Curassows, Guans, and Chachalacas in Mexico

5

Roel R. Lopez, Nova J. Silvy, Markus J. Peterson, Daniel M. Brooks, Erick H. Baur, and Fernando González-García

With the exception of one species, the family Cracidae comprises forest and brushland bird species (i.e., chachalacas, curassows, and guans) endemic to the Neotropics of Mexico and Central and South America. Mexico is the northernmost distributional range for many of these species groups, except for the plain chachalaca (*Ortalis vetula*), which extends into the Rio Grande Valley of South Texas (Peterson 2000). Cracids, especially chachalacas and guans, are primarily arboreal, whereas other galliforms (e.g., turkeys, pheasants, and quails) are ground dwellers. This chapter focuses on the biology and management of three cracid groups that occur in Mexico: chachalacas, curassows, and guans.

Eight species and five genera of cracids occur in Mexico: the plain chachalaca, rufous-bellied chachalaca (*O. wagleri*) (fig 5.1), west Mexican chachalaca (*O. poliocephala*) (fig 5.2), white-bellied chachalaca (*O. leucogastra*) (fig. 5.3); highland guan (*Penelopina nigra*), crested guan (*Penelope purpurascens*), horned guan (*Oreophasis derbianus*), and great curassow (*Crax rubra*) (figs. 5.4 and 5.5) (Leopold 1959). Only the horned guan is typically found in the temperate uplands of Chiapas, Mexico (González-García 2001).

Figure 5.1. Rufous-bellied chachalaca (*O. wagleri*). Mathew Garvin/Macaulay Library at the Cornell Lab of Ornithology.

Species range in size from chachalacas (the size of a female pheasant) to guans (medium-sized turkey) to curassows (large turkey) (Brooks and Strahl 2000, Brooks and Fuller 2006).

Roughly one-half of the 50 cracid species are threatened at some level (Brooks et al. 2006). Cracids are of great social and economic value to indigenous populations and campesinos (Jorgenson 1995, 1997, González-García et al. 2001). As frugivores,

Figure 5.2. West Mexican chachalaca (*O. poliocephala*). Louis Imbeau/Macaulay Library at the Cornell Lab of Ornithology.

Figure 5.3. White-bellied chachalaca (*O. leucogastra*). Erick Hernandez/Macaulay Library at the Cornell Lab of Ornithology.

Figure 5.4. Great curassow female (*Crax rubra*). Don Coons/Macaulay Library at the Cornell Lab of Ornithology.

Figure 5.5. Great curassow male (*Crax rubra*). James Bozeman/Macaulay Library at the Cornell Lab of Ornithology

cracids serve an important ecological function by maintaining forested ecosystems and regenerating plant communities through their seed scarification and dispersal (Érard and Théry 1994, Santamaria-G. and Franco 1994, Peres and van Roosmalen 1996, Sedaghatkish 1996). More recently, their increased popularity among ecotourists, principally bird-watchers, has provided an economic incentive to conserve cracids. In addition to their intrinsic and biological value, cracids also serve as an important source of meat protein (Delacour and Amadon 1973). Several studies (Silva and Strahl 1991, Begazo 1997, Begazo and Bodmer 1998) have indicated that the largest avian biomass removed in Neotropical forests by subsistence hunters consisted of cracids. Cracid populations most threatened with overharvest were negatively and positively correlated, respectively, with distance to a city and city population size (Brooks 1999). These studies demonstrate the significance of cracids to the livelihood of many cultures in Mexico and other regions of Latin America.

Habitat destruction and unsustainable hunting are primary factors in cracid declines throughout their distribution (Brooks and Strahl 2000, Brooks and Fuller 2006). From a wildlife management perspective, it is important to note the sharp differences in population response among these species to human activities. In general, curassows and guans depend on climax tropical and montane forests and respond negatively to significant timber harvesting (Brooks 2006). Further, these species cannot withstand significant hunting pressure, whether subsistence or recreational (Brooks 1999, Peres 2000, 2001). It may not be practical to separate the effects of habitat

deterioration and hunting pressure on curassows and guans because both practices are detrimental to cracid populations. Throughout Mexico and Latin America, the status of several of these species ranges from near threatened (e.g., greater curassow) to vulnerable (e.g., highland guan) to critically endangered (e.g., horned guan; Brooks et al. 2006). In contrast, chachalacas fare well in second-growth forests and brushland, and most of the species can sustain significant hunting pressure (Brooks 1997a, Brooks and Fuller 2006). This is not to suggest that chachalacas do not prefer climax tropical and montane forests; rather, they readily adapt to dense brushlands (i.e., second-growth forests) resulting from timber harvest (Brooks 1997b). Many chachalacas are heavily hunted throughout their range, with few observed impacts on populations (Arriaga-U. and Baquero 1997). In our discussion of wildlife management practices, we organize our recommendations based on these important differences in response to human activities between curassows and guans versus chachalacas. We also discuss the life histories of cracids in three broad categories (i.e., chachalacas, guans, and curassows).

Taxonomy and Evolution

Cracids are a primitive family of game birds that originated nearly 50 million years ago. During the Oligocene era, much of North America was tropical, including the northern plains (Wetmore 1956). The earliest fossil records are those of a primitive bird, considered to be arboreal, found in the state of Wyoming (del Hoyo 1994). Other fossil forms (approximately 30 million years old) related to chachalacas have been found in South Dakota (Tordoff and MacDonald 1957). Cracids probably originated in North and Central America and expanded to South America coincident with climate and habitat changes (Brodkorb 1964). Recent fossils of contemporary cracids (e.g., *Crax, Penelope*), approximately 20,000 years old, have been found in their current distributional range (del Hoyo 1994).

Distribution

Chachalacas

In Mexico, chachalaca species are widely distributed along the Gulf-Caribbean slope from the lower Rio Grande Valley of Texas and the Pacific coast of western Mexico (fig. 5.6), southward to northern Honduras and north-central Nicaragua. Although their historical distribution was probably similar to their current distribution, many populations are disjunct because of agricultural and urban development, rendering isolated populations more vulnerable (Peterson 2000, Brooks 2006, Brooks et al. 2006). Other chachalaca

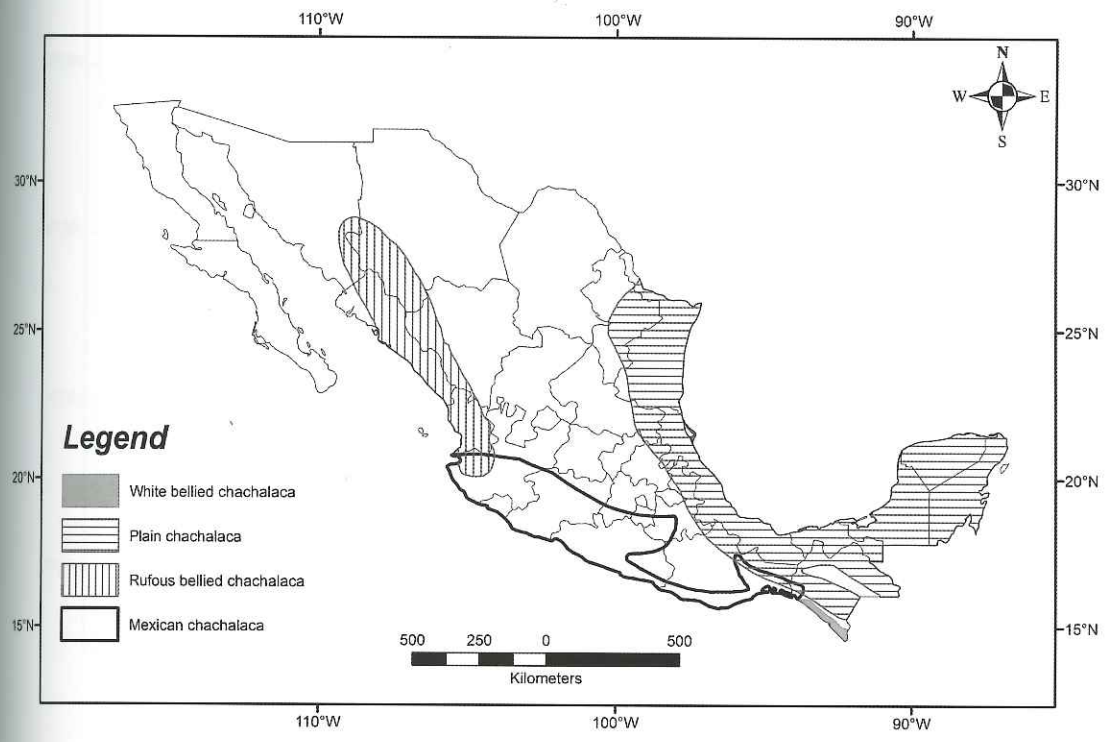

Figure 5.6. Distribution of the white-bellied chachalaca (*Ortalis leucogastra*), plain chachalaca (*O. vetula*), rufuous-bellied chachalaca (*O. wagleri*), and west Mexican chachalaca (*O. poliocephala*) in Mexico.

species occurring within or adjacent to the range of the plain chachalaca (fig. 5.7) include the west Mexican chachalaca and white-bellied chachalaca (Wagner 1953, Vaurie 1965, 1968, Delacour and Amadon 1973). The ranges of the plain and west Mexican chachalaca overlap on the Isthmus of Tehuantepec in Oaxaca (Peterson 2000). These two species occur in parapatry with the white-bellied chachalaca in coastal western Chiapas. The rufous-bellied chachalaca occurs in northwestern Mexico (Sibley and Monroe 1990).

Figure 5.7. Plain chachalaca (*Ortalis vetula*) is the only species with a distributional range that extends into the Rio Grande Valley of South Texas. Jordan Broadhead/Macaulay Library at the Cornell Lab of Ornithology.

Hybridization among these species probably does not occur in the wild (Wagner 1953, Leopold 1959, Vaurie 1965, 1968, Vuilleumier 1965).

Curassows

The great curassow is the only species in the genus *Crax* in Mexico and includes two subspecies—the mainland form (*rubra*), distributed along the coastal region of eastern Mexico; and the Cozumel curassow (*griscomi*), occurring on the island of Cozumel, Mexico (fig. 5.8) (Delacour and Amadon 1973, del Hoyo 1994, Martínez-Morales 1999). Curassows inhabit mature tropical forests between sea level and 1,200 m (0 and 3,937 ft) (Arguedas et al. 1997, Delgado 1997, McCoy 1997, Midence 1997, Sermeño 1997, Vannini and Rockstroh 1997), and occasionally up to 2,000 m (6,562 ft) (Vaughan 1983). Mainland populations have been extirpated in portions of their range (Howell and Webb 1995, González-García et al. 2001), with remaining populations highly fragmented. In some areas, populations are locally abundant (Martínez-Morales 1996), and a favorite game species (Jorgenson 1997).

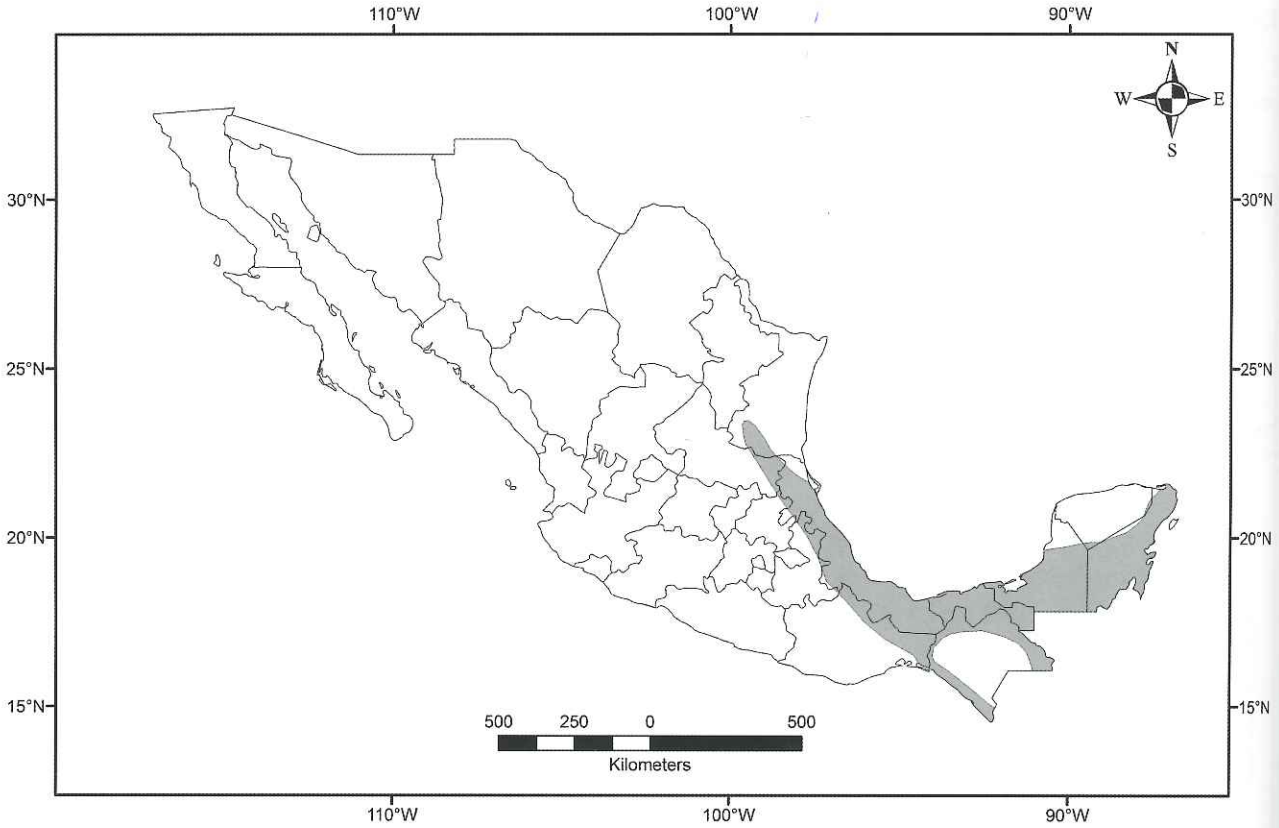

Figure 5.8. Distribution of the great curassow (*Crax rubra*) in Mexico.

Guans

Guans in Mexico inhabit cloud forests at elevations of 1,000–3,350 m (3,280–11,483 ft) (fig. 5.9). Horned guans are found on the slopes of the Sierra Madre de Chiapas, primarily in humid evergreen forests (fig. 5.10) (González-García et al. 2001). Highland guans occupy a variety of forest types in Chiapas and Oaxaca, including deciduous cloud, pine-oak, and coniferous forests at 900–3,300 m (2,953–10,827 ft) (Delacour and Amadon 1973, Eisermann et al. 2006), but they may also occupy adjacent low-canopy secondary forests (Eisermann 2005). In Mexico, the crested guan occurs in tropical forests of northern Sinaloa and central Tamaulipas, southward toward the forests of Chiapas and the Yucatán Peninsula. Seasonally, guans appear to move altitudinally, likely following fruit blooms.

Description

Chachalacas

Chachalacas are similar in size to female ring-necked pheasants (*Phasianus colchicus*) (Peterson 2000), except chachalacas have a broader, longer tail and a different plumage pattern. The general body color is olive drab; west Mexican and white-bellied chachalacas have much whiter underparts and/or white-tipped rectrices (Delacour and Amadon 1973). As the common name suggests, the abdomen and undertail coverts of the rufous-bellied chachalaca are rufous (reddish brown). All species are characterized by long legs, necks, and tails and lack wattles and caruncles, which are common in other cracid species (Delacour

Figure 5.10. A horned guan (*Oreophasis derbianus*) in natural habitat in Mexico. Photo by Fernando González García.

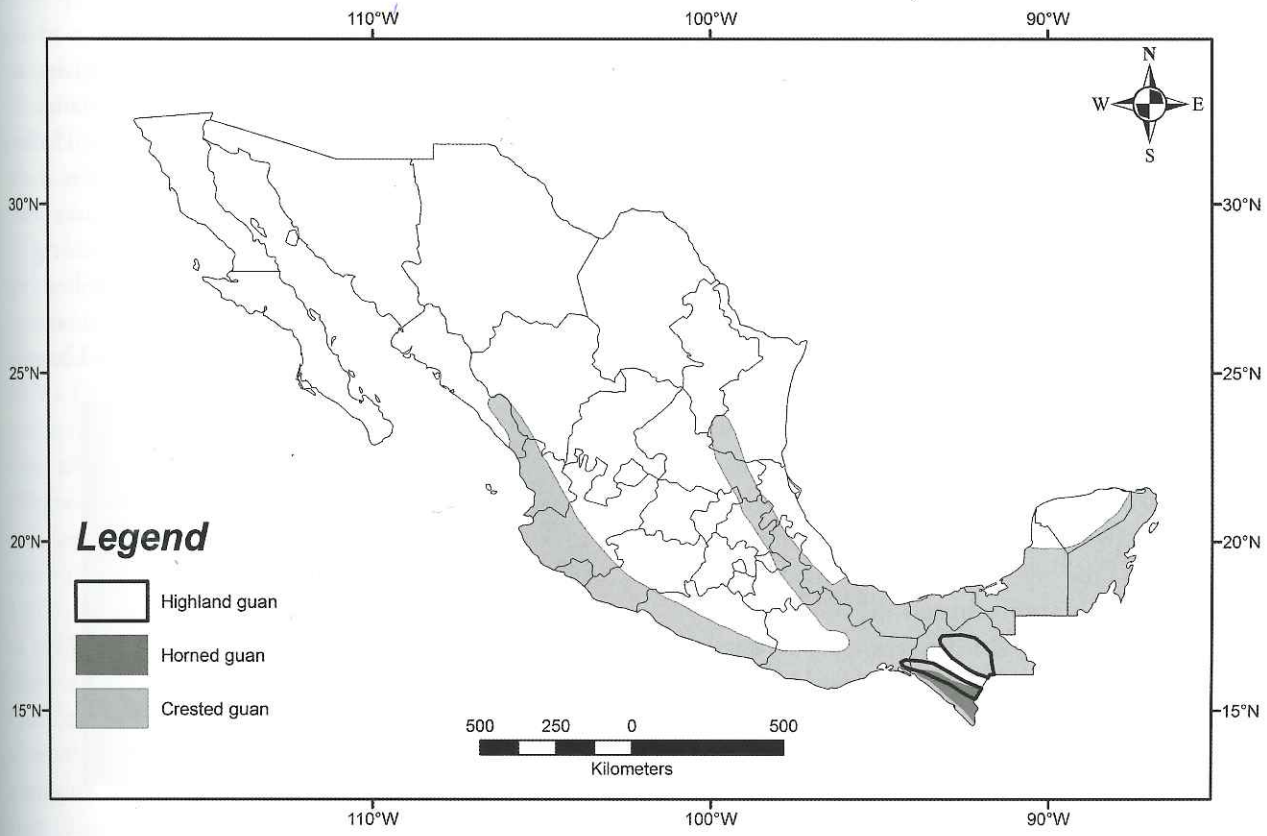

Figure 5.9. Distribution of the highland guan (*Penelopina nigra*), horned guan (*Oreophasis derbianus*), and crested guan (*Penelope purpurascens*) in Mexico.

and Amadon 1973). There is relatively little variation in body size, except for the smaller bodies of white-bellied chachalaca and certain populations of plain chachalaca (Vaurie 1965, 1968). Males are only slightly larger than females, and sexes can be differentiated by the presence of a tracheal loop found only in adult males (Peterson 2000).

Curassows

The great curassow is a magnificent bird approximately the size and shape of a large turkey with a crest of curly feathers. The general body color varies between sexes, with males being all black, except for a white abdomen and crissum, and females having cinnamon brown on the underside, shading to black on the neck and tail (Delacour and Amadon 1973). Rufous (reddish-brown) and barred (yellow, black, and white) morphs are possible in females (Delacour and Amadon 1973). Although it has been suggested that these morphs vary along a latitudinal gradient (del Hoyo 1994), different morphs have been observed in the same flock (barred and plain morphs in Belize) contemporaneously (Zimmer 1999). Males are slightly larger (3,600–4,600 g, 7.9–10 lb) than females (3,100–4,200 g, 6.8–9.3 lb).

Guans

Guans have the form of a pheasant or turkey, and the long tail typical of cracids. The crested guan is about the size of a small turkey (1,600–2,400 g, 3.5–5.3 lb), with a dusky olive-brown color. Breast feathers are edged with white, with the throat sparsely covered with bristles and a small red wattle. The crested guan is named after its normally erect crown feathers and is sexually monomorphic. The highland guan is the smallest guan in Mexico, approximately the size of a chicken (800–1,000 g, 1.8–2.2 lb). Common anatomical characteristics include a long tail, bare throat wattle, and low crest. Males are black, while females are barred brown—both have orange legs and feet, and the male has a red bill (Delacour and Amadon 1973). Horned guans are approximately the size of a turkey (2,000–2,300 g, 4.4–5 lb). The horned guan has a pronounced bright red casque that is in the form of a "horn" (hence its name). Both sexes are predominantly black with whiter underparts, red feet and legs, and a yellow bill (Delacour and Amadon 1973). Females are smaller than males and have a less pronounced "horn."

Life History

Chachalacas

This section will focus primarily on studies of plain chachalacas because the four species found in Mexico are similar behaviorally and ecologically. The plain chachalaca has been studied the most, but we do include information on the other species. While there are no known studies of rufous-bellied chachalaca, the two remaining species (west Mexican and white-bellied chachalaca) have been studied in detail. In El Salvador, diets included the fruits of 11 plant genera (at least 12 species) (Simas 1979). Studies on behavior and reproduction of west Mexican chachalaca were carried out by Rowley (1984) and Gurrola (1985). This species consumed the fruits of 24 plant genera (at least 27 species), as well as beetles, ants, crickets, snails (*Triodopsis* sp.), and soil (Gurrola 1985, Berlanga 1991), and was found to be an important disperser of *Spondias purpurea* and *Ficus cotinifolia* (Berlanga 1991, Mandujano et al. 1994). The forest falcon (*Micrastur semitorquatus*) is a known predator (Delacour and Amadon 1973) of plain chachalacas.

Diet

Chachalacas are primarily folivorous and frugivorous but also eat invertebrates and other plant material such as flowers and seeds (fig. 5.11) (Leopold 1959, Oberholser 1974, Marion 1976, Christensen et al. 1978). They are readily domesticated or semidomesticated and consume feed supplied by humans (e.g., cracked corn, milo, sunflower seeds) (Oberholser 1974, Marion 1976). In a year-round food-habit study of plain chachalacas, conducted in the Lower

Figure 5.11. Although primarily folivorous and frugivorous, chachalacas also eat other plant parts like the flowers of *Ehretia anacua*. Photo by Carlos Abrego.

Rio Grande Valley of Texas (Marion 1976), plant species provided more than 90% of the diet by volume and included coyotillo (*Karwinskia humboldtiana*), Mexican ash (*Fraxinus berlandieriana*), bloodberry rougeplant (*Rivina humilis*), and anaqua (*Ehretia anacua*). Food consumption was related to food availability, likely as with other species in the genus. Based on 205 diet samples of specimens from tropical lowland forest, Baur (2008) found that diets included the seeds of 86 plant species, and overall diets comprised seeds (82%), 3–7% each for pulp, leaf, and grit and snail parts, and less than 2% each for other animals, flowers, and stems. Approximately one-half (47%) of the diet was shared with sympatric galliforms (Baur 2008). Baur (2008) found diet overlap of 65% with crested guan, 49% with great tinamou (*Tinamus major*), 39% with great curassow, and 33% with ocellated turkey (*Meleagris ocellata*).

Reproduction and behavior

The only reproductive study of any of the four chachalaca species included herein was conducted on plain chachalacas in South Texas (Marion 1978, Marion and Fleetwood 1978). Little information for other species is available; however, a few generalities can be extrapolated for chachalacas regarding latitude, altitude, and habitat conditions relative to the timing of reproduction (Peterson 2000). Chachalacas are probably monogamous, with pair formation beginning when individuals are still in winter feeding flocks (Wagner 1953, Leopold 1959, Delacour and Amadon 1973, Marion and Fleetwood 1978). Typically, in early spring (February–March in their northern range), an increase in activity and loud calling signals the beginning of the breeding season (Marion and Fleetwood 1978). Once mating occurs, chachalaca pairs begin nest construction and egg laying. Most nests are in trees, tall shrubs, or vines supported by trees or shrubs (Wagner 1953, Leopold 1959, Peterson 2000); however, some studies report that chachalacas occasionally nest on the ground between shrubs (Alvarez del Toro 1952). In Chiapas, nests were reported to be 6–10 m (19.7–32.8 ft) above the ground (Wagner 1953), whereas in the geographically proximal lowlands of Guatemala, nests ranged from 1 to 18 m (3.3 to 59 ft) above the ground (mean = 5.7 m, or 18.7 ft) in trees averaging 16.9 cm (6.7 in) DBH; 73% of nests were in trees (Baur 2008). Peak nesting season is late spring but varies considerably by latitude (March–July) (Alvarez del Toro 1952, Wagner 1953, Paynter 1955, Leopold 1959, Marion and Fleetwood 1978, Baur 2008); it is triggered by seasonal temperature changes in northern regions, or the beginning of the wet season in southern areas (Wagner 1953, Delacour and Amadon 1973). Nesting pairs are territorial, and males aggressively defend nests during the incubation period (Delacour and Amadon 1973, Marion 1974a). Incubation is approximately 25–28 days (Peterson 2000), with a clutch size of two to three eggs (Bent 1932, Oberholser 1974, Peterson 2000, Baur 2008). Chicks are brooded by both parents, parental care is provided for approximately six to eight months (Marion and Fleetwood 1978), and offspring are present from March to October (peaking from April to June) (Baur 2008).

Chachalacas are not strong fliers and instead make short flights from tree to tree or glide through dense vegetation with skill and accuracy (Bent 1932, Wagner 1953, Leopold 1959, Oberholser 1974). One of the most striking characteristics of chachalacas is the loud, raucous calls a flock emits when in full chorus (Peterson 2000). The resultant sound has been previously described as making "the valleys ring" (Baird 1857); "loud and simply indescribable" and "deafening" (Sennett 1878); "a pandemonium" (Sutton 1951); "ear-splitting" (Delacour and Amadon 1973); and comparable to the sound of howler monkeys (*Alouatta* spp.) (Oberholser 1974). To humans, this overlapping chorus sounds much like *cha-cha-lac-a*—hence the onomatopoeic common name for this genus (Delacour and Amadon 1973, Oberholser 1974, Peterson 2000). Pairs and family groups (3–5) are the basic social unit (Leopold 1959, Delacour and Amadon 1973, Marion 1974a, Peterson 2000), but flocks of 10–20 form during the fall and winter (Smith 1910, Teale 1965, Stiles and Skutch 1989) and probably represent transitory family group aggregations resulting from factors such as clumped food availability (Sutton 1951, Teale 1965, Marion 1976, Brooks 1997a).

Population dynamics

There are no reliable survey methods for chachalacas because of their secretive nature and the dense habitats they typically occupy, although road transects can provide a relative population index (Brooks 1997b). Marion et al. (1981) and Marion (1982) used loud prerecorded calls to estimate density in South Texas for plain chachalacas; they reported a

density of 2.5 birds/ha (1 bird/ac), or approximately 15,000–18,000 birds for the three-county region (Marion 1974b). Though absolute density estimates for chachalaca species are not available, overall populations appear to be doing well throughout their range, despite considerable hunting pressure wherever sufficient suitable habitat remains (Lowery and Dalquest 1951, Leopold 1959, Delacour and Amadon 1973). Chachalacas are permanent residents in the areas they occupy (Peterson 2000).

Few studies have been conducted on chachalacas to determine survival and mortality factors. Incidental recapture of 10 banded plain chachalacas revealed that 1 male was 8 years of age or more, 3 females and 1 male were 7 years old or more, and the 5 remaining individuals were 5 years of age or more (Marion and Fleetwood 1974); thus, adults probably commonly live 5–8 years or more in the wild. Balda and Schemnitz (1997) translocated 17 birds to other parts of South Texas: 13 had lost or failed transmitters, 2 were killed by predators, and 2 were successfully tracked. Translocation to other sites in South Texas was not successful (Balda and Schemnitz 1997). Sex ratios of wild-trapped plain chachalacas were not significantly different ($p > 0.05$) from a 1:1 ratio (Marion and Fleetwood 1978). Similarly, of 26 birds collected in Chiapas, Mexico, the sex ratio was 12:14 males to females (Wagner 1953). The primary mortality factor for chachalacas is nest predation. In South Texas, mammalian predators such as raccoons (*Procyon lotor*) and Virginia opossum (*Didelphis virginiana*), and snakes such as Texas indigo (*Drymarchon corais erebennus*), accounted for 44% and 25% of 47 incubated-nest losses, respectively (Marion and Fleetwood 1978). Of 77 nests, only 3 (4%) were predated in Guatemalan lowlands (Baur 2008). The population-level significance of nonhuman predation, if any, is unknown. The black spider monkey (*Ateles paniscus*) and kinkajou (*Potos flavus*) might prey on nests in Chiapas, Mexico (Wagner 1953). Coyotes (*Canis latrans*), domestic dogs, bobcats (*Lynx rufus*), hawk-eagles (*Spizaetus* spp.), and Harris's hawks (*Parabuteo unicinctus*) are known or probable predators of juveniles and adults in Chiapas (Wagner 1953). Baur (2008) found annual harvest by humans to be 16% of all game birds harvested during the first year of study, and 25% the second year; respective first- and second-year total game bird biomass was 3% and 6%. Chachalacas represented the least-harvested galliform in total galliform biomass but were the third most harvested game birds in number of individuals, most of which were usually taken 0–4 km (0–2.5 mi) from camp (Baur 2008). Other recorded mortality factors for chachalacas included exposure to cold weather, which likely limits their northern distributional range (Balda 1989, Balda and Schemnitz 1997). Cold temperatures (–11.7°C, or 10.9°F) killed thousands of plain chachalacas in South Texas in February 1898 (Smith 1910).

Population management

Although market hunters pursued chachalacas historically (Peterson 2000), most direct exploitation today is by subsistence hunters; the taste and texture of chachalaca flesh are not desirable. These species have been domesticated by capturing chicks and using domestic hens to incubate eggs. Habitat destruction through clear-cutting continues to be the primary factor likely restricting their distribution (Peterson 2000, González-García et al. 2001). In some regions, native habitat has been replaced with vast industrialized, agricultural landscapes, while urban sprawl and other habitat conversions have destroyed native habitats. Unregulated exploitation, particularly in sites near towns and villages, can depress population numbers even where habitat is otherwise suitable. Despite these challenges, chachalacas fare well compared to other species of cracids under these environmental pressures. Population management strategies should include providing suitable habitat—both climax and second-growth forests and brushlands—and monitoring hunting pressure on local populations. Basic research on topics such as survival and reproduction is needed to establish a database to better manage populations.

Great curassow

Diet

The primary diet of the great curassow is fruit, but it also eats invertebrates and other plant materials (Leopold 1959). Using 267 samples, Baur (2008) found 74 species of seeds in the diet, with overall diet consisting of seeds (70%), grit and snail parts (20%), pulp (7%), 2% each of leaves and other animals, and less than 1% of flowers and stems. Sermeño (1997) reported that curassows consumed fruits of 15 plant species, leaves of 4 plant species, and 4 species of invertebrates. Some

of the more common species of fruits consumed were represented by the following plant families: Moraceae (at least two species of *Ficus*, and *Brosimum alicastrum* and *B. terrabanum*), Sapotaceae (*Manilkara chicle* and *Mastichodendron capiri*), and Urticaceae (*Cecropia peltata* and *C. obtusifolia*) (Sermeño 1997). Rivas (1995) reported that curassow consumption included fruits and seeds of approximately 44 plant species, and over 22 species of arthropods; thus, curassows perform an important ecosystem service by dispersing and scarifying seeds in tropical montane forests (Rivas 2004). Dietary overlap is extensive with sympatric galliforms. Baur (2008) found 86% overlap with great tinamou, 68% with crested guan, 58% with ocellated turkey, and 39% with plain chachalaca, with a mean overlap of 63% for all four species.

Reproduction and behavior

Although curassows mature at two years of age, they often will not successfully reproduce until their third year (Alvarez del Toro 1952, Guido 1985). Pair formation begins following courtship, and males actively participate in nest construction and chick rearing, but only the females incubate (Guido 1985, Sermeño 1986). Baur (2008) provided the following breeding chronology: male booming calls from January to August (peaking March–June), nesting April–June (peaking in April), and offspring present April–October (peaking June–July).

The male has an elaborate courtship display that includes "strutting" with raised tail feathers and emitting a loud, booming "hum" or "oomp" from a tall treetop (Sutton and Pettingill 1942, Alvarez del Toro 1952, Garcia and Brooks 1997). When calling, the male sits on a branch or stands on the ground with lowered head and tail and "booms" to lure the female (Delacour and Amadon 1973; C. Garcia, personal observation). The male will offer the hen pieces of fruits or nuts, green leaf fragments, or even pebbles (D. Brooks, personal observation). The nest is made of branches and leaves (both dried and green), typically placed in the fork of a tree and often covered with vines, and measures 26–46 cm (9.4–18 in) in diameter, 16–27 cm (6.3–10.6 in) high at the sides, and 8–13 cm (3.1–5.1 in) deep (Guido 1985, Sermeño 1997). Nests are typically placed 4–10 m (13–33 ft) high in the tree but may be as high as 30 m (66 ft). Nest trees average 20 cm (7.9 in) DBH; at least 31 species of trees have been recorded to contain nests, with the most frequent being *Brosimum alicastrum, Faramea occidentalis, Hirtella racemosa, Inga punctata, Licania retifolia, Lonchocarpus salvadorensis, Rheedia edulis*, and *Swartzia simplex* (Sutton and Pettingill 1942, Guido 1985, Sermeño 1986, 1997, Baur 2008). After nest construction, the female lays two (rarely three) large white eggs, each averaging 250 g (0.6 lb), with an incubation period of 31–33 days. The female will take recesses off the nest ranging from 20 to 120 minutes. Chicks are brooded with biparental care for approximately eight months (Guido 1985, Quinto 1981, Sermeño 1997; J. Estudillo, personal communication).

In addition to the booming "oomp" call described above, alarm calls to warn of a potential predator are also made through a series of short "piit witt" calls (D. Brooks, personal observation). The basic social unit for the curassow is primarily individuals or small groups of up to 6 birds (Sermeño 1997, Zimmer 1999). Occasionally curassows form flocks of 20 or more birds of both sexes, but flocks typically do not exceed 10 to 15 birds (Guido 1985, Sermeño 1997, Zimmer 1997).

Population dynamics

Curassows are considered threatened (mainland population) to critically endangered (Cozumel population), and they have been extirpated from many areas, resulting in highly fragmented, localized populations (Howell and Webb 1995, Brooks and Strahl 2000, Rios and Muñoz 2006). Densities were estimated at 0.4–1.2 birds/km^2 (1–3.1 birds/mi^2) (minimum population = 500 individuals) in Costa Rican forest fragments (Vaughan 1983, McCoy 1997); 0.9 birds/km^2 (2.3 birds/mi^2) (97–304 total individuals) on Cozumel Island (Martinez-Morales 1999); 1.4 birds/km^2 (3.6 birds/mi^2) within Punta Manabique, a protected area along the Guatemalan Atlantic coast (Eisermann 2004); and 6–8 individuals along about 45 km (28 mi) of transect in Tikal, Guatemala (Donegan 2001).

There are few studies on longevity, mortality, or recruitment for great curassow populations (Arguedas et al. 1997). A captive female lived 24 years, laying two eggs per clutch for 23 of those years (Taibel 1940). Martinez-Morales (1999) reported a sex ratio of 1:1 for the Cozumel population, with approximately 80% of the estimated population being adults. Baur (2008) reported that of 24 nests, only 1 (4%) was predated. Predators include Neotropical felids, some canids and mustelids, large raptors that specialize on large verte-

brates (e.g., *Spizaetus*), and humans (González-García et al. 2001). Parasites include ticks, cestodes, *Capillaria* sp., and *Eimeria* sp. (Delacour and Amadon 1973, Palomares 1980, García 1998). Baur (2008) found annual harvest by humans to be 278 individuals (47% of all game bird harvest), or 946 kg (2,086 lb) of biomass (58% of total game bird biomass). This represented by far the most-hunted game bird in the region, and individuals were usually harvested 4–8 km (2.5–5 mi) from camp (Baur 2008).

Population management

Principal threats to the great curassow are habitat loss or degradation and hunting (Brooks and Strahl 2000, Rios and Muñoz 2006). The size of the curassow makes it an easy target for human hunters (i.e., for human consumption, sport, and illegal pet trafficking) (Brooks and Strahl 2000, Rios and Muñoz 2006). Even though the species can withstand some level of habitat alteration (McCoy 1997), the great curassow is sensitive to changes in habitat structure. In some regions, native habitat has been replaced with vast industrialized, agricultural landscapes; in addition, urban sprawl, along with other habitat conversions, has also displaced this species (Vannini and Rockstroh 1997). Population management strategies include providing suitable habitat—both climax and pristine montane tropical forests—and monitoring and regulating hunting pressure on local populations (Rios and Muñoz 2006). More detailed research on life history and survivorship is needed to better manage these populations.

Guans

Diet

The primary diet for guans, as for other cracids, is fruits, but they also eat other plant materials (e.g., tender leaves, orchid flowers) and some invertebrates (Leopold 1959, González-García 2005). González-García (2005) reported that horned guans consumed at least 57 plant species. In Guatemala, horned guans consume fruits of *Dendropanax arboreus*, *Symplocos hartwegii*, *Phoebe* sp., and nectar of *Chiranthodendron pentadactylon* (Gonzalez-García et al. 2006a; O. Mendez, personal communication). Alvarez del Toro (1952) observed highland guans "on the ground scratching in the leaf litter for fruits, insects, and tender green plants," although their diet may also include crabs, small rodents, and salamanders (Rowley 1984, González-García et al. 2001). Highland guans have been recorded eating fruits of 24 different genera in El Triunfo, Mexico (F. González-García, personal observation), and 10 genera in Montecristo, El Salvador (Pullen 1978), 6 of which were different genera from those in Mexico, with a total of at least 33 different species of fruit. Based on 142 samples from Guatemalan lowlands, Baur (2008) found 72 species of seeds in the diet of the crested guan, with overall diet consisting of seeds (79%), 9% each for pulp and grit/snail parts, and less than 1% each for leaves, flowers, stems, and other animals. In Costa Rican dry forest, crested guans consumed 38 species of plants from 27 families, with the diet constituting 76% fruit, 21% flowers, leaves, and tender shoots, and 3% ants, but only when fruit was scarce (Pacheco 1994). Leopold (1959) examined bird crops and found that the crested guans consumed primarily fruit, including that of the capulin selvaje (*Bumelia peninsularis*); additionally, he reported the consumption of xocotl plums (*Spondias mombin*) as a dominant spring food (fig. 5.12). McCoy (1997) noted crested guans consuming *Bumelia peninsularis*, *Chione mexicana*, *Guatteria* sp., and *Symplocos* spp. Seeds of *Tetragastris panamensis* and *Virola surinamen-*

Figure 5.12. *Spondias mombin* plums provide spring food for the crested guan. Photo by Marco Schmidt.

sis are among the seeds dispersed by the crested guan (fig. 5.13) (Howe and Vande Kerckhove 1980, 1981; Howe 1984, 1993). Dietary overlap between crested guans and sympatric galliforms is extensive. Baur (2008) found 73% overlap with great tinamou, 68% with great curassow, 65% with plain chachalaca, and 57% with ocellated turkey, with a mean overlap of 66% for all four species.

Reproduction and behavior

Reproduction may start as early as two years of age in crested and highland guans (Wagner 1953, Leopold 1977). The breeding season for horned and crested guans begins in the spring and continues through the summer (March–August) (Alvarez del Toro 1952, Wagner 1953, Baur 2008). The reproductive season of the highland guan is from January to June, peaking between March and April, and is initiated by calls of the male, the first of which are heard sporadically during November and December (Jiménez 2002); in El Salvador, O. Komar (personal observation) reported a female incubating on 21 July.

During courtship, male crested guans raise their crest feathers, display the bare part of their throat, which is an intense red color, and emit vocalizations that can be heard as far as 0.5 km (0.3 mi), primarily during crepuscular periods (Schäefer 1953; F. González-García, personal observation). The whistle of the male highland guan during courtship is its best-known vocalization; the male also flies from its perch, producing a sound like a stampede or fabric tearing (Dickey and Van Rossem 1938, Salvin and Godman 1902, Andrle 1967), and makes short hops among branches close to the female, raising and lowering its tail with great agility (Jiménez 2002). Pair formation of highland guans begins in January, and nesting behavior begins in February (Jiménez 2002). Horned guans emit courtship calls primarily from November through May, when males make short flights from tree to tree, constantly emitting bellowing vocalizations to lure females; males will also offer fruit and leaf fragments to females, either regurgitated or directly (González-García 1995, Gómez de Silva et al. 1999, González-García et al. 2001). The social system of the horned guan is serial polygyny; the male has access to three or four females (González-García 1995). Most guans are probably polygamous, with limited to no assistance from the males during the nesting season (e.g., in nest construction, brooding, and rearing) (Wagner 1953, González-García 1994, 1995; González-García et al. 2001). The courtship call is elaborate and includes "drumming" (i.e., rapid beating of wings) (Salvin and Godman 1897–1904, Sutton and Pettingill 1942, Alvarez del Toro 1952), similar to the sound of the ruffed grouse (*Bonasa umbellus*).

Figure 5.13. The seeds of *Virola surinamensis* are consumed and dispersed by the crested guan. Photo by Feroze Omardeen.

In Mexico, horned guans build their nest of bromeliad roots, orchids, and dead leaves; it measures 32 × 30 cm (12.6 in × 11.8 in) and is located in upper, isolated canopy trees with an average height of 19 m (62 ft), in species including *Matudaea trinervia*, *Ternstroemia lineata*, *Quercus* sp., and *Clethra* sp. (González-García 1994, 1995, 1997). In contrast, Méndez (2000) found a Guatemalan horned guan nest at a height of 7.8 m (25.6 ft) in *Chiranthodendron pentadactylon*. The female horned guan will take one to four 30-minute breaks per day to eat, drink, or dust bathe (González-García 1995, 1997). All but 1 of 16 highland guan nests were in trees, averaging 5 m (16 ft) above the ground (range = 2.4–12.1 m, 7.9–39.7 ft) (Rowley 1984); similarly, F. González-García (personal observation) found nests 1–15 m (3.3–49 ft) above the ground. Highland guans generally construct their nest in forks of medium-sized trees; external measurements are 13 cm (5.1 in) deep × 30 cm (11.8 in) in diameter, and cup measurements are 4.5 cm (1.8 in) deep × 20 cm (7.9 in) in diameter; the nest is made of interwoven leaves and green twigs and is

covered with dry leaves, moss, and sometimes pine needles (Pullen 1983, González-García et al. 2001, Jiménez 2002). Baur (2008) found crested guan nests invariably in trees, at a height ranging from 4 to 15 m (13 to 49 ft) (mean = 9.75 m, 32 ft), in trees averaging 26.3 cm (10.4 in) DBH. The nest of the crested guan is a large, bulky structure covered with branches and both green and dry leaves (Rowley 1984). Nest construction and egg laying (clutch size = 2) begin immediately following the mating season, with an incubation period of approximately 35–36 days in horned guans (Wagner 1953, Rowley 1984, González-García 1995, Baur 2008), 25–28 days estimated in highland guans (González-García et al. 2001), and 26–28 days in captive crested guans (data not available for wild birds) (Taibel 1957). Horned guan chicks hatch within an hour or two of one another, stay in the nest for three to seven days, and then leave the nest, where they "peep" for the female to reunite the group (González-García 1995). The chicks of the highland guan take approximately 18 hours to hatch and dry. They leave the nest the day after hatching, after which the female diminishes her arboreal activity and stays with the chicks (Andrle 1967, Pullen 1978, Rowley 1984, González-García et al. 2001; F. González-García, personal observation). Crested guan offspring have been encountered from May to September, with a peak in July (Baur 2008). The chicks leave the nest only minutes after hatching, where they initially live on the ground but quickly shift to trees (Leopold 1977).

When disturbed on the ground, crested guans immediately fly high and land on tree branches or fly strongly for short distances; the main reaction to a potential threat, however, is to remain silently perched high in the branches, where their location can be revealed by displaced fruit that falls to the ground (Pacheco 1994, González-García et al. 2001). The "cauk, cauk, cauk" call of crested guans is emitted up to 144 times/minute (Kilham 1978); other vocalizations can be compared to pig "grunts," but the usual alarm call is a "honk" (Lowery and Dalquest 1951, Slud 1964, McCoy 1997). The whistle of the male highland guan is used for territoriality, and courtship that involves two phases: first, the male perches on a branch with an open bill and head thrown backward, emitting a loud, guttural whistle (like that of a human) that lasts 2.5–3 seconds and is phonetically similar to a "caahahahuiuiui." This is generally followed by the other vocalization, which is structured in three phrases; the first two phrases are two whistles each, and the third phrase has a variable number of whistles (Pullen 1978, Jiménez 2002). Male and female horned guans make four and eight types of vocalizations, respectively (González-García 1995). The estimated area of activity for a nesting female horned guan is 9 ha (22 ac), and 8 ha (19.8 ac) for a male (González-García 1991). They are typically solitary, in pairs, or in small groups of up to five (Andrle 1967, Parker et al. 1976, Pullen 1978, 1983). The small groups appear to be females with young subadults (González-García et al. 2001). Apart from this, little is known about guan social structure and spacing.

Population dynamics

The density of horned guans at El Triunfo was estimated to be 4.5–6.7 birds/km^2 (11.8–17.6 birds/mi^2) (González-García 1995, Gómez de Silva et al. 1999). The entire population in Mexico was estimated at 4,500–6,700 individuals (González-García 2005). Highland guan density estimates are similar in Guatemala (1–10 birds/km^2, or 2.6–26 birds/mi^2) (Eisermann 2004, Renner 2003), though some estimates exceed 25 birds/km^2 (65 birds/mi^2) (Morales 1991, 2004). Brooks and Strahl (2000) considered the latter density estimates unrealistic. In El Salvador, abundance (per four hours of observation) averaged 1 bird in pine-oak forest, 0.7 in cloud forest, and 0.3 in cypress plantations (Komar 2002), whereas Pullen (1983) recorded 121 sightings during 126 days in Montecristo Reserve. Reliable density estimates for crested guans are lacking. The status of these species ranges from lower risk (crested guan) to vulnerable (highland guan) to critically endangered (horned guan) (Brooks et al. 2006, Eisermann et al. 2006, González-García et al. 2006a). Outside of natural history studies of guans (González-García 1995, Delacour and Amadon 1973), there are few studies on longevity, mortality, and recruitment.

Possible predators on eggs and chicks of horned and highland guans include green toucanet (*Aulacorhynchus prasinus*), red-tailed hawk (*Buteo jamaicensis*), and fulvous owl (*Strix fulvescens*). Various carnivores that prey on adults include tayra (*Eira barbara*), kinkajou (*Potos flavus*), coati (*Nasua narica*), jaguar (*Panthera onca*), and puma (*Puma concolor*) (González-García et al. 2001). Primary predators of crested guan include ocelot (*Leopardus pardalis*),

margay (*Leopardus wiedii*), and puma (*Puma concolor*) (Schäefer 1953). Raptors such as the ornate hawk-eagle (*Spizaetus ornatus*) attack adult crested guans (Kilham 1978), and birds such as toucans probably prey on eggs in the nest (González-García et al. 2001). Of 19 crested guan nests in Guatemalan lowlands, none were preyed on (Baur 2008). Baur (2008) found annual harvest of crested guans by humans to be 7% of the total game bird harvest during the first year of study, and 17% the second year; respective first- and second-year biomass quantities were 6% and 16% of total game bird biomass.

Population management

Principal threats to guans are habitat loss or degradation and unregulated hunting (Brooks and Strahl 2000, González-García 2005, González-García et al. 2001, 2006a). In recent years, uncontrolled forest fires have threatened prime guan habitat. Asbjornsen et al. (2005), for example, reported a 60% reduction in the Chimalapas National Forest Reserve. Population management strategies include providing suitable habitat and continued protection from hunting pressure (e.g., the horned guan is officially protected in Mexico) (Brooks and Strahl 2000, González-García et al. 2006a). Little is known about guan life histories; basic research addressing survival and reproduction is needed to better manage these populations.

Habitat and Management

Habitat requirements

Chachalacas occupy a variety of subtropical and tropical habitat types ranging from altered landscapes (e.g., plantations, agriculture-brushland mosaics, urban areas, degraded forests) to lowland moist forests, tropical mangroves, and lowland deciduous thorn shrublands (del Hoyo 1994, Stattersfield et al. 1998, Peterson 2000). In Mexico, chachalacas are rarely found at elevations above 1,300 m (4,265 ft) (del Hoyo 1994, Peterson 2000) and are classified as species of "least concern" (Brooks et al. 2006). In general, and unlike other cracids, chachalacas thrive in the thickets and brushlands that often arise after the clearing of tropical forests (Alvarez del Toro 1952, Leopold 1959, Delacour and Amadon 1973, Martínez-Sánchez 1997, Peterson 2000).

In contrast, guans and curassows occupy various subtropical and tropical habitats ranging from wet premontane and montane broad-leaved forests to lowland moist forests and tropical mangroves (Eisermann et al. 2006, González-García et al. 2006a, 2006b, Rios and Muñoz 2006). The general habitats guans and curassows prefer, however, are typically areas with less human disturbance (e.g., climax forest) (Eisermann et al. 2006; González-García et al. 2006a, 2006b; Rios and Muñoz 2006). Highland and horned guans typically occupy habitats at higher elevations (700–3,330 m, 2,297–10,827 ft), whereas the crested guan and great curassow are found at lower elevations (0–2,000 m, 0–6,562 ft), with the latter group in many cases overlapping with chachalacas (Escobar-Ortíz 1997). In Mexico, the status of guans and curassows ranges from near threatened (e.g., great curassow), to vulnerable (e.g., highland guan), to critically endangered (e.g., horned guan) (Eisermann et al. 2006, González-García et al. 2006a, Rios and Muñoz 2006).

Management

Habitat destruction and unsustainable hunting practices are principal threats to cracids throughout Mexico (Eisermann et al. 2006, González-García et al. 2006a, 2006b, Rios and Muñoz 2006). The sharp differences in the population responses of chachalacas versus those of guans and the great curassow related to these primary threats have already been noted. Cracid management recommendations to address threats in Mexico fall into three broad categories: (1) forest management (i.e., protection, restoration, and coordination of timber management practices); (2) management of hunting pressure (i.e., numbers taken, access to species); and (3) ecological research related to population dynamics and species response to habitat management practices. Each of these will be discussed individually.

Forest management

Management of cracids in Mexico requires continued protection and preservation of remaining habitats for these species (González-García et al. 2006b). This is particularly important for species that depend on climax forests, such as montane or cloud forest habitats (e.g., horned guan, highland guan). Deforestation is prevalent throughout Mexico and much of Central America. For example, despite having over 55 million ha (135 million ac) of forest cover in 2000 (the second-highest area of any Latin American country next to Peru), Mexico lost over

630,000 ha (1.6 million ac) per year from 1990 to 2000, a greater yearly loss than in any other Latin American country (Brooks 2006). This has resulted in habitat fragmentation and increased human access, which collectively relegate cracid populations to isolated habitat patches where they are more vulnerable to extirpation by subsistence hunters or other human activities (Martínez-Sánchez 1997). National parks and other protected areas can serve to protect cracids in Mexico (McCoy 1997, Midence 1997). However, legal and physical protection of habitat and protection of populations are not necessarily synonymous. Although designating protected areas is a useful conservation strategy, such designation does not necessarily prevent fuel-wood collection, grazing, illegal hunting, or even extraction of valuable timber resources, particularly near the boundaries of protected areas (Bruner et al. 2001).

Hunting

A second management recommendation for cracid conservation in Mexico is gaining a better understanding of the effects of unrestricted hunting and controlling it where appropriate. Illegal and unregulated subsistence hunting can limit cracid populations and can cause local extirpations, particularly in habitat "islands" near villages or local communities (McCoy 1997, Vannini and Rockstroh 1997, González-García et al. 2006b). Impacts from hunting obviously vary among the different cracid species in Mexico. In such cases, active regulation of hunting of the more accessible populations is recommended (González-García et al. 2006b).

Historically, hunting statutes and regulations have been instituted but not often heeded by subsistence hunters (Leopold 1959). Ambiguously worded statutes also serve to render legal protection uncertain (Vannini and Rockstroh 1997). Even if laws were clarified, however, insufficient agents and funding would inhibit their meaningful enforcement. Strictly regulated hunting practices should be initiated for cracid populations that occupy sufficiently large areas of suitable habitat and that can tolerate some level of hunting (e.g., chachalacas). Thus, chachalaca hunting, for example, would continue to provide human food and recreation as well as badly needed funds for species conservation (Waggerman 1979, McCoy 1997). This option deserves further exploration. An increase in basic knowledge regarding the ecology of these species—and their anticipated population responses to external variables such as land-use changes (e.g., patch size and condition) and other human-related influences (e.g., subsistence hunting and other mortality factors)—is required to establish sound management of these species in Mexico.

Research

The biology of most cracid species is poorly understood, despite great improvements in the last two decades (Brooks et al. 2006). These species need more basic research for informed wildlife management. High-priority research needs include (1) surveys of local population densities and total population sizes; (2) estimates of rates of cloud-forest destruction and degradation within the range of each species; (3) studies of population responses to land-use changes, particularly estimates of population dynamics (e.g., survival, mortality factors, reproduction); and (4) assessment of the economic and biological impacts of nature tourism and ecotourism related to cracids (González-García et al. 2006b). Other important areas of research include the impact of climate change on cracid populations, the impact of wildfires in primary cloud forests, and the benefits of forest restoration practices to cracid populations.

Management Challenges in Mexico

The greatest management challenges for cracid conservation in Mexico are protecting remaining habitat for cracid species, particularly those requiring mature forest, and improving hunting impacts where appropriate. The former will require incentives for forest conservation and restoration. Currently, the rate of deforestation in Mexico is driven by traditional uses (e.g., timber exploitation, agriculture, mining). A shift in management approaches will require fundamental changes in the value of these areas beyond traditional uses (e.g., timber, minerals) to include alternative or emerging values (e.g., ecotourism, regulated sport hunting). Conservation of these areas through these alternative approaches can ultimately serve to protect habitats critical to cracids throughout Mexico. To improve hunting impacts, basic knowledge of these impacts on cracid population dynamics, followed by implementation of pragmatic management strategies based on these data, is required. Additionally, increased enforcement coupled with improved reserve design and hunter

access will require greater coordination in the management of remaining habitats for cracid populations.

Literature Cited

Alvarez del Toro, M. 1952. Los animales silvestres de Chiapas. Ediciones del Gobierno del Estado, Tuxtla Gutiérrez, Chiapas, México.

Andrle, R. F. 1967. Notes on the black chachalaca (*Penelopina nigra*). Auk 84:169–172.

Arguedas, N., P. Mayer, D. Milligan, and L. Nordstrom. 1997. Plan de recuperación para *Crax rubra* en Costa Rica. Pages 249–262 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Arriaga-U., I., and B. Baquero. 1997. Criterios para la clasificación de grupos por edad y aspectos reproductivos en la guacharaca (*Ortalis ruficauda*) en el estado Cojedes. Pages 48–60 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Asbjornsen, H., N. Velázquez-Rosas, R. García-Soriano, and C. Gallardo-Hernández. 2005. Deep ground fires cause massive above- and below-ground biomass losses in tropical montane cloud forests in Oaxaca, Mexico. Journal of Tropical Ecology 21:427–434.

Baird, S. F. 1857. Birds of the boundary, with notes by the naturalists of the survey. United States and Mexican boundary survey. Government Printing Office, Washington, DC, USA.

Balda, W. E. 1989. Evaluation of success of plain chachalaca (*Ortalis vetula*) transplants in South Texas. Thesis, New Mexico State University, Las Cruces, USA.

Balda, W. E., and S. D. Schemnitz. 1997. Evaluation of success of plain chachalaca (*Ortalis vetula*) transplants in South Texas. Pages 201–210 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Baur, E. H. 2008. Structure of a lowland Neotropical galliform bird guild. Thesis, University of Florida, Gainesville, USA.

Begazo, A. J. 1997. Use and conservation of the Cracidae in the Peruvian Amazon. Pages 449–459 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Begazo, A. J., and R. E. Bodmer. 1998. Use and conservation of Cracidae (Aves: Galliformes) in the Peruvian Amazon. Oryx 32:301–309.

Bent, A. C. 1932. Life histories of North American gallinaceous birds. Bulletin of the United States National Museum 162:1–490.

Berlanga, G. H. A. 1991. Las aves frugívoras de Chamela, Jalisco. Su recurso vegetal y su papel en la dispersión de semillas. Thesis, UNAM, México, D. F., México.

Brodkorb, P. 1964. Catalogue of fossil birds. Part 2. Bulletin of the Florida State Museum 8:195–335.

Brooks, D. M. 1997a. The influence of habitat structure upon species evenness and diversity. Texas Journal of Science 49:247–254.

Brooks, D. M. 1997b. Population and ecological parameters of the Chaco chachalaca (*Ortalis canicollis*). Pages 412–417 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Brooks, D. M. 1999. *Pipile* as a protein source to rural hunters and Amerindians. Pages 42–50 *in* D. M. Brooks, A. J. Begazo, and F. Olmos, editors. Biology and conservation of the piping guans (*Pipile*). Special Monograph 1. Cracid Specialist Group, Houston, Texas, USA.

Brooks, D. M. 2006. The utility of hotspot identification for forest management: cracids as bioindicators. Acta Zoologica Sinica 52:199–201.

Brooks, D. M., L. Cancino, and S. L. Pereira, editors. 2006. Conserving cracids: the most threatened family of birds in the Americas. Miscellaneous Publication Number 6. Houston Museum of Natural Science, Texas, USA.

Brooks, D. M., and R. A. Fuller. 2006. Biology and conservation of cracids. Pages 9–21 *in* D. M. Brooks, L. Cancino, and S. L. Pereira, editors. Conserving cracids: the most threatened family of birds in the Americas. Miscellaneous Publication Number 6. Houston Museum of Natural Science, Texas, USA.

Brooks, D. M., and S. D. Strahl. 2000. Cracids: status survey and conservation action plan. IUCN, Gland, Switzerland.

Bruner, A. G., R. E. Gullison, R. E. Rice, and G. A. B. da Fonseca. 2001. Effectiveness of parks in protecting tropical biodiversity. Science 291:125–128.

Christensen, Z. D., D. B. Pence, and G. Scott. 1978. Notes on food habits of the plain chachalaca from the Lower Rio Grande Valley. Wilson Bulletin 90:647–648.

Delacour, J., and D. Amadon. 1973. Curassows and related birds. American Museum of Natural History, New York, New York, USA.

Delgado, F. S. 1997. Situación de los cracidos de Panamá. Pages 345–349 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

del Hoyo, J. 1994. Family Cracidae. Pages 310–363 *in* J. del Hoyo, A. Elliot, and J. Sargatal, editors. Handbook of the birds of the world. Volume 2. Lynx Edicions, Barcelona, Spain.

Dickey, D. R., and A. J. Van Rossem. 1938. The birds of El Salvador. Field Museum of Natural History, Zoological Series 23:1–609.

Donegan, T. M. 2001. Recent records of cracids from Tikal, Petén, Guatemala, with notes on their conservation. Boletín de Grupo de Especialistas en Crácidos 12:4–7.

Eisermann, K. 2004. Estatus de *Crax rubra* en punta de Manabique, Guatemala: hábitat, tamaño de la población e impacto humano. Boletín de Grupo de Especialistas en Crácidos 18:4–8.

Eisermann, K. 2005. Noteworthy bird observations in Alta Verapaz, Guatemala. Bulletin of the British Ornithologists Club 125:3–11.

Eisermann, K., N. Herrera, and O. Komar. 2006. Highland guan (*Penelopina nigra*). Pages 85–89 *in* D. M. Brooks, L. Cancino, and S. L. Pereira, editors. Conserving cracids: the most threatened family of birds in the Americas. Miscellaneous Publication Number 6. Houston Museum of Natural Science, Texas, USA.

Érard, C., and M. Théry. 1994. Frugivorie et ornithocorie en fôret Guyanaise: l'exemple des grans oiseaux terrestres et de la *Penelope marail.* Alauda 62:27–31.

Escobar-Ortíz, E. R. 1997. Situación actual del pavo de cacho *Oreophasis derbianus* en Guatemala. Page 217 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Garcia, C., and D. M. Brooks. 1997. Evolution of *Crax*: sociobiology and phylogeny using behavioral and ecological characters. Pages 401–410 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

García, F. L. M. 1998. Determinación de parásitos gastrointestinales de crácidos silvestres libres y en cautiverio. Thesis, UNAM, México, D. F., México.

Gómez de Silva, G. H., F. González-García, and M. P. Casillas-Trejo. 1999. Birds of the upper cloud forest of El Triunfo, Chiapas, Mexico. Ornitología Neotropical 10:1–26.

González-García, F. 1991. Observaciones sobre la ecología y biología reproductiva del pavón *Oreophasis derbianus* en la Reserva de la Biosfera El Triunfo, Chiapas, México. IV Congreso de Ornitología Neotropical, Quito, Ecuador.

González-García, F. 1994. Behavior of horned guans in Chiapas, Mexico. Wilson Bulletin 106:357–365.

González-García, F. 1995. Reproductive biology and vocalizations of the horned guan *Oreophasis derbianus* in Mexico. Condor 97:415–426.

González-García, F. 1997. Conducta de anidación del pavón *Oreophasis derbianus* (Aves, Cracidae) en la Reserva de la Biosfera El Triunfo, Chiapas, México. Pages 147–166 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

González-García, F. 2001. Estado de conservación del pavón *Oreophasis derbianus* en el campo y en cautiverio en México. Pages 147–166 *in* D. M. Brooks and F. González-García, editors. Cracid ecology and conservation in the new millennium. Miscellaneous Publication Number 2. Houston Museum of Natural Science, Texas, USA.

González-García, F. 2005. Dieta y comportamiento de forrajeo del pavón *Oreophasis derbianus* en la Reserva de la Biósfera El Triunfo, Chiapas, México. Thesis, UNAM, México, D. F., México.

González-García, F., D. M. Brooks, and S. D. Strahl. 2001. Estado de conservación de los crácidos en México y Centroamérica. Pages 1–50 *in* D. M.

Brooks and F. González-García, editors. Cracid ecology and conservation in the new millennium. Miscellaneous Publication Number 2. Houston Museum of Natural Science, Texas, USA.

González-García, F., J. A. Rivas-R., and A. J. Cóbar-C. 2006a. Horned guan (*Oreophasis derbianus*). Pages 35–40 *in* D. M. Brooks, L. Cancino, and S. L. Pereira, editors. Conserving cracids: the most threatened family of birds in the Americas. Miscellaneous Publication Number 6. Houston Museum of Natural Science, Texas, USA.

González-García, F., J. A. Rivas-R., A. J. Cóbar-C., K. Eisermann, N. Herrera, O. Komar, M. M. Rios, M. C. Muñoz, and D. M. Brooks. 2006b. Northern Central America: Mexico, Guatemala, Belize, El Salvador, Honduras and Nicaragua. Pages 114–116 *in* D. M. Brooks, L. Cancino, and S. L. Pereira, editors. Conserving cracids: the most threatened family of birds in the Americas. Miscellaneous Publication Number 6. Houston Museum of Natural Science, Texas, USA.

Guido, M. M. Y. 1985. Proyecto de reproducción de pavos silvestres (*Crax rubra*) en El Imposible, Zona II, San Benito. Informe interno. Servicio de Parques Nacionales y Vida Silvestre, Ministerio de Agricultura y Ganadería, San Salvador, El Salvador.

Gurrola, H. M. A. 1985. Hábitos de alimentación, reproducción y comportamiento de la chachalaca (*Ortalis p. poliocephala*, Aves: Cracidae) en la región costera de Chamela, Jalisco. Thesis, UNAM, México, D. F., Mexico.

Howe, H. F. 1984. Implications of seed dispersal by animals for tropical reserve management. Biological Conservation 30:261–281.

Howe, H. F. 1993. Aspects of variation in a Neotropical seed dispersal system. Vegetation 107/108:149–162.

Howe, H. F., and G. A. Vande Kerckhove. 1980. Nutmeg dispersal by tropical birds. Science 210:925–927.

Howe, H. F., and G. A. Vande Kerckhove. 1981. Removal of wild nutmeg (*Virola surinamensis*) crops by birds. Ecology 62:1093–1106.

Howell, S. N. G., and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford University Press, New York, New York, USA.

Jiménez, G. J. 2002. Contribución al conocimiento de la biología, distribución y abundancia del pajuil *Penelopina nigra* (Aves: Cracidae, Fraser 1850) en la Reserva de la Biosfera, El Triunfo, Chiapas, México. Thesis, UNAM, México, D. F., Mexico.

Jorgenson, J. P. 1995. Maya subsistence hunters in Quintana Roo, Mexico. Oryx 29:49–57.

Jorgenson, J. P. 1997. Cambios en los patrones de la cacería de subsistencia a través de mejoramientos socio-económicos: el ejemplo de los cazadores Mayas en México. Pages 31–40 *in* T. G. Fang, R. E. Bodner, R. Aquino, and M. H. Valqui, editors. Manejo de fauna silvestre en la Amazonia. Universidad Arturo Prat, University of Florida, and United Nations Development Program/Global Environment Facility, La Paz, Bolivia.

Kilham, L. 1978. Alarm call of crested guan when attacked by ornate hawkeagle. Condor 80:347–348.

Komar, O. 2002. Birds of Montecristo National Park, El Salvador. Ornitología Neotropical 13:167–193.

Leopold, A. S. 1959. Wildlife of Mexico: the game birds and mammals. University of California Press, Berkeley, USA.

Leopold, S. A. 1977. Fauna silvestre de México. IMERNAR, México, D. F., México.

Lowery, G. H., and W. W. Dalquest. 1951. Birds from the state of Veracruz, Mexico. University of Kansas Publications, Museum of Natural History 3:531–649.

Mandujano, S., S. Gallina, and S. H. Bullock. 1994. Frugivory and dispersal of *Spondias purpurea* (Anacardiaceae) in a tropical deciduous forest in Mexico. Revista de Biología Tropical 42:107–114.

Marion, W. R. 1974a. Ecology of the plain chachalaca in the Lower Rio Grande Valley of Texas. Dissertation, Texas A&M University, College Station, USA.

Marion, W. R. 1974b. Status of plain chachalaca in South Texas. Wilson Bulletin 86:200–205.

Marion, W. R. 1976. Plain chachalaca food habits in South Texas. Auk 93:376–379.

Marion, W. R. 1978. Nesting ecology of the plain chachalaca in South Texas. Wilson Bulletin 90:386–395.

Marion, W. R. 1982. Plain chachalaca. Pages 57–58 *in* D. E. Davis, editor. CRC handbook of census methods for terrestrial vertebrates. CRC Press, Boca Raton, Florida, USA.

Marion, W. R., and R. J. Fleetwood. 1974. Longevity of chachalacas. Bird-Banding 45:178.

Marion, W. R., and R. J. Fleetwood. 1978. Nesting ecology of plain chachalaca in South Texas. Wilson Bulletin 90:386–395.

Marion, W. R., T. E. O'Meara, and D. S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. Studies in Avian Biology 6:81–85.

Martínez-Morales, M. A. 1996. The Cozumel curassow: abundance, habitat preference and conservation. Thesis, University of Cambridge, United Kingdom.

Martínez-Morales, M. A. 1999. Conservation status and habitat preferences of the Cozumel curassow. Condor 101:14–20.

Martínez-Sánchez, J. C. 1997. Deforestación y conservación de cracidos en Nicaragua: un informe preliminar. Pages 340–344 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

McCoy, M. 1997. Country report on cracids of Costa Rica. Pages 298–313 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Méndez, O. 2000. Conducta de anidación del pavo de cacho *Oreophasis derbianus* en el Volcán Tolimán, Guatemala. IV Congreso de la Sociedad Mesoamericana para la Biología y la Conservación. Fundación Natura, Ciudad de Panamá, Panamá.

Midence, S. F. 1997. Informe de la familia Cracidae en Honduras. Pages 335–339 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Morales, C. L. 1991. Estimados de población de la chachalaca negra (*Penelopina nigra*) en el sur-oeste de Guatemala por el método de censo de crácidos de Strahl y Silva. Informe final. Fundación Interamericana de Investigación Tropical, Universidad de San Carlos, Guatemala, Guatemala.

Morales, J. R. 2004. Programa piloto de conservación y manejo de especies cinegéticas en dos comunidades de la Reserva de Biosfera Sierra de las Minas. Segundo informe técnico parcial. Organización Nacional para la Conservación y el Ambiente, Guatemala, Guatemala.

Oberholser, H. C. 1974. The bird life of Texas. University of Texas Press, Austin, USA.

Pacheco, S. C. C. 1994. Hábitos alimentarios y uso estacional de hábitat de la pava crestada (*Penelope purpurascens*) en el bosque seco tropical, Parque Nacional Santa Rosa, Costa Rica. Thesis, Universidad Nacional de Costa Rica, Heredia, Costa Rica.

Palomares, H. E. 1980. Estudio coproparasitoscopico de algunas aves exóticas criadas en cautiverio. Thesis, UNAM, México, D. F., México.

Parker, T. A., III., S. Hilty, and M. Robbins. 1976. Birds of El Triunfo cloud forest, Mexico, with notes on the horned guan and other species. American Birds 30:779–782.

Paynter, R. A., Jr. 1955. The ornithogeography of the Yucatán Peninsula. Bulletin of the Peabody Museum of Natural History 9:1–347.

Peres, C. A. 2000. Effects of subsistence hunting on vertebrate community structure in Amazonian forests. Conservation Biology 14:240–253.

Peres, C. A. 2001. Perils in parks or parks in peril? Reconciling conservation in Amazonian reserves with and without use. Conservation Biology 15:793–797.

Peres, C. A., and M. G. M. van Roosmalen. 1996. Avian dispersal of "mimetic seeds" of *Ormosia lignivalvis* by terrestrial granivores: deception or mutualism? Oikos 75:249–258.

Peterson, M. J. 2000. Plain chachalaca (*Ortalis vetula*). *In* The birds of North America. Philadelphia Academy of Natural Sciences, Pennsylvania, and American Ornithologists' Union, Washington, DC, USA.

Pullen, T. M., Jr. 1978. A field study of the black chachalaca (*Penlopina nigra*, Fraser 1850) in El Salvador. Unidad de Parques Nacionales, Vida Silvestre, and Ministerio de Agricultura y Ganadería, San Salvador, El Salvador.

Pullen, T., Jr. 1983. Sound production and reproductive biology of the highland guan in El Salvador's Montecristo cloud forest. American Birds 37:948–950.

Quinto, A. J. F. 1981. Observaciones y reproducción de *Crax rubra* en condiciones seminaturales en San Felipe Bacalar, Quintana Roo, México. Pages 249–259 *in* J. Estudillo, editor. Primer simposio internacional de la familia Cracidae. UNAM, Morelos, México.

Renner, S. 2003. Structure and diversity of cloud forest bird communities in Alta Verapaz, Guatemala, and implications for conservation. Dissertation, Georg-August-Universität, Göttingen, Germany.

Rios, M. M., and M. C. Muñoz. 2006. Great curassow (*Crax rubra*). Pages 104–108 *in* D. M. Brooks, L. Cancino, and S. L. Pereira, editors. Conserving cracids: the most threatened family of birds in the Americas. Miscellaneous Publication Number 6. Houston Museum of Natural Science, Texas, USA.

Rivas, J. A. 2004. Endozoocoria en los crácidos (Aves: Galliformes) de Petén-Guatemala. Mesoamerica 8:59–60.

Rivas, R. J. 1995. Preferencias alimenticias del faisán o pajuil (*Crax rubra rubra* L.) en condiciones naturales. Thesis, Universidad de San Carlos, Guatemala, Guatemala.

Rowley, J. S. 1984. Breeding records of land birds in Oaxaca, Mexico. Proceedings of the Western Foundation of Vertebrate Zoology 2:74–224.

Salvin, O., and F. D. Godman. 1897–1904. Biologia Centrali-Americana: Aves. Volume 3. Taylor and Francis, London, United Kingdom.

Santamaría-G., M., and A. M. Franco. 1994. Historia natural del pajuil (*Mitu salvini*) y densidades poblacionales de cracidos en un bosque de la Amazonia Colombiana. Informe final. Wildlife Conservation Society, New York, New York, USA.

Schäefer, E. 1953. Estudio bioecológico comparativo sobre algunos Cracidae del norte y centro de Venezuela. Boletín de la Sociedad Venezolana de Ciencias Naturales 15:30–63.

Sedaghatkish, G. 1996. The importance of seed dispersers in the conservation of useful wild plant species: a case study of the avian family Cracidae. Thesis, University of Maryland, College Park, USA.

Sennett, G. B. 1878. Notes on the ornithology of the Lower Rio Grande of Texas, from observations made during the season of 1877. Bulletin of the US Geological and Geographical Survey of the Territories 4:1–66.

Sermeño, M. A. 1986. Alimentación y reproducción del pajuil *Crax rubra* en El Salvador. Thesis, Universidad de El Salvador, San Salvador, El Salvador.

Sermeño, M. A. 1997. Situación de la familia Cracidae en El Salvador. Pages 320–324 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Sibley, C. G., and B. L. Monroe. 1990. Distribution and taxonomy of birds of the world. Yale University Press, New Haven, Connecticut, USA.

Silva, J. L., and S. Strahl. 1991. Human impact on populations of chachalacas, guans and curassows (Galliformes: Cracidae) in Venezuela. Pages 37–52 *in* J. G. Robinson and K. H. Redford, editors. Neotropical wildlife use and conservation. University of Chicago Press, Illinois, USA.

Simas, K. J. 1979. Observations on the white-bellied chachalaca *Ortalis leucogastra*. Informe no publicado. Unidad de Parques Nacionales, Vida Silvestre, and Ministerio de Agricultura y Ganadería, El Salvador, San Salvador.

Slud, P. 1964. The birds of Costa Rica: distribution and ecology. Bulletin of the American Museum of Natural History 128:1–430.

Smith, A. P. 1910. Miscellaneous bird notes from the Lower Rio Grande. Condor 12:93–103.

Stattersfield, A. J., M. J. Crosby, A. J. Long, and D. C. Wege. 1998. Endemic bird areas of the world: priorities for biodiversity conservation. BirdLife International, Cambridge, United Kingdom.

Stiles, F. G., and A. R. Skutch. 1989. A guide to the birds of Costa Rica. Christopher Helm, London, United Kingdom.

Sutton, G. M. 1951. Mexican birds: first impressions. University of Oklahoma Press, Norman, USA.

Sutton, G. M., and O. S. Pettingill Jr. 1942. Birds of the Gomez Farias region, southwestern Tamaulipas. Auk 59:1–34.

Taibel, A. M. 1940. Osservazioni sulla riproduzione in cattivitá di *Crax globicera globicera* Linneos. Rivista Italiana di Ornitologia 10:93–126.

Taibel, A. M. 1957. Riproduzione in cattivitá di *Penelope purpurascens* e *Penelope pileata*. Rivista Italiana di Ornitologia 3:3–28.

Teale, E. W. 1965. Wandering through winter. Dodd, Mead, New York, New York, USA.

Tordoff, H. B., and J. R. MacDonald. 1957. A new bird (family Cracidae) from the early Oligocene of South Dakota. Auk 74:174–184.

Vannini, J. P., and P. M. Rockstroh. 1997. The status of cracids in Guatemala. Pages 326–334 *in* S. D. Strahl, S. Beaujon, D. M. Brooks, A. J. Begazo, G. Sedaghatkish, and F. Olmos, editors. The Cracidae: their biology and conservation. Hancock House, Blaine, Washington, USA.

Vaughan, C. 1983. A report on dense forest habitat for endangered wildlife species in Costa Rica. Editorial Universidad Nacional, Heredia, Costa Rica.

Vaurie, C. 1965. Systematic notes on the bird family

Cracidae. No. 2. Relationship and geographical variation of *Ortalis vetula*, *Ortalis poliocephala*, and *Ortalis leucogaster*. American Museum Novitates 2222:1–36.

Vaurie, C. 1968. Taxonomy of the Cracidae (Aves). Bulletin of the American Museum of Natural History 138:131–260.

Vuilleumier, F. 1965. Relationships and evolution within the Cracidae. Bulletin of the Museum of Comparative Zoology 134:1–27.

Waggerman, G. L. 1979. Brush country pheasants. Texas Parks and Wildlife 37:20–22.

Wagner, H. O. 1953. Die Hockohühner der Sierra Madre de Chiapas, Mexiko. Veröffentlichungen aus dem Überseemuseum Bremen 2:105–128.

Wetmore, A. 1956. A fossil guan from the Oligocene of South Dakota. Condor 58:234–235.

Zimmer, B. 1997. Observations on a large flock of greater curassow (*Crax rubra*). Bulletin of the Cracid Specialist Group 5:10–12.

Zimmer, B. 1999. Observations on a barred morph of the greater curassow (*Crax rubra*) in Belize. Bulletin of the Cracid Specialist Group 8:18–20.