Poultry predation	Antioquia	Colombia	PAC-C	Zuluaga et al. 2021a

(continued)

Table 1. (continued)

Date	N. de birds	Sex	Age	Type of incident	Main cause	Department or province	Country	Source	Reference
Jan. 2016	1	Unknown	Immature	Unknown	Unknown	Quindío	Colombia	Diana M. Sánchez	Restrepo-Cardona et al. 2020
Sep. 2016	1	Unknown	Immature	Gunshot	Poultry predation	Huila	Colombia	CAM	Restrepo-Cardona et al. 2020
Oct. 2016	1	Unknown	Immature	Illegal capture	Illegal trafficking	Meta	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
2017	1	Unknown	Immature	Gunshot	Poultry predation	Huila	Colombia	Edwin Martínez	Restrepo-Cardona et al. 2020
Feb. 2017	1	Unknown	Adult	Gunshot	Unknown	Boyacá	Colombia	CORPOBOYACÁ	Restrepo-Cardona et al. 2020
Jun. 2017	1	Unknown	Immature	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
Jun. 2017	1	Unknown	Immature	Gunshot	Poultry predation	Putumayo	Colombia	Alvaro Cardenas	Restrepo-Cardona et al. 2020
Aug. 2017	1	Unknown	Immature	Illegal capture	Poultry predation	Huila	Colombia	CAM	Restrepo-Cardona et al. 2020
Oct. 2017	1	Female	Immature	Illegal capture	Poultry predation	Cesar	Colombia	CORPOCESAR	Restrepo-Cardona et al. 2020
2018	1	Unknown	Adult	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
Feb. 2018	1	Female	Adult	Gunshot	Unknown	Antioquia	Colombia	CORPOURABÁ	Restrepo-Cardona et al. 2020
Apr. 2018	1	Female	Immature	Accident	Electrocution	Tungurahua	Ecuador	Fundación Cóndor Andino	This study
Apr. 2018	1	Male	Immature	Gunshot	Poultry predation	Cesar	Colombia	CORPOCESAR	Restrepo-Cardona et al. 2020
Sep. 2018	1	Unknown	Immature	Gunshot	Poultry predation	Cesar	Colombia	CRARSI-FADA	Restrepo-Cardona et al. 2020
Oct. 2018	1	Male	Immature	Gunshot	Unknown	Huila	Colombia	CAM	Restrepo-Cardona et al. 2020
Nov. 2018	1	Male	Immature	Accident	Falling from nest	Morona Santiago	Ecuador	Bioparque Amaru	This study
2019	1	Unknown	Immature	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
2019	1	Unknown	Adult	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
2019	1	Unknown	Adult	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
Apr. 2019	1	Unknown	Immature	Illegal capture	Poultry predation	Magdalena	Colombia	Tony Cala	Restrepo-Cardona et al. 2020

(continued)

Table 1. (continued)

Date	N. de birds	Sex	Age	Type of incident	Main cause	Department or province	Country	Source	Reference
May. 2019	1	Unknown	Adult	Gunshot	Unknown	Huila	Colombia	IAvH	Restrepo-Cardona et al. 2020
Jun. 2019	1	Unknown	Immature	Gunshot	Poultry predation	Tolima	Colombia	IAvH	Restrepo-Cardona et al. 2020
Jul. 2019	2	Unknown	Immature	Illegal capture	Poultry predation	Huila	Colombia	CAM	Restrepo-Cardona et al. 2020
Oct. 2019	1	Unknown	Immature	Accident	Electrocution	Cundinamarca	Colombia	ICN-UN	Restrepo-Cardona et al. 2020
Oct. 2019	1	Male	Immature	Intraspecific attack	Intraspecific attack	Tungurahua	Ecuador	Fundación Cóndor Andino	This study
2020	1	Unknown	Immature	Gunshot	Poultry predation	Pichincha	Ecuador	Fundación Cóndor Andino	This study
2020	1	Unknown	Adult	Gunshot	Poultry predation	Huila	Colombia	Erik Gaitán	This study
2020	1	Unknown	Immature	Gunshot	Poultry predation	Huila	Colombia	Erik Gaitán	This study
Feb. 2020	1	Male	Immature	Accident	Collision with vehicle	Napo	Ecuador	Wilmer Simbaña	This study
Apr. 2020	1	Female	Immature	Accident	Electrocution	Tungurahua	Ecuador	Mauricio Iglesias	This study
Apr. 2020	1	Unknown	Adult	Illegal capture	Poultry predation	Risaralda	Colombia	Juan D. Sánchez	This study
Aug. 2020	1	Unknown	Immature	Gunshot	Unknown	Tolima	Colombia	CORTOLIMA	This study
Nov. 2020	1	Unknown	Adult	Gunshot	Poultry predation	Huila	Colombia	Erik Gaitán	This study
Nov. 2020	1	Female	Adult	Gunshot	Poultry predation	Tolima	Colombia	CORTOLIMA	This study
2021	1	Unknown	Immature	Accident	Electrocution	Quindío	Colombia	Sergio García	This study
Jan. 2021	1	Unknown	Immature	Accident	Falling from nest	Huila	Colombia	Erik Gaitán	This study
Jan. 2021	1	Unknown	Immature	Unknown	Unknown	Napo	Ecuador	Fundación Jocotoco	This study
Feb. 2021	1	Unknown	Immature	Unknown	Unknown	Napo	Ecuador	MAATE	This study
Feb. 2021	1	Unknown	Immature	Gunshot	Poultry predation	Napo	Ecuador	Fundación Cóndor Andino	This study
Mar. 2021	1	Unknown	Immature	Gunshot	Unknown	Napo	Ecuador	Fundación Cóndor Andino	This study
Apr. 2021	1	Unknown	Immature	Gunshot	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
May. 2021	1	Female	Immature	Unknown	Unknown	Napo	Ecuador	Fundación Zoológica del Ecuador	This study
Jul. 2021	1	Unknown	Immature	Gunshot	Poultry predation	Tolima	Colombia	CORTOLIMA	This study
Aug. 2021	1	Unknown	Immature	Gunshot	Unknown	Tolima	Colombia	CORTOLIMA	This study
Jan. 2022	1	Unknown	Adult	Gunshot	Poultry predation	Pichincha	Ecuador	Fundación Cóndor Andino	This study

(continued)

Table 1. (continued)

Date	N. de birds	Sex	Age	Type of incident	Main cause	Department or province	Country	Source	Reference
Mar. 2022	1	Unknown	Immature	Accident	Electrocution	Putumayo	Colombia	ICN-UN	This study
Mar. 2022	1	Unknown	Immature	Unknown	Poultry predation	Morona Santiago	Ecuador	Fundación Cóndor Andino	This study
May. 2022	1	Unknown	Adult	Gunshot	Poultry predation	Napo	Ecuador	Fundación Cóndor Andino	This study
Jun. 2022	1	Female	Immature	Gunshot	Poultry predation	Pichincha	Ecuador	Fundación Cóndor Andino	This study
Jul. 2022	1	Unknown	Immature	Gunshot	Unknown	Huila	Colombia	Alejandra Mañosca	This study
Dec. 2022	1	Unknown	Immature	Accident	Electrocution	Tungurahua	Ecuador	Fundación Cóndor Andino	This study

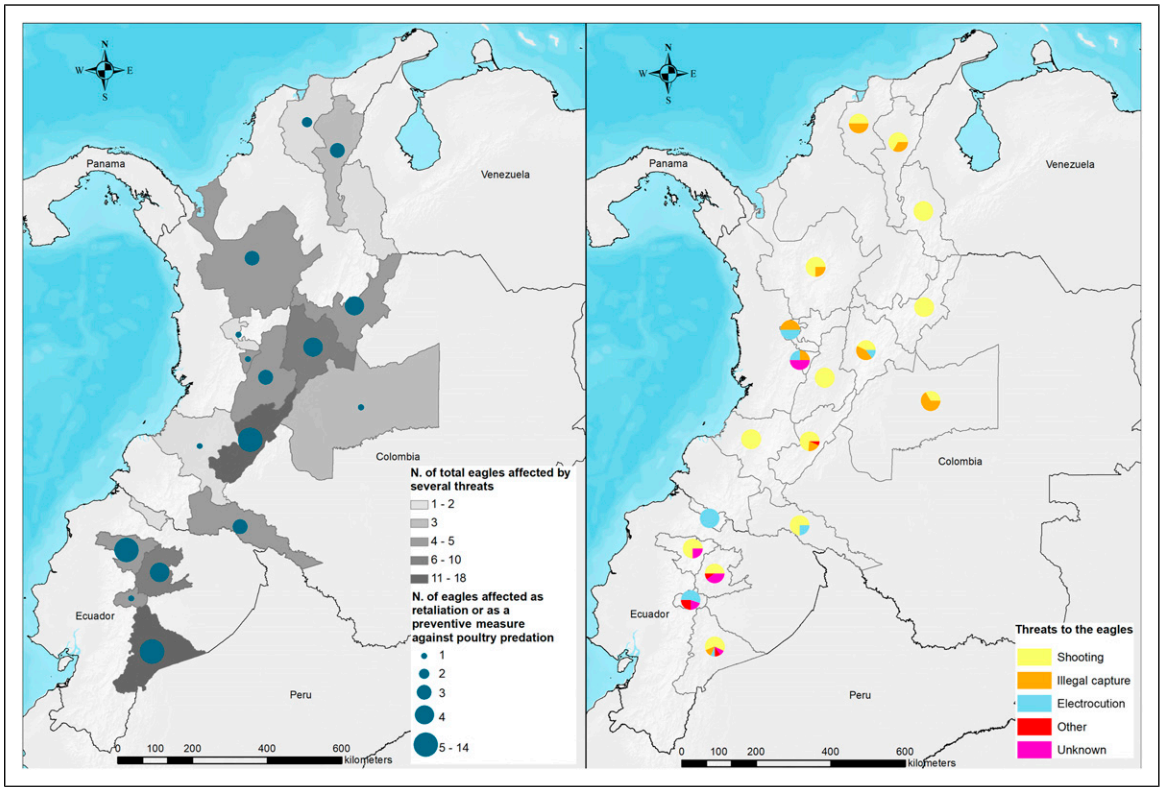

Figure 1. Number of Black-and-chestnut Eagles (*Spizaetus isidori*) affected by several threats in the northern Andes (Ecuador and Colombia) between 2000 and 2022. The polygons correspond to provinces in Ecuador and departments in Colombia.

(Restrepo-Cardona et al., 2019). This may lead to immature individuals being more likely to prey on poultry and thus be more vulnerable to human persecution.

Control of predators using firearms is a particularly important threat to the conservation of Neotropical eagles. This cause of affectation is especially high for the Black-and-chestnut Eagle in the northern Andes, where at least 57 eagles were shot between 2000 and 2022 (Table 1). Similarly, in Ecuador, Colombia, Panama, and Belize, 35 Harpy Eagles were shot between 1998 and 2019 (Giraldo-Amaya et al., 2021) and, in Argentina, 16 Chaco Eagles were shot between 1999 and 2014 (Barbar et al., 2016). According to current environmental legislation in Ecuador and Colombia, the Black-and-chestnut Eagle is a protected species

(Renjifo et al., 2014; Freile et al., 2019), and the strict application of these laws is therefore a fundamental tool in preventing the use of firearms against this species in these two countries.

Human persecution has been an important threat to the conservation of the Black-and-chestnut Eagle in the northern Andes over the last 23 years, although this threat has apparently been highest between 2014 and 2022 (Table 1). However, it remains unclear whether this finding is due to a real increase in events of human persecution of the Black-and-chestnut Eagle or to an increase in the number of people studying the species in these countries (Renjifo et al., 2014; Zuluaga & Echeverry-Galvis 2016; Restrepo-Cardona et al., 2019, 2020, Zuluaga et al., 2021a,b, 2022). The data presented in this study were obtained from heterogeneous sources of information and it is therefore important to consider their limitations in terms of reliably determining if there has been a true increase in human persecution of the species from 2014 onwards. Considering these limitations, we did not make comparisons between the numbers of Black-and-chestnut Eagles affected by different threats over time or between countries. Despite these limitations, our analysis provides a good indication of the minimum number of eagles that could have been injured as a result of different threats affecting this species in the northern Andes.

Implications for Conservation

Human persecution of the Black-and-chestnut Eagle as retaliation or as a preventive measure against poultry predation is a conservation problem widely distributed in the northern Andes. This includes at least four provinces in Ecuador and 12 departments in Colombia (Figure 1). The northern Andes has been estimated to support between 28 and 48% (between 285 to 485 pairs) of the total Black-and-chestnut Eagle population (Renjifo et al., 2014; Freile et al., 2019). We highlight the fact that a greater decline of population of the Black-and-chestnut Eagle in this geographical region, one of the last population strongholds of the species, could have important implications for the Black-and-chestnut Eagle conservation.

Being a highly-mobile species with specific habitat requirements, Black-and-chestnut Eagle can be considered an umbrella species (Bennett et al., 2015; Restrepo-Cardona et al., 2019; Zuluaga et al., 2022). When initiatives to protect particular species, such as umbrella species, are carried out efficiently to support actions that also benefit other species, the benefits for biodiversity are more significant (Bennett et al., 2015). Human persecution, illegal capture and trafficking, electrocution, and collision with vehicles also threaten numerous other wild vertebrates along the Andes (Renjifo et al., 2014; Harfoot et al., 2021; Restrepo-Cardona et al., 2022). For this reason, actions to mitigate and prevent anthropogenic threats to the Black-and-chestnut Eagle can help guide the conservation of other species in the ecosystem.

Human-wildlife conflicts are extremely variable, complex, and defy simple explanations. Patterns in human-wildlife conflicts are valid only for informing actions at a local scale, and it is important not to generalize from case studies (Zimmermann et al., 2020, 2021). Even although each case of conflict is particular and requires a customized solution, the best way to scale up human-wildlife conflict mitigation may by practicing and improving effective processes for sustainable, community-focused conservation collaborations (Zimmermann et al., 2021). Evidence-based management actions are key for mitigating conflicts between people and the Black-and-chestnut Eagle and eliminate human persecution of the species in the northern Andes (Restrepo-Cardona et al., 2020). These actions could include the strengthening of technical capacities of rural communities, such as bird watching tourism that may create benefits to local people, tourists and eagles (Miranda et al., 2022). As well as the identification and monitoring of areas with high risk of human-eagle conflict, development of environmental educational programs, maintaining or even increasing forest cover, enhancing populations of the eagle´s arboreal mammal prey species, reducing the exposure of poultry by using enclosures, and offering economic compensation or other economic alternatives when poultry are eaten by the Black-and-chestnut Eagle (Restrepo-Cardona et al., 2019, 2020).

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