

Using Citizen Science Data to Investigate the Diet of the Mountain Caracara (*Phalacrocorax mexicanus*) and White-throated Caracara (*Phalacrocorax albogularis*)

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ABSTRACT.—The Mountain Caracara (*Phalacrocorax mexicanus*) and White-throated Caracara (*Phalacrocorax albogularis*) are two sister species each with a limited distribution along the Andes from Ecuador to Tierra del Fuego. They occur in remote areas and are among the least known caracaras, and their diet has been little studied, particularly for the White-throated Caracara. We investigated the diet of these two caracaras by analyzing photographs provided by citizen scientists and obtained from the Macaulay Library (eBird) and iNaturalist platforms. We obtained 43 photographs for Mountain Caracara and 42 photographs for White-throated Caracara that could be used to identify food items. Photographs of the Mountain Caracara showed the species mainly feeding on carrion, often of domestic animals, followed by human foods and garbage. Photographs of the White-throated Caracara showed this species mainly feeding on carrion and garbage. However, we did find photographs of both caracaras feeding on wild species including camelids, rodents, birds, lizards, and some invertebrates. Further research should investigate possible effects of human-derived items in the diet of these caracaras, such as malnutrition due to consumption of inappropriate foods, and effects of ingestion of plastics and toxic substances.

KEY WORDS: Andean raptors; Anthropocene; caracara; carrion; diet; garbage; opportunism; rubbish; scavenger.

USO DE CIENCIA CIUDADANA PARA EL ESTUDIO DE LA DIETA DE *PHALACROCORAX MEGALOPTERUS* Y *P. ALBOGULARIS*

RESUMEN.—*Phalacrocorax mexicanus* y *P. albogularis* son dos especies hermanas que muestran distribuciones limitadas a lo largo de los Andes, desde Ecuador hasta Tierra del Fuego. Estas especies ocupan hábitats remotos y son de las menos conocidas dentro del grupo de los caracaras. Consecuentemente, su dieta ha sido poco estudiada, particularmente en *P. albogularis*. Investigamos la dieta de estos caracaras mediante el análisis de las fotografías disponibles en las plataformas de ciencia ciudadana iNaturalist y Macaulay Library (eBird). Obtuvimos 43 fotografías de *P. mexicanus* y 42 fotografías de *P. albogularis* que permitieron identificar componentes de la dieta. *P. mexicanus* se alimentó principalmente de carroña, frecuentemente de animales domésticos, seguido de restos de comida y basura de origen antrópico. Las fotografías obtenidas para *P. albogularis* mostraron que esta especie se alimenta principalmente de carroña y basura. Sin embargo, encontramos fotografías de ambas especies alimentándose de animales silvestres, incluyendo camélidos, ratones, aves, lagartijas y algunos invertebrados. En el futuro, los estudios sobre estas especies deberán investigar los efectos potenciales de estas dietas de origen antrópico, tales como la malnutrición por consumo de alimentos inapropiados y la ingesta de plásticos y sustancias tóxicas.

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INTRODUCTION

The Mountain Caracara (*Phalcooboenus megalopterus*) and White-throated Caracara (*Phalcooboenus albogularis*) have limited distributions along the Andes from Ecuador to Tierra del Fuego (Bierregaard and Kirwan 2022a, 2022b). Because they inhabit remote areas of the Andes, typically at high altitudes, both species are among the least studied caracaras; therefore, little is known about their diet (Bierregaard 1995, Donadio et al. 2007, Barros 2018).

The Mountain Caracara is distributed from Ecuador (0°7'48"S) to the Araucanía region, Chile (38°37'S), whereas the White-throated Caracara occurs from the Neuquén Province, Argentina (40°11'24"S) to Navarino Island, Magallanes region, Chile (55°4'48"S; Barros 2018, Basso 2018, Bierregaard and Kirwan 2022a, 2022b). These species are allopatric along most of their ranges although areas of sympatry occur in the Río Negro Province, Argentina (Basso 2018). Both the Mountain Caracara and the White-throated Caracara use a variety of habitats, including open *puna* grasslands, meadows around wetlands, heavily grazed areas, the Atacama Desert, and recently plowed lands. Both species use cliffs for nesting and roosting (Fjeldså and Krabbe 1990, Jaramillo 2003). Groups of White-throated Caracaras can be observed at garbage dumps and cattle slaughtering sites in Patagonia (Fjeldså and Krabbe 1990).

Historical accounts of the diet of these two species are scarce. Gay (1847) and Housse (1938) reported Mountain Caracaras feeding on sheep carcasses, rodents, birds, and invertebrates such as mollusks, larvae, worms, and insects. White and Boyce (1987) reported the species feeding on carrion and garbage, and Jones (1999) observed two adults and a juvenile Mountain Caracara turning over rocks to feed on worms and arthropods. Donadio et al. (2007) described the Mountain Caracara in northwestern Argentina as being highly dependent on camelid carcasses, which made up approximately 65% percent of the species' diet, followed by rodents, birds, and invertebrates in lesser amounts. In an analysis of pellets obtained in south-central Chile, Figueroa et al. (2004) found that insects constituted approximately 94% of the diet, with birds and rodents making up the remainder. Recently, in a periurban area of La Paz, Bolivia, a Mountain Caracara was recorded as a predator on a nest with eggs (Salazar-Pammo and Garitano-Zavala 2022).

There is essentially no information available on the diet of the White-throated Caracara; its diet is probably generally similar to that of the Mountain Caracara. The White-throated Caracara is known to

consume carrion, and also to prey on small rodents (Couve and Vidal 2003). This caracara is often seen in small groups with vultures at carcasses and at garbage dumps or sites where sheep are slaughtered (Bouker et al. 2021, Bierregaard and Kirwan 2022b).

Traditional methods for studying raptor diet such as analysis of pellets or prey remains are limited as they typically are focused on local populations at nesting sites or wintering areas, and are expensive and difficult to conduct on species that are widely distributed, uncommon, or that inhabit remote areas (Murgatroyd et al. 2016, Redpath et al. 2001, Panter and Amar 2021). The use of photographs can be a noninvasive and relatively inexpensive way to investigate aspects of diet in birds over larger geographic areas (Gaglio et al. 2017).

In recent years, the use of citizen science data has become a valuable approach to study several aspects of avian natural history, including diet (Berryman and Kirwan 2021, Sandvig and Cerpa 2022, Panter and Amar 2021), migration (DeGroot et al. 2020), and distribution (Johnston et al. 2021). Here, we used photographs reported in eBird and iNaturalist to investigate the diet of the Mountain Caracara and White-throated Caracara by analyzing the prey items in the photographs.

METHODS

We searched for all the photographs of Mountain Caracara and White-throated Caracara on two platforms: the Macaulay Library (<https://media.ebird.org/catalog>) and iNaturalist (<https://inaturalist.org>). We examined each photograph in detail, first to be sure the caracara was correctly identified, and then to determine whether the caracara was holding or eating a food item; we selected those photographs for our diet investigation. We recorded the date and location where each photograph was taken with the objective of eliminating possible duplicates. We also recorded the food item in each photograph. If it was difficult to identify what a caracara was feeding on by examining the photo, we consulted the comments associated with the photo to assist with identification of the food item, following the methods of González and Gutiérrez (2022), and Sandvig and Cerpa (2022). We identified food items to the lowest taxonomic level possible (e.g., horse [*Equus caballus*], guanaco [*Lama guanicoe*]). We classified food items that could not be identified to species as carrion, garbage, human food, invertebrates, seeds, lizards, or mice.

RESULTS

From the Macaulay Library (eBird), we obtained a total of 1623 photographs: 1377 of Mountain Caracaras

and 246 of White-throated Caracaras. From iNaturalist, we obtained 1077 photographs, 894 of Mountain Caracaras and 183 of White-throated Caracaras. After ensuring there were no photographs with species identification errors and that there were no duplicates, and selecting only photos with prey visible, we had 43 photos for the Mountain Caracara (Supplemental Material Table S1) and 42 photos for the White-throated Caracara (Table S2) that were suitable for our analysis of these species' diet. All 85 photos used were taken between the months of January 2000 and July 2023.

Eight (18.6%) of the photographs of the Mountain Caracara included items classified as human food (e.g., cookies, bread, raw chicken, and nuts; Table S1), and four (9.3%) photographs showed a caracara feeding on garbage; apparently these photographs were taken at garbage dumps. Twenty-two (51.2%) photographs included a Mountain Caracara feeding on carrion; eight (18.6%) of those photographs included unidentified carrion. Among the carrion identified, in five photographs (11.6%) the caracara was feeding on carrion of a dead unidentified camelid (genus *Lama* or *Vicugna*). In two photographs (4.7%), the caracara was feeding on a dead viscacha (*Lagidium viscacia*) and six (13.9%) photographs included a caracara feeding on carcasses of domestic and livestock animals such as domestic cat (*Felis catus*), donkey (*Equus asinus*), goat (*Capra hircus*), horse, and lamb (*Ovis aries*). In one photograph (2.3%), the Mountain Caracara was feeding on a European hare (*Lepus europaeus*), an introduced species in South America. Three (7%) photographs showed a Mountain Caracara eating invertebrates (e.g., insects [including a Coleoptera sp.] and worms), and three photographs showed this caracara feeding on carcasses of birds, including an unidentified flamingo (*Phoenicopterus/Phoenicoparrus* sp.), a Gray Gull (*Leucophaeus modestus*) and Markham's Storm-Petrel (*Hydrobates markhami*). In one photograph, an adult Mountain Caracara feeds lizards (*Liolaemus nigroviridis*) to a juvenile caracara, and in another photo an adult Mountain Caracara digs and apparently feeds on seeds. One photographer reported observing a Mountain Caracara chasing and apparently capturing a Puna Yellow-finch (*Sicalis lutea*), although the record is not clear as to whether the finch was captured on the ground or in flight. The photograph shows the caracara feeding on the finch (Araya 2021). Interestingly, some photographs of the Mountain Caracara were taken near Bariloche (Río Negro Province, Argentina), which documents a range expansion for this species by more than 500 km to the south.

In more than half (26; 62%) of the 42 photographs found for the White-throated Caracara, the individuals were feeding on garbage at the municipal landfill of Ushuaia (Tierra del Fuego, Argentina; Table S2). Many photographs have been taken since 2000 of White-throated Caracaras feeding at this landfill (Schulz 2000). The other 16 photographs included two (4.7%) photographs of a White-throated Caracara feeding on unidentified carrion, one (2.3%) of a caracara feeding on a carcass of a domestic sheep, and one of an individual eating unidentified human food. Eight (19%) photographs included a caracara feeding on a carcass of guanaco, one photograph included a caracara eating a rabbit (*Oryctolagus cuniculus*), and in one photo the caracara was eating a beetle (Coleoptera). In one photograph, the caracara was delivering a small lizard (*Liolaemus* sp.) to young in the nest, and in one other photograph, an adult White-throated Caracara was feeding a mouse to two juvenile caracaras.

DISCUSSION

Our study documented that photographs submitted as citizen science can be used to help describe the diet of two poorly known caracaras, the Mountain Caracara and the White-throated Caracara. Conducting diet studies in the field for these two caracaras would be difficult and costly because these species typically inhabit areas that are difficult to access. Thus, using input from citizen scientists can be a powerful and low-cost way to obtain information on diet and, possibly on other aspects of these species' natural history. Although the information presented here about the diet of these caracaras is descriptive, using citizen science photographs has resulted in an expanded knowledge of the variety of food items consumed by these raptors. These photos also indicate that both species of caracara are opportunists and can exhibit commensalism with humans, benefiting from human activities such as managing livestock and creating landfills.

Consistent with the findings of Donadio et al. (2007), we found that carcasses of camelids and many types of domestic and wild animals apparently constitute part of the diet of the Mountain Caracara. For the White-throated Caracara, many photographs were of individuals feeding on food associated with human activities, particularly at garbage dumps and landfills. In particular, some photographs expanded our knowledge of the food resources used by the White-throated Caracara in more natural environments, including guanacos, lizards, invertebrates, and rodents.

Although these photographs were useful for our study, it is important to consider the biases associated with citizen science data. For example, many photographs were of caracaras feeding on food items associated with humans, but that may be because areas like landfills and garbage dumps are easily accessible to photographers. In addition, photographs do not provide information about whether a prey item was actually consumed by the caracara, or whether the caracara captured a prey species or simply found it dead. Thus, the percentages of food items in the photographs likely do not correspond with the percentage of these items in the species' overall diet. Finally, the photographs are likely biased toward large food items such as carcasses of mammals and garbage, and probably miss the capture and consumption of smaller food items that may constitute a larger percentage of the diet than is suggested by the photographs.

Although our study does not provide evidence, the availability of human-derived food items may be changing these caracaras' foraging behavior. In the past, these caracaras were described as elusive and distrustful of humans (Gay 1847, Housse 1937). However, in recent years, some groups of caracaras have been observed in parking lots, along hiking trails, and at garbage dumps. These new associations are likely related to the availability of carcasses and to human-related activities, potentially including decreasing persecution. Further research is needed to identify possible negative effects of these raptors feeding on human-derived foods, such as lack of nutrients due to eating inappropriate foods, and ingestion of plastics and toxic substances (Zurita et al. 2022).

SUPPLEMENTAL MATERIAL (available online). Table S1: Photographs used to assess diet of the Mountain Caracara (*Phalcoboenus megalopterus*). Table S2: Photographs used to assess diet of the White-throated Caracara (*Phalcoboenus albogularis*)

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