STUDIES ON NEOTROPICAL FAUNA AND ENVIRONMENT, 2017
http://dx.doi.org/10.1080/01650521.2016.1276716

Taylor & Francis
Taylor & Francis Group

SHORT COMMUNICATION

Harpy Eagle (*Harpia harpyja*) mortality in Ecuador

Ruth Muñiz-López

Grupo de Investigación de Zoología de Vertebrados, Departamento de Ciencias Ambientales y Recursos Naturales, University of Alicante, Alicante, Spain; Sociedad para la Investigación y Monitoreo de la Biodiversidad Ecuatoriana (SIMBIOE), Quito, Ecuador

ABSTRACT
Data about death incidents of Harpy Eagles in Ecuador were documented as a result of prolonged monitoring of their breeding activity. Adult mortality was recorded less frequently than juvenile mortality (9.4% and 28.6% respectively) and all adults were killed due to human persecution (shots) for different reasons. Reasons for juvenile death included falling or loss of height from the canopy while learning to fly and becoming trapped near the ground. There was one case where a juvenile was shot, and another of death after some aggressive behavior of an adult toward the juvenile when it should have been beginning its dispersion. This is the first account on mortality causes in a natural population of Harpy Eagle.

ARTICLE HISTORY
Received 9 February 2016
Accepted 22 December 2016

KEYWORDS
Harpy Eagle; mortality; Ecuador; human persecution; accident; aggressive behavior

Introduction

Mortality rate is an important parameter for understanding the population structure and dynamics of a raptor species (Meyburg & Meyburg 2009). In raptors and at the individual level, the estimation of this rate is based mainly on information from ring recoveries and other identification marking tools such as wing tags, color rings or satellite and radio tracking (Meyburg & Meyburg 2009). In most cases, however, these records do not serve to detect causes of death (Brownie et al. 1985; Williams et al. 2002).

In general, mortality is higher for younger birds than for adults in both passerine and larger and long-lived bird populations (Newton 1998). In long-lived birds of prey, annual pre-adult mortality rate exceeds 80% (Ferrer & Calderon 1990).

Direct analysis of causes of mortality of free-living raptors is difficult to perform because most deaths go unobserved (Newton 1980; Molina Lopez et al. 2011). This work is the first publication about the natural and non-natural mortality of not manipulated wild Harpy Eagles (*Harpia harpyja*) gained from continuously monitoring their breeding areas. Survival and causes of death after release of captive-bred eagles and rehabilitated individuals hatched in the wild were analyzed in a study about trial re-establishment of this species in Panama and Belize, but this work includes only rehabilitated and captive bred specimens (Watson et al. 2016). The Harpy Eagle is a long-lived tropical forest raptor whose longevity is estimated to be 35 years (Lerner et al. 2009). It is considered one of the most powerful birds of prey in the world, as well as one of the largest (Collar 1989; Sick 1997). It is intermittently found from southern Mexico to northern Argentina (Vargas et al. 2006) in tropical and subtropical rainforests (Stotz et al. 1996). It feeds mainly on arboreal mammals, especially sloths and monkeys (Alvarez Cordero 1996; Galetti & Carvalho 2000; Muñiz Lopez et al. 2007; Piana 2007; Aguiar Silva et al. 2014). Harpy Eagles breed every 2.5-3 years and the resulting offspring, usually one per pair, fledges at about five months of age (Rettig 1978; Alvarez Cordero 1996; Muñiz Lopez 2007) and remains in the natal area under parental care for at least two years before dispersing (Rettig 1978; Ruschi 1979; Alvarez Cordero 1996; Muñiz Lopez et al. 2012). The first active nest of a Harpy Eagle to be monitored in Ecuador was found in 2002 in the northeast of the country (Muñiz Lopez 2002).

In Ecuador, the species' distribution is restricted to several small patches of forest in the northwest of the country and more consistently in the east, where the Ecuadorian Amazon Basin begins (Guerrero 1997; Ridgely & Greenfield 2001; Muñiz Lopez 2005). The Harpy Eagle is currently considered "Near-Threatened" throughout its range (BirdLife International 2013). In Ecuador it is classified as "Vulnerable" (Granizo et al. 1997).

It is thought that the main reasons for population decline of the Harpy Eagle are human persecution and habitat deterioration (Vargas et al. 2006;

CONTACT Ruth Muñiz-López harpyec@gmail.com

BirdLife International 2013), although there is little information about how the species is affected by these (Gorzula & Medina Cuervo 1986; Alvarez Cordero 1996; Guerrero 1997; Valdez 2002; Ghomeshi et al. 2005; Vargas et al. 2006; Trinca et al. 2008).

This paper presents the registration and causes of death of individual Harpy Eagles, including some measures to mitigate these events.

Materials and methods

Study area

The study was performed in the Reserve Cuyabeno and its buffer zone in Sucumbios province in northeast Ecuador (0.1167°S, 75.8333°W). This zone included 15 of 16 nesting areas that were monitored. This reserve comprises 590,112 ha (Ministerio del Ambiente 2012) of humid tropical forest (Cañadas 1983). Culturally, it is divided into territories of the indigenous nations of Siona, Siecopai, Shuar, Cofan or Ai and Kichwa, which are located close to the main rivers.

Our data were collected between 2001 and 2011 by direct observation by members of the Harpy Eagle Conservation Program in Ecuador (PCAHE in Spanish) and biomonitors who are trained indigenous people or peasants living near the 16 nesting areas. All nesting areas were visited at least once a week. Observations were made using binoculars from the ground or from towers 25 to 30 m in height. We monitored 53 individual Harpy Eagles, 32 adults and 21 juveniles, continuously throughout the 10 years of study. All dead specimens were found during these monitoring activities in the vicinity of their corresponding breeding areas. In addition, we conducted informal conversations with the local indigenous communities to collect information about why people wanted to kill the Harpy Eagles.

Results

Nine cases of death were detected, which represents 17% of the total individuals monitored. Three of the monitored adults died during the study period (9.4%). All adult deaths were caused by gunshots (Table 1). Six juveniles (28.6%) died during the study period; this is 67% of total number of deaths. On five occasions (records 3, 5, 7, 8 and 9, Table 1) juveniles fell to the ground and died. In case number 7 the juvenile was found dead on some branches of a shrub with more than half of its body submerged under water and only a few meters away from the nest tree located in a flooded forest with water level of approximately 1 m. Days before, an observer noted one of the adults, presumably the father, performing demonstration flights of attack toward this juvenile that was perched in a tree adjacent to the nest tree.

Post-mortem veterinary examinations identified starvation and drowning as causes of death of juveniles that fell to the ground and could not return to the canopy.

On two occasions, biomonitors discovered juveniles on the ground. One was an eight-month-old bird that was weak but still alive. A veterinary detected that it was too thin to fly; it had a very pronounced breastbone and would not have been able to generate enough muscle force to fly. This individual was recovered and returned to its nest tree successfully and was seen alive at least six months thereafter. The second, a five-month-old juvenile was found very weak a few meters under its nest tree. It was also rescued with success.

Table 1. Cases of Harpy Eagle mortality recorded by monitoring nests in the reserve Cuyabeno, Ecuador.

Case no.	Site	Nest discovery	Date of death	Estimated age at the time of death	Sex	Cause of death
1	Zábala	2002	December 2002	13 months	Female	Shot. Conflict within the human community.
2	Tarapuy	2003	June 2003	Adult	Unknown	Shot in fear. Eagle close to the vegetable garden.
3	Pakuyo	2003	November 2010	12 months	Male	Fall from a tree.
4	2 de Agosto – Dureno	2005	July 2005	Adult	Male	Shot because the eagle approached domestic animals.
5	Churuyacu Playas de Cuyabeno	2006	November 2006	3 months	Male	Fall from a tree
6	Nueva Vida	2008	February 2008	Adult	Unknown	Shot for trophy
7	Masakay	2008	October 2008	30 months	Female	Fall from a tree/loss of balance due to parental display?
8	Charap 1	2009	November 2009	13 months	Unknown	Fall from a tree
9	Charap 2	2011	January 2011	9 months	Unknown	Fall from a tree

Discussion

Hunting, or other forms of direct human persecution, may play an important role in the decline of some raptor populations and it is a significant conservation issue worldwide (Raptor Research Foundation 2016). Large biomass raptors such as the Harpy Eagle are particularly sensitive to hunting pressure (Redford & Robinson 1987; Silva & Strahl 1991) as it was found in this study where all adult deaths were directly due to man induced causes. Watson et al. (2016) show a similar situation in their study where shooting was the main cause of adult mortality. On the other side the highest Harpy Eagle density found in a region of Panama was in areas where there were low levels of human persecution (Vargas Gonzalez & Vargas 2011), showing how human-induced mortality could model the population dynamics of this species.

On the other hand, most cases of death of juveniles happened by natural causes. Juveniles who were learning to fly or perfecting their flying techniques when they are about one year old perform exploratory flights and sometimes land in difficult positions when they try to grab a new perch (Muñiz Lopez 2007). They must be able to correct these positions properly to avoid accidents such as falling to the ground. We were able to verify that on three of the days when juveniles fell (records 3, 5 and 8) there were strong gusty winds that are typical of this season of the year (November–December) which could have caused the instability of these juveniles. If they fell to the ground or to a lower forest stratum, they may not have been able to propel themselves to a higher perch from which they could achieve enough height to fly again, staying trapped under the canopy without the possibility of being fed by their parents. We have not detected any adults descending to feed or take care of the juveniles on the ground. Cases of predation on the floor have been reported on released captive-bred juveniles (five to eight months) released in Panama and Belize (Campbell-Thomson et al. 2012). In addition, if the nest is located in a flooded forest, a juvenile that falls to the ground is at risk of drowning or getting wet so that it will not be able to fly.

To decrease the number of juveniles that die as a result of falling to the forest floor, biomonitors could be trained to monitor fledglings during seasons of strong wind in order to retrieve and reintegrate these individuals as soon as possible. In these cases, juveniles could be placed in the nest tree or in a nearby tree, so that the parents will return to feed it. Our success with two juveniles shows that this effort is worthwhile.

The detection of dead Harpy Eagle individuals is extremely difficult, especially without identification markings or tracking tools, so it is easy to underestimate the number of mortality events. Comprehensive monitoring of individuals through direct observation can reveal valuable information including the way deaths occur on an individual level as well as their causes.

Efforts should be made to monitor the survival of juveniles in both the breeding and non-breeding areas, since studies focused only on adults may not detect a decline due to death of juveniles before they become part of the breeding population (Kokko & Sutherland 1998; Kenward et al. 2000). Understanding the elements that affect the reproductive success of this species is essential for population dynamics studies and to develop conservation strategies (Newton 1979; Penteriani et al. 2005). Detailed studies using more sophisticated methods such as telemetry are needed to fill knowledge gaps concerning temporal and spatial patterns of mortality rates. In addition, formal and informal awareness and education programs are essential to mitigate or eliminate the causes of mortality due to hunting in local communities.

Acknowledgments

I wish to thank the indigenous and colonist communities who allowed the PCAHE team to work in their territories. I thank Irina Muñoz Ron, Lina Santacruz, Erika Vinueza, Andrea Calispa, Enrique de la Montaña Andres, Maximo Sanchez Cobo and Andres Ortega for helping with data collection and assistants and volunteers for field work. I appreciate the improvements in English usage made by Susan Heath through the Association of Field Ornithologists' program of editorial assistance.

Disclosure statement

No potential conflict of interest was reported by the author.

Funding

This study received financial support from SIMBIOE (Sociedad para la Investigacion y Monitoreo de la Biodiversidad Ecuatoriana); Ecuadorian Environmental Ministry and EcoFondo Foundation.

References

Aguiar Silva FH, Sanaiotti TM, Luz BB. 2014. Food habits of the Harpy Eagle, a top predator from the Amazonian rainforest canopy. J Raptor Res. 48(1):24–35.

Alvarez Cordero E. 1996. Biology and conservation of the Harpy Eagle in Venezuela and Panama [PhD. dissertation]. [Gainesville (FL)]: University of Florida.

BirdLife International. 2013. Harpia harpyja. In: UICN, editor. IUCN red list of threatened species Version 2013. [cited 2016 Jan 2]. doi:10.2305/IUCN.UK.2013-2.RLTS.T22695998A48128299

Brownie C, Anderson DR, Burnham KP, Robson DS. 1985. Statistical inference from band recovery data - a handbook. Washington DC: Fish and Wildlife Service, Resource Publication N° 156.

Campbell-Thomson E, Vargas FH, Watson RT, Muela A. 2012. Effect of sex and age at release on the independence of hacked Harpy Eagles. J Raptor Res. 46(2):158–167.

Cañadas L 1983. El mapa bioclimatico y ecologico del Ecuador. MAG-PRONAREG. Ecuador.

Collar NJ. 1989. Harpy eagle red data page. World Birdwatch. 11(3):5–6.

Ferrer M, Calderon J. 1990. The Spanish imperial eagle *Aquila adalberti* CL Brehm 1981 in Doñana national park (South West Spain): a study of population dynamics. Biol Conserv. 51:151–161.

Galetti M, Carvalho Jr O. 2000. Sloths in the diet of a Harpy Eagle nestling in eastern Amazon. Wilson Bull. 112:535–536.

Ghomeshi K, Ryan A, Valiquette M. 2005. Acciones antropogenicas actuales que afectan al aguila arpia en la cuenca del Canal y Darien. Panama: Fondo Peregrino; [cited 2016 Sep 16]. Available from: https://www.mcgill.ca/pfss/files/pfss/Harpy_Eagle_Darien_Report_Spanish.pdf

Gorzula S, Medina Cuervo G. 1986. La fauna silvestre de la cuenca del rio Carona y el impacto del hombre. Interciencia. 11:137–324.

Granizo T, Guerrero M, Pacheco C, Phillips R, Ribadeneira MB, Suarez L 1997. Lista de aves amenazadas de extinción en el Ecuador. UICN-Sur, CECIA, INEFAN. Quito: EcoCiencia, BirdLife International.

Guerrero M. 1997. Evaluacion del estado poblacional y etnozoologia del aguila arpia (*Harpia harpyja*) en el Ecuador [Bachelor's thesis]. [Quito, Ecuador]: Universidad Central del Ecuador.

Kenward RE, Walls SS, Odre KH, Pahkala M, Freeman SN, Simpson VR. 2000. The prevalence of non-breeders in raptor populations: evidence from rings, radio-tags and transect surveys. Oikos. 91:271–279.

Kokko H, Sutherland WJ. 1998. Optimal floating and queuing strategies: consequences for density dependence and habitat loss. Am Nat. 152:354–366.

Lerner HRL, Johnson JA, Lindsay AR, Kiff LF, Mindell DP. 2009. It's not too late for the Harpy Eagle (*Harpia harpyja*): high levels of genetic diversity and differentiation can fuel conservation programs. Plos ONE. 4(10):e7336.

Meyburg BU, Meyburg C. 2009. Hohe Mortalität bei Jung- und Altvögeln: todesursachen von Schreiadlern. Falke. 56:382–388.

Ministerio del Ambiente. 2012. Plan de manejo de la Reserva de Producción de Fauna Cuyabeno. Quito, Ecuador. p. 56.

Molina Lopez RA, Casal J, Darwich L. 2011. Causes of morbidity in wild raptor populations admitted at a wildlife rehabilitation centre in Spain from 1995-2007: A long term retrospective study. Plos ONE. 6(9):e24603.

Muñiz Lopez R. 2002. Recent data from surveys of Harpy Eagles in a region of eastern Ecuador. In: The Peregrine Fund and El Fondo Peregrino-Panama, editor. I Conference on and Symposium on the Harpy Eagle; 2002 Oct 24-27; Panama: The Peregrine Fund.

Muñiz Lopez R. 2005. Discovery of the first harpy eagle (*Harpia harpyja*) nest on the western side of the Andean Cordillera. Newsl Neotropical Raptor Netw. 1(1–2):6.

Muñiz Lopez R. 2007. Ecologia, biologia y habitat del Aguila Harpia (*Harpia harpyja*). In: Tufiño P, editor. Cunsi Pindo. Conservacion del Aguila Harpia en Ecuador. Quito: SIMBIOE; p. 190–251.

Muñiz Lopez R, Criollo O, Mendua L. 2007. Results of five years of the Harpy Eagle (*Harpia harpyja*) research program in the Ecuadorian tropical forest. In: Bildstein KL, Barber DR, Zimmerman A, editors. Neotropical raptors. Pennsylvania (PA): Hawk Mountain Sanctuary; p. 23–32.

Muñiz Lopez R, Limiñana R, Cortes GD, Urios V. 2012. Movements of Harpy Eagles *Harpia harpyja* during their first two years after hatching. Bird Study. 59 (3):1–6.

Newton I. 1979. Population ecology of raptors. England: Buteo Books, Vermillion. South Dakota and T&AD Poyser Ltd. p. 399.

Newton I. 1980. Mortality factors in wild populations—chairman's introduction. In: Cooper JE, Greenwood AG, editors. Recent advances in the study of raptor diseases. Chiron, Keighley, West Yorkshire, England; p. 141

Newton I. 1998. Population limitation in birds. London: Academic Press. p. 579.

Penteriani V, Otalora F, Ferrer M. 2005. Floater survival affects population persistence. The role of prey availability and environmental stochasticity. Oikos. 108:523–534.

Piana RP. 2007. Anidamiento y dieta de *Harpia harpyja* Linnaeus en la Comunidad Nativa de Infierno, Madre de Dios, Peru. Rev Peru Biol. 14:135–138.

Raptor Research Foundation. 2016. Available from: http://www.raptorresearchfoundation.org/Conservation on 2 January 2016

Redford KH, Robinson JG. 1987. The game of choice: patterns of Indian and colonist hunting in the Neotropics. Am Anthropol. 89:650–667.

Rettig NL. 1978. Breeding behavior of the harpy eagle, *Harpia harpyja*. Auk. 95:629–643.

Ridgely R, Greenfield P. 2001. The birds of Ecuador. Vol. I and II. Ithaca (NY): Cornell University Press.

Ruschi A. 1979. Aves do Brasil. Sao Paulo, Brazil: Editora Rios Ltda.

Sick H. 1997. Ornitologia Brasileira. Rio de Janeiro, Brasil: Nova Fronteira.

Silva JL, Strahl SD. 1991. Human impact on populations of chachalacas, guans, and curassows (Galliformes: cracidae) in Venezuela. In: Robinson JG, Redford KH, editors. Neotropical wildlife use and conservation. Chicago: USA University of Chicago Press. p. 37–52.

Stotz F, Fitzpatrick JW, Parker III TA, Moskovits K. 1996. Neotropical birds. Ecology and conservation. Chicago: USA University of Chicago Press.

Trinca CT, Ferrari SF, Lees AC. 2008. Curiosity killed the bird: arbitrary hunting of Harpy Eagles *Harpia harpyja* on an agricultural frontier in sourthern Brazilian Amazonia. Cotinga. 30:12–15.

Valdez U. 2002. Why do people persecute Harpy Eagles? Peregrine Fund Newsletter. 33:6.

Vargas Gonzalez J, Vargas FH. 2011. Nesting density of Harpy Eagles in Darien with population size estimates for Panama. J Raptor Res. 45(3):199–210.

Vargas J, Whitacre D, Mosquera R, Albuquerque JLB, Piana R, Thiollay JM, Marquez C, et al. 2006. Estado y distribucion actual del Aguila Arpia (*Harpia harpyja*) en Centro y Sur America. Ornitol Neotrop. 17:39–55.

Watson RT, McClure CJW, Vargas FH, Jenny P. 2016. Trial restoration of the Harpy Eagle, a large, long-lived, tropical forest raptor, in Panama and Belize. J Raptor Res. 50 (1):3–22.

Williams BK, Nichols JD, Conroy MJ. 2002. Analysis and management of animal populations. San Diego (CA): Academic Press.