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CONSERVATION STATUS OF DIURNAL RAPTORS IN VENEZUELA

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ABSTRACT.—I here evaluate the conservation status of 64 species of diurnal raptors in Venezuela based on extent of occurrence (EOO) and area of occupancy (AOO) derived from geomatic-based geographic distribution modeling and gap analysis. I modeled the geographic distribution of raptor species to quantify distribution areas using the maximum entropy modeling techniques with nine environmental variables that were believed to influence the geographic distribution of raptors. The EOO and AOO were used to reevaluate the conservation status of diurnal raptors in Venezuela, applying Criteria B of the IUCN Red List. Furthermore, a gap analysis was performed to evaluate the effectiveness of strictly protected areas (SPA) in the conservation of birds of prey. EOO ranged from 10,423 km² to 907,223 km² and AOO values ranged from 6566 km² to 903,193 km²; four species met the B1 criterion and are qualified to be reclassified. The gap analysis revealed that, on average, 20% and 24% of species' EOO and AOO, respectively, were protected within SPA. In theory, SPA are assuming an effective role in the protection of species' geographic distribution. Raptor conservation in Venezuela must be thoroughly planned; an update in land-use planning (territorial ordering) to enhance the connectivity among SPA would improve the protection of raptors.

KEY WORDS: *Accipitriformes*; *area of occupancy*; *Cathartiformes*; *extent of occurrence*; *Falconiformes*; *neotropic*; *Venezuela*.

ESTADO DE CONSERVACIÓN DE RAPACES DIURNAS EN VENEZUELA

RESUMEN.—En este trabajo evalué el estado de conservación de 64 especies de rapaces diurnas en Venezuela basado en la extensión de presencia (EDP) y el área de ocupación (ADO) derivada de modelos de distribución basados en geomática y análisis de vacíos de conservación. Modelé la distribución geográfica de las especies de rapaces para cuantificar las áreas de distribución utilizando técnicas de modelado de máxima entropía con nueve variables ambientales que supuestamente influyen en la distribución geográfica de las especies de rapaces. La EDP y ADO fueron empleados para re-evaluar el estado de conservación de las rapaces diurnas en Venezuela, aplicando el criterio B de la Lista Roja de la UICN. Además, se realizó un análisis de vacíos de conservación para evaluar la efectividad de las áreas protegidas estrictas (APEs) en la conservación de especies de aves de presa. La EDP varió de 10,423 km² a 907,223 km² y los valores de ADO oscilaron de 6566 km² a 903,193 km²; cuatro especies cumplieron con el criterio B1 y califican para ser re-clasificadas. El análisis de vacíos de conservación mostró que la representación de la EDP y ADO de las especies en las APEs tuvieron valores medios de 20% y 24%, respectivamente. En teoría, las APEs están asumiendo un papel efectivo en la protección de la distribución geográfica de las especies. La conservación de rapaces en Venezuela debe ser planeada cuidadosamente; una actualización del ordenamiento territorial para mejorar la conectividad entre APEs podría mejorar la protección de las aves de presa.

[Traducción de los autores editada]

Birds are the best known vertebrate group in Venezuela (Lentino 2003); nevertheless, the development of the ornithological knowledge in the country is still in its early stages, particularly in some groups including raptors. The diurnal raptors in Venezuela include 68 species in the orders Cathartiformes,

Accipitriformes, and Falconiformes (Ascanio et al. 2012, Hilty 2003). Raptors are threatened by habitat loss, environmental pollution, and human persecution (Bierregaard 1998, Bildstein et al. 1998).

In the last evaluation of extinction risk of Venezuelan wildlife, several species of diurnal raptors were included (Rodríguez and Rojas-Suárez 2008); one species was listed as critically endangered, two

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as vulnerable, three as near threatened, and six as data-deficient. The conservation status assessment of Venezuelan raptors in some cases has been estimated too favorably, whereas in others it has been estimated too negatively.

According to IUCN (2012), the classification of the conservation status of a species is based on any of the following five criteria: population and changes in population size (criteria A, C, and D), geographic range in the form of Extent of Occurrence (EOO) or Area of Occupancy (AOO; criterion B), and quantitative analysis showing the probability of extinction in the wild (criterion E). The information required to evaluate any of these criteria is not available in Venezuela, due to a dearth of information on raptors.

Sound scientific evidence based on a number of biological factors, such as the knowledge of geographic distribution and population density (Bierregaard 1998), is crucial in monitoring and understanding the vulnerability of raptor species. In an attempt to fill this gap, the objectives of this study were to assess the current conservation status of diurnal raptors in Venezuela, based on extent of occurrence and area of occupancy derived from geomatic-based geographic distribution modeling and gap analysis.

METHODS

Study Area. Venezuela is in northern South America, between latitudes 00°45'N and 15°40'N and between meridians 59°45'W and 73°25'W. Its total land mass is 916,445 km² and its maritime territory covers around 900,000 km². Venezuela holds a special ecological significance due to its geography, which includes part of the Cordillera de Los Andes, the Guiana Shield, the Llanos, the Caribbean Sea, and the Atlantic Ocean. These features give the country a wide diversity of biomes along 27 climatic zones, giving rise to 650 natural vegetation types, 23 landforms, and 37 major geological units. In consequence, Venezuela is among the 17 countries with the greatest biological diversity in the world (megadiverse countries), with 15,000 higher plant species, 351 mammal species, 1400 bird species, 340 reptile species, 315 amphibian species and over 1800 fish species (Mittermeier et al. 1997, MARN 2000, Aguilera et al. 2003, Rodríguez and Rojas-Suárez 2008).

Species Data. I conducted the analyses on 64 species of the order Cathartiformes, Accipitriformes, and Falconiformes present in Venezuela (Ascanio et al. 2012). Presence records of the species were obtained from voucher specimens deposited

in the Colección Ornitológica Phelps (COP), Colección de Vertebrados de la Universidad de Los Andes (CVULA), Museo de la Estación Biológica de Rancho Grande (EBRG), Museo de Biología de la Universidad del Zulia (MBLUZ), Museo de Biología de la Universidad Central de Venezuela (MBUCV), Museo de Ciencias Naturales de Caracas (MCNC), Museo de Ciencias Naturales de Guanare (MCNG) and Museo de Historia Natural La Salle (MHNLS). Additional records were obtained from eBird (Sullivan et al. 2009) and the pertinent literature. All gathered records were georeferenced, and taxonomically standardized following Remsen et al. (2013). The database containing 9237 occurrence records was revised using expert knowledge criterion to reduce geographical and taxonomical bias resulting from input sources. The final edited database included 6273 records from 1950 to 2014. Mississippi Kite (*Ictinia mississippiensis*), Northern Harrier (*Circus cyaneus*) and Buckley's Forest-Falcon (*Micrastur buckleyi*) were not included in the analysis because recent presence records are lacking; Rufous-thighed Kite (*Harpagus diodon*) was excluded from the analysis since it is considered a vagrant species in Venezuela (Lees and Martin 2015).

Species Geographic Distribution. For each species I generated a species distribution model (SDM) to describe the geographic distribution by means of ecological niche modeling (Peterson 2001) using the maximum entropy method in the program MaxEnt 3.3.3k (Phillips et al. 2006). Nine environmental predictors with spatial resolution of 1 × 1 km obtained from remote sensing data were used in MaxEnt. These included annual mean temperature and annual precipitation available in WorldClim 1.4 (Hijmans et al. 2005), elevation (digital elevation model; DEM) terrain slope and aspect derived from (DEM), topographic roughness index derived from DEM (Jenness 2013), percentage of tree canopy cover (Townshend et al. 2011), forest canopy height (Simard et al. 2011) and land-cover classes (NASA 2013). SDM were developed using MaxEnt default settings and cumulative output. Model accuracy was evaluated using Area Under the Curve (AUC) of Receiver Operator Characteristic; SDM with AUC values >0.8 were considered indicative of good accuracy.

The models generated were reclassified into models of presence/absence (binary models) using MaxEnt's minimum training presence (used to determine EOO) and maximum training sensitivity plus specificity (used to determine AOO). Presence

pixels of the binary models of each species were converted to polygons in ArcGIS 9.3 (ESRI 2008).

Conservation Status Assessment. Conservation status of diurnal raptors in Venezuela was evaluated using the geographic range in the form of EOO (B1) and AOO (B2; IUCN 2012). I did not use other criteria because the required information is non-existent for many diurnal raptors in Venezuela. A GAP analysis (Scott et al. 1993) was performed to evaluate the effectiveness of protected areas in habitat protection; I used the digital cartography of strict protected areas (SPA) which include national parks, natural monuments, and wildlife refuges (Rodríguez and Rojas-Suárez 1998, Rodríguez et al. 2005). Using ArcGIS 9.3, I intersected the species data set with SPA to estimate the amount of EOO and AOO protected.

RESULTS

Species Geographic Distribution. The 64 SDM were accurate, with mean AUC values averaging 0.87 with a range from 0.77 to 0.96 (Table 1). EOO had values from 10,423 km² to 907,223 km² (Table 1). The White-throated Hawk (*Buteo albigula*) and Semicollared Hawk (*Accipiter collaris*) had the lowest EOO: 10,423 km² and 11,545 km², respectively; Black Vulture (*Coragyps atratus*) and Hook-billed Kite (*Chondrohierax uncinatus*) had the greatest EOO (>907,000 km²). AOO values ranged from 6566 km² to 903,193 km² (Table 1); Andean Condor (*Vultur gryphus*) and Black-chested Buzzard-Eagle (*Geranoaetus melanoleucus*) had the lowest AOO (<6800 km²), Roadside Hawk (*Rupornis magnirostris*) and Zone-tailed Hawk (*Buteo albonotatus*) had the greatest AOO: 903,193 km² and 397,676 km², respectively.

Conservation Status Assessment. Four species (Andean Condor, Semicollared Hawk, White-throated Hawk and White-rumped Hawk [*Parabuteo leucorhous*]) met the B1 Red List criterion (Table 1) to be classified as Vulnerable; and the Black-chested Buzzard-Eagle should be classified as Near Threatened because it is close to meeting the B1 criteria. The remaining 59 species are appropriately classified as Least Concern. The gap analysis revealed that the representation of species' EOO in SPA varied from 4% (Harris's Hawk [*Parabuteo unicinctus*]) to 65% (Semicollared Hawk) with a mean value of 20%. Species' AOO in SPA varied from 3% (Harris's Hawk) to 65% (Semicollared Hawk) with a mean value of 23%. EOO and AOO values for each of the 64 species are presented in Table 1.

DISCUSSION

Species Geographic Distribution. The geographic distribution of raptors in Venezuela has been poorly documented. Ornithological field guides (Hilty 2003, Restall et al. 2006) and electronic databases (Ridgley et al. 2007) constitute the main sources of information on this subject; nonetheless, the available maps from these sources lack metadata and/or they are not georeferenced, which makes them not useful for management and conservation purposes. EOO and AOO were estimated for each species; this information is not available in field guides cited above.

There are no references on previous estimates of EOO and AOO of raptors species for Venezuela. Red Lists of Threatened Species are references of these estimates for each species given that EOO and AOO are used as evaluation criteria, but in spite of this, the last edition of the Red List of Venezuelan Fauna (Rodríguez and Rojas-Suárez 2008) did not report estimates of EOO and AOO. The most complete study on the biology of a raptor species in Venezuela, the Harpy Eagle (*Harpia harpyja*), includes an analysis of the geographic and ecological range of this species (Álvarez-Cordero 1996) but it does not provide estimates of EOO and AOO. Other references on the geographic distribution of diurnal raptors in Venezuela are available in the form of distribution extensions (Barrowclough et al. 1997, Calchi and Vilorio 1991, Ríos et al. 2010, Hilty 1999, Kirwan and Sharpe 1999, Pérez-Emán et al. 2003, Sharpe et al. 2001, Zimmer and Hilty 1997, Naveda-Rodríguez and Bisbal 2008, Naveda-Rodríguez and Lugo-Fuenmayor 2014) and only document distribution points.

EOO and AOO estimates of raptor species in northern South America are available for only four species (Andean Condor, Solitary Eagle [*Buteogallus solitarius*], Black-and-chestnut Eagle [*Spizaetus isidori*], and Semicollared Hawk) in Colombia (Renjifo et al. 2002). EOO and AOO estimates in this study ranged between 5% and 61% of the EOO and AOO values estimated for these species in Colombia. This variation may possibly be attributable to two sources. First, the methods used by Renjifo et al. (2002) are a modification of the minimum convex polygon method suggested by IUCN (2012), but the method I used in this study (ecological niche modeling) did not consider the minimum convex polygon. Second, the heterogeneous environmental conditions (including human disturbance) of each geopolitical unit influence the

Table 1. Number of species presence records (#PR), accuracy of species distribution models (AUC), extent of Occurrence (EOO), percent of EOO protected, area of occupancy (AOO), percent of AOO protected and Red List status of 64 species of diurnal birds of prey in Venezuela.

SPECIES	#PR	AUC	EOO km ²	EOO PROTECTED km ² (%)	AOO km ²	AOO PROTECTED km ² (%)	STATUS
Turkey Vulture (<i>Cathartes aura</i>)	436	0.835	894,067	147,468 (17)	171,528	39,002 (23)	LC
Lesser Yellow-headed Vulture (<i>Cathartes burrovianus</i>)	82	0.879	703,908	106,824 (15)	172,791	19,116 (11)	LC
Greater Yellow-headed Vulture (<i>Cathartes melambrotus</i>)	96	0.923	395,492	95,500 (24)	190,482	58,909 (31)	LC
Black Vulture (<i>Coragyps atratus</i>)	578	0.865	907,196	148,706 (16)	109,535	27,765 (25)	LC
King Vulture (<i>Sarcoramphus papa</i>)	117	0.834	845,650	141,066 (17)	143,900	36,061 (25)	LC
Andean Condor (<i>Vultur gryphus</i>)	9	0.926	16,544	6442 (39)	6566	3995 (61)	VU
Osprey (<i>Pandion haliaetus</i>)	161	0.878	860,041	135,748 (16)	124,904	16,065 (13)	LC
White-tailed Kite (<i>Elanus leucurus</i>)	135	0.884	784,199	106,288 (14)	209,945	18,511 (9)	LC
Pearl Kite (<i>Gampsonyx swainsonii</i>)	148	0.892	612,244	59,325 (10)	161,201	7531 (5)	LC
Hook-billed Kite (<i>Chondrohierax uncinatus</i>)	78	0.819	907,223	148,995 (16)	153,994	44,098 (29)	LC
Gray-headed Kite (<i>Leptodon cayanensis</i>)	64	0.775	870,440	146,477 (17)	164,910	27,418 (17)	LC
Swallow-tailed Kite (<i>Elanoides forficatus</i>)	128	0.869	885,592	147,936 (17)	131,329	39,451 (30)	LC
Crested Eagle (<i>Morphnus guianensis</i>)	21	0.856	557,390	114,825 (21)	151,201	45,462 (30)	LC
Harpy Eagle (<i>Harpia harpyja</i>)	25	0.803	385,420	104,116 (27)	108,290	38,491 (36)	LC
Black Hawk-Eagle (<i>Spizaetus tyrannus</i>)	75	0.88	773,591	138,940 (18)	210,351	41,563 (20)	LC
Black-and-white Hawk-Eagle (<i>Spizaetus melanoleucus</i>)	31	0.912	344,452	92,906 (27)	92,856	25,243 (27)	LC
Ornate Hawk-Eagle (<i>Spizaetus ornatus</i>)	50	0.871	579,447	115,935 (20)	137,596	37,659 (27)	LC
Black-and-chestnut Eagle (<i>Spizaetus isidori</i>)	14	0.822	50,060	15,616 (31)	13,548	7543 (56)	LC
Black-collared Hawk (<i>Busarellus nigricollis</i>)	96	0.89	645,964	75,567 (12)	168,858	12,432 (7)	LC
Snail Kite (<i>Rostrhamus sociabilis</i>)	86	0.886	788,033	115,292 (15)	95,488	12,727 (13)	LC
Slender-billed Kite (<i>Helicolestes hamatus</i>)	12	0.87	352,396	33,468 (10)	269,913	25,085 (10)	LC
Double-toothed Kite (<i>Harpagus bidentatus</i>)	39	0.876	343,905	95,264 (28)	129,978	42,375 (33)	LC
Plumbeous Kite (<i>Ictinia plumbea</i>)	180	0.829	894,839	148,742 (17)	227,297	45,965 (20)	LC
Long-winged Harrier (<i>Circus buffoni</i>)	17	0.902	495,535	48,768 (10)	175,672	15,659 (9)	LC
Gray-bellied Hawk (<i>Accipiter poliogaster</i>)	9	0.908	117,789	16,485 (14)	117,789	16,485 (14)	LC

Table 1. Continued.

SPECIES	#PR	AUC	EOO km ²	EOO PROTECTED km ² (%)	AOO km ²	AOO PROTECTED km ² (%)	STATUS
Tiny Hawk (<i>Accipiter superciliosus</i>)	30	0.9	182,252	55,300 (30)	350,876	90,931 (26)	LC
Semicollared Hawk (<i>Accipiter collaris</i>)	7	0.948	11,545	7547 (65)	11,545	7547 (65)	VU
Sharp-shinned Hawk (<i>Accipiter striatus</i>)	63	0.945	244,516	93,993 (38)	75,205	36,403 (48)	LC
Bicolored Hawk (<i>Accipiter bicolor</i>)	38	0.791	693,570	129,833 (19)	182,434	47,538 (26)	LC
Crane Hawk (<i>Geranospiza caerulescens</i>)	91	0.868	728,285	95,335 (13)	270,241	24,591 (9)	LC
Slate-colored Hawk (<i>Buteogallus schistaceus</i>)	11	0.964	67,263	6157 (9)	18,808	1970 (11)	LC
Common Black Hawk (<i>Buteogallus anthracinus</i>)	71	0.891	442,075	36,280 (8)	94,566	19,766 (21)	LC
Rufous Crab Hawk (<i>Buteogallus aequinoctialis</i>)	24	0.92	35,146	3429 (10)	16,823	1580 (9)	LC
Savanna Hawk (<i>Buteogallus meridionalis</i>)	154	0.825	826,991	126,687 (15)	378,925	20,040 (5)	LC
Great Black Hawk (<i>Buteogallus urubitinga</i>)	125	0.847	699,306	101,349 (15)	150,896	20,206 (13)	LC
Solitary Eagle (<i>Buteogallus solitarius</i>)	12	0.93	149,214	41,133 (28)	54,958	16,381 (29)	LC
Roadside Hawk (<i>Bupornis magnirostris</i>)	473	0.806	188,531	39,291 (21)	903,193	148,761 (17)	LC
Harris's Hawk (<i>Parabuteo unicinctus</i>)	45	0.933	432,998	18,930 (4)	151,752	5192 (3)	LC
White-rumped Hawk (<i>Parabuteo leucorhous</i>)	19	0.875	18,533	6933 (37)	10,303	3537 (34)	VU
White-tailed Hawk (<i>Geranoaetus albicaudatus</i>)	126	0.856	759,481	117,361 (16)	154,649	21,333 (14)	LC
Black-chested Buzzard-Eagle (<i>Geranoaetus melanoleucus</i>)	25	0.911	20,689	6639 (12)	6792	2982 (44)	NT
White Hawk (<i>Pseudastur albicollis</i>)	56	0.833	619,713	133,100 (22)	162,437	60,360 (37)	LC
Black-faced Hawk (<i>Leucopternis melanops</i>)	18	0.878	209,451	60,664 (29)	39,756	9358 (24)	LC
Gray-lined Hawk (<i>Buteo nitidus</i>)	134	0.877	643,961	88,940 (14)	203,360	25,826 (13)	LC
Broad-winged Hawk (<i>Buteo platypterus</i>)	142	0.912	495,515	118,970 (24)	81,988	36,045 (44)	LC
White-throated Hawk (<i>Buteo albigula</i>)	7	0.855	10,423	6481 (62)	10,423	6481 (62)	VU
Short-tailed Hawk (<i>Buteo brachyurus</i>)	81	0.896	644,095	98,383 (15)	249,287	55,347 (22)	LC
Swainson's Hawk (<i>Buteo swainsoni</i>)	13	0.809	39,590	10,491 (27)	7575	1720 (23)	LC
Zone-tailed Hawk (<i>Buteo albonotatus</i>)	59	0.823	558,924	62,133 (11)	397,676	37,591 (10)	LC
Laughing Falcon (<i>Herpetotheres cachinnans</i>)	129	0.855	700,243	112,522 (16)	229,247	35,504 (13)	LC
Barred Forest-Falcon (<i>Micrastur ruficollis</i>)	67	0.871	478,733	103,679 (22)	164,344	39,722 (24)	LC

Table 1. Continued.

SPECIES	#PR	AUC	EOO km ²	EOO PROTECTED km ² (%)	AOO km ²	AOO PROTECTED km ² (%)	STATUS
Lined Forest-Falcon (<i>Micrastur gilvicolis</i>)	17	0.853	378,774	94,966 (25)	52,478	9,521 (18)	LC
Slaty-backed Forest-Falcon (<i>Micrastur mirandollei</i>)	12	0.873	173,259	18,595 (11)	47,431	2789 (6)	LC
Collared Forest-Falcon (<i>Micrastur semitorquatus</i>)	42	0.837	690,801	120,801 (18)	263,895	47,374 (18)	LC
Crested Caracara (<i>Caracara cheriway</i>)	251	0.839	822,728	136,375 (17)	263,607	32,542 (12)	LC
Red-throated Caracara (<i>Ibycter americanus</i>)	76	0.828	761,987	140,378 (18)	238,922	63,171 (26)	LC
Black Caracara (<i>Daptrius ater</i>)	66	0.885	548,672	86,007 (16)	114,775	13,963 (12)	LC
Yellow-headed Caracara (<i>Milvago chimachima</i>)	355	0.851	744,637	113,425 (15)	176,235	31,069 (18)	LC
American Kestrel (<i>Falco sparverius</i>)	351	0.871	678,469	93,353 (14)	214,687	31,135 (15)	LC
Merlin (<i>Falco columbarius</i>)	54	0.915	644,360	109,433 (17)	88,231	24,457 (28)	LC
Bat Falcon (<i>Falco ruficularis</i>)	144	0.811	844,839	146,017 (17)	289,847	55,706 (19)	LC
Orange-breasted Falcon (<i>Falco deiroleucus</i>)	12	0.835	321,295	99,604 (31)	52,900	20,384 (39)	LC
Aplomado Falcon (<i>Falco femoralis</i>)	107	0.844	647,238	93,566 (15)	193,107	19,521 (10)	LC
Peregrine Falcon (<i>Falco peregrinus</i>)	41	0.931	397,853	62,863 (16)	65,564	13,690 (21)	LC

niche variables and dispersal dynamics that shape the species' geographic range boundaries.

Conservation Status Assessment. Previous conservation assessments of diurnal raptors in Venezuela lacked expert on-site field knowledge. The Red List of Venezuelan Fauna (Rodríguez and Rojas-Suárez 1999, 2008) and the IUCN Red List of Threatened Species (IUCN 2013) did not provide detailed information on arguments used when selecting the criteria for the evaluation of raptor species. This lack of sound scientific evidence leads the evaluation process to a wrong estimation of extinction risk.

The geographic distribution, in the form of EOO (criterion B1) and AOO (criterion B2), is one of the five criteria used to evaluate conservation status (IUCN 2012). Based on my preliminary assessment, I recommend to the Red List authorities to change the status of Andean Condor, Semicollared Hawk, White-throated Hawk, Harpy Eagle, Crested Eagle (*Morphnus guianensis*), Solitary Eagle, and Black-and-chestnut Eagle in Venezuela from the current status in Rodríguez and Rojas-Suárez (2008) and IUCN (2013) to that proposed in this study (Table 2). This

recommendation is based on the availability of quantitative data for the species proposed as Vulnerable and Near Threatened or the lack of quantitative data for the species proposed as Least Concern.

Although Rodríguez and Rojas-Suárez (2008) evaluated the status of Andean Condor, Harpy Eagle, and Crested Eagle using others' criteria, they did not provide quantitative indicators of the criteria used. For these species, they mentioned the criteria C2 and D1 (C2, D1 for Harpy Eagle and Crested Eagle; D1 for Andean Condor) but did not provide an estimate of the numbers of mature individuals in Venezuela. Criterion C corresponds to a population estimate of fewer than 10,000 mature individuals, whereas criterion D1 refers to a population size estimated to be fewer than 1000 mature individuals. Thus, the assessment presented by Rodríguez and Rojas-Suárez (2008) could be interpreted as subjective, as it was made without real population estimates of the number of mature individuals of each species.

In theory, strictly protected areas are assuming an effective role in the protection of species' geographic

Table 2. Current and proposed Red List Status of diurnal birds of prey in Venezuela. CR=Critically Endangered, EN=Endangered, VU=Vulnerable, NT=Near Threatened, LC=Least Concern, DD=Data Deficient, NE=Not Evaluated. Roman numerals in parentheses are part of the criterion definition according to IUCN (2012).

SPECIES	RED LIST STATUS AND CRITERIA USED		
	IUCN 2013	RODRÍGUEZ AND ROJAS-SUAREZ 2008	THIS STUDY
Andean Condor (<i>Vultur gryphus</i>)	NT	CR D1	VU B1ab(i,iii,iv)
Semicollared Hawk (<i>Accipiter collaris</i>)	NT	NT	VU B1ab(i,iii,iv)
White-throated Hawk (<i>Buteo albigula</i>)	LC	DD	VU B1ab(i,iii,iv)
White-rumped Hawk (<i>Parabuteo leucorhous</i>)	LC	NE	VU B1ab(i,iii,iv)
Black-chested Buzzard-Eagle (<i>Geranoaetus melanoleucus</i>)	LC	NE	NT
Harpy Eagle (<i>Harpia harpyja</i>)	NT	VU C2a(ii); D1	LC
Crested Eagle (<i>Morphnus guianensis</i>)	NT	VU C2a(ii); D1	LC
Solitary Eagle (<i>Buteogallus solitarius</i>)	LC	NT	LC
Black-and-chestnut Eagle (<i>Spizaetus isidori</i>)	VU C2a(i)	NT	LC

distribution, with >20% of species' EOO and AOO protected on average. Seven species have low percentage (<10%) of EOO protected and 11 species have <10% of AOO protected. This could be critical for Rufous Crab Hawk (*Buteogallus aequinoctialis*), whose 35,146 km² of EOO are only 10% protected and AOO (16,823 km²) only 9% protected; this species has a restricted distribution and has the lowest EOO and AOO protected. Conservation goals proposed for biodiversity protection range from 10% to 70% of species habitats (Pearce et al. 2008) or 30% of the species distribution (Douglass et al. 2011). For bird species, Pearce et al. (2008) proposed a conservation goal of 40% and 20% of restricted and wide distribution, respectively. Seven species of diurnal raptors in Venezuela are restricted in distribution to one or two bioregions (Naveda-Rodríguez 2013). Of this number, only the Semicollared Hawk has 65% of its EOO protected; the remaining six species have less than 40% of EOO protected. Vulnerable species have between 38% and 65% of their EOO under protection. A large number of species (37) with wide distribution in the country have more than 80% of their range unprotected.

Application of Red List criteria for extinction risk assessments must be based in quantitative data derived from scientific research (Mace et al. 2008).

Unfortunately, this information is not available for raptor species in Venezuela. The Andean Condor and Crested Eagle are classified as critically endangered and vulnerable, respectively; nonetheless, systematic population surveys and geographic distribution evaluations have not been previously done. The situation for the Harpy Eagle is different from that of other species, in large part because since 1992 there has been an extraordinary research and conservation effort for this species in Venezuela (Álvarez-Cordero 1996, Kung and Álvarez-Cordero 1997). The Harpy Eagle Conservation Project in Venezuela has been gathering data on nest-sites (nest numbers) and movements of adults and juvenile eagles using radio and satellite telemetry (La Cruz 2010); these data are crucial for applying Red List criteria. Unfortunately, the information gathered for more than two decades has not yet been published.

Finally, I suggest that the method proposed by IUCN (2012) to define EOO should be revised and improved. With the available technology and GIS data, ecological niche modeling would be the best current option. Raptor conservation in Venezuela must be thoroughly planned; an update in land-use planning (territorial ordering) to enhance the connectivity among SPA and/or the creation of new protected areas would improve the protection

of raptors. Raptor conservationists should remember early advice from Rosalie Edge—"The time to protect a species is while it is still common."

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