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LETTERS

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HUMAN PERSECUTION OF THE HARPY EAGLE: A WIDESPREAD THREAT?

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Among birds of prey, the largest species are usually considered more sensitive to human disturbance and threats (McClure et al. 2018). Large raptors are ecologically unique due to their strong effects on prey populations (Preisser et al. 2005, Sekercioglu 2006); for some species, even just the raptor's presence is perceived as a potential predation risk, affecting distribution and behavior of prey (Sodhi et al. 1990, Gil-da-Costa et al. 2003, Harris et al. 2020). Consequently, the importance of large raptors is at least partly due to their position as regulators of herbivore populations, which in turn can affect landscape composition (Estes et al. 2011). Declines in large tropical forest raptors could have significant impacts on the numbers (Mitani et al. 2001) and behavior (Brown and Kotler 2004) of their prey, with further changes potentially spreading throughout trophic cascades (Terborgh and Estes 2010) and ultimately affecting humans as well (O'Bryan et al. 2018).

The Harpy Eagle (*Harpia harpyja*) is one of the largest raptors worldwide (Brown and Amadon 1968). This raptor may be perceived as a potential threat to livestock and humans due to its large size, and as a consequence may be the object of human persecution and poaching (DeLuca 2012). The Harpy Eagle has been completely extirpated from countries such as El Salvador (Vargas et al. 2006), while suffering human persecution throughout its distribution (Chebez et al. 1990, Alvarez-Cordero 1996, Trinca et al. 2008, Acevedo-Charry et al. 2015, Gusmão et al. 2016, Muñiz-López 2017). In Colombia, although only three records of persecution have been published in the scientific literature (Acevedo-Charry et al. 2015, Zuluaga et al. 2018), there have been several additional cases in recent years reported on popular media (e.g., https://sostenibilidad.semana.com/medio-ambiente/articulo/asi-es-el-romance-de-una-pareja-de-aguilas-arpia/48601). Similarly, in Panama, the latest persecution case reported in scientific literature was in 2006 (Vargas et al. 2006), but we know by reviewing popular media that persecution persists (e.g., https://www.tvn-2.com/nacionales/cazadores-Aguila-Harpia-Guna-Yala_0_4778522156.html; https://www.critica.com.pa/sucesos/hurtan-aguila-harpia-del-parque-summit-552647). In this letter, we report new records of human persecution of the Harpy Eagle in Colombia and Panama in the last two decades. We include cases previously reported in the media and also additional records that we and other researchers have collected. Also, because the published records of Harpy Eagle persecution in other countries are dispersed in a variety of publications, we compiled published records of Harpy Eagle persecution across its distribution. Finally, we discuss conservation

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Table 1. Persecution records of the Harpy Eagle (*Harpia harpyja*) in Colombia and Panamá. Year indicates the year in which persecution happened and/or was recorded. Region indicates the department, state, province, or specified zone in which persecution happened and/or was recorded. No available data (-).

Country	Region	Coordinates	Year	Age	Sex	Remains in Captivity?	Type of Persecution and/or Cause of Mortality	Source
Colombia	Caquetá	1.61887°N, 75.6038°W	2003	Juvenile	♀	Yes	Captivity	I. Lozano pers. comm.
	Puerto Leguízamo	0.18596°S, 74.7837°W	2004	-	-	No	Gunshot	F. A. Peña-Álzate pers. comm.
			2005	-	-	No	Gunshot	F. A. Peña-Álzate pers. comm.
			2009	-	-	No	Gunshot	F. A. Peña-Álzate pers. comm.
			2011	-	-	No	Gunshot	F. A. Peña-Álzate pers. comm.
			2015	-	-	No	Gunshot	F. A. Peña-Álzate pers. comm.
			2016	Adult	♀	No	Gunshot	F. A. Peña-Álzate pers. comm.
	Nuquí	5.7096°N, 77.2667°W	2019	Juvenile	-	No	Gunshot	L. Puerta pers. comm.
	Guaviare	2.5694°N, 72.6389°W	2016	Adult	-	No	Gunshot	C. Arredondo pers. comm.
			2018	Juvenile	-	No	Gunshot	C. Arredondo pers. comm.
			2018	Adult	♂	Yes	Gunshot	I. Lozano pers. comm.
			2020	Adult	-	No	Gunshot	J. S. Barreto pers. comm.
	Unknown origin	-	2018	Adult	♀	Yes	Captivity	I. Lozano pers. comm.
Panamá	Darien Province	8.0880°N, 77.8433°W	2013	Juvenile	-	No	Died in captivity	K. M. Aparicio U. unpubl. data
			2015	Adult	-	No	Died in captivity	K. M. Aparicio U. unpubl. data
			2015	Juvenile	-	No	Gunshot	K. M. Aparicio U. unpubl. data
			2015	Juvenile	-	No	Died in captivity	K. M. Aparicio U. unpubl. data
			2016	Juvenile	♂	No	Gunshot	K. M. Aparicio U. unpubl. data
	GunaYala	9.0584°N, 78.3223°W	2017	Juvenile	-	No	Gunshot	K. M. Aparicio U. unpubl. data
	Guna de Madugandí	9.1490°N, 78.4214°W	2018	Adult	♀	No	Gunshot	K. M. Aparicio U. unpubl. data
	Colón	9.3235°N, 79.9375°W	2019	Juvenile	♀	No	Gunshot	K. M. Aparicio U. unpubl. data

measures that should be taken to mitigate the species' persecution in regions where conflict persists.

We found a total of 132 cases of Harpy Eagle persecution between 1950 and 2020. Unpublished records from Colombia and Panama in the last two decades comprised 21 cases (13 in Colombia and eight in Panama; Table 1). In Colombia, the cases happened in four departments (in three biogeographic regions: Amazon, Choco, and Orinoco); three of the eagles involved are now in captivity in an *ex situ* breeding program (I. Lozano pers. comm.). In Panama, the cases occurred in four provinces (in the Darien and Caribbean biogeographic regions), and the

Table 2. Published historical records of human persecution of 113 Harpy Eagles (*Harpia harpyja*) across Central and South America. Year indicates the year(s) in which persecution was recorded and/or reported. Region indicates the department, state, province, or specified zone in which persecution happened and/or was recorded. Mortality type refers to death caused by gunshot and poaching (to eat or to collect a trophy). No available data (-).

Country	Region	Year	No. Affected Individuals	Age	No. of Individuals by Sex	Captivity/ Returned to the Wild (Number)	Type of Persecution and/or Cause of Mortality	Source
Mexico	Veracruz	1985	1	Juvenile	-		Gunshot	Iñigo et al. 1987
Nicaragua	Río San Juan	1950	1	-	-		Poaching	Lezama-López 2002
Belize	Stann Creek	1998	1	Adult	1♀		Gunshot	Whitacre et al. 2002
Guatemala	Petén	1983	2	-	-	Captivity (1)	Gunshot	Whitacre et al. 2002
	Petén	2000	1	Adult	1♂		Gunshot	Whitacre et al. 2002
Honduras	Valle del Aguán	1960	2	-	-	Captivity (1)	Gunshot	Midence et al. 2002
	Yoro	1981	1	-	-		Gunshot	Midence et al. 2002
	El Paraíso	1984–1985	1	-	-	Captivity	Captivity	Midence et al. 2002
Panama	Darién	1980–1996	12	-	-		Gunshot	Alvarez-Cordero 1996
Panama/Belize	-	1998–2006	8	-	6♀ 2♂	Returned (4) Captivity (4)	Gunshot	Watson et al. 2016
Venezuela	Amacuro, Bolívar	1980–1996	34	Adults, juveniles, subadult	-		Poaching, Gunshot	Alvarez-Cordero 1996
Colombia	Unknown origin	1999	2	Juvenile and subadult	-	Returned (2)	Gunshot, Captivity	Márquez et al. 2005
	Arauca	2015	2	-	-		Gunshot	Acevedo-Charry et al. 2015
	Bahía Solano	2016	1	Adult	1♀		Gunshot	Zuluaga et al. 2018
Ecuador	Sucumbíos	2002–2008	4	Adults and juvenile	1♀ 1♂		Gunshot	Muñiz-López 2017
Brazil	Paraná	1989	2	Adults	-	Captivity (1)	Gunshot	Albuquerque 2002
	Espírito Santo	1997	1	Juvenile	-		-	Aguiar-Silva et al. 2012
	Amazonas	2004	1	Adult	-		Hunting	Valsecchi and Amaral 2009
	Mato Grosso	2008	12	Adult and juvenile			Gunshot	Trinca et al. 2008
	Acre	2012	8	-	-		Gunshot	DeLuca 2012
	Maranhão	2013	2	Adults	-		Poaching	Freitas et al. 2014
	Pará	2001	1	Adult	-		Gunshot	Henriques et al. 2008
	Pará	2011	1	Adult	1♀		Poaching	Aguiar-Silva et al. 2014
	Pará	2014	2	Adult and juvenile	-		Gunshot	Sanaiotti et al. 2015
	Rondônia	2006/2013	3	Adult	-		Gunshot	Gusmão et al. 2016
	Goiás	2013	2	Adult and subadult	-		Gunshot	Silva et al. 2013
Argentina	Misiones	1986	1	Juvenile	-	Captivity	-	Chebez et al. 1990
	Misiones	1987	1	Nestling	-		-	Chebez et al. 1990
	Misiones	1988	1	Nestling	-		-	Chebez et al. 1990

only eagle that survived was stolen while it was still in captivity (https://www.critica.com.pa/sucesos/hurtan-aguila-harpia-del-parque-summit-552647). None of the eagles involved in these persecution cases in Colombia and Panama were returned to the wild. Published records of persecution over the last seven decades comprised 111 records (Table 2) from 11 of the 18 countries currently inhabited by the Harpy Eagle in Central and South America. A high percentage of the total persecution cases (89%; 117 of 132) resulted in the death of the eagle(s). Of the cases in which the eagle survived (11%; 15 of 132), six individuals were returned to the wild after rehabilitation (Table 2).

We identified two important information gaps in the published literature. First, there is a lack of records of persecution in Bolivia, Costa Rica, French Guiana, Guyana, Paraguay, Peru, and Suriname (Table 2). Second, we found only a few persecution cases ($n = 6$) in which Harpy Eagles were successfully returned to the wild after treatment (Table 2). Both information gaps suggest not necessarily an absence of human-Harpy Eagle conflict in several countries, or that the proportion of eagles successfully returned to the wild after persecution is so low (i.e., 6 of 132 cases), respectively, but likely that these have simply been poorly documented in the literature. One example of the latter knowledge gap is the persecution case of the Harpy Eagle named Tuery that was shot and successfully returned to wild after treatment, but this case remains undocumented in the literature although it was covered by the popular media (see www.youtube.com/watch?v=J3eEdAq1kkM&feature=emb_logo). It is important to make this evidence available in the scientific literature so that it can inform conservation measures and law enforcement. We encourage researchers and others to publish this information so as to generate solid scientific evidence that can inform future conservation efforts for the Harpy Eagle.

Harpy Eagles also may benefit from combining *in situ* and *ex situ* conservation programs to mitigate the human persecution. This charismatic species could catalyze public engagement in conservation across Central and South America through people visiting local zoos (e.g., Gusset and Dick 2010, Conde et al. 2011, Consorte-McCrea et al. 2019); however, on the local scale there is a lack of cooperation between *ex situ* and *in situ* programs aimed at the conservation of Harpy Eagle in natural ecosystems. Cooperation among researchers and zoos managers should be fostered. For instance, local zoos could support *in situ* conservation programs with economic and technical resources (e.g., wildlife medicine), bring rural people to visit zoos and become acquainted with the captive eagles that survived persecution, and increase visibility of the importance of rural initiatives to save the species in nature (i.e., conservation and ecotourism). Researchers from *in situ* conservation programs could help improve the signage in zoos to reflect current research advances, give talks for the public at zoos, or work together with zoo managers to address the conservation of the Harpy Eagle.

Awareness campaigns and environmental education on the ecological importance of the Harpy Eagle and its potential for bird-watching programs also could be implemented. Information about cases of persecution could be useful to encourage further studies of human-Harpy Eagle interactions (e.g., to understand attitudes and the socioecological contexts that motivate persecution of Harpy Eagles), as well as to inform evidence-based conservation planning and implementation (e.g., environmental education, law enforcement, mitigation actions; Zuluaga et al. 2020). Some of the possible motivations for Harpy Eagle persecution include: lack of knowledge, fear, perceived/real risk of livestock predation, curiosity, illegal trafficking, desire to keep an eagle in captivity, or need for animal protein in cases where eagles are hunted as food (Valdez 2002, Trinca et al. 2008, Valsecchi and Amaral 2009, Freitas et al. 2014, I. Lozano pers. comm., J. S. Barreto pers. comm., L. Puerta pers. comm.). Actions focused on changing these negative human-Harpy Eagle interactions are necessary, as are studies to address other human-eagle conflicts.

Fragmentation of the world's most intact forest landscapes—such as those in the Neotropics—is predicted to increase over the coming five decades (Taubert et al. 2018), thus likely increasing the probability and severity of human-wildlife conflicts (Betts et al. 2017, Frank et al. 2019). Several studies have documented human persecution of other large Neotropical raptors that might be related to habitat fragmentation (Barbar et al. 2016, Restrepo-Cardona et al. 2020). However, broader socio-ecological investigations should address the human as well as the ecological factors behind human-raptor conflict (Restrepo-Cardona et al. 2020). Through a better understanding of the drivers and contexts in which human persecution of these species happens, we may inform conservation efforts to improve human-Harpy Eagle relationships throughout the eagle's distribution.

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