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A cultural consensus regarding the king vulture?: preliminary findings and their application to Mexican conservation

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ABSTRACT

Ecosystem management regularly requires bridging diverse cultural perspectives. As a result, researchers commonly assert that including local ecological knowledge in conservation strategies is essential to crafting enduring environmental solutions. Using the case of the king vulture (*Sarcoramphus papa*), we take preliminary steps in asking how ethnoecology and field biology might be combined in conservation practice. The paper reports on a questionnaire applied to sixty-six local experts in southern Yucatán, home to Mexico's largest expanse of tropical forest and the Calakmul Biosphere Reserve. Local experts included forest workers, i.e. hunters, loggers, and gum tappers, some of whom worked as guides for field biologists. The research results point to the possibility of a cultural consensus among these experts regarding the bird's natural history. After outlining this preliminary consensus and contrasting it with academic findings, the paper considers the implications of a consensus for conservation programming.

Keywords: *Local ecological knowledge, governance, Southern Yucatan Calakmul*

INTRODUCTION

How might researchers combine ethnoecology and field biology to suggest conservation measures? In this paper, we take steps toward answering this question for a species of concern in Mexico, the king vulture (*Sarcoramphus papa*, **Figure 1**). The bird is currently categorized as Least Concern in the Red List of the IUCN (BirdLife International 2011). Nonetheless, Mexican authorities view the king vulture at risk of extinction in that country (SEMARNAT 2002). Honduran authorities list it in Appendix 3 of the Convention on International Trade in Endangered Species (CITES 2011). These different levels of concern relate to an overall paucity of information about the number of *Sarcoramphus papa* in the wild and its biology (Houston 1994). In a geographical range extending from Southern Mexico to Northern Argentina, the king vulture appears to use well-preserved forests to roost, feed and breed, while also using open grasslands close to preserved forest for food supply (Houston 1994; Kirk and Curral 1994; Smith 1970). Ecological information on habitat use

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and reproduction is scarce and anecdotal (Loiselle 1988; Ramo and Busto 1988; Smith 1970). The king vulture's feeding habits are better documented, but often contradictory, especially regarding the way it locates carcasses (Houston 1984; Lemon 1991).

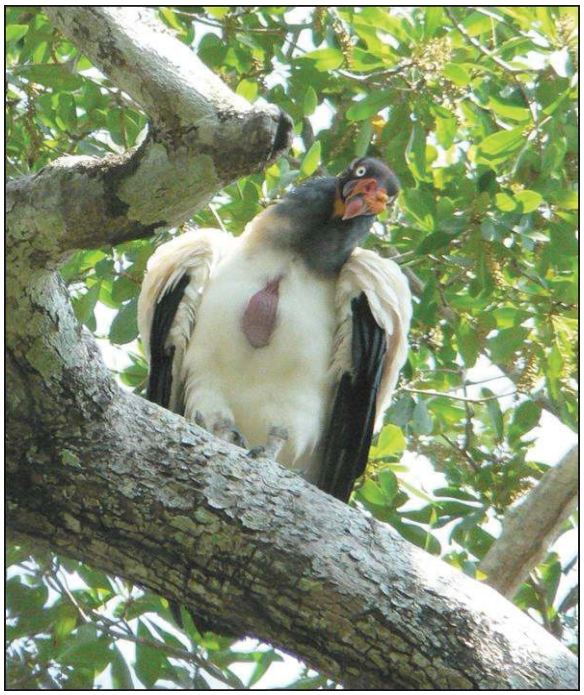

Figure 1. King vulture in a permanent roosting site in southern Yucatán, Mexico.

In situations like the king vulture, researchers benefit by turning to local people who frequently observe and interact with the species in question. The findings reported here draw on a questionnaire applied to a purposeful (i.e. naturalistic, convenience or judgment) sample (Marshall 1996) to document local understandings of, among other points, the location of roosting sites and feeding habits. Biologists commonly use experienced guides to access this sort of information. In this paper we go one step farther by arguing these informants constitute a corps of local experts whose combined knowledge offers the possibility of revealing a cultural consensus regarding the king vulture's biology, one that could contribute to the specie's conservation. In doing so, the paper reports on the first of a two-phase project which included the use of a questionnaire applied to select individuals (see below) to identify the bird's biological features. The second phase, reported elsewhere (Reyes Martínez 2008), entailed evaluating at multiple spatial scales the forest characteristics of the king vulture's roosting sites.

Cultural consensus theory posits that experts on a topic tend to agree more than do non-experts and this agreement can be assessed through structured interviewing (Romney et al. 1986). Researchers have used consensus theory to contrast environmental knowledge in more and less urbanized settings (Shenton et al. 2011), to compare local and scientific notions of primary forests (Casagrande 2004), and to examine the connection between market economies and environmental knowledge (Reyes-García et al. 2005). This paper draws inspiration from cultural consensus theory by reporting on interviews of local environmental experts on the king vulture to identify in a preliminary manner a shared body of knowledge regarding the vulture's biology.

Comparisons of vernacular and scientific knowledge constitute one aspect of ethnoecology, and findings in ethnoecology provide a framework for connecting localized information with action plans and for incorporating environmental perceptions into resource/habitat management (Hunn 2007; Nazarea 1999). Employed carefully, ethnoecology opens the way to fuse knowledge studies with environmental protection which inescapably entails public policies and politicking (Zimmerer 2001). In this regard, research in ethnoecology is particularly appropriate to conservation settings. Because ecosystems of interest for conservation are generally embedded in diverse social organizations, their management entails governing at multiple levels where diverse cultural perspectives will have to be reckoned with (Brondizio et al. 2009).

Thus far, the tendency within state institutions has been to mute multi-culturalism in favor of coherent narratives that, ultimately, fail to cope with environmental crises (Mathews 2011). In Calakmul, local knowledge is weakly connected to conservation programming, as we denote in the paper's discussion. If local knowledge is necessary to conservation strategies for species like the king vulture (Baral and Gautan 2007; Berkes et al. 2000), the communication structures we describe among

local experts, researchers, and conservation staff will have to be addressed.

Ethnoecology and conservation biology

For two decades, researchers have sought to establish practicable conservation strategies that address both the ecological needs of particular species and the ways people understand and work in specific environments (Russell and Harshbarger 2003; Western and Wright 1994). These attempts arose out of some stark realities. A recent overview of global biodiversity loss finds that most indicators—including species population trends, risk of extinction, habitat size and condition—show negative pressures on biodiversity continue to increase (Butchart et al. 2010). The news is not all grim. The same report notes that 12% of the Earth's terrestrial surface is under some form of protected status, while 87% of countries have biodiversity strategy plans. A major challenge in this movement has been the variety of social and cultural contexts in which environmental protection takes place, as social factors determine program success or failure (Mascia et al. 2003). Social scientists note that social and cultural diversity can challenge one-size-fits-all conservation strategies, such as the formation of protected areas (Agrawal and Gibson 2001). More forceful critiques question the political implications of conservation practices, including the imposition of management strategies on unwilling local populations and the use of force to maintain programs (Brechin et al. 2003; Ferguson 2006; Igoe and Brockington 2007).

In his genealogy of ethnoecology, Stanford Zent situates the field in the midst of these debates (Zent 2009). On the one hand, ethnoecology offers hope for a common conversational arena where scientific and lay understandings may be combined in a team approach. On the other hand, ethnoecology researchers are keenly aware of the politically laden quality of these interactions even when carried out in the spirit of equality (Heckler 2009). Ethnoecologists, thus, combine a concern for knowledge with a concern for egalitarian power relations.

Heckler (2009) and Zent's (2009) work grows out of a history of ethnoecology research that has never really resolved a central epistemological tension. Do ethnoecologists elucidate local expertise in its own right, thereby validating culturally distinct ways of knowing? Or, do ethnoecologists demonstrate how local expertise matches scientific taxonomies, thereby validating the universality of science? Nazarea (1999) responds to this contrast by emphasizing methodology. Ethnoecology's strength, she says, lies in its data collection. Consequently, the goal of ethnoecology is to offer descriptions that situate environmental knowledge in particular social worlds. Another avenue of thought adds that localized cultural consensuses and scientific knowledge should "be treated as complementary resources which are most effectively used in tandem" (Zent 2009: 34). This outlook is especially important to crafting enduring conservation strategies tailored to fit local circumstances (Brosius 2006). A complementary approach does not resolve the power issues noted above. Some researchers describe collaborations as obscuring the unequal relations that persist when scientists—who enjoy greater wealth and prestige than local informants—report on local knowledge systems (Zent 2009). Still, a complementary approach can form one step toward ameliorating these power differences. In the following paragraphs, we undertake this effort by elaborating the collaborative quality of data collection as it is already taking place and by illuminating the depth of information that exists within a corps of lay experts.

Describing a cultural consensus requires translation, admittedly a fraught process (Gentzler 2002) and one that is of great concern in ethnoecology (Heckler 2009). In conservation settings, translation carries with it possibilities for misunderstandings and re-contextualizations that obscure local experts' original meaning and reinforce the perspectives of dominant conservation actors (Hanson 2008). We recognize these hazards and, rather than suggest the translation process premises scientific knowledge, our reporting aims at marshaling the variety of information available regarding a little known species. In the paper's discussion, we note the usefulness of this knowledge to conservation as

well as the way conservation employees currently overlook folk knowledge regarding the king vulture.

MATERIAL AND METHODS

Study area

The municipality of Calakmul on Mexico's southern Yucatán peninsula is situated on the central karst uplands (i.e. the meseta) that form the peninsula's spine. Home to 27,000 people, two-thirds of whom work in subsistence and cash crop agriculture (Haenn 2011), the region is delimited to the east and west by the meseta's 100 m contour which, at its highest, rises to 350 m above sea level. A central feature of the municipality is the Calakmul Biosphere Reserve whose southern boundary coincides with Mexico's border with Guatemala (**Figure 3**). During the past two decades, the southern Yucatán has attracted an array of biologists, conservationists, and social scientists because of the Biosphere Reserve (decreed in 1989) and because the region supports Mexico's largest expanse of tropical forest (Martínez and Galindo-Leal 2002; Vester et al. 2007*).*

The region's forests are broadly classified among scientists as seasonally dry tropical forests, mainly medium-stature upland and low-stature forests (see Peréz-Salicrup 2004 for details). Local land classifications are not that distinct from the scientific categories in use of forest height as a focal point for organization. However, where scientists view forest height through the lens of an absence of human activity, Calakmul's farming population understands forest height as the consequence of subsistence work (for a fuller account, see Haenn 1999). Both scientific and local environmental categories emphasize the region's seasonal pattern of rainfall, with a wet season from May to October (Magaña et al. 1999). Average annual precipitation is around 1025 mm, but precipitation patterns have become spatially and temporally inconsistent since the mid-1980s and droughts are common (Márdero et al. 2012). The region has no permanent streams and few permanent lagoons, because of the karstic nature of the substrate.

Today's forests follow on centuries during which the region housed few human settlements. The area's many ruins recall lowland Maya urban society, when hundreds of thousands of people worked in agriculture (Foster and Turner 2004). By the year 1000, urban Mayan society in the southern Yucatán had declined and human populations clustered in the peninsula's north (Mann 2006). Present day settlements tend to date to the 1960s and 1970s. At that time, forest extraction and road construction, along with state-sponsored land distribution programs, created more than 80 towns and villages. Today, Calakmul is home to an ethnic mix of peninsular Mayans, indigenous people from Chiapas (e.g. Ch'ol and Tzeltal) and *Mestizo* or non-indigenous people predominantly from the Mexican states of Veracruz and Tabasco (Gurri 2003). Some 42% of the municipality identifies as indigenous (INEGI 2010).

As expected with any population growth, forest cover diminished and forest fragmentation increased (Lawrence et al. 2004). Taking a look at the broader Southern Yucatán Peninsula Region, which includes Calakmul and a neighboring municipality, Ramírez-Delgado et al. (2014) estimate that from 1990-2006 the annual rate of deforestation was 0.12% per year. Most forest loss was concentrated in the first 10 years (1990-2000) of the study period, with deforestation rate of 0.15% per year, decreasing to 0.06% per year from 2000-2006. This figure takes into account secondary growth by considering successional stands of 25 years and older as forest. Ramírez-Delgado's el al. (2014) study also indicates that forest fragmentation during the 1990–2006 period in the southern Yucatán shows a decrease in the connectivity of forest fragments, dissecting the forest into smaller and more isolated fragments.

Since 2000, the natural-resource based economy of Calakmul has diversified considerably. This point matters both for changing forest cover and king vulture habitat but also for questions of ethnoecology. At the turn of the new century, a number of Calakmul households joined the international migration stream. By 2003, some 7% of Calakmul's adult population lived in the United States (Schmook and Radel 2008). Also in the past decade, expanded state welfare meant that

three-fourths of the municipality's households received regular cash payments from the state. As of 2010, two-thirds of municipal residents were working in agriculture, and many combined this work with forestry activities, including non-timber products. In the 1990s, the figure was considerably higher (Haenn 2011). The net effect has been some expansion in forest cover, and, very likely, a changing quality of ecological knowledge. As fewer people work in the woods, we suspect knowledge of species such as the king vulture has become specialized to a handful of individuals.

Data collection and analysis

In order to identify a preliminary cultural consensus regarding the king vulture, one of the authors sought to locate lay experts. The consensus is preliminary because, given the project's role in the larger research, it did not follow the formal methods of a cultural consensus model (see Shenton et al. 2011). Instead, in preparation for an examination of the forest characteristics of the king vulture's roosting sites, the research first required identifying such sites, and, in the process, sought baseline data on local knowledge regarding the king vulture.

Consequently, Reyes employed a judgment or purposeful sampling approach and asked authorities in 46 *ejidos* or communal land tenure settlements to identify informants with an in depth knowledge of the bird. Because the research sought specialized knowledge, which is not normally distributed within a population, the purposeful sampling sought to take advantage of the richer information espoused by a subpopulation, namely "forest workers," people whose frequent engagement in hunting, logging, and gum tapping might bring them into contact with the king vulture. The research also sought people engaged in extensive cattle ranching since vultures feed on dead animals left in pastures. In purposeful sampling, investigators actively select the most productive individuals to answer the research question. Selected respondents will often be based on the investigators' practical knowledge of the research area, the available literature and evidence from the study itself as it develops (Guest et al. 2006; Marshall 1996). Of the 46 communities originally selected for the research we found that in 10 *ejidos*, people had no knowledge whatsoever of the king vulture. This left 36 candidate communities, nine of which would ultimately provide half of the questionnaire's 66 respondents (see below).

The application of a questionnaire to this sort of purposive sampling is typical in field situations where probabilistic sampling is not logistically feasible and where the research does not aim to provide statistically generalizable results (Marshall 1996). Purposive sampling is widely used in qualitative research where random sampling is likely to produce a representative sample only if the characteristic under consideration is normally distributed within a population. There is no evidence that the values, beliefs and attitudes that form the core of qualitative investigation are normally distributed. Furthermore, researchers recognize that people are not equally good at observing, understanding and interpreting social and natural worlds. Thus, qualitative research seeks out those key informants who are more likely to provide insight and understanding for the researcher (ibid.). One way to probe the reliability of such information is to contrast evidence provided by key informants until information saturation has occurred. Saturation is the point at which no new themes or information appear in the data, thereby suggesting the research has captured the range of socially shared knowledge. Recommendations on the number of interviews required to gain saturation are mixed. In their review of the literature, Guest et al. (2006) find researchers advocate as few as five interviewees and as many as 36.

In our case we knew the characteristics we wanted our informants to have (forest workers and ranchers) and approached village heads (*comisariados*) to point out who in the community might espouse these characteristics. Contacting *ejido* authorities in this way is considered the politically appropriate first step in establishing research relationships. Given their status, *ejido* authorities are popularly considered to be the most knowledgeable about their communities. In practice, authorities' social and ecological knowledge can be variable. Consequently, one of the authors also contacted directly a few villagers

with profiles resembling those of forest workers. Reyes informally questioned *ejido* residents about who hunted and logged and introduced herself to men on village streets who appeared to be returning from a forest outing. She subsequently approached these individuals singly to solicit their participation in the research.

The gendered quality of the research deserves mention here. In Calakmul, women regularly visit forests on their way to farm fields, often in the company of a male relative. However, forests are generally construed as a masculine space. Women who visit forests in inappropriate ways are accused of licentious or anti-social behavior, and, in general, women's travel outside the home is discouraged (Radel et al. 2012). Thus, biologists rely on men exclusively as their guides. At the same time, the researchers involved in the findings reported here are all women. This fact points to the complexities of working with local experts, issues too intricate to detail here (see Radel 2011a; b for discussions of gender and environment in Calakmul). In the early 1990s, when biological research in the region began, stigmas regarding women's work in forests could be applied to female scientists. Over time, academic researchers have become a separate social category in local cultural settings, and the habits of female biologists may be perceived as strange but are no longer transgressive.

The sampling identified a corps of 66 respondents, half of whom were aged 30 to 50 years at the time of questioning (see **Figure 2**). Five of the men were already known to the academic research community from past work. All others were new informants. Different communities were represented unevenly among the group. For example, 20 of the 36 communities provided just one respondent each. Another seven communities provided two respondents each. The remaining 32 respondents were located in 9 *ejidos*. These communities included five 'forestry *ejidos*', places with extensive forested areas.

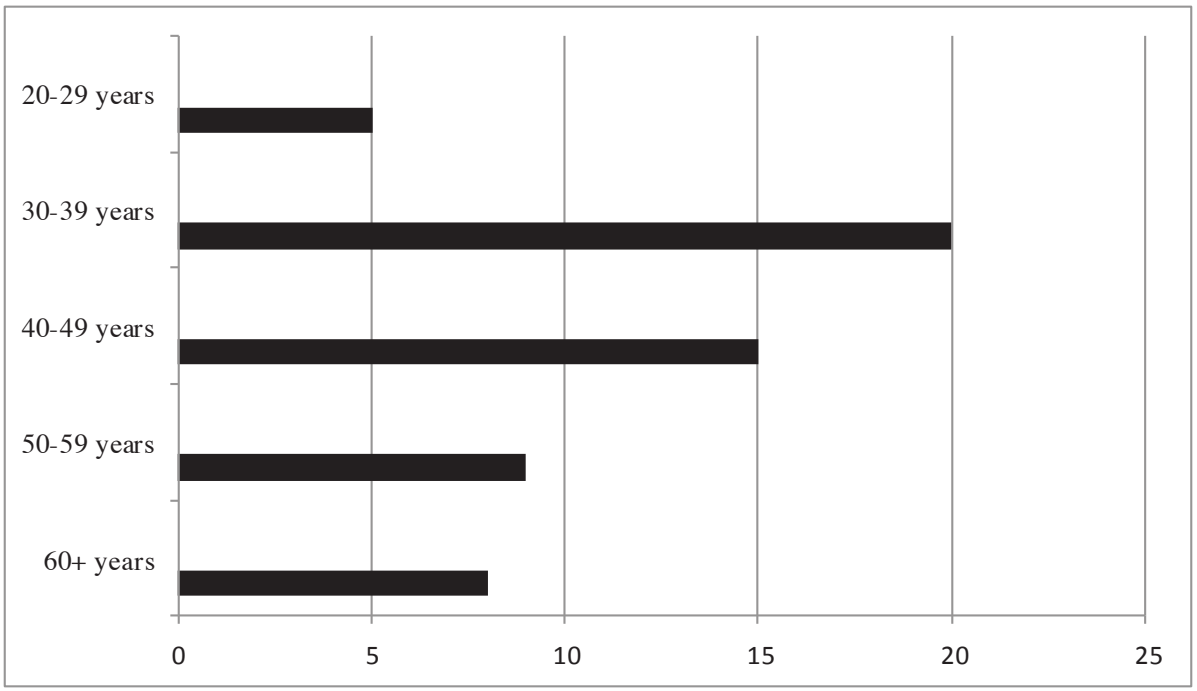

Figure 2. Age distribution of the 66 respondents.

This variable geographic distribution also affected respondents' ethnic affiliations. We speak to this point in a general manner. Because the research was a first step in the evaluation of the forest characteristics of the king vulture's roosting sites, the research design did not contemplate an in-depth assessment of the ethnic dimensions of experts' environmental knowledge. Also, given the region's history as an agricultural frontier, the relationship between ethnic affiliation and environmental knowledge in Calakmul is too complicated to address in this brief space. Immigrants from the Mexican states of Tabasco and Veracruz, for example, tend to share a Mestizo identity, even if their places of origin are ecologically quite distinct. Similarly, peninsular Mayans and Ch'ol are both considered indigenous, even though they view themselves as culturally different from one another and, again, have roots in diverse ecological settings. Nonetheless, we estimate 34 of the 66 respondents were indigenous. Because municipal-level data lists the region's total population as 40% indigenous this suggests an over-representation of indigenous people in the sample.

Once the group of 66 experts had been identified, the research then entailed the application of a face-to-face questionnaire. Questions were posed to respondents individually, in one-on-one settings with the interviewer. In the questionnaire we asked about king vulture roosting sites, breeding seasons, feeding habits, its interactions with other vultures (namely the black vulture, *Coragyps atratus* and the turkey vulture, *Cathartes aura*), as well as its role in the environment. We also asked the men about possible threats they saw to the king vulture population, their knowledge regarding its protection under Mexican law, and whether the *ejidos* in question had developed any protective measures of their own.

Questionnaires and qualitative research are clearly different kinds of techniques requiring different sorts of analytical frameworks. Nonetheless, Romney et al. (1986) "found that small samples can be quite sufficient in providing complete and accurate information within a particular cultural context, as long as the participants possess a certain degree of expertise about the domain of inquiry ("cultural competence")" (Ibid.: 74). In the findings reported below, some respondents were more familiar with the king vulture than others and could thus provide more insight. The size of the interview population and the overall consistency in the respondents' information, however, suggests the research succeeded in identifying a preliminary cultural consensus regarding the king vulture, one that could be used to inform future research (cf. Marshall 1996).

RESULTS

In this results section, we report findings from the questionnaire with particular emphasis on the king vulture's roosting sites, interactions with other vulture species, and diet. "King vulture" is a literal translation of the bird's popular Spanish name in Calakmul, *chombo rey*. Both terms are synonymous with the bird's Mayan name *batab ch'om*.

Sightings

Local experts in Calakmul told us that their actual sightings of the king vulture were infrequent. Nearly half of local experts said that, on average, they see a king vulture once a year or less. Opinions were split almost evenly on whether these sightings were more common during the dry season or whether the king vulture can be seen all year (**Table 1a**). In general, most sightings took place in mature upland forests, places that hunters and loggers frequent. These men, thus, provided the most information on the bird's roosting and nesting habits. The second most common place for sightings took place in pastures where the birds feed on dead cattle. Accordingly, cattle ranchers provided the most information about the bird's feeding habits. Other people's experiences with the species were restricted to sightings at garbage disposal sites or along highways where the king vultures scavenged road kill (**Table 1b**). While king vultures were observed in the 29 of the 36 *ejidos,* roosting sites were reported in only 12 (**Figure 3**).

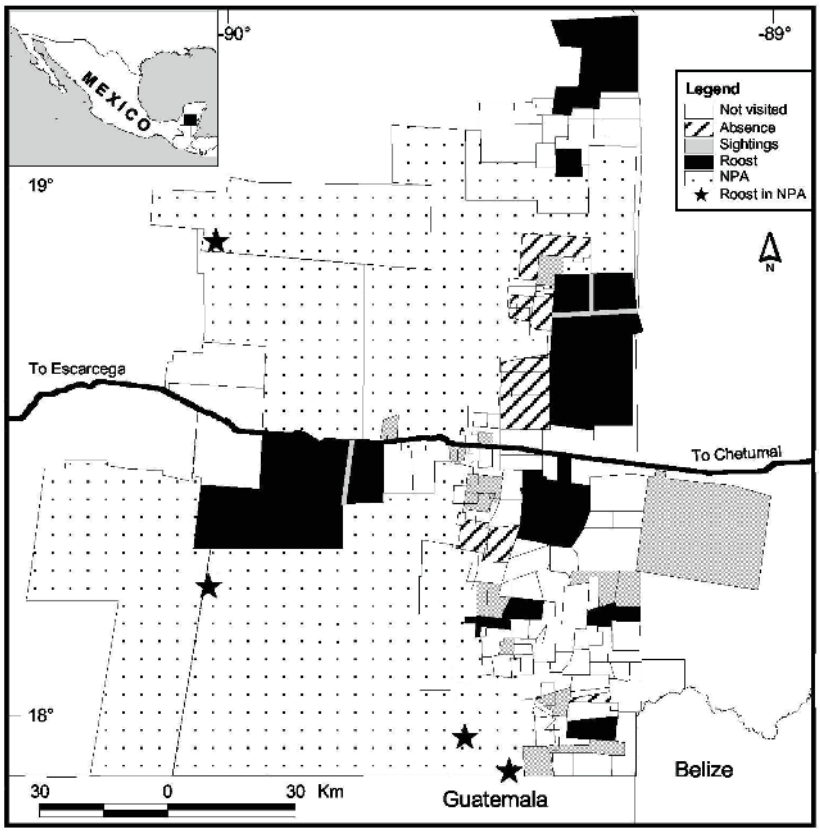

Figure 3. King vulture's distribution in communal lands and natural protected areas of southern Yucatán, Mexico. The study area is indicated by the black rectangle in the small map. The information provided by local informants included sightings of the species (grey area) or the lack of observation during the past three years (slashed area), and the presence of roosting sites (black area).

Roosting sites

More than half the men (n=34) reported knowing where king vultures roost. About the same number (n=30) listed large trees such as black olive (*Bucida buceras* L.), chicle tree (*Manilkara zapota* (L.) P. Royen), and the Caribbean black cherry (*Lonchocarpus castilloi* Standl.) as preferred roosting sites. Three local experts mentioned that king vultures also roost in cavities in Maya ruins. All local experts who knew the location of roosts mentioned that roosts are always close to a creek or a pond.

Our visits to several active roosting sites duplicated these findings (Reyes Martínez 2008) with the added observation that mature individuals of these tree species typically project above the canopy. This makes the trees suitable for king vultures to take off or land. At the same time, these slow-growing, hard wood species are sought after for logging (Weterings et al. 2008), a point proffered by some local experts. They noted that once an area had been logged of black olive, chicle, and Caribbean black cherry, their sightings of king vultures dwindled and then fell off altogether.

The questionnaire asked: "When you see the king vulture, is the bird generally alone, with a partner, or in a group (and if in a group, how many are present)?" A follow up question probed the bird's activities at the moment when people tend to see them: flying, eating, roosting, or resting. Observations of king vultures in larger groups mainly took place at roosting sites, where sometimes more than 20 birds gathered; only a few local experts (n=6) reported that information. In contrast, most local experts (n= 54) reported observing king vultures in groups of mainly three to eight birds (n=25), but also in pairs (n=23) as the

birds were flying, eating, and/or resting. Sightings of groups of 10 or more carrying out these same activities were less common (n= 6).

Local experts also noted a high level of fidelity to some roosting sites, apparently those that support the largest groups. We were led to two roosts that they had known respectively for 15 and 24 years. We have been visiting these roosting sites almost every year since 2007, and they are still in use.

Nesting

Sixteen local experts indicated having seen a king vulture nest with one or both parents nearby (**Table 1c**). We considered only those reports with individuals close to the nest to make sure they belonged to king vulture. All nests were seen during the dry season and were located 10.2 to 15.7 km away from villages in mature forest. Of the 16 interviewees, 10 had seen only eggs and six had seen chicks. Usually local experts saw two eggs but sometimes only one. On the two occasions in 2008 and 2009 when two of the authors accompanied local experts to nests, both contained just a single chick. Local experts in Calakmul are the first to report Mayan ruins used by king vultures for nesting sites. The practice was further confirmed by the biologist Jose Puc, who saw first-hand a nest containing a chick in a Mayan ruin.

Vulture species relationships

According to the 52 local experts who spoke about social behavior, the smaller turkey and black vultures are commonly associated with king vultures when the latter is feeding (**Table 1d**). Of the 52 local experts who provided information on dietary habits, 32 reported a feeding order whenever several vulture species arrive at a carcass: king vultures are the first to eat, while other species watch from a distance (see Discussion). Despite the above mentioned, 20 local experts reported king vulture feeding on carcasses within the forest without the presence of any other vulture species. Field observations during 2008 – 2011 by one of the authors indicate that king vultures in Southern Yucatan are always accompanied by other vultures in perturbed areas, but do not always share feeding sites with other vulture species in mature forest environments.

Diet

Fifty-two local experts answered questions on dietary habits. Of these, 32 indicated the king vulture feeds on large animal carcasses, such as tapir (*Tapirus bairdii*), deer (*Odocoileus virginianus*), white-lipped and collared peccaries (*Pecari tajacu, Tayassu pecari*), and domestic cattle (*Bos taurus x B. indicus*). Another 15 local experts stated that king vultures feed on any carcass, regardless of size (**Table 1e**). Respondents commonly agreed that, through their feeding, king vultures 'clean' the countryside of diseases that could affect humans or livestock.

Cultural Context/Significance

Data collection that employs a questionnaire is necessarily limited in the ability to convey the larger body of cultural information in which to situate the research findings. Here, we offer some suggestive findings that may anticipate future research in this area. Anecdotally, three Mayan speaking respondents recalled their grandparents using the king vulture's excrement and plumage to cure leishmaniasis. One of these respondents added that his family kept a captive king vulture to defend the household against *espanto*, a disease of the soul that arises when a person undergoes a terrible fright. Vultures, more generally, feature in a prominent morality tale. Ch'ol immigrants from Chiapas relate the story of a lazy man who changed places with a vulture to avoid the hard work that farming entails. The man assumed the birds had an easy life, as they simply waited for their food to appear. He soon regretted his decision once he found that even vultures can go days without eating. He asked the vulture that had transformed into a human being to again change places. The vulture-turned-human refused. He had become an assiduous cultivator and was happy with his new life. All creatures must suffer for their food, the story suggests. Humans can ameliorate that suffering by working hard on their farms.

Table 1. Characteristics of the observations of king vulture by local experts of Southern Yucatan, Mexico, in relation with a) time of the day, season and frequency of sightings, b) vegetation or specific sites where sightings take place, c) nest, d) composition of the groups at carcasses, and e) size of prey animals.

	Characteristics of sightings	n*	%
a	*Time of the day*	78	
	Morning	24	31
	Afternoon	26	33
	Evening	18	23
	Night	1	1
	Any hour	9	12
	Seasonality	59	
	Dry	31	53
	Rain	0	0
	Northern lows	2	3
	Any season	26	44
	Frequency	50	
	Daily	2	4
	Weekly	3	6
	Monthly	2	4
	Annually	9	18
	Less than annually	23	46
	Variable	11	22
b	*Vegetation type or site*	91	
	Mature forest	52	57
	Secondary vegetation	2	2
	Pasture	19	21
	Road kill	6	7
	Garbage dump	3	3
	Water point	4	4
	Other	5	5
c	*Nests*	16	
	Cavities in large trees	8	50
	Caves or holes in Maya ruins	6	38
	On the ground	2	12
d	*Group composition at carcasses*	52	
	With conspecifics	18	35
	With black vulture	29	56
	With turkey vulture	5	9
e	*Size of prey animals*	52	
	Big animals	32	61
	Big and medium animals	5	10
	Any size	15	29

n represents either the number of local experts who answered a given question or reported a given information for that given question; % represents the percentage (rounded to the nearest integer) a given answer represents relative to the total of answers for the corresponding question.

* Some local experts reported several observations, so the total of answers for a given section can be higher than the number of informants who responded (n).

DISCUSSION

A preliminary consensus regarding the king vulture

A paucity of information regarding the king vulture led to the research project described here. One challenge in turning to local experts to fill this gap is the relatively infrequent interactions and sightings that local experts have with the bird. In Calakmul, today, people are spending less time in the forest in comparison to the 1990s, when forestry activities formed a greater part of the regional economy (Haenn 2011). Despite this, the research located 66 men whose collective knowledge provided an introductory cultural consensus regarding the vulture. These men reported that they tend to see the vulture more frequently during the dry season. This upturn might be due to a number of factors. Drier conditions allow people to travel into more remote forests at this time of year. Also, during the dry season, cattle ranchers need to visit their cattle more often to supply them with water, and many ranchers pass through forests to reach their pastures.

Local experts further noted that king vultures prefer to roost in stands of black olive, chicle, and Caribbean black cherry. Once an area had been logged of these species, sightings of king vultures dwindled and then fell off altogether. Selective logging of these species, especially the mature trees located close to water, removes the king vultures' roosting habitat (Reyes Martínez 2008). The importance of these roosting stands is substantial considering that king vultures appear to have a high level of fidelity to certain sites, using them over a period of one or two decades, a figure generally corresponding with the arrival of the informant in the area. Interestingly, local experts in Calakmul identified the region's archaeological ruins as additional nesting sites. They are the first to suggest that stone ruins located within mature forests may present alternative nesting sites if large trees become increasingly rare. Although often barely recognizable as former buildings, the use of ruins parallels observations of turkey vultures that occupy abandoned houses or barns to nest (Buhnerkempe and Westemeier 1984).

Where local experts differ from academic accounts based in other geographic regions is in the number of eggs housed in any given nest. Biologists working in Calakmul have showed relatively little interest in the bird, and what research exists has yet to be published. Thus, any comparisons must be made with birds living outside the region. The ten local experts who reported seeing eggs recalled two eggs per clutch rather than the one noted by scientists. Three nests with one single egg have been reported in the wild by Smith (1970), Ramo and Busto (1988), and Carvalho Filho et al. (2004). The same appears to be the case for king vultures held in captivity. This discrepancy suggests future questions regarding the vulture's reproduction that examine what kinds of conditions might lead to increased reproduction. Regarding the location of the nests, local expert observations are in agreement with the few observations reported in the literature by the above mentioned authors. This additional information consolidates the fragmentary scientific knowledge about the characteristics of king vulture's nesting sites.

On the topic of feeding, local expert findings concur with those by Lemon (1991) in Costa Rica's primary rain forests, that king vultures can be the first to arrive at a carcass. This information contrasts with research in central Venezuela's gallery forests (Houston 1988) and the peninsular beaches and desert grasslands of northern Peru (Wallace and Temple 1987). In these places, king vultures appeared to depend on turkey vultures to locate food, conclusions that point to possible limitations with data provided by local experts. Because sightings tend to be by chance, many local experts may not witness the actual arrival of all vulture species. Also, the king vulture's name inspires notions of hierarchy that may or may not exist in practice. The belief that the king vulture arrives first, while other vultures are waiting is widespread across Mesoamerica which could bias the observation and explain why some local experts reported that the king vulture always eats first "because he is the king." Most local experts, however, accurately described king vultures eating while other vulture species wait at a distance. For the guild of Neotropical avian scavengers, the

scientific literature reports similar findings that reveal a feeding order based on body size (Houston 1988; Wallace and Temple 1987).

We tentatively assert the king vulture opportunistically uses information provided by other vulture species to locate food. This opportunism would further explain why local experts in Calakmul suggested that king vultures feed on various sized animals. Information available from the academic literature coincides with these observations, reporting that king vultures may feed on animals as small as chicken and as large as donkeys (Houston 1988; Lemon 1991; Wallace and Temple 1987). Nevertheless king vultures have an advantage over competitors regarding larger prey species, as the skin of larger mammals, such as the tapir, is especially thick, and, we surmise, the king vulture is the only vulture species strong enough to rend it. This ability might explain any dominance of the king vulture in the feeding order (Houston 1984). Also, the carcasses of larger mammals can nourish vultures for several days. Consequently, they tend to attract larger clusters of birds for a longer time period, a point which raises the likelihood observers will see king vultures feeding on a large carcass. In noting this, we do not rule out the importance of small animals in the king vulture's diet. Its opportunistic feeding behavior was illustrated by a respondent who reported that king vultures ate the dead fish at a drying pond every year.

Contribution of local expert's knowledge to conservation

Despite a large number of publications that assert the importance of local knowledge for conservation programming (Baral and Gautan 2007; Berkes et al. 2000; Brondizio et al. 2009; Casagrande 2004; Hunn 2007; Mascia et al. 2003; Nazarea 1999), in Calakmul, conservation employees rarely turn to local expertise to design conservation programs. To the contrary, the presence of local knowledge in conservation programming is regularly erased in favor of scientific accounts. This is the case even when such science is based on a close collaboration between conservation employees and local experts (see Haenn et al. 2014). Typically, Calakmul's Biosphere Reserve officers implement conservation programs designed by park service staff in the nation's capital. These programs tend to view residents of Calakmul as beneficiaries of state largesse rather than as environmental knowledge-bearers (cf. Berlanga and Faust 2007; Durand and Vazquez 2011).

Because of this, conservation employees at Calakmul tend to be ignorant of the precise quality of local environmental knowledge. At the same time, local experts in Calakmul tend to be equally unaware of the policy world which shapes conservation programming. Only 13 of the 66 local experts knew the king vulture is protected under Mexican law. Unsurprisingly, no *ejido* included in the research had created its own conservation plans for the bird.

As such, it seems pressing that, in developing conservation strategies for species like the king vulture, conservation officials collaborate closely with local experts. We have already mentioned the importance of local knowledge to species, like the king vulture, about which there is a paucity of knowledge. Additionally, this collaboration could compensate for the fact that the Calakmul Biosphere Reserve has just one scientific officer responsible for monitoring all research relevant to conservation. Field biologists working in the region are also limited in number and none spends as much time in the forests as do local experts.

Skilled local experts might be employed as peer collaborators in conservation in a number of ways. As consultants, local experts could gather baseline biological data and carry out species monitoring. As liaisons, local experts might work with the Reserve offices and the assemblies which govern Calakmul *ejidos* to explore the possibility of *ejido*-level protection strategies. These strategies might focus on the preservation of existing nesting sites and the cultivation of groves of black olive, chicle, and Caribbean black cherry for future harvesting. In the past, Reserve authorities worked with assemblies in the establishment of village-level protected areas (Haenn 2005). These efforts were dropped with changing administrators and changing conservation priorities. The strategy, however, could counter forest fragmentation, and local experts could help identify where corridors might best serve king vulture populations.

Finally, as conservation programs become more geographically expansive (Naughton-Treves et al. 2005), local expertise becomes increasingly important. We suggest that local expertise could be incorporated into ecoregional plans and (sub)national biodiversity strategies and action plans. The early steps of these processes require significant data collection which could be undertaken by incorporating experts. At this scale, questions of translation and the political weight of different knowledge systems become even more challenging. Nonetheless, they are questions that must be addressed if species like the king vulture are to survive.

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