

Primates of the Valleys of the Rios Jequitinhonha and Mucuri, Brazil: Occurrence and Distribution

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Abstract: We report on a study of the occurrence and distribution of primates in three areas in the valleys of the rios Mucuri and Jequitinhonha in the states of Minas Gerais and Bahia. The areas were chosen on the basis of their classification as priority areas of high biological importance for conservation (numbered 213, 217, and 221) during a regional priority-setting workshop organized by the Brazilian government in 1999. We carried out surveys using a number of methods including line-transect sampling. Seven species were recorded in priority area 217, three in priority area 213, and three in 221. We saw six species in 66 encounters along 167.2 km of line transect surveys. The encounter rate for each species varied from 0.26 encounters/10 km to 2.49 encounters/10 km. Geoffroy's tufted-ear marmoset (*Callithrix geoffroyi*) was the most frequently sighted and was particularly abundant in the Mucuri valley. The brown howler monkey (*Alouatta guariba*) was also relatively common in the Mucuri valley. The northern muriqui (*Brachyteles hypoxanthus*) was seen in one of the survey sites, the most northerly register for the species. Five of the seven primates in the region are threatened. We found evidence of illegal hunting and selective logging in all the localities surveyed, and conservation measures are needed, specifically: an increase in surveillance against hunting, wood extraction and fires. Minas Gerais is one of the Brazilian states where deforestation levels are still of concern. It has been among the three states with the highest deforestation rates for the past five years, with the Jequitinhonha valley being one of the regions most impacted. The Fazenda Santana is located on the banks of the Rio Jequitinhonha and, despite the intense observed logging, it still has considerable areas of lowland deciduous forest, a rare phytogeography that is now restricted almost entirely to this part of the state of Minas Gerais. The maintenance of some of the forest fragments surveyed would protect nearly 70% of the threatened primates of Minas Gerais, notably *Sapajus xanthosternos*, *Callicebus melanochir*, and *Brachyteles hypoxanthus*.

Key Words: *Alouatta guariba*, *Callicebus melanochir*, *Sapajus robustus*, *Sapajus xanthosternos*, marmosets, *Brachyteles hypoxanthus*, distribution, endangered species

Introduction

We carried out primate surveys in three areas in Brazil's Atlantic forest that were identified as of high priority for conservation during a Workshop "Areas and Priority Actions for Biodiversity Conservation of the Atlantic Forest and Southern Grasslands" organized by the Brazilian Ministry of the Environment and held in Atibaia, São Paulo, in August 1999 (see Brazil, MMA 2002). The three priority areas, numbered 213, 217, and 221 in Brazil, MMA (2002), were in the valleys of the lower rios Jequitinhonha and Mucuri in the states of Minas Gerais and Bahia (Fig. 1) (Guedes 2006; Neves 2008). Eleven primate species are known from the Jequitinhonha valley, including populations of the endangered golden-headed lion tamarin (*Leontopithecus chrysomelas*) and yellow-breasted capuchin (*Sapajus xanthosternos*), and it is, as such, the richest primate community in the entire state of Minas Gerais (Rylands *et al.* 1988; Hirsch 2003; Melo 2004). The few faunal inventories that have been carried out in this region since 1999, however, are restricted to birds (Ribon and Maldonado-Coelho 2001; Ribon *et al.* 2002), frogs (Feio and Caramaschi 2002), and mammals (Melo *et al.* 2000, 2002; Melo 2004; Neves 2008).

Here we report on our findings concerning the occurrence and distribution of the primates in the three priority areas, focusing particularly on threatened species endemic to the Atlantic Forest (Fig. 1).

Methods

Collection and data analysis

Primate nomenclature follows the *Annotated Checklist of Brazilian Mammals* of Paglia *et al.* (2012) but using the genus name *Sapajus* Kerr for the robust tufted capuchins, as proposed by Lynch Alfaro *et al.* (2012). We carried out line-transect sampling, following the main assumptions necessary for this method (Buckland *et al.* 2001) but, given time and

logistical limitations, we sampled primates using only pre-existing trails, including such as forest edge and dirt roads in the fragments. Surveys were carried out early in the morning (06:00–10:00). The locations and the dates of the surveys are shown in Figure 1 and Table 1.

In total, we covered 167.2 km (Table 2). We located the primates by direct sightings or their calls. The walking pace was between 0.5 and 1.0 km/h. We recorded the beginning and end of each survey and the distance traveled, in order to estimate relative abundance (Chiarello 1999, 2000a; Thomas *et al.* 2010). We measured distances using GPS devices. For all sightings, we recorded the time, location, type of forest, record type and number of individuals seen. We interviewed owners, residents and hunters in each area we surveyed to complement the data from the formal methods. At the end of the interview, we showed them a handout with illustrations of Neotropical primates, for confirmation of the identity of the species referred to.

Results and Discussion

Study sites: species communities

Overall, we recorded the presence of seven primates in area 217 (Fig. 1), three in area 213, and three in area 221 (Table 3). The number of species recorded (reported and confirmed) in each site varied from two (in the fazendas Serra Azul and Bom Jardim of the Bandeira Complex) to four (Fazenda Santana – Santana Complex) (Table 3).

Priority area 213

The location with the highest species richness in this area was the Fazenda Limoeiro Complex, accounting for three species (Fig. 1, Table 3). Only two species were recorded in the other two locations. The only endangered species found in this fazenda was *S. xanthosternos* (Table 3). We also encountered a group of *S. xanthosternos* in the Fazenda Bom Jardim where some individuals were on the ground and on

Table 1. Conservation priority areas (Brazil, MMA 2002) included in our sampling and the dates of the respective expeditions.

Priority Area	Site (#)	Geographical Coordinates	Municipality	Dates of expeditions
213	Limoeiro Complex (1)	16° 02'S 40° 49'W	Almenara, MG	14–17 November 2003 20–23 April 2004
	Bandeira Complex – fazendas Serra Azul (2) and Bom Jardim (3)	15° 48'S 40° 31'W (Serra Azul) 15° 45'S 40° 06'W (Bom Jardim)	Serra Azul: Jordânia, MG - Bandeira, MG, and Bom Jardim: Macarani, BA - Itarantim, BA	13–17 March 2003 07–09 July 2004 24–29 April 2003
217	Santana Complex (4)	16° 03'S 40° 02'W	Salto da Divisa, MG	10–13 February 2003 11–16 June 2004
	Fazenda Duas Barras (5)	16° 24'S 40° 03'W	Santa Maria do Salto, MG and Guaratinga, BA	03–07 August 2003 03–07 August 2004
221	Mumbuca Complex (6)	17° 37'S 41° 57'W	Ladainha, MG	19–23 June 2003 02–06 February 2004
	Fazendas Nossa Senhora de Fátima and Bálamo (7)	17° 44'S 41° 43'W	Poté, MG and Novo Cruzeiro, MG	23–29 September 2003 07–10 April 2004

MG = Minas Gerais, BA = Bahia

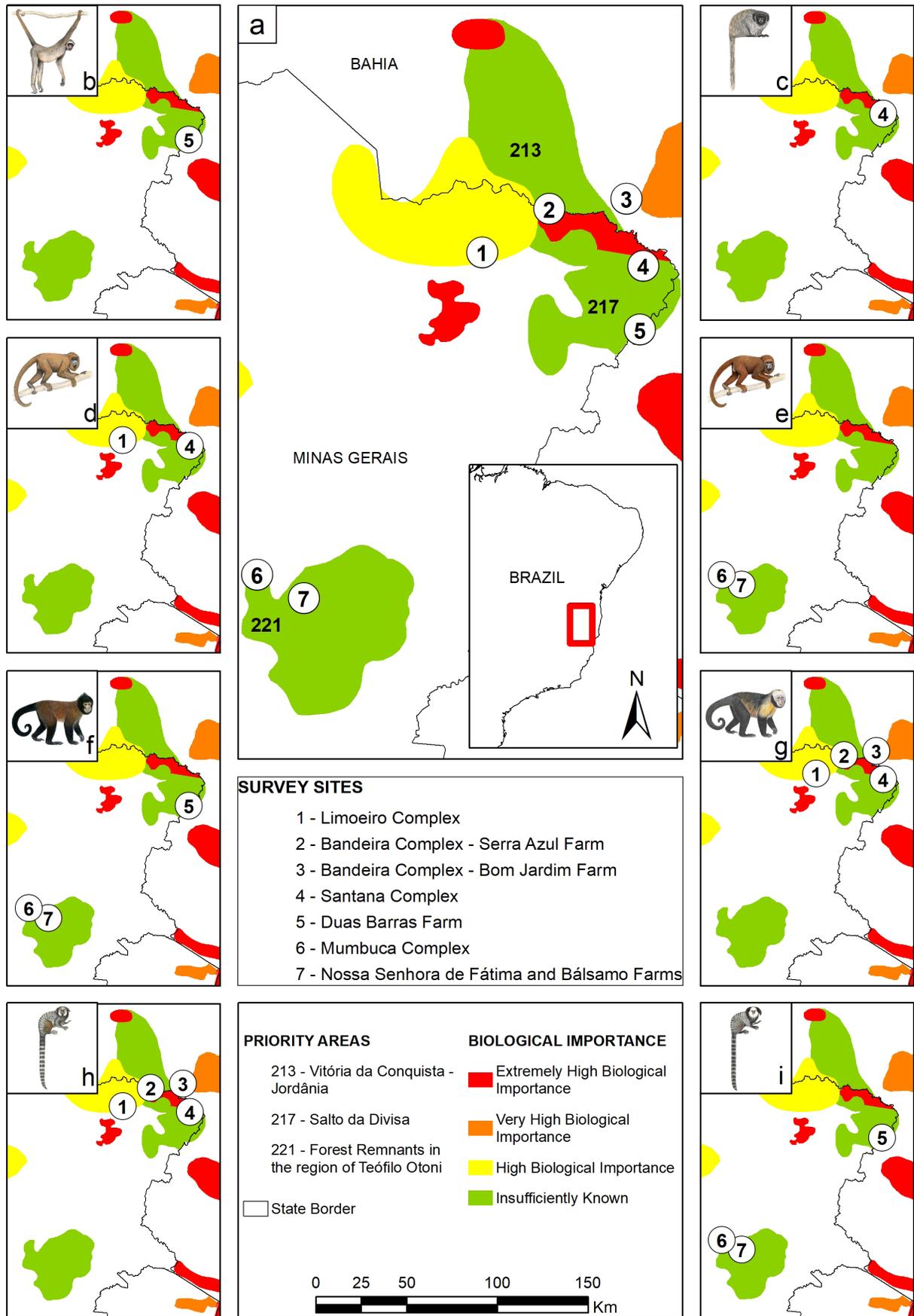


Table 2. Study sites, campaign periods, survey effort, and distance travelled on trails and roads during the censuses (km) in the seven study areas in the valleys of the Rios Jequitinhonha and Mucuri.

Locations	Priority Area	Sampling period	Field days	Distance walked (km)
Fazenda Serra Azul (Bandeira Complex)	213	13–17 March 2003	5	6.13
Fazenda Serra Azul (Bandeira Complex)	213	07–09 July 2004	3	10.74
Fazenda Bom Jardim (Bandeira Complex)	213	25–28 April 2003	4	7.00
Fazenda Limoeiro	213	14–17 November 2003	4	12.04
Fazenda Limoeiro	213	20–23 April 2004	4	7.20
Total Area 213			20	43.11
Fazenda Santana	217	10–13 February 2003	4	5.81
Fazenda Santana	217	11–16 June 2004	5	19.34
Fazenda Duas Barras	217	03–07 August 2003	5	7.50
Fazenda Duas Barras	217	03–07 August 2004	5	30.95
Total Area 217			19	63.60
Fazendas Mumbuca and Araras	221	19–23 June 2003	5	24.58
Fazenda Mumbuca and Araras	221	02–06 February 2004	5	11.83
Fazenda Bálsamo	221	24–28 September 2003	5	11.64
Fazenda Nossa Senhora de Fátima	221	07–10 April 2004	4	12.40
Total Area 221			19	60.45
Grand Total			58	167.20

rock formations in the forest fragment. We saw a single sub-adult male *A. guariba* at the Fazenda Limoeiro and, following visits by other researchers in the area, we confirmed it was the Critically Endangered subspecies *Alouatta guariba guariba* (Brazil, MMA, ICMBio 2018; IUCN 2016). The identification was made based on pelage color which differs between the sexes and subspecies as indicated by Kinzey (1982). This threatened subspecies was also confirmed for the Mata Escura Biological Reserve, also on the left bank of the Rio Jequitinhonha, just 40 km from this location (Melo 2004).

Priority area 217

Three species were recorded in the Fazenda Duas Barras and four in the Santana Complex. Duas Barras was the only location where we were able to confirm the presence of the Critically Endangered *B. hypoxanthus* (Brazil, MMA, ICMBio 2018; IUCN 2016) (Table 3). This population, and another confirmed in a preliminary study in the Mata Escura Biological Reserve, constitute the northernmost remaining populations of the species (Melo 2004, 2005; Melo *et al.* 2004). We also observed groups of the robust capuchin (*Sapajus robustus*) there on three occasions. Our only record of the southern Bahian masked titi (*Callicebus melanochir*) was in the Fazenda Santana. In 2010, however, we heard loud calls characteristic of this species at the Fazenda Alto Cariri, municipality of Guaratinga, in Bahia (about 30 km from the

Santana Complex) and which has been part of Alto Cariri National Park (19,200 ha) since 2010.

Priority area 221

We confirmed three species at the Mumbuca Complex and the same three in the fazendas Bálsamo and Nossa Senhora de Fátima (Fig. 1; Table 3). At the fazendas Araras and Mumbuca we saw one group of *S. robustus* and encountered *C. geoffroyi* 18 times and *A. guariba* 12 times (Table 3). *Alouatta guariba clamitans* was relatively abundant in the Fazenda Nossa Senhora de Fátima, given the high frequency of calling, and the same was true at the Fazenda Bálsamo. *Sapajus robustus*, *A. guariba*, and *C. geoffroyi* were seen in both fazendas. In the areas where Wied's black-tufted-ear marmoset (*Callithrix kuhlii*) and *C. geoffroyi* were registered, *S. xanthosternos* and *S. robustus*, respectively, were also confirmed.

Line-transect surveys: relative abundance

The number of encounters and their relative abundance (encounter rate/10 km) in each study area, counting only the sightings obtained, are presented in Table 4. We recorded six primate species during the line transect surveys—66 encounters along 167.2 km walked. The encounter rate varied from 0.26 encounters/10 km (Fazenda Duas Barras) to 2.61 encounters/10 km (the fazendas Araras and Mumbuca – Mumbuca

Table 3. Primate species recorded in the study sites during surveys or opportunistic encounters. vis = sighting, voc = heard calling with the number of records in parentheses.

Species	Priority Area 213			Priority Area 217		Priority Area 221	
	Bandeira Complex (Fazenda Serra Azul)	Bandeira Complex (Fazenda Bom Jardim)	Limoeiro Complex	Fazenda Santana	Fazenda Duas Barras	Fazendas Araras & Mumbuca	Fazendas Bálsamo & Nossa Senhora de Fátima
<i>Callithrix kuhlii</i>	voc (1) vis (4)	voc (1)	vis (2)	voc (3) vis (4)	-	-	-
<i>Callithrix geoffroyi</i>	-	-	-	-	voc (4)	voc (5) vis (13)	voc (4) vis (7) out (1)
<i>Sapajus robustus</i>	-	-	-	-	vis (3)	vis (1)	vis (1)
<i>Sapajus xanthosternos</i>	vis (2)	voc (2) vis (1)	voc (1)	voc (4) vis (1)	-	-	-
<i>Callicebus melanochir</i>	-	-	-	vis (1)	-	-	-
<i>Alouatta guariba clamitans</i>	-	-	-	-	-	voc (5) vis (7)	voc (9) vis (2)
<i>Alouatta guariba guariba</i>	-	-	voc (3) vis (1)	voc (1)	-	-	-
<i>Brachyteles hypoxanthus</i>	-	-	-	-	vis (1)	-	-
Species/locality	2	2	3	4	3	3	3
Species/priority Area	3			7		3	

Table 4. Number of sightings and respective encounter rate per 10 km of primates during line-transect surveys in the sites in three priority areas in the valleys of the Rios Jequitinhonha and Mucuri.

Species	Priority Area 213			Priority Area 217		Priority Area 221	
	Bandeira Complex (Fazenda Serra Azul)	Bandeira Complex (Fazenda Bom Jardim)	Limoeiro Complex	Fazenda Santana	Fazenda Duas Barras	Fazendas Araras & Mumbuca	Fazendas Bálsamo & Nossa Senhora de Fátima
<i>Callithrix kuhlii</i>	1 (0.59)	1 (1.43)	-	1 (0.39)	-	-	-
<i>Callithrix geoffroyi</i>	-	-	-	-	-	9 (2.61)	6 (2.49)
<i>Callicebus melanochir</i>	-	-	-	1 (0.39)	-	-	-
<i>Alouatta guariba clamitans</i>	-	-	-	-	-	6 (1.65)	2 (0.83)
<i>Brachyteles hypoxanthus</i>	-	-	-	-	1 (0.26)	-	-
<i>Sapajus robustus</i>	-	-	-	-	2 (0.52)	1 (0.27)	-
Species/locality	1	1	0	2	2	3	2
Species/Priority Area	1			4		3	

Complex). The highest values were obtained for *C. geoffroyi* with 2.61 groups/10 km in the fazendas Araras and Mumbuca, and 2.49 groups/10 km in the fazendas Bálsamo and Nossa Senhora de Fátima. These estimates are a little higher than the 2.16 groups/10 km observed by Chiarello (1999) for the same species at the Linhares Reserve of the Companhia Vale do Rio Doce (CVRD) and Sooretama Biological Reserve (1.81 encounters/10 km)—two large reserves in the north of the state of Espírito Santo.

The encounter rate of *Alouatta guariba clamitans* was 1.65 groups/10 km in the fazendas Araras and Mumbuca.

This was also higher than that for the same species obtained in Espírito Santo; 0.22 groups/10 km (Chiarello 1999). The relative abundance of *Sapajus robustus* was 0.27 groups/10 km in the surveys carried out in the fazendas Araras and Mumbuca, and 0.52 groups/10 km at the Fazenda Duas Barras. These numbers are lower than for *S. robustus* in four strictly protected areas in the north of Espírito Santo (0.60–2.47 groups/10 km; Chiarello 1999). The low values probably result from hunting. Even considering deficiencies in surveillance, hunting in protected areas is usually less intense than in private properties.

Table 5. Primates of the Atlantic Forest with confirmed presence in the study sites (report only not included), and their threatened status according to the IUCN Red List (2016) and the Official List of Endangered Brazilian Fauna (Brazil, MMA 2014).

	Threatened (IUCN 2016)	Threatened (Brazil, MMA 2014)
<i>Sapajus robustus</i>	Endangered	Endangered
<i>Sapajus xanthosternos</i>	Critically Endangered	Endangered
<i>Callicebus melanochir</i>	Vulnerable	Vulnerable
<i>Alouatta guariba guariba</i>	Critically Endangered	Critically Endangered
<i>Alouatta guariba clamitans</i>	Least Concern	Vulnerable
<i>Brachyteles hypoxanthus</i>	Critically Endangered	Critically Endangered
Total	5	6

Threatened species

Six threatened species (Brazil, MMA, ICMBio 2018; IUCN 2016) were recorded in the study areas (Tables 4 and 5). Of these, two are Critically Endangered: *B. hypoxanthus*, confirmed only for the Fazenda Duas Barras (priority area 217), and *A. guariba guariba*, confirmed in two fazendas north of the Rio Jequitinhonha (Limoeiro and Santana), in priority areas 213 and 217, respectively.

Interviews with residents, farm workers and former hunters

Interviews, when well conducted, increase substantially the results of short-term inventories and should be a standard procedure in studies of short duration and with few resources (Voss and Emmons 1996). They also provide relevant information for conservation, otherwise not obtained with sampling alone, particularly regarding species present in the past, information on elusive species, and the likely presence of threatened species that we failed to see or hear.

Table 6. Primate species with occurrence reported through interviews with hunters, workers and local residents in the study sites. R = Unconfirmed reports; R/C – Confirmed reports.

Species	Priority area 213			Priority area 217		Priority area 221	
	Fazenda Serra Azul	Fazenda Bom Jardim	Fazenda Limoeiro	Fazenda Santana	Fazenda Duas Barras	Fazenda Araras	Fazendas Balsamo & Nossa Senhora de Fátima
<i>Callithrix kuhlii</i>	-	R/C	-	R/C	-	-	-
<i>Callithrix geoffroyi</i>	-	-	-	-	R/C	R/C	R/C
<i>Leontopithecus chrysomelas</i>	-	-	-	R	-	-	-
<i>Sapajus robustus</i>	-	-	-	-	R/C	-	R/C
<i>Sapajus xanthosternos</i>	R/C	R/C	-	R/C	-	-	-
<i>Callicebus melanochir</i>	-	-	-	R/C	-	-	-
<i>Callicebus sp.</i>	-	R	-	R	R	R	R
<i>Alouatta guariba clamitans</i>	-	-	-	-	-	R/C	R/C
<i>Alouatta guariba guariba</i>	-	-	R/C	R/C	R	-	-
<i>Brachyteles hypoxanthus</i>	R	-	-	-	R/C	-	-
Species/locality	2	3	1	6	5	3	4
Species/area	5			6		4	

Our interviews with people familiar with the fauna of each locality indicated ten primates in seven locations (Table 6), two more than we recorded during reconnaissance surveys and line transects. One was *L. chrysomelas*, reported for the Fazenda Santana in area 217. This species is believed to have been extirpated in Minas Gerais and was removed from the state's threatened species list (Chiarello *et al.* 2008). The other was an unidentified species of titi, *Callicebus*, reported for five fazendas in the three priority areas (Table 6). The number of species reported by locality ranged from one (Limoeiro Complex) to six (Fazenda Santana). For the three priority areas, the species totals ranged from four in area 221, to five in area 213, to six in area 217 (Table 6). None of the six threatened species (Brazil, MMA 2014) was reported for all the six study sites.

Endemic and Threatened Primates

The six sites surveyed are in two zoogeographic regions in the Atlantic Forest primate fauna (Rylands *et al.* 1988): one north of the Rio Jequitinhonha (fazendas Santana, Serra Azul, Bom Jardim and Limoeiro), and the other south of the Jequitinhonha (fazendas Araras, Duas Barras, Balsamo and Nossa Senhora de Fátima). In the first, we found *C. kuhlii*, *L. chrysomelas*, *C. melanochir* and *S. xanthosternos*; species typical of the Hiléia Baiana—a portion of the Atlantic forest that has elements of its flora that are otherwise Amazonian (Costa 2003). In the second region, the primates are typical of the forests of northeastern Minas Gerais and northern Espírito Santo: *C. geoffroyi*, *S. robustus* and *Callicebus sp.*, which was probably *C. personatus* (not confirmed).

We confirmed the occurrence of *S. xanthosternos* in the four localities north of the Jequitinhonha (Fig. 1). This species, once Critically Endangered, has been listed as one of the world's 25 most endangered primates (Mittermeier *et al.* 2005). We saw groups in the fazendas Santana, Serra Azul and Bom Jardim (Table 3) and, with the exception of Melo (2004), it had not previously been confirmed for the north-east of the state of Minas Gerais (Rylands *et al.* 1988; Oliver and Santos 1991). Its calls were also heard in the Limoeiro

Complex. Endemic to the Atlantic Forest of southern Bahia and the far north of Minas Gerais, it is seriously threatened due to habitat loss and to heavy hunting for illegal trade or subsistence (Santos *et al.* 1987; Rylands *et al.* 1988; Mittermeier *et al.* 2005). The creation of protected areas and the discoveries of previously unknown populations has improved the conservation status of *S. xanthosternos*, and it is now ranked as Endangered in the most current national list of threatened fauna (Brazil, MMA 2014; Canale *et al.* 2015).

Sapajus robustus replaces *S. xanthosternos* on the right bank of the Rio Jequitinhonha (Fig. 1). Its range extends south to the Rio Doce, another zoogeographic barrier in the lower part of its course (Kinzey 1982). Although having a wider distribution, *S. robustus* is rare in the Jequitinhonha valley (Rylands *et al.* 1988; Melo *et al.* 2002). Its conservation status is Endangered (Brazil, MMA 2014; IUCN 2016). It occurs in protected areas in the north of Espírito Santo, such as the Sooretama and Córrego do Veado biological reserves and the forest reserve of the Companhia Vale do Rio Doce in Linhares (Chiarello, 1999), as well as the Monte Pascoal National Park and Vera Cruz Private Natural Heritage Reserve (RPPN) in southern Bahia. We confirmed the presence of *S. robustus* in the fazendas Araras and Mumbuca, Duas Barras, and Bálamo and Nossa Senhora de Fátima, all south of the Jequitinhonha, extending to the Alto Mucuri valley.

With small and fragmented populations distributed unevenly through its former range, the northern miqui, *Brachyteles hypoxanthus* (Fig. 1), was also once on the list of the 25 most endangered primates in the world (Strier and Fonseca 1996–1997; Mittermeier *et al.* 2005). This rare and endemic primate of the Brazilian Atlantic Forest is nationally and internationally listed as Critically Endangered (Brazil, MMA, ICMBio 2018; IUCN 2016). It has been considered as almost extinct in the Jequitinhonha valley in Minas Gerais and southern Bahia (Santos *et al.* 1987; Rylands *et al.* 1988; Oliver and Santos 1991; Melo 2005). Surveys by Melo (2004) in the Jequitinhonha valley, however, confirmed the survival of a group of about 30 in the Mata Escura Biological Reserve created in 2003 (51,436 ha) in the municipalities of Jequitinhonha and Almenara on the left bank of the Rio Jequitinhonha (Melo 2005). It is the only protected area of the Atlantic Forest that has three Critically Endangered primates (Melo 2005). Surveying forests for primates in southern Bahia, Moura (2003) was able to obtain just a few old reports of the presence of *B. hypoxanthus*, and concluded that it was probably extinct in the region. We located a group at the Fazenda Duas Barras, in the largest and best-preserved fragment that we surveyed (Tables 3 and 4). This may well be the last surviving population of the species in southern Bahia; the forest there straddles the state border with Minas Gerais. The confirmation of this population is important not only for the conservation of the species but also, considering the species' charisma and potential as a “flagship” species, should inspire the creation of further private and public reserves there. Between 2008 and 2010, four reserves were created in the region of the Fazenda Duas Barras, namely the Private

Natural Heritage Reserve (RPPN) Loredano Aleixo of 567 ha, where the species was seen in 2004, the Alto Cariri State Park, with 6,100 ha, and the Wildlife Refuge (RVS) Mata dos Muriquis, with 2,722 ha, located in the state of Minas Gerais. The fourth was the Alto Cariri National Park, created in 2010 with 19,200 ha, a part of which extends into the state of Bahia. The creation of these protected areas resulted mostly from initiatives made possible by the larger project from which our primate surveys derived.

As expected, *C. kuhlii* groups were registered in locations surveyed on the northern bank of the Rio Jequitinhonha (Fig. 1), and *C. geoffroyi* in locations south of the river, extending to the Rio Mucuri (Fig. 1). The first records of *C. kuhlii* for Minas Gerais are from Rylands *et al.* (1988), and the first records of this primate for the municipalities of Bandeira, Jordânia and Salto da Divisa, in Minas Gerais are from Oliver and Santos (1991). This species has a similar distribution to that of *L. chrysomelas*, between the Rio de Contas and the Jequitinhonha. According to Moura (2003), it is still relatively common in its range in southern Bahia. Although not listed nationally as threatened, regionally, in the lower valley of the Jequitinhonha, populations of *C. kuhlii* are now diminished, primarily as a result of decades of anthropogenic disturbance (Rylands *et al.* 1988). The species is currently listed as Near Threatened (NT) on the national list (Pereira 2015) and its distribution appears to be smaller than previously thought (Neves 2008).

As pointed out by Melo (2004), although occurring in important forest remnants within its range in Minas Gerais, *C. kuhlii* is not in any protected area there. Populations of *C. geoffroyi* are better off, but the species' range has contracted in Minas Gerais, and it is possibly increasingly threatened in many areas of its current distribution (Oliver and Santos 1991). Confirmation of new populations in the northwest of the state is needed for a better understanding of the population status of this species (Melo *et al.* 2002; Melo 2004).

Rylands *et al.* (1988) listed two subspecies for *Alouatta guariba*—*A. g. guariba* and *A. g. clamitans*—for the Jequitinhonha valley (Fig. 1). Both forms occur in areas close to the river, but there is little information (and too little forest) to properly understand the limits of their distributions (Rylands *et al.* 1988; Gregorin 2006). The differentiation of the two forms in the field is, however, very difficult. The only areas in the Jequitinhonha valley where the species has been confirmed is in the Santana Complex in the municipality of Salto da Divisa, and the Fazenda Limoeiro, in the municipality of Almenara. At the Fazenda Duas Barras, municipality of Santa Maria do Salto, we only obtained reports from people living close to the forests we surveyed. Rylands *et al.* (1988) cited Salto da Divisa and Santa Maria do Salto as likely locations where *A. g. guariba* could still occur in Minas Gerais. Since this subspecies is nationally and internationally listed as Critically Endangered, it is essential that more detailed studies confirm its presence or otherwise in the region. New populations have been identified south of the Alto Cariri National Park, Bahia, where they are present in isolated forest

fragments outside the boundaries of the park (L. Neves pers. comm.; Neves *et al.* 2015). In other areas where *A. guariba* was seen (the two fazendas of the 221 area in the Rio Mucuri), the slight sexual dichromatism (golden males and brown/coffee females) indicates that they may be *A. g. clamitans* (also threatened, but less so). According to Gregorin (2006), however, this small difference in pelage color is evidenced by him in populations of *A. g. guariba*, unlike the other subspecies in which dichromatism is more pronounced. Further studies, including a phylogenetic approach, need to be carried out with these populations to resolve doubts regarding the geographic range of these two taxa.

The surveys carried out by Santos *et al.* (1987) and Pinto and Tavares (1994) showed that the distribution of *L. chrysomelas* is larger than was previously thought. Near the Atlantic coast, the northern boundary is apparently the Rio Almada, the southern boundary is the Rio Jequitinhonha, and to the west the species is found up to the headwaters of the Rio Gongogi (Bahia). Through interviews with hunters in the region, Santos *et al.* (1987) and Rylands *et al.* (1991–1992) indicated that this species could occur in Minas Gerais, in the municipality of Salto da Divisa, extreme northeast of the State. However, just like Melo *et al.* (2002), we failed to see it in this region, despite convincing reports that it occurred in the Fazenda Santana, municipality of Salto da Divisa. If the species still persists there, its population should be greatly reduced, and it is entirely isolated from other forest fragments by extensive pasture.

We obtained the single visual record of *C. melanochir* in the complex of forest patches at the Fazenda Santana (Fig. 1). This is also an Atlantic Forest endemic, and is considered Vulnerable (Brazil, MMA, ICMBio 2018; IUCN 2016). Oliver and Santos (1991) indicated that its distribution is restricted to southern Bahia and surrounding areas. In the study of Moura (2003), this was the primate most mentioned in interviews, but with just a single visual confirmation (W2 – Fazenda São João, Nilo Peçanha, Bahia).

Conclusions

The Atlantic forest has long been hunted (Oliver and Santos 1991; Dean 1995; Canale *et al.* 2012) but the fragmentation of the remaining forest patches means that the surviving populations are small and isolated, making them more susceptible to extinction, even when hunting pressure is low (Chiarello 1999, 2000a). The impact of hunters and loggers is greater in fragments when compared to wider expanses of forest, since fragmentation facilitates access to areas previously remote (Redford 1992). We found evidence of illegal hunting and selective logging in all the localities we worked. Apart from encounters with hunters in the fragments, we also found numerous hunting devices, locally known as *poleiros* or *giraís* (ladders; see Appendix), and traps, such as the *trabuco* or *canhão* (rustic guns armed with simple but functional automatic triggers).

Hunting was evidently more prevalent at the fazendas Santana, Bálsamo and Nossa Senhora de Fátima with the larger number of *poleiros* we found, and dogs and hunters were seen almost daily at the Fazenda Santana. Dogs are an increasing threat in the Atlantic Forest because of the forest's proximity to urban areas and farms. They are not only a threat to the native fauna, but also a threat regarding the transmission of zoonoses (Cleaveland *et al.* 2000; Oliveira *et al.* 2008). Hunting for deer, paca, peccary and primates (especially capuchin monkeys and howlers) is still common in southern Bahia, including the Jequitinhonha valley (Moura 2003; Canale *et al.* 2012). Even *L. chrysomelas* is sought after. Another associated threat is the free entry of cattle, horses and donkeys in the survey sites, where fences separating the pasture from the forest are frequently lacking. They disturb the soil (trampling and killing seedlings), defecate exotic grass seeds in the forest, and can also carry diseases to the deer (Tomas *et al.* 1997).

Selective logging was also evident and widespread in the sites we surveyed; in some places, the withdrawal method is still rudimentary and uses animals to drag the logs out (see Appendix). The timber is sold or used on the farm or on other farms of the same owner (for example, Fazenda Santana). We saw evidence of recent fires at the Fazenda Santana forest complex, in large portions of the fazendas Bálsamo and Nossa Senhora de Fátima (Nossa Senhora de Fátima Complex), and at the Fazenda Serra Azul (Bandeira Complex).

Generally, these anthropogenic pressures indicate that the situation for wild mammals, particularly the rarer and most endangered, is worrying. With the exception of the Fazenda Duas Barras, where the remaining forest area is still significant (around 20,000 ha), the forests are all small patches. Chiarello (2000b) argued that viable populations of medium to large mammals of the Atlantic Forest can only persist in forest fragments of 20,000 ha or more, where population sizes can reach hundreds or even thousands. The picture becomes more critical when we consider that these populations, already reduced and most likely isolated (the fragments are immersed in a matrix of mostly pasture and agricultural crops) are suffering numerous impacts—hunting, fires, logging and entry and disturbance of domestic animals. The sum of these impacts suggests that, even in the near future (10–20 years), important populations of endangered and rare species will be extirpated. Species most vulnerable to fragmentation and isolation, such as jaguars, white-lipped peccaries, giant anteaters and armadillos, are already largely gone from the areas we surveyed.

Thus, emergency conservation measures must be taken, including increased surveillance against hunting, timber extraction and fire. Minas Gerais, in particular, has been shown to be one of the Brazilian states where the levels of loss of its Atlantic Forest are still alarming, and for some years it has been among the top three worst offenders, with the Jequitinhonha valley being one of the most impacted regions (SOS Mata Atlântica and INPE 2016). The Fazenda

Duas Barras Complex has now four protected areas, with the largest forest patch still well preserved. It is important to encourage and help landowners to create private reserves (RPPNs) in other farms, since many of them have excellent potential for ecologically sustainable activities such as ecotourism and birdwatching. Some cattle ranchers (Fazenda Limoeiro – Limoeiro Complex and the Fazenda Duas Barras) were sympathetic to this initiative. Others, however, seemed indifferent (Fazenda Bom Jardim – Bandeira Complex) or even averse, for being effectively involved in hunting or the illegal exploitation of timber (Fazenda Santana – Santana Complex; Fazenda Serra Azul – Bandeira Complex; fazendas Nossa Senhora de Fátima and Balsamo – Nossa Senhora de Fátima Complex; and Fazenda Araras – Mumbuca Complex). The Fazenda Santana is pleasantly located on the banks of the Rio Jequitinhonha, and, despite the intense observed logging, still has considerable areas of lowland deciduous forest, a rare phytophysiology that is now almost entirely limited to this region of the state of Minas Gerais. Equally concerning is the low adherence of local farm owners to the Brazilian Forest Code. This law mandates the preservation of a portion of rural properties as forest reserves (Legal Reserves and Areas of Permanent Preservation), particularly alongside rivers, on slopes and mountain tops (Soares-Filho *et al.* 2014). If effectively implemented by all farm owners, these private reserves would benefit primates, increasing habitat availability and improving matrix permeability (Tambosi *et al.* 2015), and mitigating genetic deterioration that might result from population isolation, besides other benefits to the environment and society (Tambosi *et al.* 2015; Freitas *et al.* 2018).

The maintenance of some of the forest fragments that we surveyed could mean: the preservation of nearly 70% of the primate fauna of Minas Gerais, the survival of highly threatened populations in the state, such as *C. melanochir* and, finally, of populations of threatened species such as *B. hypoxanthus* and *S. xanthosternos*.

Minas Gerais has nearly 10.3% of its Atlantic Forest remaining (Fundação SOS Mata Atlântica and INPE 2016) and, based on the results presented here, there is strong evidence of the need for more protected areas in the Jequitinhonha valley. Their lack could well result in regional extinction of the primates there. It should not be difficult. The actions necessary are described in Melo (2004, 2005), who has advocated the creation of just one more area, to combine with one already created (the Mata Escura Biological Reserve) that would cover forests in the fazendas Limoeiro (Almenara) and Serra Azul (Bandeira), protecting the ‘Bandeira Complex’ (the only refuge for the Stresemann’s Bristle-front *Merulaxis stresemanni*; Ribon *et al.* 2004). This new protected area would be very effective in minimizing the possibility of local extinction for the species not yet protected, such as *C. kuhlii* and possibly, *Leontopithecus chrysomelas*, although quite probably already extinct in Minas Gerais.

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Appendix



Illegal removal of timber using buffalos. Fazenda Serra Azul, Bandeira, Minas Gerais. Photo by Adriano G. Chiarello.



Charcoal being produced with native species of the Atlantic Forest. Fazenda Araras, Ladainha, Minas Gerais. Photo by Adriano G. Chiarello.



“Poleiros de espera” or “girais” used for hunting mammals. Fazenda Bom Jardim, Itarantim, Bahia. Photo by Adriano G. Chiarello.



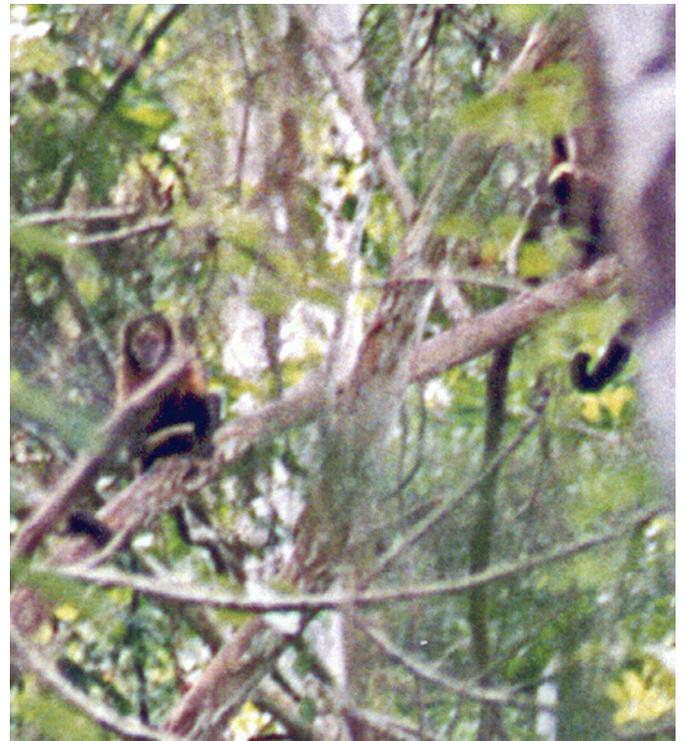
Wooden stake used to secure a trap, known locally as “canhão” or “trabuco,” for hunting mammals. Fazenda Duas Barras, Santa Maria do Salto, Minas Gerais. Photo by Adriano Chiarello.



Adult female and infant of the northern muriqui, *Brachyteles hypoxanthus*. Fazenda Duas Barras, Santa Maria do Salto, Minas Gerais. Photo by Adriano G. Chiarello.



Adult male brown howler, *Alouatta guariba clamitans*. Fazenda Araras, Ladainha, Teófilo Otoni, Minas Gerais. Photo by Adriano G. Chiarello.



Yellow breasted capuchins, *Sapajus xanthosternos*. Fazenda Bom Jardim, Itarantim, Bahia. Photo by Pedro A. de Oliveira.