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Assessing Knowledge of the Caracaras: Compiling Information, Identifying Knowledge Gaps, and Recommendations for Future Research

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ABSTRACT.—Because information availability and management are essential components of wildlife conservation, we sought to compile literature published since 1900 on the caracaras, a group of nine extant species, eight of which occur only in Central America and South America. Our findings revealed that the number of sources and therefore, the amount and types of information available varied considerably among the caracara species and among countries where these raptors occur. Most sources represented studies conducted in Argentina, the United States, Brazil, and Chile, and many focused on the more common species, for example, the Crested Caracara (*Caracara plancus*) and the Chimango Caracara (*Milvago chimango*). Most sources published in the early 20th century focused on breeding and feeding ecology and natural history. Since the 1960s, the number of studies published per decade has increased, and since the 1990s, more studies have addressed a broader range of topics including behavioral ecology, demography, infectious agents, parasites, contaminants, biomedicine, and taxonomic relatedness among the caracara species and other falcons. Aside from the Striated Caracara (*Phalcoboenus australis*), which recently has been the subject of intensive research, other species in the genus *Phalcoboenus* (the Mountain Caracara [*P. megalopterus*]; the White-throated Caracara [*P. albogularis*]; and the Carunculated Caracara, [*P. carunculatus*]) remain little known, as do the two forest-dwelling caracaras, the Black Caracara (*Daptrius ater*) and the Red-throated Caracara (*Ibycter americanus*). Knowledge gaps exist for all the caracaras; research is especially needed on subjects outside typically studied topics such as breeding and feeding ecology. Also important to expanding knowledge of this group will be collaboration with researchers studying other avian scavengers such as condors and vultures, focusing on common threats, and coordination among researchers in countries inhabited by multiple caracara species.

KEY WORDS: *caracara*; Daptrius; Ibycter; Milvago; Phalcoboenus; *scavengers.*

EVALUANDO EL CONOCIMIENTO SOBRE LOS CARACARAS: COMPILANDO INFORMACIÓN, IDENTIFICANDO VACÍOS DE CONOCIMIENTO Y RECOMENDACIONES PARA INVESTIGACIONES FUTURAS

RESUMEN.—Contar con información y poder implementar medidas de gestión es esencial para la conservación de la fauna silvestre. Consecuentemente, realizamos una revisión exhaustiva de la literatura existente para las nueve especies reconocidas de caracaras, sobre las que existe información limitada cuando se compara con rapaces de Norte América, Europa y otras regiones fuera de la región Neotropical. Nuestro análisis identificó, en base al número y tipos de fuente, que la cantidad de información existente sobre este grupo varió en función de la especie y del país donde habitan. La mayoría de las publicaciones se originaron en estudios realizados en Argentina, Estados Unidos, Brasil y

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Chile y sobre las especies más comunes, por ejemplo, *Caracara plancus* y *Milvago chimango*. A partir de la década de 1960 se observó un aumento en el número de publicaciones; previamente éstas estaban focalizadas en la historia natural y la ecología reproductiva y trófica de estas especies. A partir de la década de 1990, los trabajos publicados sobre este grupo ampliaron el rango de temas estudiados, incluyendo ecología comportamental, demografía, agentes infecciosos y parasitarios, contaminantes, biomedicina, e incluso estudios taxonómicos dedicados a entender mejor tanto las relaciones entre las distintas especies de caracaras entre sí como su relación con los halcones. Excepto para *Phalcoboenus australis*, quien recientemente ha sido objeto de investigación intensiva, otras especies en el género *Phalcoboenus* (*P. megalopteris*, *P. albogularis* y *P. carunculatus*) siguen siendo prácticamente desconocidas, al igual que las dos especies de caracaras selváticos, *Daptrius ater* e *Ibycter americanus*. Se necesita un mayor número de estudios sobre todas las especies de caracaras que incluyan otros temas más allá de la ecología reproductiva y trófica. La colaboración con investigadores que trabajan con otras especies de rapaces carroñeras, como cóndores y gallinazos, es esencial. Una mayor integración y coordinación de los esfuerzos permitirá identificar y reducir las amenazas comunes para estos grupos, sobre todo en aquellos países que cuentan con varias especies de caracaras.

[Traducción de los autores editada]

INTRODUCTION

As a group, raptors are often the focus of conservation efforts because of their exposure, globally, to a variety of human-caused environmental changes. These changes have led to the threatened or endangered status of many species. Owing to their ecology, life history, and often limited geographic distributions, raptors are disproportionately threatened with extinction compared to other avian groups (McClure et al. 2018, Buechley et al. 2019). To identify and mitigate threats to raptor populations, research on an individual species throughout its geographic distribution, along with communication and collaboration among scientists can lead to successful conservation measures. For example, dedicated research and collaboration have led to significant progress toward long-term population persistence of the Peregrine Falcon (*Falco peregrinus*), Bald Eagle (*Haliaeetus leucocephalus*), and California Condor (*Gymnogyps californianus*) in North America (Watts et al. 2008, 2015, Walters et al. 2010), Mauritius Kestrel (*Falco punctatus*) on the island of Mauritius in the western Indian Ocean (Jones et al. 1994), and the Golden Eagle (*Aquila chrysaetos*, Fernández-Gil et al. 2022) and Saker Falcon (*Falco cherrug*, Lazarova et al. 2021) in Europe.

Information availability and management are essential components of wildlife conservation. The lack of research findings or lack of availability thereof can hinder development and implementation of appropriate conservation strategies (Sunderland et al. 2009, Buechley et al. 2019). Recent efforts toward systematically gathering and summarizing literature have proven useful in identifying knowledge gaps for some species (Trejo 2007, Lincer et al. 2018, McClure et al. 2022, Méndez et al. 2022). Research is often focused on large and widely recognized charismatic species that garner media attention, and these species often are more likely to receive research funds. Although this strategy generally results in a broad knowledge base on those species, other less recognized species may remain relatively unknown.

Caracaras are included in Polyborinae, the most diverse subfamily of the avian family Falconidae (Fuchs et al. 2012). This group includes nine extant species of caracaras; one species, the Guadalupe Caracara (*Caracara lutosa*), is extinct. This species, known only from the Island of Guadalupe off the coast of the Baja peninsula, Mexico, represents a classic example of extinction due to lack of basic knowledge. In 1900, a collector encountered a group of 11 caracaras on the island. Not knowing of this species' social behavior and believing earlier reports that it was abundant, the collector shot and killed all 11, the last individuals of the species (Abbott 1933).

The Polyborinae are endemic to the New World, and most species occur only in Central and South America (Ferguson-Lees and Christie 2001). Distribution maps and basic information on the extant caracaras can be found in ebird (https://ebird.org/home) and in the Birds of the World (https://birdsoftheworld.org/bow/home) accounts; however, most accounts provide little information other than a species' distribution and food habits. The Black Caracara (*Daptrius ater*) and Red-throated Caracara (*Ibycter americanus*) are primarily omnivorous forest dwellers ranging throughout northern South America. The Yellow-headed Caracara (*Milvago chimachima*) ranges from the lowlands in Costa Rica south throughout northern Amazonia. The Chimango Caracara (*M. chimango*) is one of the most common open country birds found throughout southern South America.

The four species in the genus *Phalcoboenus* are terrestrial generalists and scavengers and have limited distributions along the Andes and Southern Atlantic Ocean islands. These species range from coastal areas and open foothill slopes (White-throated Caracara [*P. albogularis*]) to the *puna* grasslands (Mountain Caracara [*P. megalopterus*]) and the high Andean *paramo* (Carunculated Caracara [*P. carunculatus*]). The Striated Caracara (*P. australis*) occurs only on the Islas Malvinas/Falkland Islands and coastal areas of Isla Grande de Tierra del Fuego and adjacent islands. The Crested Caracara (*Caracara plancus*), a generalist and scavenger, occurs throughout South and Central America and is the only species with a distribution extending into North America.

Some caracara species are easily observed particularly as they are common on ranchlands and in some urban and suburban areas of South and Central America (Leveau and Leveau 2004, Solaro and Sarasola 2019). Some species are easily recognized by indigenous groups; thus, they have an important role in the local folklore and ethnology (Oramas 1989, Díaz 1992, Meiburg 2021). Yet as a group, caracaras seem to receive less attention relative to other raptors, and to our knowledge there has been no gathering of information or broad assessment of the status of knowledge of this group. Even though most caracaras are classified as Least Concern by the International Union for Conservation of Nature (IUCN; https://www.iucnredlist.org/), there is little reliable information justifying these classifications. Here we present a compilation of the existing literature on this group of raptors, for the purpose of obtaining a general understanding of what has been published on this group, on each species, and on which subjects. Our intent was to assess and summarize the types of information available on these raptors, to identify knowledge gaps, and to provide recommendations for future research.

METHODS

We searched for and compiled scientific literature on all nine extant species of caracaras. We searched for sources published from 1900 through December 2022 using online databases including BioOne, Google Scholar, PubMed, Scopus, Biological Abstracts, Web of Science, SORA (Searchable Ornithological Research Archive, https://sora.unm.edu/), and GRIN (Global Raptor Impact Network, https://globalraptors.org/). Key words used in searches included English, Spanish, Portuguese, French, and native common names that were mentioned in the sources; we searched these names broadly in the literature. Searches also included scientific names and genera that represented both current and previously recognized taxonomies (e.g., *Polyborus* as a synonym of *Caracara*) and variable taxonomic status, e.g., Northern Caracara (*C.* [*plancus*] *cheriway*) and Southern Caracara (*C.* [*plancus*] *plancus*). In our analyses, we maintained the use of scientific names of all caracaras as currently recognized by the American Ornithological Society in North and Middle America (Chesser et al. 2023) and South America (Remsen et al. 2023), and by this journal. We also searched for sources in several South and Central American ornithological and wildlife journals known by the authors but not indexed in online databases (Supplemental Material Table S1) by reviewing their tables of contents and full articles if in doubt as to their focus. We examined all references listed for all caracara species in Birds of the World online. Finally, we searched recent reviews and/or compilations of ornithological literature for references to caracaras in specific countries (e.g., Argentina: Trejo 2007, de la Peña 2020; Chile: Pincheira-Ulbrich et al. 2008). When we found the same source in multiple databases, we included that source only once in our analyses.

Our final list of sources included peer-reviewed articles, book chapters, and appropriate gray literature (hereafter sources) that met our inclusion criteria. Included sources had a focus on one or more caracara species. We did not include sources that merely listed the species as part of a broader catalogue or checklist or that included only anecdotal field observations (e.g., extra-limital records). Field guides (e.g., Hilty and Brown 1986, Schulenberg et al. 2010, Pearman and Areta 2021) and many classic ornithological books (e.g., Johnson 1965, Fjeldså and Krabbe 1990, Sick 1993), including those focused on raptors from countries throughout the New World (e.g., Johnsgard 1990, Márquez et al. 2005, Iriarte et al. 2019) often provide some information on caracaras. However, we did not include these sources in our final source list or in analyses because there are many and because they typically are based on compilation of previously published literature so become dated when new scientific information is published. We did, however, review references listed in some of these volumes, e.g., in Handbook of the Birds of the World (del Hoyo et al. 1994) and Raptors of the World (Ferguson-Lees and Christie 2001) and pursued these references if they were relevant to our analysis.

For the analyses, we classified each source by the focal species, the country where the study was conducted, and the source name and year of publication.

Table 1. Categories and their definitions used to classify sources on caracaras and in our analyses.

Category	Definition and/or Scope
Behavioral ecology	Studies of behaviors that allow animals to adapt to and thrive in their environment. Includes studies of cognition, but excludes studies of foraging and breeding behaviors
Biomedicine	Studies focused on anatomy, physiology, health, noninfectious or parasitic diseases, diagnosis, therapeutics, medicine, etc.
Breeding ecology	Studies of nesting habits and reproductive success
Conservation and management	Studies focused on threats and mitigation of those threats
Contaminants	Studies focused on exposure to and consequences of environmental contaminants
Demography	Studies focused on the status of and changes in raptor populations
Ethno-ornithology	Studies focused on knowledge that embraces the relationship between people and birds
Evolutionary biology	Studies focused on adaptations or causes of changes in populations over time
Feeding and foraging ecology	Studies focused on diet, feeding and predation behaviors, foraging modes
Infectious and parasitic agents	Studies focused on infectious and parasitic agents
Movement	Studies focused on animal movements (local, long-distance, and migratory)
Natural history	Studies that contained only limited discussion of one or more of the other categories, that provided only basic or anecdotal information about a species, or for which none of the categories could be specifically assigned
Phylogeny, systematics, and genetics	Studies focused on investigations of biological relatedness among species, including morphological and genetic analyses

To aid in identifying the focus of each source (*sensu* McClure et al. 2022), we assigned each source to one of 13 categories that we designated based upon topics gleaned from source titles, key words (when available), and topics that were the source's primary focus (Table 1).

RESULTS

We identified a total of 335 sources that met our inclusion criteria. These were research articles, short communications, notes, letters, and book chapters published in 156 different resources including books, peer-reviewed journals, and a few sources from the gray literature (Haddaway et al. 2015).

Information about the extant caracaras in these sources was unevenly distributed across countries and species. Most sources (31%) represented studies conducted in Argentina followed by sources representing studies conducted in the United States, Brazil, and Chile (Table 2). Nine sources focused on caracaras from multiple countries; most were comparative examinations of morphology and phylogenetic relationships among all extant species within Polyborinae and multiple species within Falconidae (e.g., Griffiths 1999, Fuchs et al. 2012). We found only one source focused on caracaras from the Caribbean region (Nijman et al. 2009). Four sources discussed studies conducted only on museum specimens or on captive birds in facilities out of the species' home country.

Two hundred seventy-four sources (82%) focused on a single caracara species, 37 sources (11%) focused on two species, and 24 sources (7%) included comparisons among three or more species of caracaras. Sources including multiple species often represented studies conducted in countries where several caracara species occur (e.g., Argentina and Brazil). These sources often focused on topics such as comparative abundance, nesting and feeding ecology, habitat use, and conservation status. The four species most often the focus of all sources were the Crested Caracara, Chimango Caracara, Yellow-headed Caracara, and Striated Caracara. The Crested Caracara was represented in 145 (53%) sources having a single-species focus and in 58 (95%) sources that included multiple species (Table 3).

The total number of sources focused on caracaras and the number per decade has increased since 1900 (Fig. 1). Most sources published before the 1960s were descriptions of the caracaras' natural history, breeding ecology, or feeding ecology, but a few sources examined infectious and parasitic agents. More sources were published beginning in the 1980s, and the number of sources increased during the subsequent three decades mostly due to extensive research conducted on the most common species—Crested Caracara and Chimango Caracara—with contributions from Argentina, Chile, and the United States.

Overall, aspects of caracaras' feeding and foraging ecology, behavioral ecology, and breeding ecology

Table 2. Countries represented in sources that included information on caracaras.

Country	Number of Sources	Percent
Argentina	102	31
USA	59	18
Brazil	56	17
Chile	37	11
Islas Malvinas/Falkland Islands	13	4
Costa Rica	9	3
Multiple countries	9	3
French Guyana	8	2
Mexico	8	2
Colombia	6	2
Ecuador	4	1
Peru	4	1
Panama	3	1
Venezuela	3	1
Honduras	2	1
Surinam	2	1
Belize	1	<1
Bonaire (Netherlands Antilles)	1	<1
Guatemala	1	<1
Nicaragua	1	<1
Paraguay	1	<1
Uruguay	1	<1

were the focus of most studies (Table 4). Sources focused on topics related to raptor health (the categories of biomedicine and infectious and parasitic agents) originated primarily in Argentina and Brazil (Table 5). Growth in the number of sources focused on contaminants, behavioral ecology, phylogeny and systematics, and conservation and management has increased since the early 2000s.

Among the four species most commonly encountered in all sources, the Crested Caracara was the focus of most sources across all 13 categories, and most sources that included these four species focused on feeding and foraging ecology (Fig. 2). Multiple sources represented studies conducted on these more common species although even they have not been studied widely throughout their respective distributions. Many publications are available on the Florida population of the Crested Caracara in North America (e.g., Morrison 1999, Dwyer et al. 2013), but this species has not been well studied throughout the majority of its broad range in Central and South America or in other US states where it occurs. The Chimango and Yellow-headed Caracaras are becoming increasingly common in developed areas in South America (e.g., Leveau and Leveau 2004, de La Ossa-Lacayo and de La Ossa 2011); however, much of the information known for the Chimango Caracara comes from behavioral and cognitive studies conducted on captive birds (e.g., Biondi et al. 2008, Guido et al. 2017). In the last three decades, the diet and foraging behavior of the Yellow-headed Caracara has received more attention (e.g., de Lima Pereira and Araujo 2020, Gijsman and Guevara 2020) although comprehensive studies on the ecology of this caracara are still lacking.

Table 3. Representation of each extant caracara in single-species-focused sources ($n = 274$) or sources that included multiple species of caracara ($n = 61$).

Species	Occurrence in Sources with a Single Species Focus	Occurrence in Sources that included Multiple Species
Crested Caracara	145 (53%)	58 (95%)
Chimango Caracara	62 (23%)	43 (70%)
Striated Caracara	22 (8%)	14 (21%)
Yellow-headed Caracara	21 (8%)	29 (48%)
Red-throated Caracara	9 (3%)	9 (15%)
Mountain Caracara	7 (3%)	10 (16%)
Black Caracara	6 (2%)	10 (16%)
White-throated Caracara	1 (<1%)	9 (15%)
Carunculated Caracara	1 (<1%)	1 (2%)

The two forest-dwelling caracaras, the Black Caracara and the Red-throated Caracara, are also little studied despite being described as having comparatively large geographic distributions (Bierregaard et al. 2020, Davis and McCann 2020). Most sources found for these species included comparisons of food habits among them, other caracaras, and other falcons (e.g., Olmos and Sazima 2009, McCann et al. 2013). We found only a few studies on these caracaras' breeding biology (e.g., Whittaker 1996, McCann et al. 2010).

The Striated Caracara is common where it occurs, but it has a limited, insular geographic distribution. As such, this caracara is listed as near threatened by the IUCN, yet only recently has it been the subject of focused research (e.g., Harrington et al. 2018, Autilio et al. 2019). Colonies of this raptor occurring in the Staten Island, Tierra del Fuego province, Argentina, have been the subject of additional research (Balza et al. 2020).

We found few sources focused on the three other species in the genus *Phalcoboenus*. Most sources for the Mountain Caracara addressed diet and foraging (e.g., Donadio et al. 2007). We found

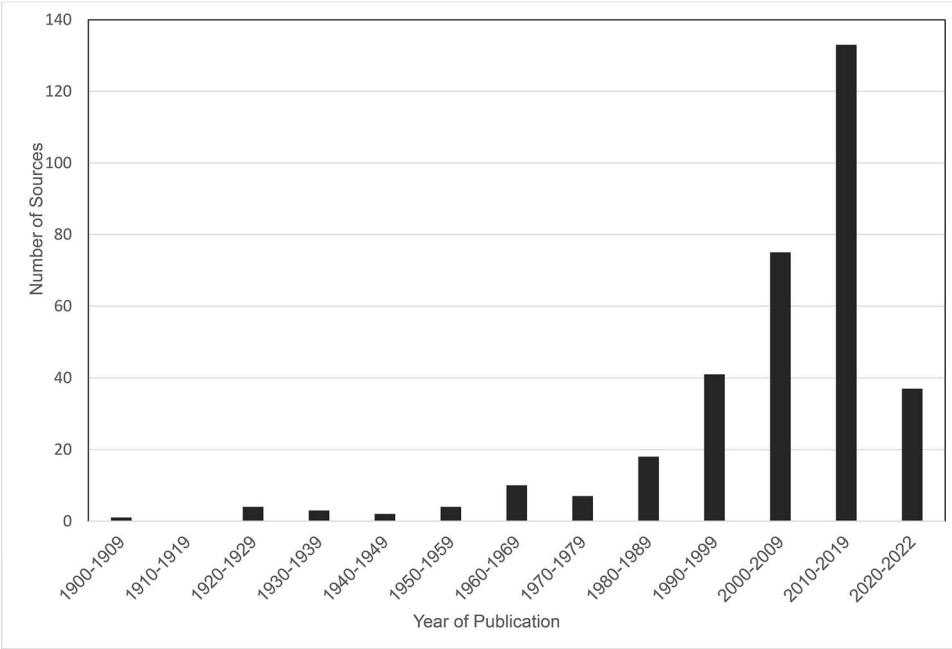

Fig. 1. The total number of sources focused on caracaras and the number identified per decade has increased since 1900. The cutoff date for including sources in our analyses was December 2022.

information on parasites of the White-throated Caracara (Moreno and González-Acuña 2015) but no sources on its breeding ecology and very limited information on the Carunculated Caracara, mostly from only one source that contained natural history information (de Vries et al. 1983).

Four sources were based on studies conducted on live caracaras being held in captivity outside the American continents; these studies focused mainly on biomedical aspects of these raptors (e.g., Potier et al. 2016). Although the first biomedical studies on caracaras were conducted in the 1960s (e.g., Glerean and de Castro 1965), biomedical investigations on these raptors began increasing in the 1990s; these included anatomical, histological, and physiological investigations (e.g., Inzunza et al. 1991, de Speroni and Carezzano 1992, Samar et al. 1996). From 2000 onward, biomedical studies have expanded to include aspects of veterinary medicine relevant to caracaras such as anesthesia, pharmacology, surgery, hematology and clinical biochemistry, and neoplastic and ocular disorders. These studies have been conducted mostly on captive caracaras in collections or on birds admitted to rehabilitation centers.

DISCUSSION

Our explorations of the scientific literature revealed that the number of sources and therefore, the amount and types of information available varied considerably among the caracara species and

Table 4. Proportion of sources focused on caracaras that included information about each category. We designated the categories based upon the source's title, key words (when available), and the topic that was the source's main focus.

Category	Proportion of Sources
Behavioral ecology	0.13
Biomedicine	0.09
Breeding ecology	0.11
Conservation and management	0.04
Contaminants	0.02
Demography	0.10
Ethno-ornithology	<0.01
Evolutionary biology	0.01
Feeding and foraging ecology	0.22
Infectious and parasitic agents	0.08
Movement	0.01
Natural history	0.15
Phylogeny, systematics, and genetics	0.04

Table 5. Number of sources in each category that originated in countries/territories with 10 or more sources focused on caracaras.

Category	Argentina	Brazil	Chile	USA	Islas Malvinas/Falkland Islands
Behavioral ecology	16	6	1	9	3
Biomedicine	10	15	1		
Breeding ecology	13	2	2	13	1
Conservation and management	5		3	3	
Contaminants	3	2		1	
Demography	15	3	1	7	
Evolutionary ecology	4				
Feeding and foraging ecology	19	14	8	7	6
Infectious and parasitic agents	3	10	8	4	
Movement	2			1	1
Natural history	12	3	12	7	2
Phylogeny, systematics, and genetics				4	

among countries where these raptors occur. As for most Neotropical raptors, there is little information on the basic ecology of most of the caracaras. The geographic distribution and even much of the natural history are not well known for most species, highlighting the need for more research overall (Saggese 2021). Even with the advancement of Neotropical ornithology in recent decades, raptor biologists often focus on hypothesis-based research, rarely covering natural history and basic ecology of Neotropical raptors in their studies (Figueroa Rojas 2015, Saggese 2021). We recommend that future research for all caracaras should expand to focus on a broad range of subjects, for example, as enumerated by our listed categories, especially given recent advances in tracking and veterinary technology. Topics such as movement ecology, evolutionary biology, and raptor health issues such as the role of contaminants and infectious and parasitic agents in population ecology should be of increased interest to caracara researchers.

We identified the most and a wide breadth of sources for the more common and widely distributed species but few sources for species with limited geographic distributions. This could be due to lack of interest possibly attributable to negative perceptions of scavengers but also, and more likely, because many of the areas where the latter species occur are difficult to access (e.g., high elevation, Amazon forest, and islands located across dangerous waterways), making conducting research challenging. Better information on the status of all the caracaras is needed, particularly for those species that apparently occur in disjunct or small populations across limited distributions. These species would benefit by direction of more human and economic resources toward supporting research to better determine the current status and conservation needs of populations.

Collaboration among researchers in countries inhabited by one or more of these raptors is critical to better understand species' distribution, status, and ecology. For example, long-term persistence of the Striated Caracara throughout its distribution in Tierra del Fuego and across the islands of the southern Atlantic and Pacific and the Islas Malvinas/Falkland Islands will require collaboration among researchers in Chile, Argentina, and the United Kingdom. Better understanding of how the Chimango and Yellow-headed Caracaras respond to urban environments throughout their respective ranges will require communication and collaboration among researchers throughout areas where those ranges overlap.

Despite the lack of basic natural history information for some caracaras, sources assigned to our category Conservation and Management often identified threats (*sensu* Salafsky et al. 2008). Many of these threats were common among all the caracaras (e.g., destruction and degradation of habitat due to urbanization and agricultural expansion, direct persecution such as shooting or poisoning, and harassment). Poisoning is often aimed at mammalian carnivores, yet this threat is shared among avian scavengers including the endangered California Condor (*Gymnogyps californianus*) in North America, the Andean Condor (*Vultur gryphus*) along the Andes and in Patagonia, several caracaras, and vultures. Collaboration among condor biologists and others studying avian scavengers focusing on common threats would enhance knowledge and possibly foster conservation strategies targeted at all these species. We recommend that caracara researchers interact with the IUCN Vulture

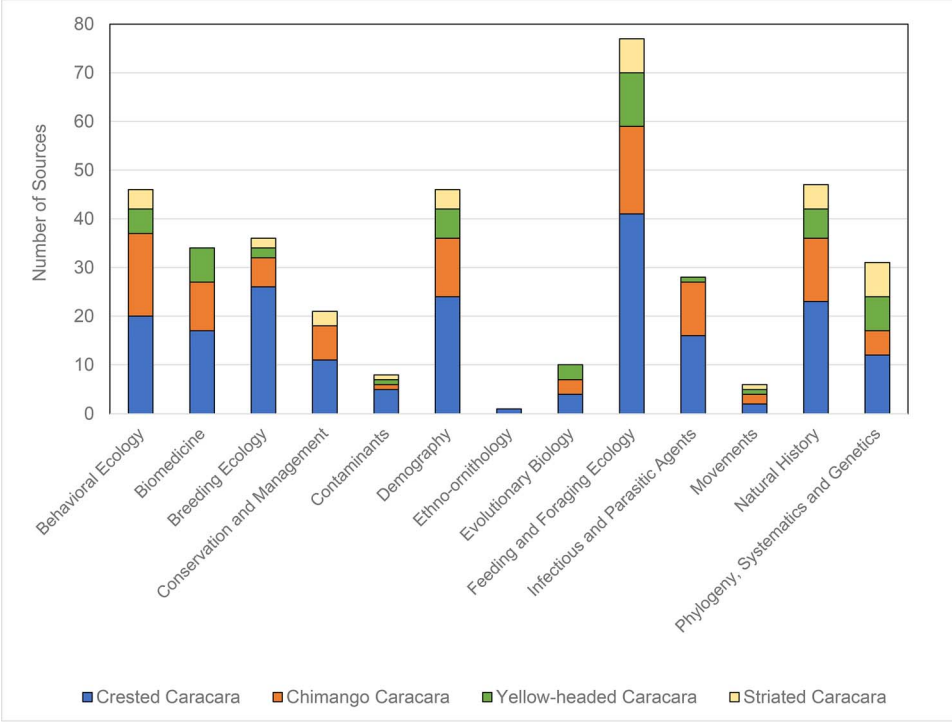

Fig. 2. Among the four species most commonly encountered in all sources, the Crested Caracara was the focus of most sources across all 13 categories.

Specialist Group (https://www.iucnvsg.org/) as these species face many of the same threats as caracaras, especially in their role as scavengers.

Owing to their generalist diet and often gregarious nature, several species of caracaras have expanded into and seem to be thriving in urban and peri-urban areas. As such, future research on these species necessitates a focus on human–wildlife conflicts. Particularly in high density urban areas, caracaras may be subject to the above threats but also could encounter threats typically associated with developed areas. Threats include predation by pets or feral domestic animals, encountering and then feeding on novel and possibly unhealthy foods (e.g., at rubbish dumps), and increased intra-specific competition or competition with common species that the caracaras would not historically have encountered such as other scavengers and urban exploiters. Some caracaras actively include human-made materials in their nests; entanglement of nestlings in these materials can cause injuries and even mortality (Mallet et al. 2020, Lima et al. 2022). Many species use anthropogenic substrates for nesting, including utility poles, billboards, light towers, and petroleum drilling machinery (e.g., Dwyer and Dalla Rosa 2015, Saggese et al. 2022a), likely contributing to an increase in perceived or real human–raptor conflicts. Because of their tendency to scavenge for road-killed animals, caracaras are highly susceptible to road mortality (Morrison 2003). Given this variety of threats, urban areas may become ecological traps for some caracaras.

Scavengers and common urban species such as crows (*Corvus* spp.) or Rock Pigeons (*Columba livia*) are often viewed as pests and thus are subject to harassment. Because caracaras tend to gather in (sometimes noisy) feeding groups, these raptors could also engender these negative attitudes, particularly as they expand into urban areas. In some regions of South America, groups of caracaras may prey on diseased or weakened young livestock and thus caracaras are heavily persecuted (Zambra et al. 2022). Given increasing contact among humans and caracaras in agricultural and now more often in urban areas, human dimensions will be an essential component of future research on these raptors. A major task will be to work at dismantling the negative perceptions of scavengers.

Another threat increasingly faced by raptors worldwide is the broad use of rodenticides. These can pose serious threats to caracaras in urban and rural areas (Saggese et al. 2022b). Unfortunately, many areas of South America lack the facilities to investigate exposures to pathogens and contaminants, a fact that likely affects the identification and mitigation of these threats for all raptors and scavengers, including caracaras (Saggese et al. 2022b).

Finally, taxonomic relationships among the caracara species within the subfamily Polyborinae and even within the broader Falconidae remain in flux and not well understood. Numerous revisions of generic and specific names for the caracaras have occurred in the past century; these can be found in various lists, monographs, and catalogues (e.g. Swann 1925, Hellmayr and Conover 1949). We did not include these in our final list of sources, however; we only included sources that described studies focused specifically on taxonomic relationships among caracaras within Polyborinae and/or Falconidae (e.g., Griffiths 1999, Fuchs et al. 2012). Studies of genetic relationships among the caracara species and focused on population genetics within species remain badly needed.

Conservation Priorities and Recommendations for Future Research. We intend for this article to serve as a resource not only for baseline information on all caracaras and to facilitate literature searches, but to encourage further research interest, particularly on the lesser-known species and on the aforementioned subjects, in those countries where available information on these raptors is scarce or nonexistent. Expanding the knowledge base for all caracara species will require collaboration among researchers in all countries where these raptors occur. To facilitate collaboration and communication, we established a caracara working group that we hope will lead to information sharing and continued discussions about research needs, including study sites and funding sources. Because the goal of the working group is to generate more interest in all the caracaras and to encourage more research, we encourage regular communication among group members. Readers interested in participating in the working group may contact either author. Additionally, we encourage readers to share information within the group of newly published sources focused on caracaras.

Lack of information on caracaras is not just due to lack of interest. Barriers to expanding knowledge of this group exist that may challenge researchers seeking to start new projects or to publish existing data. Funding is a barrier to conducting research in many countries in Central and South America. Particularly challenging is that funding is often disproportionally allocated to listed species and to some species that are common (e.g., Crested Caracara, Chimango Caracara, and Striated Caracara). Such allocations may enhance our knowledge of these species but may inadvertently limit studies on other lesser-known species (e.g., the Andean caracaras: White-throated Caracara, Carunculated Caracara, and Mountain Caracara). There is an urgent need for more focused studies on these and on the two forest-dwelling caracaras (the Black Caracara and the Red-throated Caracara).

Finally, while conducting research on some caracara species can be challenging, for other species the opposite is true. Overall, caracaras are not shy; they are gregarious and quite intelligent, similar to crows and ravens. Some species are abundant locally and congregate in groups, which fosters social behavior-based research. All species are large enough for currently available GPS/GSM transmitters, many of which provide data globally, and trapping methods have been described for some species (Morrison and McGehee 1996, McCann et al. 2010, Sarasola et al. 2011, Harrington et al. 2018). We hope these facts and the need for expanding the knowledge base on these unique raptors will encourage increased attention and additional research.

SUPPLEMENTAL MATERIAL (available online). Table S1: Final caracaras literature, 1900–2022.

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