

A PRELIMINARY ASSESSMENT OF AVIFAUNA OF THE BOLIVIAN CHIQUITANO AND CERRADO

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Resumen. – **Inventario preliminar de las aves del chiquitano y cerrado Boliviano.** – Analizamos datos provenientes del chiquitano, del cerrado y del este de Bolivia con el objetivo de describir los patrones de riqueza y la abundancia de aves, documentar los registros de distribución, y discutir el valor de esta región para la conservación. Registramos 154 especies en total (116 en el chiquitano y 100 en el cerrado). Registramos 38 especies en el cerrado pero no en el chiquitano, y 54 en el chiquitano pero no en el cerrado. Los dos hábitat comparten sólo 62 de las especies registradas (40% del total). De las especies más abundantes, solo *Bubulcus ibis*, *Pyrrhura molinae*, y *Pionus Maximiliano* fueron registradas en los dos hábitat. Reportamos extensiones del rango de distribución geográfica hacia el este de Bolivia para cinco especies (*Leucopternis albicollis*, *Otus watsonii*, *Chloroceryle inda*, *Myiopagis viridicata* y *Elaenia flavogaster*). *Tringa solitaria* ha sido considerado como una especie migratoria que no se reproduce en el Neotrópico; *Casmerodius alba*, *Nycticorax nycticorax*, *Accipiter striatus*, *Falco peregrinus*, *Hirundo rustica*, *Coccyzus americanus* y *Vireo olivaceus* han sido registrados como especies migratorias que se reproducen en el Neotópico. Se registraron dos especies raras, *Falco peregrinus* y *Herpsilochmus atricapillus*, y dos especies comercialmente amenazadas, *Crax fasciolata* y *Ara chloroptera*. En base de nuestros resultados, discutimos los patrones de diversidad y abundancia de especies y la conservación de la zona.

Abstract. – Herein, we analyze data from the chiquitano and cerrado of eastern Bolivia in order to describe patterns of avian species richness and abundance, document distributional records, and address the conservation value of this region. A total of 154 species were accounted for (116 in chiquitano, 100 in cerrado). Fifty-four species were found in chiquitano but not in cerrado, whereas 38 species were found in cerrado but not in chiquitano. Only 62 species (40% of all species) were shared between the two habitats. Of the most abundant species recorded, the Cattle Egret (*Bubulcus ibis*), the Green-cheeked Parakeet (*Pyrrhura molinae*) and the Scaly-headed Parrot (*Pionus maximiliani*) were the only species found in both habitats. Five species [White Hawk (*Leucopternis albicollis*), Tawny-bellied Screech-Owl (*Otus watsonii*), Green-and-rufous Kingfisher (*Chloroceryle inda*), Greenish Elaenia (*Myiopagis viridicata*), and Yellow-bellied Elaenia (*Elaenia flavogaster*)] are documented as eastern range extensions for the country. The Solitary Sandpiper (*Tringa solitaria*) represented a migrant that does not breed in the Neotropics, and Great Egrets (*Casmerodius alba*), Black-crowned Night-Herons (*Nycticorax nycticorax*), Sharp-shinned Hawks (*Accipiter striatus*), Peregrine Falcons (*Falco peregrinus*), Yellow-billed Cuckoos (*Coccyzus americanus*), Barn Swallows (*Hirundo rustica*) and Red-eyed Vireos (*Vireo olivaceus*) were documented as migrants that breed in the Neotropics. Rare [Peregrine Falcon and Black-capped Antwren (*Herpsilochmus atricapillus*)] and commercially threatened [Bare-faced Curassow (*Crax fasciolata*) and Red-and-green Macaw (*Ara chloroptera*)] species were documented.

Results are discussed in light of patterns of species richness and abundance, and conservation value is assessed. *Accepted 23 December 2004.*

Key words: Bolivia, avifauna, chiquitano, cerrado, species richness, species abundance, species distribution, conservation.

INTRODUCTION

Tropical dry forests are among the world's most threatened habitats (Gentry 1995). The largest remaining tracts of dry forest in the Neotropics are in eastern Bolivia (Parker *et al.* 1993). Ironically, these regions are poorly known relative to other more intensively studied Neotropical dry forests (e.g., Guanacaste, Costa Rica). For example, despite some avian studies in the Paraguayan cerrado (e.g., Hayes & Scharf 1995, Robbins *et al.* 1999) and the vast Brazilian cerrado (e.g., Silva 1995, 1997), about 70% of this region is inadequately sampled; consequently, we are unable to truly understand the patterns of avian composition in this region, especially in the southern cerrado (Silva 1995).

Despite their unique habitat architecture, the chiquitano and cerrado of eastern Bolivia, Departamento de Santa Cruz, are among the least known in terms of avifauna. Although some faunal inventories have been accomplished in these regions (e.g., Parker 1993, Remsen & Parker 1993), the overall number of such inventories is quite low. Moreover, avian inventories in this region were conducted during June, July, and October, but not during other times of the year. Nonetheless, these inventories are especially important contributions in light of how little is known about avian distribution and occurrence in eastern Bolivia. Because there are still many wide gaps of knowledge in this region, we analyzed our pooled data to gain a better understanding of avifaunal composition and abundance in these habitats.

Our objectives herein specifically are to: 1) describe patterns of avian species richness and abundance in this region; 2) document

distributional records; and 3) address the conservation value of this region.

STUDY SITES AND SAMPLING

Chiquitano. The chiquitano (Fig. 1) is interesting from a phytogeographic perspective; it reaches canopy heights (> 35 m) and stratification rivaling Amazonian forest to the north, yet its xeric nature is similar to the chaco to the south. The plant species richness in chiquitano is among the highest documented for any tropical deciduous forest (Gentry 1995).

DMB and RAH worked in chiquitano habitat, where approximately 3 km of transects were walked each outside the village of San Juan (18°47'S, 60°12'W) on 18–19 April 1999, and in the region of Mina Don Mario (17°20'S, 59°41'W) on 20–21 and 24 April 1999. Birds were also observed incidentally by DMB and RAH along a 326 km path of road-driven transects (17°34'S, 59°28'W – 18°47'S, 60°12'W – 17°20'S, 59°41'W – 17°34'S, 59°28'W) 18–21 April 1999, and during > 10 h helicopter overflights covering the aforementioned localities, plus the Río Mercedes (18°47'S, 60°14'W) on 16 and 22–23 April 1999 (Fig. 1).

ALP, JJW, AMS, and MH worked in chiquitano habitat on 21–30 November 2000, in the Provincia of Velasco, near the locality of El Tuná and along the northern bank of the Mercedes River (16°33'S, 59°39'W; Fig. 1). The habitat consisted of a typical matrix of chiquitano forest interspersed with open habitat. Additionally, two specimens, one each of Red-winged Tinamou (*Rhyrchotus rufescens*) and White-bellied Nothura (*Nothura boraquira*), were collected incidentally near Santiago de

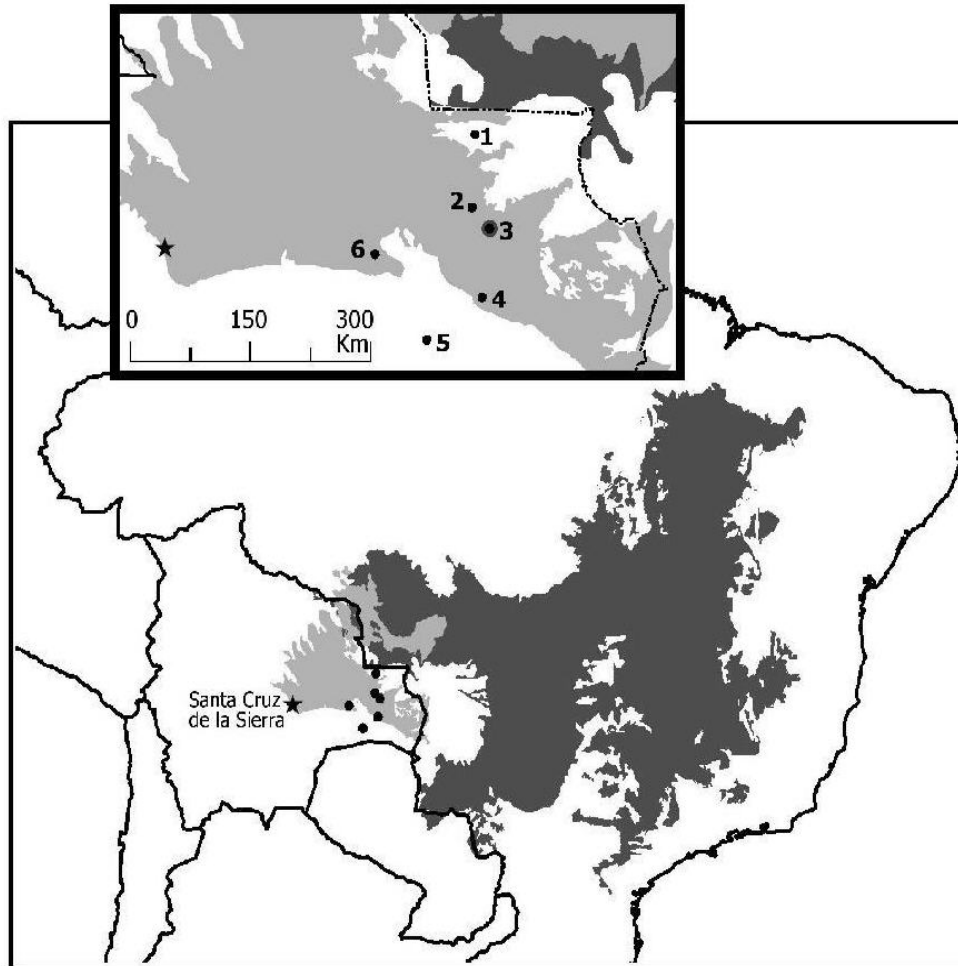


FIG. 1. Map highlighting chiquitano (light gray) and cerrado (dark gray) biomes in South America, as well as study sites in relation to the city of Santa Cruz. The biome delineations follow Olson & Dinerstein (1998) & National Geographic (2004), although these delineations are coarse at the local level and do not include detailed habitat patches; for a more detailed description of the habitat at each locality, please see the study site descriptions in the text. Gazetteer: 1 = El Tuná ($16^{\circ}33'S$, $59^{\circ}39'W$), 2 = Mina Don Mario ($17^{\circ}20'S$, $59^{\circ}41'W$), 3 = Río Las Conchas ($17^{\circ}34'S$, $59^{\circ}28'W$), 4 = Santiago de Chiquitos ($18^{\circ}19'S$, $59^{\circ}34'W$), 5 = Village of San Juan ($18^{\circ}47'S$, $60^{\circ}12'W$) and Río Mercedes ($18^{\circ}47'S$, $60^{\circ}14'W$), 6 = San José de Chiquitos ($17^{\circ}51'S$, $60^{\circ}47'W$).

Chiquitos ($18^{\circ}19'S$, $59^{\circ}34'W$) and San José de Chiquitos ($17^{\circ}51'S$, $60^{\circ}47'W$), respectively.

Cerrado. The cerrado (Fig. 1) is characterized by rocky outcrops and rolling terrain, and a

mosaic of palm savannah and forest. When compared to forest within the chiquitano, forest within the cerrado is more variable in terms of understory cover, and has an overall shorter canopy height than chiquitano.

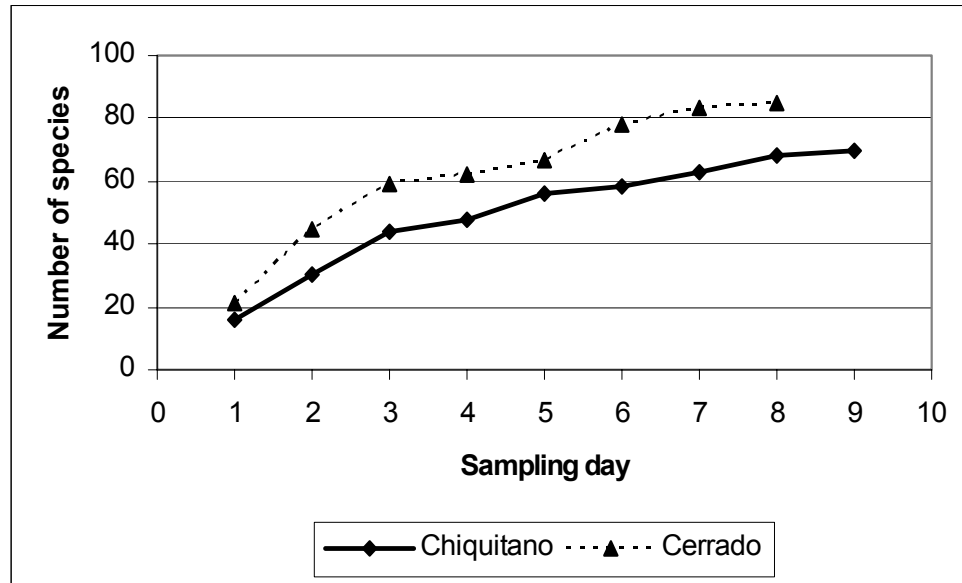


FIG. 2. Species accumulation curves from chiquitano ($16^{\circ}33'S$, $59^{\circ}39'W$) and cerrado ($17^{\circ}34'S$, $59^{\circ}28'W$) regions. Cerrado data were collected by RAH, and chiquitano data are specimens collected during the Mercedes River expedition.

DMB and RAH worked in the Río las Conchas ($17^{\circ}34'S$, $59^{\circ}28'W$; Fig. 1) area on 15–18 and 21–24 April 1999; approximately 11.5 km of transect was walked, as well as a 10-km tract of road transect driven in the region at dusk on 21 April 1999. This was complemented with > 5 h helicopter overflights 15–16 and 22–23 April 1999 to collect incidental data.

METHODS

Field methods. We followed rapid assessment program (RAP) protocols (e.g., Parker 1993, Remsen & Parker 1993, Bates & Parker 1998), with slight modifications. Numbers of individuals were estimated through visual and auditory detections along walked transects. Additionally, incidental observations were made while driving along roads or flying in a helicopter; these observations augment our

existing inventories to determine which species occur in the area. ALP, JJW, AMS and MH collected specimens for museum collections and genetic studies, and thus most of their observations recorded correspond to captured birds. The survey included approximately 1 km of walked transects, occasional scientific collecting by shooting, and approximately 500 h of mist-netting.

Selected voucher recordings were deposited at the BioAcoustics Laboratory at Texas A&M University. Voucher specimens were deposited at the American Museum of Natural History and Museo de Historia Natural Noel Kempff Mercado.

Designation of species status. Range extensions within the Departamento de Santa Cruz were determined by comparing species herein to the easternmost avifaunal inventories in Bolivia (Parker 1993, Remsen & Parker 1993,

Hennessey *et al.* 2003). The two Parker studies published in 1993 were conducted at similar parallels of longitude to our study sites; Hennessey *et al.* (2003) included information on two protected areas (San Matias and Otuquis) that are located along the eastern border of Bolivia. Species present in this study but absent from these inventories were considered significant eastern range extensions for Bolivia.

New records for Bolivia and Departamento de Santa Cruz were assessed by comparing species in this study to prior inventories (e.g., Davis 1993, Kratter *et al.* 1993, Parker 1993, Remsen & Parker 1993, Bates & Parker 1998, Hennessey *et al.* 2003).

Migrant status was assessed using appendices C and D in Stotz *et al.* (1996). Conservation status was assessed following Rocha & Quiroga (1996).

RESULTS

Species richness and abundance. A total of 154 species were documented (Appendix 1). The slope of the species accumulation curves (Fig. 2) began to decrease after the third day of sampling. Although the curves do not reach completely level plateaus, few new species were added to the chiquitano and cerrado inventories after the fifth and sixth days, respectively.

We found 116 species in the chiquitano region, and 100 species in cerrado. A total of 54 species were found in the chiquitano region but not in cerrado, whereas 38 species were found in the cerrado region but not in the chiquitano. A total of 62 species (40% of all species) were shared between the two habitats.

The most abundant species (> 15 individuals accounted for) in the chiquitano region were: Cattle Egret (*Bubulcus ibis*), Green-cheeked Parakeet (*Pyrrhura molinae*), Scaly-

headed Parrot (*Pionus maximiliani*), Brown-crested Flycatcher (*Myiarchus tyrannulus*), Purplish Jay (*Cyanocorax cyanomelas*), and Sayaca Tanager (*Thraupis sayaca*). The most abundant species in the cerrado region were: Cattle Egret, Picui Ground-Dove (*Columbina picui*), Yellow-chevroned Parakeet (*Brotogeris chiriri*), Green-cheeked Parakeet, Scaly-headed Parrot, Guira Cuckoo (*Guira guira*), and Crested Oropendola (*Psarocolius decumanus*). The Cattle Egret, Green-cheeked Parakeet, and Scaly-headed Parrot were the only species found in abundance in both habitats.

Distributional records. The birds we recorded constitute new site records, as these localities have not been surveyed before. Five species were considered eastern range extensions for the country (Appendix 1). Of these five species, White Hawk (*Leucopternis albicollis*), Green-and-rufous Kingfisher (*Chloroceryle inda*), and Greenish Elaenia (*Myiopagis viridicata*) were recorded in the chiquitano region, and Tawny-bellied Screech-Owl (*Otus watsonii*) and Yellow-bellied Elaenia (*Elaenia flavogaster*) were recorded in the cerrado region.

The specimen of White-bellied Nothura collected at San José de Chiquitos is the only specimen record for the country. Similarly, the sightings of five Scaly Doves (*Columbina squammata*) at Río las Conchas, and one at San Juan, add to the few documented records for Bolivia.

Migration and conservation status. Solitary Sandpiper (*Tringa solitaria*), recorded in the cerrado region, represented the only migrant that does not breed in Neotropics (Stotz *et al.* 1996). Seven species were migrants that breed in the Neotropics (Stotz *et al.* 1996), represented by three each recorded in the cerrado region [Black-crowned Night-Heron (*Nycticorax nycticorax*), Peregrine Falcon (*Falco peregrinus*), and Barn Swallow (*Hirundo rustica*)] and chiquitano region [Sharp-shinned Hawk (*Accipiter striatus*),

TABLE 1. Species richness and sampling effort for this study compared to three other studies at nearby locations.

Sites	Number of species	Number of samplers	Days	Sources
Chiquitano	116	6	10	This study
Cerrado	100	2	8	This study
Curuyuqui	165	1	?	Parker (1993)
Tucuvaca	111	3	8	Remsen & Parker (1993)
Santiago de Chiquitos	86	3	9	Remsen & Parker (1993)

Yellow-billed Cuckoo (*Coccyzus americanus*) and Red-eyed Vireo (*Vireo olivaceus*); the Great Egret (*Casmerodius alba*) was recorded in both habitats. While species such as the Yellow-billed Cuckoo only breed in the northern hemisphere, others (e.g., the Peregrine Falcon and the Red-eyed Vireo) have migratory populations that breed in both northern and southern hemispheres. Species such as the Barn Swallow also breed in both hemispheres, but breeding populations are much larger in the northern hemisphere when compared to the southern hemisphere.

We accounted for four species considered “rare” or “commercially threatened” in the Department of Santa Cruz (Rocha & Quiroga 1996). Peregrine Falcons and Black-capped Antwrens (*Herpsilochmus atricapillus*) are considered as rare and Bare-faced Curassows (*Crax fasciolata*) and Red-and-green Macaws (*Ara chloroptera*) are commercially threatened. Three of these species were observed only once (singletons for the Peregrine Falcon and the Black-capped Antwren; a pair for the Bare-faced Curassow), whereas Red-and-green Macaws were encountered more frequently (Appendix 1).

DISCUSSION

Species richness. We found a total of 154 species. By pooling data from seven Bolivian lowland dry forest sites, Herzog & Kessler (2002) found a total of 231 core avian species that

regularly breed, winter, or migrate through this region. Intuitively, if we inventory for a longer duration, the species curves would level out completely.

We found 116 species in the chiquitano region, and 100 species in the cerrado region. Three sites located relatively nearby permit comparisons of regional species richness: Curuyuqui (Parker 1993), Tucuvaca, and Santiago de Chiquitos (Remsen & Parker 1993) contained a mean species richness of 121 species (range = 86–165). The numbers we found for the chiquitano and cerrado regions were comparable, as were sampling efforts (Table 1).

It is interesting to note the sharp contrast in composition between avifaunas in these two habitats. In this study, 47% of the chiquitano avifauna is exclusive to that region, and 38% of the cerrado avifauna is exclusive to that region. This highlights the uniqueness of these two habitats despite the rapid transition from chiquitano to cerrado. The fact that only 40% of the species were shared between these two habitats suggests beta-diversity (variation in species composition among separate communities) is high among dry habitats in eastern Bolivia.

Species abundance. The widespread Cattle Egret as well as Green-cheeked Parakeet and Scaly-headed Parrot were the only species found in abundance in both regions. It is interesting to note that three of the most abundant species

found in the two regions were psittacids. This is perhaps an artifact of sampling since psittacids almost invariably travel in large, noisy, monotypic flocks, and therefore are easily detected (Brooks & Begazo 2001). Indeed, many of the psittacids we encountered were detected while in flight.

The relationship between riverine gallery and higher faunal diversity in the cerrado has been addressed in mammals. For example, Redford & da Fonseca (1986) found 20 out of 65 (30.8%) cerrado mammalian genera to be relatively dependent upon riverine gallery, contributing to higher species richness in this region. In this study, 16 species [Rufescent Tiger-Heron (*Tigrisoma lineatum*), Capped Heron (*Pilherodius pileatus*), Cooi Heron (*Ardea cocoi*), Scaly-headed Parrot, Black-crowned Night-Heron, Green Ibis (*Mesembri-nibis cayanensis*), Wood Stork (*Mycteria Americana*), Blue-throated Piping-Guan (*Pipile cumanensis*), Limpkin (*Aramus gurauna*), Wattled Jacana (*Jacana jacana*), Solitary Sandpiper, Ringed Kingfisher (*Ceryle torquata*), Amazon Kingfisher (*Chloroceryle amazona*), Green Kingfisher (*Chloroceryle Americana*), Lesser Kiskadee (*Pitangus lektor*), and Hooded Tanager (*Nemosia pileata*)] out of 100 (16%) from the Las Conchas site were strongly tied to the Conchas River and its associated aquatic habitats, although all but two of these (Blue-throated Piping-Guan and Hooded Tanager) are species associated with aquatic habitats.

Conservation. Despite the fairly low number of rare avian taxa documented, the region is of great conservation concern for other reasons. For example, although cerrado habitat is found predominately in central Brazil, the isolated patch in eastern Bolivia may act as an island that restricts gene flow from outside habitats, and consequently promotes isolating mechanisms of speciation. New species of small mammals have already been discovered

(e.g., Brooks *et al.* 2004, Brooks *et al.* unpubl.), and preliminary molecular and morphological data indicates that the Bolivian and Paraguayan populations of White-bellied Nothura might deserve separate specific status from those in Brazil (Porzecanski 2003).

Overhunting strongly characterizes habitats that are perturbed, often exceeding human carrying capacity in terms of game extraction. Examples include the vicinity of San Juan, where “empty forest” effects (Redford 1992) were observed. However, much of the region surveyed contained abundant signs of game species (Brooks *et al.* 2002). Some of the best bio-indicators to measure levels of sustainable harvest are cracids (Brooks & Strahl 2000), which are often the first species to disappear due to overhunting, yet their presence was observed in the region.

At the time of the study, habitat at the study sites were not molested by human activities to any severe degree. The presence of roads, tree removal and various trails were minimal at best. However, in light of the fragility of this special habitat, coupled with harvest rates apparently in-check, it is our fervent hope that a diverse array of species will continue to thrive in this region. Conservation of habitat by creating reserves and providing proper infrastructure for such areas harboring wildlife are an important step for ensuring the future of wildlife in this special region: the dry habitats of eastern Bolivia.

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REFERENCES

- Bates, J. M., & T. A. Parker. 1998. The avifauna of Parque Nacional Noel Kempff Mercado and surrounding areas. Pp. 317–340 *in* Killeen, T. J. (ed.). A biological assessment of Parque Nacional Noel Kempff Mercado, Bolivia: a global conservation priority. Rapid Assessment Program (RAP) Working Paper. Volume 10. Conservation International, Washington, DC.
- Brooks, D. M., & S. D. Strahl. 2000. Cracids: Status survey and conservation action plan. International Union for the Conservation of Nature, Gland, Switzerland.
- Brooks, D. M., & A. J. Begazo. 2001. Macaw density variation in the western Amazonian basin. Pp. 427–438 *in* Marzluff, J. M., R. Bowman, & R. Donnelly (eds.). Avian ecology and conservation in an urbanizing world. Kluwer Academic Publishers, Boston, Massachusetts.
- Brooks, D. M., J. M. Rojas, H. Aranibar, R. J. Vargas, & T. Tarifa. 2002. A preliminary assessment of mammalian fauna of the eastern Bolivian panhandle. *Mammalia* 65: 509–520.
- Brooks, D. M., R. J. Baker, R. J. Vargas, T. Tarifa, H. Aranibar, & J. M. Rojas. 2004. A new species of *Oryzomys* (Rodentia: Muridae) from an isolated pocket of cerrado in eastern Bolivia. *Occas. Pap. Mus. Tex. Tech Univ.* 241: 1–11.
- Davis, S. E. 1993. Seasonal status, relative abundance, and behavior of the birds of Concepción, Dpto. Santa Cruz, Bolivia. *Fieldiana Zool.* 71: 1–33.
- Gentry, A. H. 1995. Diversity and floristic composition of Neotropical dry forests. Pp. 146–194 *in* Bullock, S. H., H. A. Mooney, & E. Medina (eds.). Seasonally dry tropical forests. Cambridge University Press, Cambridge, UK.
- Hayes, F. E., & P. A. Scharf. 1995. The birds of Parque Nacional Cerro Corá, Paraguay. *Cotinga* 4: 20–24.
- Hennessey, A. B., S. K. Herzog, & F. Sagot. 2003. Lista anotada de las aves de Bolivia. 5^a ed. Asociación Armonía/BirdLife International, Santa Cruz, Bolivia.
- Herzog, S. K., & M. Kessler. 2002. Biogeography and composition of dry forest bird communities in Bolivia. *J. Ornithol.* 143: 171–204.
- Kratter, A. W., T. S. Sillett, R. T. Chesser, J. P. O'Neill, T. A. Parker, & A. Castillo. 1993. Avifauna of a chaco locality in Bolivia. *Wilson Bull.* 105: 114–141.
- National Geographic. 2004. Terrestrial ecoregions of the world website. <http://www.nationalgeographic.com/wildworld/terrestrial.html>.
- Olson, D., & E. Dinerstein. 1998. The Global 200: a representation approach to conserving the earth's most biologically valuable ecoregions. *Conserv. Biol.* 12: 502–515.
- Parker, T. A. 1993. Bird species recorded at eight sites in the Bolivian chaco. Pp. 82–91 *in* Parker, T. A., R. B. Foster, L. H. Emmons, & B. Bailey (eds.). The lowland dry forests of Santa Cruz, Bolivia: A global conservation priority. Rapid Assessment Program (RAP) Working Paper. Volume 4. Conservation International, Washington, DC.
- Parker, T. A., R. B. Foster, L. H. Emmons, & B. Bailey (eds.). 1993. The lowland dry forests of Santa Cruz, Bolivia: A global conservation priority. Rapid Assessment Program (RAP) Working Paper. Volume 4. Conservation International, Washington, DC.
- Porzecanski, A. L. 2003. Historical biogeography of the South American aridlands: A molecular study of endemic avian taxa. Ph.D. thesis, Columbia Univ., New York, New York.
- Redford, K. H., & G. A. B da Fonseca. 1986. The role of gallery forests in the zoogeography of the cerrado's non-volant mammalian fauna. *Biotropica* 18: 126–135.
- Redford, K. H. 1992. The empty forest. *Bioscience* 42: 412–422.
- Remsen, J. V., & T. A. Parker. 1993. Bird species recorded at four, tall dry forest and cerrado localities in southeastern Bolivia. Pp. 92–99 *in* Parker, T. A., R. B. Foster, L. H. Emmons, & B. Bailey (eds.). The lowland dry forests of Santa Cruz, Bolivia: A global conservation priority. Rapid Assessment Program (RAP) Working Paper. Volume 4. Conservation International, Washington, DC.
- Robbins, M. B., R. C. Faucett, & N. H. Rice. 1999.

- Avifauna of a Paraguayan cerrado locality: Parque Nacional Serranía San Luis, Depto. Concepcion. *Wilson Bull.* 111: 216–228.
- Rocha, O., & C. Quiroga. 1996. Aves. Pp. 95–164 *in* Ergueta, P., S. & C. de Morales (eds.). *Libro rojo de los vertebrados de Bolivia*. Centro de Datos para la Conservación, La Paz, Bolivia.
- Silva, J. M. C. Da. 1995. Avian inventory of the cerrado region, South America: Implications for biological conservation. *Bird Conserv. Int.* 5: 291–304.
- Silva, J. M. C. Da. 1997. Endemic bird species and conservation in the cerrado region, South America. *Biodivers. Conserv.* 6: 435–450.
- Stotz, D. F., J. W. Fitzpatrick, T. A. Parker, & D. K. Moskovits. 1996. *Neotropical birds: ecology and conservation*. Univ. Chicago Press, Chicago, Illinois.

APPENDIX 1. Avian inventory of study sites. Record type: v = visually detected, a = auditorily detected, o = observed along road, h = observed during helicopter reconnaissance, r = archived recording, s = specimen collected, p = photographed. Species status: R = rare, CT = commercially threatened, ERE = eastern Bolivia range extension, MB = migrant breeds in Neotropics, MN = migrant not breeding in Neotropics.

		Cerrado Estancia Las Conchas	Cerrado Río Las Conchas floodplain	Chiquitano Incidental en-route	Chiquitano Río Mercedes	Chiquitano San Juan	Chiquitano Mina Don Mario	Chiquitano El Tuna	Species status
Undulated Tinamou	<i>Crypturellus undulatus</i>			1o, 1a				1s	
Small-billed Tinamou	<i>Crypturellus parvirostris</i>						2v	1s	
Red-winged Tinamou	<i>Rhyncotus rufescens</i>			1s					
White-bellied Nothura	<i>Nothura boraquira</i>			1s					
Anhinga	<i>Anhinga anhinga</i>							1s	
Rufescent Tiger-Heron	<i>Tigrisoma lineatum</i>	1o	2v			1v			
Capped Heron	<i>Ptilherodius pileatus</i>		3v						
Cocoi Heron	<i>Ardea cocoi</i>		2v						
Great Egret	<i>Casmerodius alba</i>	1v	3v, 1h			1v			MB
Cattle Egret	<i>Bubulcus ibis</i>	350v	40v			15v			
Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>		4v						MB
Green Ibis	<i>Mesembrinibis cayanaensis</i>		2v						
Wood Stork	<i>Mycteria americana</i>		3v						
Turkey Vulture	<i>Cathartes aura</i>	1v	2v	6h		6v			
Lesser Yellow-headed Vulture	<i>Cathartes burrovianus</i>					1v			
Black Vulture	<i>Coragyps atratus</i>	2v	6v						
King Vulture	<i>Sarcorampbus papa</i>	3v	1v	3h			2v		
Pearl Kite	<i>Gampsonyx swainsonii</i>			1o			1v		
Snail Kite	<i>Rostrhamus sociabilis</i>				1h				
Sharp-shinned Hawk	<i>Accipiter striatus</i>			1o					MB
White Hawk	<i>Leucopternis albicollis</i>			1op					ERE
Great Black Hawk	<i>Buteogallus urubitinga</i>		1v						
Savannah Hawk	<i>Heterospizias meridionalis</i>	1v		1h					
Roadside Hawk	<i>Buteo magnirostris</i>	2v	2v	1h, 1o		2v	1v	1s	
Crested Caracara	<i>Polyborus plancus</i>		1v	2h, 1o					

APPENDIX 1. Continuation.

		Cerrado Estancia Las Conchas	Cerrado Río Las Conchas floodplain	Chiquitano Incidental en-route	Chiquitano Río Mercedes	Chiquitano San Juan	Chiquitano Mina Don Mario	Chiquitano El Tuna	Species status
Yellow-headed Caracara	<i>Milvago chimachima</i>			1o					
Bat Falcon	<i>Falco rufigularis</i>		1v						
Peregrine Falcon	<i>Falco peregrinus</i>		1v					R, MB	
Rusty-margined Guan	<i>Penelope superciliaris</i>	2o							
Blue-throated Piping-Guan	<i>Pipile cumanensis</i>		2v						
Bare-faced Curassow	<i>Crax fasciolata</i>			2o				CT	
Gray-necked Wood-Rail	<i>Aramides cajanea</i>		1v	2a			2v	1s	
Sungrebe	<i>Heliornis fulica</i>							1s	
Sunbittern	<i>Eurypyga belias</i>		2v						
Red-legged Seriema	<i>Cariama cristata</i>	2v				2v			
Limpkin	<i>Aramus guarana</i>	1v							
Wattled Jacana	<i>Jacana jacana</i>		2v						
Solitary Sandpiper	<i>Tringa solitaria</i>	4v						MN	
Picazuro Pigeon	<i>Columba picazuru</i>	5v	1v						
Eared Dove	<i>Zenaida auriculata</i>	1v							
Ruddy Ground-Dove	<i>Columbina talpacoti</i>							1s	
Picui Ground-Dove	<i>Columbina picui</i>	20v	3v	1o		6v			
Scaly Dove	<i>Columbina squammata</i>		5v			1v			
White-tipped Dove	<i>Leptotila verreauxi</i>	4v	6v	1o		8v		1s	
Golden-collared Macaw	<i>Ara auricollis</i>	7vr	2v	6h		5v	2v		
Red-and-green Macaw	<i>Ara chloroptera</i>	2v, 3a	3h		2h		5v	CT	
Yellow-chevroned Parakeet	<i>Brotogeris chiriri</i>	10vr	20v	4h, 4o				1s	
Green-cheeked Parakeet	<i>Pyrrhura molinae</i>	15vr	6v			12v		3s	
Scaly-headed Parrot	<i>Pionus maximiliani</i>	30vr	50v			20v			
Orange-winged Parrot	<i>Amazona amazonica</i>	2ar							
Squirrel Cuckoo	<i>Piaya cayana</i>					1v	5v		
Smooth-billed Ani	<i>Crotophaga ani</i>	4vr	8v	1o				2s	

CHIQUITANO AND CERRADO ATIFAUNA

		Cerrado Estancia Las Conchas	Cerrado Río Las Conchas floodplain	Chiquitano Incidental en-route	Chiquitano Río Mercedes	Chiquitano San Juan	Chiquitano Mina Don Mario	Chiquitano El Tuna	Species status
Guira Cuckoo	<i>Guira guira</i>	10vr	5v			2v			
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>							1s	MB
Tawny-bellied Screech-Owl	<i>Otus watsonii</i>	1a							ERE
Ferruginous Pygmy-Owl	<i>Glaucidium brasilianum</i>		1v, 2a				3a	1s	
Nacunda Nighthawk	<i>Podager nacunda</i>	1o	1v						
Scissor-tailed Nightjar	<i>Hydropsalis brasiliiana</i>			1o					
Common Potoo	<i>Nyctibius griseus</i>							1s	
Glittering-bellied Emerald	<i>Chlorostilbon aureoventris</i>	3v	4v			10v			
Gilded Hummingbird	<i>Hylacharis chrysurus</i>	4vr							
Glittering-throated Emerald	<i>Amazilia fimbriata</i>							1s	
Blue-crowned Trogon	<i>Trogon curucui</i>	1a		1o					
Blue-crowned Motmot	<i>Momotus momota</i>		1a						
Ringed Kingfisher	<i>Ceryle torquata</i>	2vr	2v			1h			
Amazon Kingfisher	<i>Chloroceryle amazona</i>		2v					3s	
Green Kingfisher	<i>Chloroceryle americana</i>		1v					1s	
Green-and-rufous Kingfisher	<i>Chloroceryle inda</i>							2s	ERE
Spot-backed Puffbird	<i>Nystalus maculatus</i>							2s	
White-eared Puffbird	<i>Nystalus chacuru</i>		2v						
Black-fronted Nunbird	<i>Monasa nigrifrons</i>		1a				3a, 1v	1s	
Rufous-tailed Jacamar	<i>Galbula ruficauda</i>		2vr				1v	1s	
Chestnut-eared Araçari	<i>Pteroglossus castanotis</i>	1o		2o		2v	2v		
Toco Toucan	<i>Ramphastos toco</i>	2v		1o		10v			
White-wedged Piculet	<i>Picumnus albosquamatus</i>							1s	
White Woodpecker	<i>Melanerpes candidus</i>	8vr	6v			4v			
Pale-crested Woodpecker	<i>Celex lugubris</i>					2v			
Crimson-crested Woodpecker	<i>Campephilus melanoleucus</i>	1v							
Olivaceous Woodcreeper	<i>Sittasomus griseicapillus</i>	1o					2v	4s	

APPENDIX 1. Continuation.

		Cerrado Estancia Las Conchas	Cerrado Río Las Conchas floodplain	Chiquitano Incidental en-route	Chiquitano Río Mercedes	Chiquitano San Juan	Chiquitano Mina Don Mario	Chiquitano El Tuna	Species status
Great Rufous Woodcreeper	<i>Xiphocolaptes major</i>							2s	
Narrow-billed Woodcreeper	<i>Lepidocolpates angustirostris</i>	1v	1v			2v		5s	
Straight-billed Woodcreeper	<i>Xiphorhynchus picus</i>					1v		4s	
Rufous Hornero	<i>Furnarius rufus</i>				1h			1s	
Sooty-fronted Spinetail	<i>Synallaxis albescens</i>							1s	
Plain-crowned Spinetail	<i>Synallaxis gujanensis</i>							1s	
Yellow-throated Spinetail	<i>Certhiaxis cinnamomea</i>							1s	
Rufous-fronted Thornbird	<i>Phacellodomus rufifrons</i>	2v	8v					3s	
Streaked Xenops	<i>Xenops rutilans</i>	1v					2v	1s	
Great Antshrike	<i>Taraba major</i>	4vr	1v			1v	2v, 1a		
Barred Antshrike	<i>Thamnophilus doliatus</i>	2vr	3v	1a		1a	1a		
Variable Antshrike	<i>Thamnophilus caeruleus</i>					1v			
Stripe-backed Antbird	<i>Myrmorchilus strigilatus</i>					1v			
Black-capped Antwren	<i>Herpsilochmus atricapillus</i>			1o					R
Rusty-backed Antwren	<i>Formicivora rufa</i>							1s	
Streaked Flycatcher	<i>Myiodynastes maculatus</i>						1v	1s	
Piratic Flycatcher	<i>Legatus leucophaius</i>							1s	
Variiegated Flycatcher	<i>Empidonomus varius</i>							1s	
Tropical Kingbird	<i>Tyrannus melancholicus</i>	2v	2v	1o	1h	1v			
Fork-tailed Flycatcher	<i>Tyrannus savana</i>	1v							
Southern Beardless Tyrannulet	<i>Camptostoma obsoletum</i>		1v			2v		1s	
Scrub Flycatcher	<i>Sublegatus modestus</i>							3s	
Greenish Elaenia	<i>Myiopagis viridicata</i>							5s	ERE
Yellow-bellied Elaenia	<i>Elaenia flavogaster</i>	2v	1v						ERE
White-crested Tyrannulet	<i>Serpophaga subcristata</i>	1v				1v			
Pearly-vented Tody-Tyrant	<i>Hemitriccus margaritaceiventer</i>	1v	1v						
Fuscous Flycatcher	<i>Cnemotriccus fuscatus</i>							1s	

CHIQUITANO AND CERRADO AVIFAUNA

		Cerrado Estancia Las Conchas	Cerrado Río Las Conchas floodplain	Chiquitano Incidental en-route	Chiquitano Río Mercedes	Chiquitano San Juan	Chiquitano Mina Don Mario	Chiquitano El Tuna	Species status
Vermilion Flycatcher ¹	<i>Pyrocephalus rubinus</i>	4v	6v	4o		6v			
Cliff Flycatcher	<i>Hirundinea ferruginea</i>	2vp	1v						
Rufous Casiornis	<i>Casiornis rufa</i>	1v		1o			3v		
Swainson's Flycatcher	<i>Myiarchus swainsoni</i>							8s	
Brown-crested Flycatcher	<i>Myiarchus tyrannulus</i>	2v	6v	5o		10v	7v	6s	
Lesser Kiskadee	<i>Pitangus lictor</i>		3v					3s	
Great Kiskadee	<i>Pitangus sulphuratus</i>		2v			2v			
Boat-billed Flycatcher	<i>Megarynchus pitangua</i>	1ar	2v	1v		1v			
Rusty-margined Flycatcher	<i>Myiozetetes cayanensis</i>							3s	
Crested Becard	<i>Pachyramphus validus</i>	1v							
White-winged Becard	<i>Pachyramphus polychopterus</i>	2v	1v				1v	4s	
Green-backed Becard	<i>Pachyramphus viridis</i>	2v	1v					1s	
Black-tailed Tityra	<i>Tityra cayana</i>			1o			4v		
Black-crowned Tityra	<i>Tityra inquisitor</i>						4v		
Blue-and-white Swallow	<i>Notiochelidon cyanoleuca</i>	1v							
Tawny-headed Swallow	<i>Alopocbelidon fucata</i>	5v							
Gray-breasted Martin	<i>Progne chalybea</i>	2v	4v						
S. Rough-winged Swallow	<i>Stelgidopteryx ruficollis</i>		1v					1s	
Barn Swallow	<i>Hirundo rustica</i>	1v	1v						MB
House Wren	<i>Troglodytes aedon</i>	3v	2v			1v			
Thrush-like Wren	<i>Campylorhynchus turdinus</i>	3vr	4v			4v		1s	
Fawn-breasted Wren	<i>Thryothorus guarayanus</i>	2v	3v				3v		
Black-capped Donacobius	<i>Donacobius atricapillus</i>							1s	
Masked Gnatcatcher	<i>Polioptila dumicola</i>	2v				8v	1v	3s	
Hauxwell's Thrush	<i>Turdus hauxwelli</i>							1s	
Plush-crested Jay	<i>Cyanocorax chrysops</i>	8vr	1v	11o		1v		1s	
Purplish Jay	<i>Cyanocorax cyanomelas</i>		6v	7o		15v	6v	3s	

APPENDIX 1. Continuation.

		Cerrado Estancia Las Conchas	Cerrado Río Las Conchas floodplain	Chiquitano Incidental en-route	Chiquitano Río Mercedes	Chiquitano San Juan	Chiquitano Mina Don Mario	Chiquitano El Tuna	Species status
Red-eyed Vireo	<i>Vireo olivaceus</i>						1v	2s	MB
Rufous-collared Sparrow	<i>Zonotrichia capensis</i>	4v							
Grassland Sparrow	<i>Ammodramus humeralis</i>							1s	
Blue-black Grassquit	<i>Volatinia jacarina</i>			1o				1s	
Lesser Seedfinch	<i>Oryzoborus angolensis</i>							1s	
Red-crested Finch	<i>Coryphospingus cucullatus</i>	6v	8v			7v	1v	1s	
Yellow-billed Cardinal	<i>Paroaria capitata</i>							4s	
Guira Tanager	<i>Hemithraupis guira</i>							2s	
Hooded Tanager	<i>Nemosia pileata</i>	4v	4v					2s	
Hepatic Tanager	<i>Piranga flava</i>	2v							
Sayaca Tanager	<i>Thraupis sayaca</i>	4v	5v			25v		1s	
Purple-throated Euphonia	<i>Euphonia chlorotica</i>	1v	2v						
Orange-headed Tanager	<i>Thlypopsis sordida</i>	1v							
Tropical Parula	<i>Parula pitiayumi</i>		1v	1o, 1v		2v	5v		
Golden-crowned Warbler	<i>Basilenterus culicivorus</i>		1v						
Chestnut-vented Conebill	<i>Conirostrum speciosum</i>						2v	1s	
Bananaquit	<i>Coereba flaveola</i>	2v							
Crested Oropendola	<i>Psarocolius decumanus</i>	30v	2v	2h			2v		
Epaulet Oriole	<i>Icterus cayanensis</i>	5v	3v			10v			
Troupial	<i>Icterus icterus</i>							2s	
Shiny Cowbird	<i>Molothrus bonariensis</i>							1s	

