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A Quantitative Method for Evaluating Contemporary Cultural Uses of Birds – A case study from Mexico

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Abstract This study evaluates the relationship between people and birds in Mexico, a country where high cultural and biological diversity are reflected in the close associations between people and natural resources, recorded since pre-Hispanic times. It systematically reviews 1041 records of cultural use of wild birds in Mexico published between 1996 – 2017, and analyzes patterns of contemporary use of avifauna. It classifies information for 252 birds by grouping uses of species and families into 11 categories and quantifies overall use with a Cultural Value Index (CVI). The data show that birds have a high cultural value as food, pets, and for medicinal uses (312, 235, and 119 records, respectively), particularly in the state of Chiapas. Large edible birds had the highest CVIs and included Plain chachalacas (*Ortalis vetula*; 9.72), Black-bellied whistling-ducks (*Dendrocygna autumnali*; 6.65), Crested guams (*Penelope purpurascens;* 6.25), and Great currasows (*Crax rubra*; 6.23), with the Cracidae family recorded as favored gamebirds. Conspicuous, brightly-colored birds had high CVIs, including Keel-billed toucans (*Ramphastos sulfuratus*; 6.50), Red-lored amazons, (*Amazona autumnalis;* 6.03), and allied species, which were traded or kept as pets despite legal protection. The high CVIs of Barn owls (*Tyto alba*; 5.45) were related to medicinal uses, and Mourning doves (*Zenaida macroura*; 5.69) were mainly used as gamebirds. Wild bird populations face increasing pressure from habitat loss and overexploitation. We propose that evaluating the ethnological significance of wildlife with indices like CVIs can quantify the distinctive needs of rural communities, which when combined with information on conservation status can develop more sustainable species management plans.

Keywords Wildlife; Ethnozoology; Ethno-ornithology; Psittacidae

Introduction

Wildlife can have an economic value, but habitats and species also possess distinctive social, ecological, psychological, and ethical values (Cuéllar Soto 2017). Studying the close associations and interactions between people and animals can demonstrate the values and

cultural significances that different communities place on particular species (Alves et al. 2018). Such ethnozoological knowledge is useful when developing long-term conservation plans that not only protect wildlife, but also sustain the practices and beliefs of local communities (Alves and Souto 2015).

Ethno-orthithology considers the relationship between humans and birds. In the Americas, areas of high cultural and biological diversity frequently coincide (Costa-Neto et al. 2009) and are reflected in arts, beliefs, knowledge, cuisine, musical instruments, and clothing (Toledo and Barrera-Bassols 2008). Wild birds often feature in human diets, and their plumage and body parts are prized for aesthetic reasons and they are appreciated for their song (Anderson and Medina-Tzuc 2005; Vásquez-Dávila 2014). Birds also feature in myths, rituals, art, and architecture relating to cycles of rebirth and renewal (Anderson 2017; Hull and Fergus 2017; Sault 2016).

In Latin America birds are considered highly symbolic—especially hummingbirds and vultures, which are thought to predict life and death events (Sault 2016)—with magical powers believed to be conferred to anyone eating or possessing particular species or products (Anderson and Medina-Tzuc 2005). For centuries, indigenous Americans have made ceremonial regalia from feathers not only for their decorative qualities but also for their supposed connection to the spirit world. Those wearing feathers were thought to be able to fly, sing, and display like a bird, and could serve as sacred deities between human and other worlds (Costa-Neto et al. 2009). In pre-Hispanic Aztec culture brightly-colored iridescent feathers were highly prized, and hummingbird, quetzal, and male mallard plumage was incorporated into cloaks and shields of elite warriors, and pasted onto skin at festivals (Riedler et al. 2012). However, long-held cultural attitudes that traditionally prevented the overexploitation of natural resources are being lost, including beliefs by the Ch'orti' Maya in Guatemala about supernatural powers of birds (Hull and Fergus 2017), and traditional Maya ideology in the Yucatan that encouraged a shared responsibility for sustainably managing communally-held natural resources such as game birds (Anderson and Medina-Tzuc 2007).

Mexico is highly biodiverse with about 11% (n=1,115–1,150) of extant global bird species, including 194–212 endemic species (Navarro-Sigüenza et al. 2014). Much of its avifauna is threatened, with 26–44% of bird populations (Berlanga et al. 2017) and up to 57% of bird species (n=655) considered to be at risk (Ortiz-Pulido 2018). Avian species richness is highest in the inter-mountain habitats along the Gulf of Mexico and the Yucatan Peninsula, with endemism peaking in the western mountain ranges and Sierra Madre Oriental (Navarro-Sigüenza et al. 2014). Many bird populations are in decline owing to recent human activities (Ortiz-Pulido 2018), and endangered bird populations considered both at risk and possessing high cultural significance are considered to be especially vulnerable to over-exploitation (Tábara 2006).

This study aims to evaluate the relationship between people and birds in Mexico by analyzing patterns of contemporary cultural use of avifauna. This is achieved by quantifying the extent of cultural use of birds using a Cultural Value Index (CVI) developed for ethnobotanical studies (Turner 1988) and recently applied to ethnozoology (Ávila-Nájera et al. 2018). CVIs synthesize the detailed ethnological knowledge contained in multiple sources and generate a quantitative indicator of a species' or taxa's cultural relevance,

which can indicate its risk of exploitation. CVIs can be used to incorporate cultural attitudes into conservation management of endangered wildlife populations, and for comparative studies of use and exploitation of species from different regions or following environmental or demographic changes.

Methods

We carried out a systematic search for relevant journal articles, books, theses, and online publications in Scopus, the Web of Science, and the National Consortium of Scientific and Technological Information Resources (CONRICyT). We used English and Spanish search terms relating to the cultural value or significance of, attitude towards or specific use of, wild birds in Mexico and extracted records and relevant information for the 20-year period 1996–2017. We stored records in MS Excel and corrected synonyms using Berlanga et al. (2017), and extracted species' Mexican conservation status from the NOM-059-SEMARNAT-2010 (SEMARNAT 2010).

Records were assigned to one or more of 11 categories of cultural use as used by Ávila-Nájera et al. (2018). These were: food, pets, trade, ornamental, artisanal, magic-religious (including belief in spiritual power [Anderson 2017]), medicinal purposes, killed for sport or recreation (hunted for pleasure), considered harmful or dangerous, or considered to have other benefits.

We quantified the overall cultural significance of each species using the Cultural Value Index (CVI) (Turner 1988) via the equation:

$CVI = \Sigma (Iu + Fm + Vut)$

Where:

Iu (Intensity of use) = (Number of uses for each species from all sources / Total number of uses for all species from all sources) x 100.

Fm (Frequency of use) = (Number of records [times a species is mentioned] of all uses for each species from all sources / Total number of records of all uses for all species from all sources) x 100.

Vu (Use value) = (Number of records for each species of a single use from all sources / Total number of records of a single use for all species from all sources) x 100.

Vut (Total use value for each species) = Sum of Vu for all uses / total uses.

We also calculated CVIs for bird families by substituting the data for species in the equations above with the combined data for all species in a family.

Results

We found 56 publications documenting cultural uses of birds from over 300 sites in 21 Mexican federal states, based on more than 500 interviews (Figure 1, and Supplementary Table 1). Most records of cultural use originated from Chiapas (n=212), followed by Oaxaca (n=79), and the Estado de México (n=51) (Figure 1). There were records for 252 bird species representing 22 avian orders, 52 families, and 179 genera. Populations of 72 species (28.4%) listed in Table 1 are endangered, but for the majority of species (71.6%) there is insufficient data to ascertain their current conservation status in Mexico.

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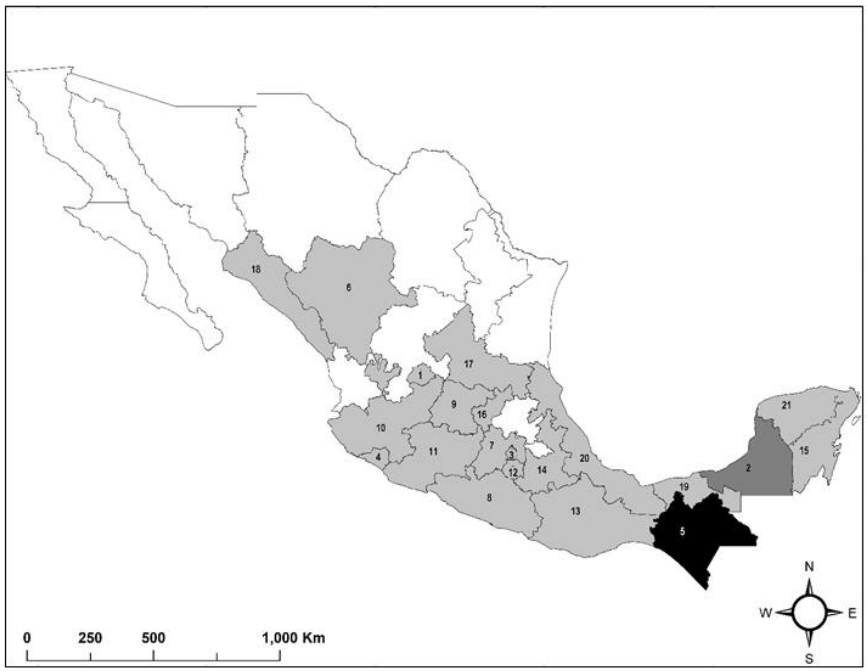

Figure 1 Location of the 21 Mexican Federal States (Labelled 1–21) with Records of Cultural Uses used to Calculate Cultural Value Indices (CVI) for 252 Bird Species. Shading Indicates the Number of Independent Sources used to Calculate the CVI, where Light Gray is <5 (1, Aguascalientes; 3, Ciudad de México; 4, Colima; 6, Durango; 7, Estado de México; 8, Guerrero; 9, Guanajuato; 10, Jalisco; 11, Michoacán, 12, Morelos; 13, Oaxaca; 14 Puebla; 15, Quintana Roo; 16, Querétaro; 17, San Luis Potosí; 18 Sinaloa; 19, Tabasco; 20, Veracruz; 21, Yucatán). Dark Gray is nine (2, Campeche). Black Indicates 12 sources (5, Chiapas).

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Birds with the highest CVIs (CVI in parentheses) were the Plain chachalaca (*Ortalis vetula*; 9.72), Black-bellied whistling-duck (*Dendrocygna autumnalis*; 6.65), Keel-billed toucan (*Ramphastos sulfuratus*; 6.51), Crested guan (*Penelope purpurascens*; 6.25), Great curassow (*Crax rubra*; 6.23), Red-lored Amazon (*Amazona autumnalis*; 6.03), Barn owl (*Tyto alba*; 5.45), Mourning dove (*Zenaida macroura*; 5.69), and Ocellated turkey (*Meleagris ocellata*; 5.44). Four of these species—*C. rubra*, *P. purpurascens*, *M. ocellata*, and *R. sulfuratus*—also have the highest number of cultural uses (Table 1). Families with notably high CVIs were Psittacidae (29.2), Cracidae (24.9), and Columbidae (19.7), followed by Anatidae (16.5) and Ramphastidae (11.6) (Figure 2).

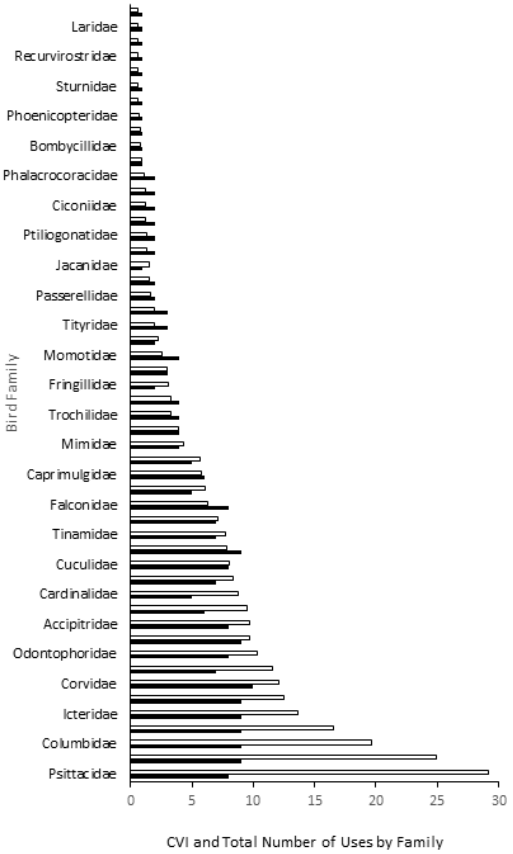

Figure 2 Cultural Value Index (CVI) (black-filled bars) and total number of uses (unfilled bars) for bird families using information from total records of cultural uses of species belonging to each family, published between 1996–2017 in Mexico.

The most common reasons for catching birds were for food (312 records), pets (235 records), and medicinal uses (119 records) (Figure 3). The most frequently taken food species—*O. vetula* (24 records), *C. rubra* (20 records), and *P. purpurascens* (17 records)—all belong to the Family Cracidae. The most common pets were *O. vetula*, *R. sulfuratus*, and *A. autumnalis* (all with 9 records). The highest number of records of medicinal use were for the Black vulture (*Coragyps astratus*; 13 records), Turkey vulture (*Cathartes aura*; 9 records), Great-tailed grackle (*Quiscalus mexicanus;* 5 records), and Common pigeon (*Columbina livia*; 5 records).

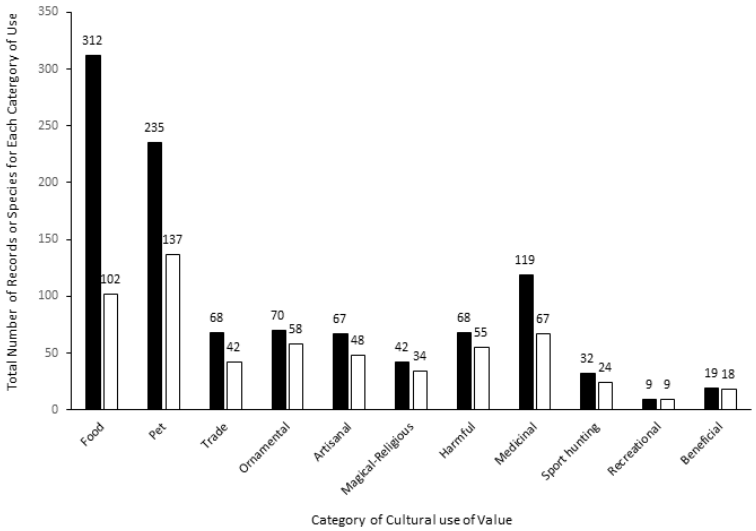

Figure 3 Number of species of birds (unfilled bars) and number of records for each category of use of birds (black bars) in Mexico grouped into 11 classes (food, pet, trade, ornamental, artisanal, magical religious, harmful, medicinal, sport hunting, recreational, or other beneficial use) from records published between 1996 and 2017.

Species belonging to three genera in unrelated families—Passerina (cardinal birds), Icterus (New World orioles), and Amazona (parrots)—experienced high levels of use (7, 6, and 6 species from each genus, respectively). Avian families with high patterns of use were Corvidae (10 uses, but no beneficial use); Anatidae, Ardeidae, Columbidae, Cracidae, Icteridae, Strigidae, and Tytonidae (all 9 uses); Accipitridae, Cuculidae, Falconidae, Odontophoridae, and Psittacidae (all 8 uses); and Picidae, Phasianidae, Ramphastidae, and Tinamidae (7 uses, Figure 2).

Discussion

Overall, this study emphasizes the incredibly high diversity and ongoing cultural significance of birds in Mexico. Nearly a quarter of the bird species we evaluated were valued for at least one cultural use, and some had multiple uses. A quarter of species of notable cultural value are considered endangered in Mexico, but the conservation status of many Mexican species probably underestimates their vulnerability because we lack sufficient data to determine whether their populations are in decline (SEMARNAT 2010). Indeed, Ortiz-Pulido et al. (2016) express concern about the conflicting information that informs the conservation status of many Mexican birds, which means that many species probably lack adequate legal protection.

The high CVIs of some birds reflect extensive levels of use (total number of records) as well as a variety of cultural applications for species such as *O. vetula*, *R. sulfuratus*, and *P. purpurascens*, of which two species are known to be endangered in Mexico (SEMARNAT 2010). The data for the CVIs originated from 21 of the 33 Mexican states, with high levels of cultural use particularly in tropical areas that also have high biodiversity and avian

endemism (Navarro-Sigüenza 2014). However, the limited nature of the available literature means that our analyses do not cover all Mexican regions to the same extent, indicating the need for further ethnozoological research.

The most frequent cultural uses of birds were for food, pets, or medicines, which together far outnumber the records for other cultural uses. Documented records of wild birds as everyday foodstuffs have existed in Mexico since the Aztec codices (Valadez 2003); They continue to have high dietary significance for rural communities like those in the Yucatan, where large birds like *C. rubra* and *M. ocellata* are the most valuable and frequently-consumed game after large mammals (Anderson and Medina-Tzuc 2005). The major food species we identified are all large Cracids (*O. vetula*, *C. rubra*, and *P. purpurascens*), and although *C. rubra* is listed in the IUCN red list status as "of least concern," it is believed to be under pressure from the international pet trade and human consumption (Birdlife International 2018). This observation emphasizes how indices of conservation status depend upon the availability of reliable population data which may differ at national or regional levels. We suggest that CVIs can help identify species that appear to be widely distributed and relatively abundant across their range, but which are in need of further study and/or protection on a regional or national level.

More species were valued as pets than for food, including 19 Psittacidae (parrot) species, echoing the global popularity of parrots, parrotlets, and macaws. *A. autumnalis* was the most frequently mentioned pet and is another Mexican bird for which we lack accurate population data. However, overcollection for the pet-trade has resulted in severely depleted populations of rarer, higher-value Psittacids across much of their ranges (Alves et al. 2013). In Mexico, 13 of the 20 endemic Psittacid species are under threat (Pires 2012), and parrots, including species listed in Table 1, are sold in rural Mexican markets despite their protected status (Roblero-Morales 2008) and are exposed to high levels of risk during capture and transport. This suggests that CVIs can identify the species and groups most at risk of overexploitation for particular purposes, and draw attention to species whose populations are not currently considered to be endangered.

Table 1.

ORDER **FAMILY** ***Species***	**Conservation Status NOM-ECOL-059**	**Conservation Status IUCN**	**Number of Reported Uses**	**Number of Records of Cultural Uses**	**CVI**
TINAMIFORMES					
TINAMIDAE					
Tinamus major	T	NT	6	14	3.24
Crypturellus boucardi	T	LC	1	5	0.79
Crypturellus cinnamomeus	P	LC	5	11	2.64
ANSERIFORMES					
ANATIDAE					
Dendrocygna autumnalis	i	LC	9	22	6.65
Dendrocygna bicolor	i	LC	3	6	1.78

Branta canadensis	i	LC	1	1	0.29
Aix sponsa	i	LC	3	3	1.15
Anas acuta	i	LC	1	1	0.29
Anas platyrhynchos	i	LC	1	3	0.54
Cairina moschata	E	LC	6	18	4.33
Bucephala albeola	i	LC	2	2	0.84
Lophodytes cucullatus	i	LC	1	1	0.34
Oxyura jamaicensis	i	LC	2	4	1.35
GALLIFORMES					
CRACIDAE					
Ortalis vetula	i	LC	9	47	9.72
Ortalis poliocephala	i	LC	3	5	1.84
Ortalis leucogastra	P	LC	2	2	0.60
Penelope purpurascens	E	LC	7	27	6.25
Penelopina nigra	E	VU	3	4	1.12
Oreophasis derbianus	E	EN	3	3	0.99
Crax rubra	T	VU	7	33	6.23
ODONTOPHORIDAE					
Dendrortys macroura	T	LC	1	3	0.54
Philortyx fasciatus	i	LC	2	6	1.34
Colinus virginianus	i	NT	6	12	2.94
Colinus nigrogularis	i	LC	4	7	1.96
Callipepla squamata	i	LC	2	2	0.63
Callipepla gambelii	i	LC	2	2	0.69
Callipepla douglasii	i	LC	1	1	0.29
Cyrtonyx ocellatus	T	VU	2	2	0.60
Cyrtonyx montezumae	P	LC	2	3	0.76
Dactylortyx thoracicus	P	LC	1	1	0.29
Odontophorus guttatus	P	LC	2	5	0.97
PHASIANIDAE					
Phasianus colchinus	i	LC	3	4	1.12
Meleagris ocellata	T	NT	7	25	5.44
Meleagris gallopavo	i	LC	2	3	0.81

PHOENICOPTERIFORMES					
PHOENICOPTERIDAE					
Phoenicopterus ruber	T	LC	1	1	0.40
PODICIPEDIFORMES					
PODICIPEDIDAE					
Tachybaptus dominicus	P	LC	1	1	0.40
Podilymbus podiceps	i	LC	1	1	0.29
COLUMBIFORMES					
Columbidae					
Columba livia	i	LC	3	9	1.88
Patagioenas flavirostris	i	LC	5	11	2.62
Patagioenas fasciata	i	LC	1	3	0.54
Patagioenas nigrirostris	P	LC	1	1	0.29
Streptopelia roseogrisea	i	LC	1	1	0.30
Columbina inca	i	LC	4	14	2.68
Columbina passerina	i	LC	4	6	1.64
Columbina talpacoti	i	LC	3	5	1.19
Clavaris pretiosa	i	LC	1	2	0.42
Geotrygon montana	i	LC	1	1	0.29
Leptotila verreauxi	i	LC	6	11	2.85
Zenaida asiatica	i	LC	5	10	2.45
Zenaida macroura	i	LC	7	26	5.69
CUCULIFORMES					
CUCULIDAE					
Crotophaga sulcirostris	i	LC	5	8	2.64
Morococcyx erythropygus	i	LC	1	1	0.29
Geococcyx velox	i	LC	4	7	1.99
Geococcyx californicus	i	LC	3	4	1.06
Piaya cayana	i	LC	2	2	1.08
CAPRIMULGIFORMES					
CAPRIMULGIDAE					
Nyctidromus albicollis	i	LC	2	3	1.13
Antrostomus badius	i	LC	1	1	0.34

Antrostomus salvini	i	LC	2	2	2.02
Antrostomus vociferus	i	NT	3	3	1.04
APODIFORMES					
APODIDAE					
Cypseloides niger	i	VU	1	1	0.74
Streptoprocne zonaris	i	LC	1	1	0.40
Aeronautes saxatalis	i	LC	1	1	0.70
TROCHILIDAE					
Archilochus colubris	i	LC	1	1	0.34
Atthis ellioti	T	LC	1	1	0.48
Amazilia beryllina	i	LC	2	2	0.82
Amazilia tzacatl	i	LC	2	2	0.70
Amazilia violiceps	i	LC	1	1	0.39
GRUIFORMES					
RALLIDAE					
Aramides cajanea			4	6	1.83
Gallinula chloropus	i	LC	1	1	0.29
Fulica americana	i	LC	1	2	0.42
CHARADRIIFORMES					
RECURVIROSTRIDAE					
Himantopus mexicanus	i	LC	1	1	0.29
CHARADRIIDAE					
Charadrius semipalmatus	i	LC	1	1	0.29
JACANIDAE					
Jacana spinosa	i	LC	1	1	1.27
SCOLOPACIDAE					
Numenius phaeopus	i	LC	1	1	0.29
Limosa fedoa	i	LC	1	1	0.29
Calidris minutilla	i	LC	1	1	0.29
Actitis macularius	i	LC	1	1	0.34
Tringa semipalmata	i	LC	1	1	0.29
LARIDAE					
Thalasseus sandvicensis	i	LC	1	1	0.29
CICONIIFORMES					
CICONIIDAE					
Mycteria americana	P	LC	1	2	0.53

SULIFORMES					
PHALACROCORACIDE					
Phalacrocorax brasilianus	i	LC	2	2	0.60
PELECANIFORMES					
PELECANIDAE					
Pelecanus occidentales	i	LC	1	1	0.29
ARDEIDAE					
Tigrisoma mexicanum	P	LC	2	2	0.70
Ardea alba	i	LC	6	8	3.41
Egretta thula	i	LC	3	4	1.56
Egretta caerulea	i	LC	3	3	1.00
Bubulcus ibis	i	LC	2	2	0.95
Butorides virescens	i	LC	2	2	0.69
Nycticorax nycticorax	i	LC	1	1	0.34
Nyctanassa violacea	i	LC	2	2	0.69
CATHARTIFORMES					
CATHARTIDAE					
Coragyps astratus	i	LC	5	19	4.61
Sarcoramphus papa	E	LC	2	3	0.99
Cathartes aura	i	LC	5	13	3.29
ACCIPITRIFORMES					
PANDIONIDAE					
Pandion haliaetus	i	LC	1	1	0.55
ACCIPITRIDAE					
Harpia harpyja	E	NT	3	3	1.24
Accipiter striatus	P	LC	1	1	0.29
Buteogallus anthracinus	P	LC	1	1	0.30
Rupornis magnirostris	i	LC	7	11	4.32
Parabuteo unicinctus	P	LC	1	1	0.30
Pseudastur albicollis	P	LC	1	1	0.55
Buteo jamaicensis	i	LC	3	3	1.33
STRIGIFORMES					
TYTONIDAE					
Tyto alba	i	LC	9	13	5.45
STRIGIDAE					
Megascops trichopsis	i	LC	4	4	1.52

Megascops guatemalae	i	LC	1	1	0.48
Megascops barbarus	E	VU	1	1	0.48
Megascops cooperi	P	LC	1	1	0.48
Pulsatrix perspicillata	T	LC	1	1	0.29
Bubo virginianus	i	LC	2	3	1.54
Glaucidium brasilianum	i	LC	7	8	4.25
Athene cunicularia	i	LC	1	1	0.74
Strix virgata	i	LC	3	3	1.18
Strix fulvescens	T	LC	1	1	0.74
Aegolius ridgwayi	E	LC	1	1	0.74
TROGONIFORMES					
TROGONIDAE					
Pharomachrus mocinno	E	NT	3	3	1.18
Trogon caligatus	i	LC	2	2	0.70
Trogon mexicanus	i	LC	2	2	0.78
Trogon collaris	P	LC	3	4	1.23
CORACIIFORMES					
MOMOTIDAE					
Momotus mexicanus	i	LC	3	3	1.10
Eumomota superciliosa	i	LC	1	1	0.34
ALCEDINIDAE					
Megaceryle torquata	i	LC	2	2	0.69
Chloroceryle amazona	i	LC	1	1	0.40
PICIFORMES					
RAMPHASTIDAE					
Aulacorhynchus prasinus	P	LC	3	3	1.09
Pteroglossus torquatus	P	LC	5	15	3.47
Ramphastos sulfuratus	T	LC	7	32	6.50
PICIDAE					
Melanerpes formicivorus	i	LC	2	2	0.69
Melanerpes pygmaeus	i	LC	2	2	0.74
Melanerpes aurifrons	i	LC	3	6	1.50
Dryobates scalaris	i	LC	1	2	0.51
Dryocopus lineatus	i		4	6	1.75

Campephilus guatemalensis	P	LC	3	5	1.24
Colaptes auratus	i	LC	1	1	0.34
FALCONIFORMES					
FALCONIDAE					
Micrastur semitorquatus	P	LC	6	7	2.41
Herpethoteres cachinnans	i	LC	4	5	1.76
Falco sparverius	i	LC	2	2	0.64
PSITTACIFORMEs					
PSITTACIDAE					
Bolborhyncus lineola	T	LC	2	2	0.80
Myiopsitta monachus	i	LC	1	1	0.30
Brotogeris jugularis	T	LC	3	5	1.47
Amazona auropalliata	E	EN	3	3	1.14
Amazona oratrix	E	EN	4	11	2.82
Amazona autumnalis	i	EN	8	26	6.03
Amazona albifrons	P	LC	5	17	3.76
Aamazona xantholora	T	LC	5	14	3.12
Amazona farisona	E	NT	5	11	2.82
Eupsittula canicularis	P	LC	5	10	2.65
Eupsittula astec	P	LC	4	5	1.53
Eupsittula nana	P	NT	4	8	1.98
Ara militaris	E	VU	3	3	1.00
Ara macao	E	LC	5	18	3.94
Rhynchopsitta pachyrhyncha	E	LC	1	1	0.40
Rhynchopsitta terrisi	E	EN	1	1	0.40
Forpus cyanipygius	P	NT	1	1	0.40
Psittacara strenuus	T		2	4	1.07
Psittacara holochlorus	T	LC	3	3	1.10
PASSERIFORMES					
TYRANNIDAE					
Attila spadiceus	Pr	LC	1	1	0.74
Myozetetes similis	i	LC	2	2	0.82
Megarynchus pitangua	i	LC	1	1	0.48
Myarchus tuberculifer	i	LC	1	1	0.48

Myarchus yucatanensis	i	LC	1	1	0.48
Pyrocephalus rubinus	i	LC	1	1	0.48
Pitangus sulphuratus	i	LC	3	3	1.13
Myiodynastes luteiventris	i	LC	1	1	0.30
Tyrannus melancholicus	i	LC	2	2	0.74
Tyrannus couchhi	i	LC	2	2	0.82
TITYRIDAE					
Pachyramphus aglaiae	i	LC	1	1	0.30
COTINGIDAE					
Cotinga amabilis	T	LC	1	1	0.34
PIPRIDAE					
Chiroxiphia linearis	P	LC	2	3	0.84
CORVIDAE					
Calocitta colliei	i	LC	1	2	0.44
Calocitta farmosa	i	LC	3	3	1.00
Psilorhinus morio	i	LC	7	9	4.05
Cyanocorax yucatanicus	i	LC	3	3	1.03
Cyanocorax yncas	i	LC	3	3	1.10
Cyanocorax beecheii	E	LC	1	1	0.30
Cyanocitta stelleri	i	LC	3	3	1.25
Aphelocoma californica	i	LC	5	5	1.82
Aphelocoma ultramarina	i	LC	1	1	0.39
Corvus corax	i	LC	3	4	1.39
HIRUNDINIDAE					
Petrochelidon fulva	i	LC	1	1	0.34
Hirundus rustica	i	LC	1	2	0.51
TURDIDAE					
Sialia mexicana	i	LC	1	1	0.39
Sialia sialis	i	LC	2	2	0.70
Myadestes occidentalis	P	LC	1	3	0.57
Myadestes unicolor	T	LC	1	1	0.30
Catharus mexicanus	P	LC	1	1	0.30
Catharus dryas	T	LC	1	1	0.30
Turdus rufopalliatus	i	LC	2	2	0.70
Turdus rufitorques	T	LC	2	2	0.70
Turdus migratorius	i	LC	3	4	1.47

Turdus infuscatus	T	LC	1	1	0.30
Turdus grayi	i	LC	3	4	1.23
MIMIDAE					
Melanotis caerulescens	i	LC	2	2	0.70
Toxostoma curvirostre	i	LC	2	3	0.83
Toxostoma crissale	i	LC	1	1	0.30
Toxostoma longirostre	i	LC	1	1	0.30
Mimus gilvus	i	LC	3	4	1.58
Mimus polyglottos	i	LC	1	3	0.57
STURNIDAE					
Sturnus vulgaris	i	LC	1	1	0.30
BOMBYCILLIDAE					
Bombycilla cedrorum	i	LC	1	3	0.57
PTILIOGONATIDAE					
Ptiliogonys cinereus	i	LC	2	2	0.70
Phainopepla nitens	i	LC	1	1	0.30
PASSERIDAE					
Passer domesticus	i	LC	1	1	0.30
FRINGILLIDAE					
Chlorophonia occipitalis	i	LC	1	1	0.30
Euphonia affinis	i	LC	1	1	0.30
Euphonis elegantissima	i	LC	1	1	0.39
Coccothraustes vespertinus	i	VU	1	1	0.30
Coccothraustes abeillei	i	LC	1	1	0.30
Haemorhous mexicanus	i	LC	2	2	0.70
Spinus psaltria	i	LC	2	2	0.70
Spinus tristis	i	LC	1	1	0.30
Spinus pinus	i	LC	1	1	0.39
Spinus notatus	i	LC	2	2	0.70
PASSERELLIDAE					
Aimophila ruficeps	i	LC	1	1	0.39
Chondestes grammacus	i	LC	1	1	0.39
Junco phaeonotus	i	LC	1	1	0.30
Zonotrichia leucophrys	i	LC	1	1	0.30
ICTERIDAE					
Amblycercus holosericeus	i	LC	3	3	0.72

Psarocolius montezuma	P	LC	5	6	3.00
Icterus gularis	i	LC	4	4	1.49
Icterus mesomelas	i	LC	1	1	0.30
Icterus galbula	i	LC	1	1	0.30
Icterus bullockii	i	LC	1	1	0.30
Icterus spurius	i	LC	1	1	0.30
Icterus parisorum	i	LC	2	2	0.70
Agelaius phoeniceus	i	LC	2	2	0.70
Molothrus aeneus	i	LC	4	5	1.66
Molothrus ater	i	LC	2	2	0.70
Molothus bonariensis	i	LC	1	1	0.30
Dives dives	i	LC	3	4	1.39
Quiscalus mexicanus	i	LC	5	14	3.26
PARULIDAE					
Geothlypis poliocephala	i	LC	1	1	0.30
Basileuterus rufifrons	i	LC	1	1	0.39
CARDINALIDAE					
Piranga bidentata	i	LC	1	1	0.39
Piranga rubra	i	LC	1	1	0.39
Cardinalis cardinales	i	LC	5	12	3.03
Cardinalis sinuatus	i	LC	1	1	0.30
Pheucticus ludovicianus	i	LC	1	2	0.44
Pheucticus melanocephalus	i	LC	1	1	0.30
Pheucticus chrysopeplus	i	LC	2	2	0.70
Amaurospiza concolor	E	LC	1	1	0.30
Cyanocompsa parellina	i	LC	3	3	1.10
Passerina ciris	P	LC	1	2	0.44
Passerina caerulea	i	LC	2	2	0.70
Passerina leclancherii	i	LC	1	1	0.30
Passerina versicolor	i	LC	2	2	0.70
Passerina amoena	i	LC	2	2	0.70
Passerina cyanea	i	LC	2	5	1.10
Passerina rositae	A	NT	1	1	0.30
THRAUPIDAE					
Thraupis episcopus	i	LC	1	1	0.30
Volatinia jacarina	i	LC	2	2	0.70

Cyanerpes cyaneus	i	LC	1	1	0.30
Tiaris olivaceus	i	LC	1	2	0.44
Sporophila torqueola	i	LC	2	3	0.83
Saltator atriceps	i	LC	1	1	0.40

Other popular pets with high CVIs include *O. vetula*, Keel-billed toucans, *R. sulfuratus*, and several small brightly-colored cardinals and songbirds. Many of these birds are regularly traded in rural Mexican markets, including those that are colorful (*Cardinalis cardinalis*, *Passerina cyanea*, and *Passerina ciris*) and songbird species (*Spinus psaltria*, *Sporophila torqueola*, and *Tiaris olivaceus*) (González-Herrera et al. 2018). Roldán-Clará et al. (2017) report that trade in passerines (Orden Passeriformes) is focused on the Mexican domestic market. Pet trade-driven extinctions of tropical birds have been reported elsewhere and are linked to the demise of at least 13 Indonesian species (Eaton et al. 2015). This suggests that the pet trade needs to be more closely monitored, particularly for species where legal protection is not being enforced (Anderson and Medina-Tzuc 2005; Roblero-Morales 2008).

High levels of medicinal use were recorded for two vultures (*C. astratus* and *C. aura*), as well as Great-tailed grackles (*Q. mexicanus*), Barn owls (*T. alba*), Mourning doves (*Z. macroura*), and Common pigeons (*C. livia*). This probably stems from ancient beliefs about vultures and owls as bearers of bad omens (Anderson and Medina-Tzuc 2005; Jacobo-Salcedo 2011), and from the ubiquity and abundance of doves and pigeons, making them readily available for ritual and other purposes.

Birds are extremely popular study subjects, so we know more about their ecology and conservation status than other terrestrial vertebrate taxa, making the state of avifauna a good indicator of overall ecosystem condition (Birdlife International 2018). Local knowledge and attitudes towards natural resources are factors behind the success or failure of many conservation initiatives (Alves et al. 2018; White et al. 2011). This suggests that CVIs could be particularly useful for species where we lack population data (like many Mexican birds) because they indicate a level of demand and identify cultural uses linked to the collection or culling of wild species. CVIs are also relevant to species that historically benefitted from the protection offered by communally-held lands such as traditional Mexican ejidos, where communities operated a system of access rights and tenure that prevented overuse. There is considerable concern that such practices are being lost or ignored (Anderson and Medina-Tzuc 2005). In addition to the spatial or countrywide approach used here, CVIs could be applied to make temporal comparisons among species or taxa, particularly following demographic change or habitat loss in an area. Therefore, use-value estimates can help inform decisions concerning the sustainable management of well-studied taxa whilst also benefitting the wider ecosystem and supporting local community efforts to sustainably manage natural resources (Alves and Souto 2015; Anderson and Medina-Tzuc 2005).

Declarations

Permissions: Not applicable, based on secondary data extracted from publications in the public domain.

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References Cited

Alves, R. R. N., R. C. L. Leite, W. M. S. Souto, D. M. M. Bezerra, and A. Loures-Ribeiro. 2013. Ethno-ornithology and Conservation of Wild Birds in the Semi-Arid Caatinga of Northeastern Brazil. *Journal of Ethnobiology and Ethnomedicine* 9:14. DOI:10.1186/1746-4269-9-14.

Alves, R. R. N., J. S. Silva, L. da Silva Chaves, and U. P. Albuquerque. 2018. Introduction—Ethnozoology Animals in Our Lives. In *Ethnozoology and Animal Conservation,* edited by R. R. N. Alves and U. P. Albuquerque, pp. 1–7. Academic Press, London, UK.

Alves, R. R. N., and W. M. S. Souto. 2015. Ethnozoology: A Brief Introduction. *Ethnobiology and Conservation* 4:1–13. DOI:10.15451/ec2015-1-4.1-1-13

Anderson, E. N., and F. Medina-Tzuc. 2005. Animals and the Maya in Southeast Mexico. University of Arizona Press, Tucson, AZ.

Anderson, E. N. 2017. Birds in Maya Imagination: A Historical Ethno-Ornithology. *Journal of Ethnobiology* 37:621–636. DOI:10.2993/0278-0771-37.4.621.

Ávila-Nájera, D. M., E. J. Naranjo, B. J. Tigar, O. Villarreal, and G. D. Mendoza. 2018. An Evaluation of the Contemporary Uses and Cultural Significance of Mammals in Mexico. *Ethnobiology Letters* 9:124–135. DOI:10.14237/ebl.9.2.2018.1106.

Berlanga, H., H. Gómez de Silva, V. M. Vargas-Canales, V. Rodríguez-Contreras, L. A. Sánchez-González, R. Ortega-Álvarez, and R. Calderón-Parra. 2017. Aves de México: Lista Actualizada de Especies y Nombres Comunes. México D.F, CONABIO. Available at:https://www.biodiversidad.gob.mx/especies/scripts_aves/docs/lista_actualizada_aos_2017.pdf. Accessed on August 26, 2019.

Birdlife International. 2018. State of the World's Birds. Taking the Pulse of the Planet. [web page]. Available at:https://www.birdlife.org/sites/default/files/attachments/BL_ReportENG_V11_spreads.pdf. Accessed on August 26, 2019.

Costa-Neto, E. M., M. Vargas Clavijo, and D. Santos Fita. 2009. *Manual de Etnozoología. Una Guía Teórico-Práctica Para Investigar la Interconexión del Ser Humano con los Animales.* Tundra Ediciones Valencia, Spain.

Cuéllar Soto, E. 2017. El Aspecto Humano de la Conservación: Algunos Conflictos, Desafíos y Acciones en Argentina. *Mastozoología Neotropical* 24:9–5. Available at:https://www.sarem.org.ar/mastozoologia-neotropical-vol-24-no1/. Accessed on August 26, 2019.

Eaton, J. A., C. R. Shepherd, F. E. Rheindt, J. B. C. Harris, S. B. van Balen, D. S. Wilcove, and N. J. Collar. 2015. Trade-Driven Extinctions and Near-Extinctions of Avian Taxa in Sundaic Indonesia. *Forktail* 31:1–12.

González-Herrera L. R., J. Chablé-Santos, W. Aguilar-Cordero, and P. Manríque-Saide. 2018. El Comercio de Aves Silvestres En La Ciudad de Mérida, Yucatán, México. *Ecosistemas y Recursos Agropecuarios* 5:271–281.

Hull, K., and R. Fergus. 2017. Birds as Seers: An Ethno-Ornithological Approach to Omens and Prognostication among the Ch'Orti' Maya of Guatemala. *Journal of Ethnobiology* 37:604–620. DOI:10.2993/0278-0771-37.4.604.

Jacobo-Salcedo, M. R., A. J. Alonso-Castro, and A. Zarate-Martínez. 2010. Folk Medicinal Use of Fauna in Mapimi, Durango, México. *Journal of Ethnopharmacology* 122:902–906. DOI:10.1016/j.jep.2010.10.005.

Navarro-Sigüenza, A. G., M. F. Rebón-Gallardo, A. Gordillo-Martínez, A. T. Peterson, H. Berlanga-García, and L. A. Sánchez-González. 2014. Biodiversidad de Aves en México. *Revista Mexicana de Biodiversidad* 85:S476–495. DOI:10.7550/rmb.41882.

Ortiz-Pulido, R. 2018. ¿Qué Especies de Aves Están en Riesgo en México? *Huitzil, Revista Mexicana de Ornitología* 19:237**–**2. DOI:10.28947/hrmo.2018.19.2.348.

Ortiz-Pulido, R., J. L. Alcántara-Carbajal, H. de la Cueva, J. Martínez-Gómez, P. Escalante Pliego, S. Parra-Martínez, T. P. Feria Arroyo, and S. Albert. 2016. Conservación de Aves en México, una Instantánea de 2015. *Huitzil, Revista Mexicana de Ornitología* 17:234–238. DOI:10.28947/hrmo.2016.17.2.252.

Partasasmita, R., J. Iskandar, and N. Malone. 2016. Karangwangi People's (South Cianjur, West Java, Indonesia) Local Knowledge of Species, Forest Utilization and Wildlife Conservation. *Biodiversitas* 17:154–161. DOI:10.13057/biodiv/d170123.

Pires, S. F. 2012. The Illegal Parrot Trade: A Literature Review. *Global Crime* 13:176–190. DOI:10.1080/17440572.2012.700180.

Riedler, R., E. Pearlstein, and M. Gleeson. 2012. Featherwork: Beyond Decorative. *Studies in Conservation* 57 (Supplement 1):S244–249. DOI:10.1179/2047058412Y.0000000052.

Roblero-Morales, M. 2008. La Relación Hombre-Naturaleza Entre los Lacandones de Nahá, Ocosingo, Chiapas. *Estudios Sociales y Humanísticos* 6:125–140. DOI:10.29043/liminar.v6i1.271.

Roldán-Clará, V., V. M. Toledo, and I. Espejel. 2017. The Use of Birds as Pets in Mexico. Journal of Ethnolobiology and Ethnomedicine 13:1–18. DOI:10.1186/s13002-017-0161-z.

Sault, N. 2016. How Hummingbird and Vulture Mediate Between Life and Death in Latin America. *Journal of Ethnobiology* 36:783–806. DOI:10.2993/0278-0771-36.4.783.

SEMARNAT. 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010. Protección Ambiental, Especies Nativas de Flora y Fauna Silvestres de México, Categorías de Riesgo y Especificaciones Para su Inclusión, Exclusión o Cambio, y Lista de Especies en Riesgo. Diario Oficial de la Federación. S. D. M. A. and R. N. (SEMARNAT, Mexico). Available at:http://dof.gob.mx/normasOficiales/4254/semarnat/semarnat.htm. Accessed on August 26, 2019.

Tábara, J. D. 2006. Las Aves Como Naturaleza y la Conservación de las Aves Como Cultura. *Papers: Revista de Sociología* 82:57–77. DOI:10.5565/rev/papers.2049.

Toledo, V. M., and N. Barrera-Bassols. 2008. *La Memoria Biocultural. La Importancia Ecológica de las Sabidurías Tradicionales,* 1st edition. Icaria, Barcelona, Spain.

Turner, N. J. 1988. The Importance of a Rose: Evaluating the Cultural Significance of Plants in Thompson and Lillooet Interior Salish. *American Anthropologist, New Serie*s 90:272–290. DOI:10.1525/aa.1988.90.2.02a00020.

Valadez, A. R. 2003. Domesticación y Zootecnia en el México Antiguo. *Imagen Veterinaria* 3:32–45.

Vásquez-Dávila, M. A, eds. 2014. *Aves, Personas y Culturas*. *Estudios de Etno–Ornitología.* CONACYT/ ITVO/Carteles Editores/UTCH. Oaxaca, México.

White, T., A. Johnson-Camacho, T. Bloom, P. Lancho-Diéguez, and R. Sellares. 2011. Human Perceptions Regarding Endangered Species Conservation: A Case Study of Saona Island, Dominican Republic. *Revista Latinoamericana de Conservación* 2:18–29.