**Estrada et al.**

**Supplementary text (Text S1)**

**Text S1**

**Survey methodology**

List of agencies consulted for data sets used to profile time series of parameters of interest for each of the four countries under investigation. The list includes the URLs of the sections of the agencies’ websites where origin, accuracy and other aspects of the nature of the data sets are found.

**FAO** Food and Agriculture Organization of the UN

**http://www.fao.org/faostat/en/#definitions**

**http://www.fao.org/statistics/en**

**The World Bank**

**http://ieg.worldbankgroup.org/methodology**

**IUCN** International Union for the Conservation of Nature Red List

**http://www.iucnredlist.org/about/overview**

**GFW** Global Forest Watch

**https://www.globalforestwatch.org/**

**CITES**

**https://trade.cites.org/;**

**https://trade.cites.org/cites\_trade\_guidelines/en-CITES\_Trade\_Database\_Guide.pdf**

**ITC** International Trade Centre

**http://www.intracen.org***/*

**http://www.intracen.org/itc/market-info-tools/market-analysis-tools/**

**Protected Planet (UNEP-WCMC)**

**https://www.protectedplanet.net/c/about**

**https://www.protectedplanet.net/c/terms-and-conditions**

**IMAGE** Integrated Model to Assess the Global Environment

**http://themasites.pbl.nl/models/image/index.php/Agricultural\_economy**

**http://themasites.pbl.nl/models/image/index.php/Agricultural\_economy/Data\_uncertainties\_limitations**

**UN Development Program Human Development Index (HDI)**

**http://hdr.undp.org/en/content/human-development-index-hdi**

[**http://hdr.undp.org/en/statistics/understanding**](http://hdr.undp.org/en/statistics/understanding)

**GPI (Global Peace Index)** **of** **the Institute for Economics and Peace** **<http://economicsandpeace.org/>.**

**http://economicsandpeace.org/research/#risk; http://economicsandpeace.org/about/**

**The 2016 Transparency International Corruption Perceptions Index (CPI)**

https://www.transparency.org/news/feature/corruption\_perceptions\_index\_2017

https://www.transparency.org/news/feature/corruption\_perceptions\_index\_2017#resources; https://www.transparency.org/whoweare/accountability

**Richness of primate taxa and IUCN conservation and population status**

Brazil, Madagascar, DRC and Indonesia are important reservoirs of the world´s biodiversity, being considered megadiverse countries (*Mittermeier, Robles Gil & Mittermeier, 1997*). For example, together they account for 36% of the world’s terrestrial mammals (n = 5,466), 44% of all birds (n = 11,121), 19% of all reptiles (n = 5473) and 27% of all amphibians (n = 6533) (Table S2). Brazil and DRC account for 64% and 60% of the Amazon (7.5 million km2) and Congo (3.5 million km2) basins, respectively (*Ernst et al., 2013*; *Rittera et al., 2017*; Fig. 1). Madagascar is the largest African island and the fourth-largest island in the world, after Greenland, New Guinea, and Borneo. It has been isolated for about 80 million years and contains the only remaining radiation of lemurs (*Zimkus et al., 2017*). Indonesia, the world's largest island country, is composed of more than seventeen thousand islands (*CIA, 2017*). Each of the four countries is characterized by a unique biogeographical history that has nurtured a highly successful radiation of endemic and more widely distributed primate taxa.

**Expansion of agricultural land**

While forest loss and agricultural expansion are common patterns in all four countries, each country differs in its type of agricultural production due to domestic and global market demands. Below we document some of these between country differences. It is worth noting that the quality of the data provided to the FAO is not the same for all countries. DRC in particular has serious infrastructure issues, including the lack of widespread power and transport lines (apart from rivers) throughout much of the country and a poorly-resourced civil service, limiting the country’s capacity to measure and report metrics that cannot be analysed using remote sensing, such as agricultural land in use, and productivity of any given crop. The World Bank’s Statistical Capacity Score (a metric reflecting a nation’s ability to collect, analyze, and disseminate high-quality data about its population and economy) reflects the likely precisión of statistics reported to the FAO. Scores are out of 100 (greatest precision) and are: DRC 46.7, Madagascar 56.7, Brazil 74.4 and Indonesia 86.7. This means that FAO data quality for DRC and Madagascar is poor. *http://databank.worldbank.org/data/reports.aspx?source=Statistical-capacity-indicators*

**Brazil**

The cattle population in Brazil grew from 169 million head in 2000 to 212 million in 2015 (larger than Brazil’ human population) with concomitant increases in pasture(*ABIEC BRAZIL, 2016*). Brazil has greatly expanded its production of soybeans (*Glycin max*), sugarcane (*Saccharum* spp.), oil palm (*Elaeis guineensis*), natural rubber (*Hevea brasiliensis*), and timber in recent decades, at the expense of primate habitats ([http://www.fao.org/](http://www.fao.org/faostat/en/" \l "data)consulted November 2017; Fig. S2). Soybean crops more than doubled from 13.6 million ha in 2000 to 30.3 million ha in 2015. Sugarcane expanded in already established pastures from 4.8 million ha in 2000 to 10.4 million ha by 2015. Oil palm and natural rubber plantations have rapidly expanded as well. The former, from 45,000 ha in 2000 to 126,559 ha in 2015. The latter, from 112,396 ha to 146,552 ha over the same 15-year period. Nonconiferous roundwood extraction in Brazil has grown from 183 million m3 in 2000to 205 million m3 in 2015 ([*http://www.fao.org*/](http://www.fao.org/faostat/en/#data)consulted November 2017; Fig. S2 for definition of FAO category).

**DRC**

In DRC the rural complex (*sensu* *Molinaro et al, 2017*) covers about 13.1% of the country’s land surface. This rural complex includes roads and villages (14% of the complex, and thus uncultivable), active and fallow fields, secondary forest and primary forest (approximately 11% of the complex); 5% of the complex are clearings and 10% are active fields; the rest (60%) is fallow land (*Molinario et al., 2017)*. The majority (76%) of the rural complex in DRC is already part of the roughly 18-year cycle of shifting cultivation, and therefore most of the forest lost within the complex represents the cyclical removal of secondary forest (*Molinario et al., 2015*; *Molinario et al., 2017*). The net annual increase of expansion into primary forest outside of the rural complex, often into protected areas is very low – about 1% of the total land area annually (*Molinario et al. 2015*). The loss of primary forest is of greatest concern for primates in DRC.

Bushmeat extraction in central African forests was already six times higher than the sustainable rate by 1999 (*Bennett et al., 2002*), and primates are one of the guilds least able to withstand any but the lightest hunting pressure (*Robinson & Bennett 2000*). Few of the larger-bodied primates in DRC are now likely to inhabit the rural complex, which has been heavily hunted in the last few decades (*Ziegler et al., 2016*).

Most land clearing in the rural complex in DRC is land that has already been cleared in the last two decades. Commercial plantations (such as rubber and oil palm cover 2% of the rural complex (*Molinario et al. 2017*) cover approximately 2,580 km2. Of these concessions (N=150), only one, which covers 464 km2 (18% of all the industrial agricultural concessions), has its center in an IFL (Intact Forest Landscape). After independence, and especially between 1996-2002, during a period of extreme political instability and civil war in DRC, commercial agricultural production fell sharply, and virtually ceased. Since then, and especially in the last decade (2006 onwards), the old pre-independence plantations have been rehabilitated on land that was cleared in colonial times or up to the mid-1990s. A handful of companies own the industrial plantations, and produce about 50,000 tons of palm oil annually. Another 50,000 tons are produced by village plantations, and the remainder – 200,000 tons – are collected from old trees in the rural complex, including from abandoned plantations (Semroc *et al.* 2015). Almost all production is consumed in-country. Given the predicted growth in the human population, DRC will need to plant an additional 1,600 km2 by 2030 (*Semroc et al. 201*5). Although FAO suggests that between 2000 and 2015, 12million ha were deforested to produce these crops (Fig. S3), most of this involved the rehabilitation of existing palm and rubber concessions, which had already been deforested when they were established at the beginning of the 1900s. Between 2000 and 2015 natural rubber plantations in DRC more than doubled from 19,000 ha to 50,600 ha and the production of oil palm fruit increased from 1.12 million metric tons in 2000 to 1.18 million metric tons in 2015 (Fig. S3). These areas are all in sites close to human settlements (*GFW, 2018*) and primates are thus likely to have been hunted out several decades ago (*Ziegler et al., 2016*).

The humid forest area of the country is primarily a forest-based farming system where the principal crops are manioc (cassava;*Manihot esculenta*) and plantains (*Musa* spp.) in forested areas, and to a smaller degree rice and maize in both forested and savannah areas (*Dixon et al., 2001*).

**Madagascar**

In Madagascar, the cultivation of roots. tubers, maize, and especially rice mostly for internal consumption and export, is an important driver of losses of native vegetation. The cultivation of these crops increased from 1.9 million ha in 2000 to 2.2 million ha in 2010. More recently the harvesting of roundwood for export has accelerated the pace of deforestation, and forest degradation and extraction grew from 9.7 million m3 in 2000 to 13.7 million m3 in 2015 (Fig. S4). In Madagascar, rapid agricultural expansion and associated habitat loss and degradation combined with logging and hunting have resulted in population declines in 90% of lemur species (e.g. Verreaux's Sifaka, *Propithecus verreauxi*) (Fig. 1).

**Indonesia**

Rice cultivation in Indonesia expanded from 8.3 million ha in 2000 to approximately 14 million ha in 2015 (Fig. S5). Global market demands have greatly accelerated the conversion of forested land to oil palm and natural rubber plantations. Oil palm plantations in Indonesia expanded from 2 million ha in 2000 to 7.4 million ha in 2015. Natural rubber plantations have increased from 2.4 million ha in 2000 to 3.6 million ha in 2015. Industrial roundwood extraction increased from 48.6 million m3 in 2000 to 62.4 million m3 in 2015 (Fig. S5). The rapid conversion of forested land to oil palm and rubber plantations in Indonesia has resulted in the loss of habitat (including protected areas) for critical many primates (e.g, orangutans, *Pongo* spp., as well as other rare primates with which they share their habitats) (*Ahrends et al., 2015*; *Warren-Thomas et al., 2015*; *Nantha & Tisdell, 2009*; *Nater et al., 2017*; *Struebig et al., 2015*); all three orangutan species are now classified as Critically Endangered (*IUCN 2017*).

**Modeling agricultural expansion and primate range contraction in the 21st century**

We present a country by country summary of the main findings of the analyses of spatial conflict between primate species and predicted agricultural expansion during the 21st century. Species distributions were obtained from the IUCN range maps (*IUCN*, 2017). Agricultural expansion is derived from the IMAGE database and represents the predicted presence (irrespective of the intensity) of agricultural production at each grid cell (0.5° of spatial resolution; see *Dobrovolski et al. 2014*). Therefore, agriculture should be viewed as a descriptor of conflict between primate occurrence and agriculture.

**Brazil**

Data on primates from Brazil included 104 species. Currently, the average spatial overlap between agriculture and individual species ranges is 10.3%, ranging from 0.0% to 60% (the greatest overlap is for the northern muriqui. The optimistic scenario is predicted to alleviate this conflict, resulting in an average overlap of 6% by 2050, ranging from 0.0% to 50% in *Leontopithecus chrysopygus*, and 4% by 2100 (0.0 to 40% in the optimistic scenario). The pessimistic scenario points to an average spatial overlap of 19.6% (0.0 – 75%) by 2050 and 79% by 2100. According to this pessimistic scenario, by the end of this century, 15 species (14.4%) will face conflict with agriculture in more than 80% of their geographical distribution. Considering a business-as-usual scenario, spatial conflict will affect, on average, 11.5% (0.0 – 68%) and 18% (0.0 – 79%) of the range of the species by 2050 and 2100, respectively.

**DRC**

Data for DRC included 34 species. Current spatial overlap, on average, is 12% of the species range (varying from 0% to 41%). Under an optimistic scenario, spatial conflict will vary from 10.7% to 18% between 2050 and 2100 but is expected to reach as high as 54% (for both periods). Presently, as well as in the optimistic and business-as-usual scenarios for 2050 the species with the greatest overlap with agriculture is *Galago matschiei*. In the business-as-usual scenario, spatial overlap with agriculture will affect 17.5% to 24.3% of the species ranges by 2050 and 2100, respectively. Higher overlap values are expected for *Gorilla beringei* (51.3%) and *Galago matschiei* (44%). In a worst-case scenario, average spatial overlap is predicted to be 34% by 2050, and to average 23.3% by 2100, varying between 0% and 53% (for *Gorilla beringei*). Note that, by 2100, the average spatial conflict with agriculture will be lower for most species. This is because agriculture is predicted to shift geographically, including abandonment of some areas.

**Indonesia**

Data for Indonesia included 48 species. From these, 13 species were not evaluated properly as they occur in very small islands lacking accurate information on agriculture at the spatial resolution adopted here (i.e., 0.5°). For those species properly evaluated, we found that currently, 15.5% of their geographic ranges are under spatial conflict with agriculture. In the optimistic scenario, this average overlap is 21% by 2050 and 18% by 2100. In the business-as-usual scenario, spatial conflict will, on average, reach 25% to 21% by 2050 and 2100, respectively. In the pessimistic scenario, we predict spatial overlap of 24.5% to 39.7% by 2050 and 2100, respectively. The maximum overlap with agriculture is found for *Macaca maura*, totaling 81.4% of its range in all scenarios and periods. *Presbytis comate* also faces strong spatial conflict with agricultural expansion (about 80% of its range, regardless of the scenario and period).

**Madagascar**

Data for Madagascar included 97 species. From these, two species are already under strong spatial conflict with agriculture, with their entire range coinciding with areas of agricultural use. These species are the endangered *Lepilemur wrightae* and the critically endangered *Hapalemur alaotrensis*. Current average spatial overlap between agriculture and species’ ranges is 33%. By 2050, this overlap is estimated at 36% for the optimistic model, 31.7% for the business-as-usual model, and 47% for the pessimistic model. By 2100, in the optimistic and business-as-usual scenarios, the spatial extent of agriculture is predicted to decrease substantially in Madagascar, reducing the conflict to 2.7% and 4.5%, respectively. In the pessimistic scenario, the overlap reaches 40% by 2100.

**Logging**

Unlike the other countries of the region, DRC has only a relatively small proportion (8%) of forest assigned as logging concessions. A moratorium on all new logging concessions was ratified into law in 2002 (*Debroux et al., 2007*) and in 2009, 60% of all existing concession contracts were cancelled due to legal issues (*ITTO, 2009*). In DRC, logging is practiced selectively (a few trees are extracted per hectare), removing 10-20% of the canopy (2-10 trees/ha). Recent work in the neighboring Republic of Congo has shown that great apes can persist in such forests if hunting is strictly controlled *(Morgan et al., 2017*). Currently, few logging concessions are guarded or protected in DRC, and guards are unlikely to be employed in logging concessions that are not certified by the Forest Stewardship Council (FSC). At present no concession in DRC is FSC-certified (*https://info.fsc.org/certificate.php#result*).

**Mining**

**DRC**

When mining concessions are opened in remote forests in DRC, access along new road networks is greatly increased. This access facilitates bushmeat hunting. The type of mining practiced in DRC tends to attract thousands of people hoping to strike it rich. These people have greater purchasing power than a rural farmer and can afford to pay high prices for bushmeat, thus increasing the incentive to hunters of harvesting more animals from the forest than they require for their own families’ protein needs. It is important to note, that a mining *prospection permit* is not the same as a mine: nevertheless, a prospection permit carries the risk that a mine will be opened, as ore extraction becomes more profitable over time. Of the existing 1,249 mining prospection permits in DRC, 952 (76%) have their centers in the rural complex (areas that have been in the cycle of slash-and-burn agriculture for at least 18 years). Permits in the rural complex cover 143,316 km2, which is 78% of the total permitted area.

**International commercial trade of commodities and primate habitat loss**

Current trends in the conversion of native vegetation to agricultural fields and wood extraction are the result of large-scale market demands by upper and middle-income nations (*World Bank, 2017*) and the actions of primate harboring countries to develop their own economies and improve the standard of living of their growing human populations. For example, in 2015 Brazil had the second largest cattle inventory in the world (*ca* 212 million cattle head), after India (*ca* 298 million cattle head) (*ABIEC BRAZIL, 2016*). In 2016, frozen beef was exported by Brazil to 38 countries, with China importing 40% of the total (see below for sources). Note that the growth of pastures is strongly associated with the growth of the cattle industry (Fig. S1). After the USA, Brazil is the largest producer of soybeans (<http://www.globalsoybeanproduction.com/> consulted May 2017) in the world. Brazil´s estimated production of soybeans in 2016 was a record *ca* 111 million metric tons (*USDA, 2017*). In 2016, Brazil exported soybeans to 27 countries, with 74% of the crop exported to China (see below for sources). Much of land devoted to soybean cultivation in Brazil is in areas that naturally contained forests and other vegetation types as well as high primate diversity.

In 2016, DRC exported minerals to eight countries but 96% of these exports went to China (60%), Malaysia (15%), Germany (11%) and India (9%). Another DRC export is natural rubber. In 2016, exports of natural rubber went to five countries, Malaysia (65%), France (16%), Romania (14%), Spain (4%) and Germany (1%). In 2016, DRC exported tropical wood to 18 countries with 84% of the share taken by China (47%), France (20%), Portugal (9%) and Belgium (8%) (see below for the source of these data). At the time of writing (March 10, 2018) DRC has passed a new law which raises the tax to be paid by mining companies from 2% to 10%, a move opposed by many companies who say it will render their operations unprofitable.

Madagascar´s top exports are minerals. In 2016, minerals were exported to eight countries but three of these countries accounted for 90% of exports (Canada 34%, China 29%, and the USA 27%). Coffee, tea, and spices also are exported by Madagascar to 29 countries, with 67% of the share taken by France (22%), the USA (21%), Germany (15%) and India (9%). Edible vegetables, roots and tubers are exported by Madagascar to 39 countries with India (36%), France (10%), and Pakistan (5%) accounting for the largest share (see source below for individual data sets).

Indonesia´s cultivation of rice is rapidly expanding, and rice exports provide important revenues to the country. In 2016, Indonesia exported rice to 11 countries in Asia, North America, and Europe and Australia, with four countries purchasing 80% of the share (India 27.2%, Thailand 22.1%, Singapore 20.7% and the Philippines 10.6%). Natural rubber, another growing and important export of Indonesia, was sent to 45 countries in 2016, with four countries importing 59% of production (USA 22%, Japan 16%, China 12%, and India 9%) (see below for the source of these data). Indonesia also exported tropical wood to 47 countries in 2016, with 51% of their production imported by three countries (China 21%, Japan 21%, and the USA 9%) (see below for the sources of this information.

General international trade maps and trade maps for selected exports for Brazil, the Democratic Republic of the Congo, Madagascar and Indonesia can be found in: International Trade Centre, 2016; http://www.intracen.org/itc/market-info-tools/trade-statistics/

Sources consulted for each country in May 2017.

**Legal and illegal primate trade**

**Legal Trade**

The data presented in Table 3 are from the CITES trade database on all international trade entries for each of the four countries for the period 2006-2016 (data from 2016 were incomplete but were included as to be as current as possible). All transactions involving primates, irrespective of the purpose of the trade, were included. For analysis, we focussed on (1) live animals, (2) bodies, skeletons and skins, and (3) specimens, as reported in the CITES trade database. Specimens were principally exported for medical or scientific purposes, and partially exported for commercial proposes. We excluded entries that were reported in g, kg, l, or ml. For each country, we calculated the proportion of trade that comprised wild-caught individuals (see *Fialho, Ludwig, Valença-Montenegro, 2016* for an analysis of the legal trade of Neotropical Primate originated in South American countries from 1977 to 2013).

**Brazil: live trade**

Legal international trade in night monkeys *Aotus* spp from Brazil appears to be very limited (Svensson et al. 2016) but illegal cross-border trade in the Brazil-Colombia-Peru tri-border area continues to flourish (*Maldonado et al., 2009*). One trader in Brazil indicated illegally exporting ~2000 night monkeys, most likely *A. nancymaai* or *A. vociferans*, over an 18-year period, and six such traders were identified by Maldonado et al. (2009) to be working close to the Peru-Colombia border. *Do Nascimento, Schiavetti & Montaño* (*2013*) reported that 15 capuchin monkeys *Sapajus* spp in rescue centers and 105 in zoos in the State of Bahia, Brazil, were derived from the illegal trade, and noted that the demand for primates as pets in Brazil, was one of the drivers. *Da Silva et al.,* (*2016*) modelled the effect of hunting to meet the demand for pets on populations of the yellow-breasted capuchin *S. xanthosternos*, an endemic species, showing that even a small offtake can have an important negative impact on species survival. However, they did not provide the number of capuchins that were extracted from the wild. Overall it seems that at present, the live trade in primates in Brazil is limited in terms of number of individuals and the number of species that are negatively affected.

In the state of Rio de Janeiro, Brazil, from 2003-to 2010 approximately 457 primate specimens were delivered to the CETAS (an animal rescue and rehabilitation center) while another 438 were recorded in citizen phone complaints that denouced illegal pets (Linha Verde). Most of the records were of the genera *Callithrix* (363 and 415 records) and *Cebus/Sapajus* (86 and 17 records) respectively although other genera (*Leontopithecus, Callicebus, Lagothrix* and *Alouatta*) also were recorded (*Oliveira & Grelle 2012*). Although the impact of such numbers in the populations of these species may be not significant, the impact of released animals outside their native range may threaten native species, by hybridization, as the case of the Buffy-tufted-ear marmoset, *Callithrix aurita* in Rio de Janeiro (*Oliveira & Grelle 2012*).

**Brazil: medicinal or meat**

Ferreira et al. (2013) surveyed animal markets throughout Brazil and found that primates made up only 1 of 131 species offered for sale. Capuchin penises, bones and fat were the parts listed as being used for medicinal purposes. *Van Vliet et al.,* (*2014*), working in the Brazil-Colombia-Peru tri-border area noted that, in terms of individuals, brown woolly monkeys, *Lagothrix lagothricha,* made up 10% (31/311) of the 16 animal species that Brazilian hunters caught in the area. These hunters sold 96% of the biomass they extracted and only 4% was used for their own consumption. In terms of the number of individuals, the brown woolly monkey was ranked 9th out of 14 species that were offered for sale in two Brazilian wildlife markets (*Van Vliet et al., 2014*).

**DRC: live trade**

Trade in live primates in DRC seems to be much less of a conservation challenge than the trade in primates for bushmeat. However, often the trade in live primates, especially infants and young juveniles, is directly linked to the bushmeat trade. *Svensson et al.,* (*2015*) reported on the trade in lorisiforms in Congo DRC and noted that pottos (*Perodicticus ibeanus)* are traded in small numbers as pets, and this same species also was traded as bushmeat (*Musibono et al., 2010*). *Hicks et al.,* (*2010*) reported on the trade of 42 chimpanzees as pets in northern DRC over an 18-month period. *Andre et al.* (*2008*) reported that 42 bonobos that had been kept as pets arrived at a sanctuary (either as donations or as part of a confiscation) over a 12-year period.

**DRC: medicinal and bushmeat trade**

*Hicks et al.* (*2010*) found 34 chimpanzee carcasses, killed for the purposes of bushmeat trade over an 18-month period in northern DRC. Primates were extracted at a rate of 26 tons a year (the equivalent of ~5,000 individuals) in two districts in the Ituri forest, partially to meet the demand for the commercial bushmeat trade (*Wilkie et al., 1998*). In this region, primates were the most commonly hunted (and traded) taxon after duikers (*Nasi et al., 2011*). Van Vliet et al. (*2012*) monitored a bushmeat market in Kisangani over a 12-month period (131 one-day visits) and found 8,228 monkeys of the genera *Chlorocebus* and/or *Cercocebus* for sale, in addition to 139 baboons (*Papio spp*), 103 chimpanzees and 17 bonobos. These numbers translate to a turnover of 65 primates / day. *Dupain et al. (2012)* recorded 4,620 primate carcasses in the market of Basankusu, a rate of 17 carcasses per visit. Similar to Kisanga, the majority comprised monkeys of the genera *Chlorocebus* and *Cercocebus*, but the meat of 934 black-and-white colobus (*Colobus angolensis*), 288 Thollon's red colobus (*Piliocolobus tholloni*) and 16 chimpanzees also was sold. While several species of primate, including chimpanzees and bonobos, are used occasionally for medicinal purposes in DRC, no quantitative data are available on how this affects wild populations (*Alves et al., 2010*). Alarmingly, the Red List assesment for Grauer’s gorilla reports an 80% decline in 20 years from almost 18,000 to fewer than 4,000 in 2015, caused principally by bushmeat hunting (*Plumptre et al., 2016*).

**Indonesia: live trade**

The trade in live primates in Indonesia occurs openly in dozens of wildlife markets, especially on the islands of Sumatra, Java and Bali. Primates are traded as pets in other parts of Indonesia as well, including Indonesian Borneo and on Sulawesi, but numbers are smaller (e.g. *Jones-Engel, et al., 2005*). *Shepherd* (*2010*) found 1,953 primates of 10 species for sale during 66 visits to bird markets in Medan, northern Sumatra. The most common species were long-tailed macaques (774 individuals), the greater slow loris (*Nycticebus coucang*, 714 individuals) and pig-tailed macaques (*Macaca nemestina,* 380 individuals). Some 1,300 primates of 8 species were recorded during 51 surveys in six markets on Java and Bali (*Nijman et al., 2017*). As in Sumatra, the most commonly traded species were long-tailed macaques (mainly infants and juveniles) and greater slow lorises (equal proportion of adults and young). Numerous primates, most notably gibbons and orangutans, have been confiscated by the authorities and taken to rescue centres (*Nijman, 2009*; *Nijman, Martinez & Shepherd, 2009*).

**Indonesia: medicinal and bushmeat trade**

In large parts of Indonesia, the majority of the local population is Muslim and individuals adhere to the principle that primates are unfit for human consumption. In parts of Indonesia where Muslims are a minority, primates are consumed, and they are traded as bushmeat. Large-scale commercial trade in primate meat (long-tailed and pig-tailed macaques, and Sulawesi crested macaques (*Macaca* *nigra*) have been reported from southern Sumatra and northern Sulawesi (*KSBK, 2002*; *Lee et al., 2005*). Based on the number of restaurants and specialized slaughterhouses in southern Sumatra, hundreds of macaques are killed monthly to meet the demand. Long-tailed macaques and, to a lesser degree, pig-tailed macaques are offered for sale in wild-meat restaurants in many of the larger cities in western Indonesia, especially in areas with a large Christian population (e.g. Medan, Pekanbaru, Jakarta). While trade in Sulawesi macaques in wild meat markets has been quantified, with typically between 0 and 5 carcasses available for sale during each visit (*Hilser et al., 2013; Lee et al., 2005*), data on turnover are lacking. Thus, it is difficult to determine the actual number involved. *Shekelle & Salim* (*2009*) reported that on Sunday afternoons, after Church, spit-roasted Sangihe Island tarsiers *Tarsius sangirensis*, were eaten communally as a snack. It is unclear to what extent this involved the commercial trade. in Indonesian Borneo, Bornean orangutans are killed for a variety of reasons but the main one appears to be for food (54% of the respondents that gave a reason indicated that this was their main motivation) and only very small proportions of respondents interviewed reported that killing occurred for traditional medicine or to sell infant orangutans (*Meijaard et al., 2012*). There was no indication that orangutan meat or medicine was traded commercially. Slow lorises are traded locally throughout Indonesia for medicinal purposes, (although numbers are dwarfed by the trade in live individuals; *Nekaris et al., 2010*). In general, the medicinal trade in primates is limited in Indonesia.

**Madagascar: live trade**

It appears that in recent years the number of lemurs kept as pets has increased throughout Madagascar. *Reuter* *et al*., (*2016*) reported ~30,000 pet lemurs of at least 16 species were identified over a three-year period. Most of these were the larger species including *Eulemur* spp., *Lemur catta* and *Varecia* spp. and excluded taxa that have taboos associated with them such as the aye-aye. The conditions in which these pet lemurs are being kept are suboptimal, resulting in short lifespans thus exacerbating the negative effect the pet trade has on wild populations (*Reuter & Schaefer, 2016*).

**Madagascar: medicinal and bushmeat trade**

Across parts of Madagascar, lemurs have been hunted for centuries, both for subsistence and trade (e.g. *Stiles, 1998*). Until relatively recently, however, the commercial trade in lemurs for meat was not considered to be a conservation concern. About a decade ago this changed, following political crisis and instability, and lemurs were traded as a premium meat (*Barrett & Ratsimbazafy, 2009*). While in the past many species of lemur were protected by taboos that prevented them from being killed, these taboos have eroded rapidly in recent years (*Jenkins et al., 2011*). The larger diurnal species such as the black-and-white ruffed lemur, Indri and sifaka are targeted, but the brown lemurs (*Eulemur* spp.) also are hunted (*Golden, 2009; Jenkins et al., 2011*; *Razafimanahaka et al., 2012*). While the emphasis of most studies has been on the larger species of lemur, even smaller species such as mouse lemurs (*Microcebus* spp*.*) are targeted. Individual hunters can capture up to 50 mouse lemurs a night, and therefore the impact on wild populations may be considerable (Gardner and Davies 2014). It appears that the commercial hunting and trade, especially in the larger species are unsustainable (*Golden, 2012*), but overall the threat that hunting and trade poses to the survival of lemurs needs to be more formally assessed (*Schwitzer et al., 2014*).

**Hunting**

The truth in DRC is that all primate species are hunted – pottos and galagos less often than the monkeys and great apes. This results in part from the fact that for most of the rural population, and for a large proportion of the urban population, other forms of animal protein are unavailable. DRC does not produce enough domestic meat to feed its population. And, although enormous quantities of Brazilian chicken and salted fish (saithe) from Norway are imported to the cities; rural people obtain their protein principally from wild animals (including freshwater fish and arthropods (*Bennett et al 2002*). Because wild meat farming tends to be far less efficient than raising domestic stock (in terms of growth rates and feed-conversion efficiency) (*Wilkie et al., 2016*; *Mockrin et al., 2005*) most workers have abandoned the idea of game ranching in forest environments and moving towards the farming of small domestic livestock such as guinea pigs and chickens (*Wilkie & Wieland, 2015*; *Wilkie et al., 2016*).

Hunting is a very serious problem and is exacerbated by increased access to forested areas using logging roads. However, in DRC hunters will actually *walk* over 100km to get to areas where they can find meat, as meat is very profitable compared to agricultural produce such as manioc tubers/ bananas which are hard to store (meat is smoked so it will last a very long time, especially if it gets re-smoked) and very inexpensive per kilo compared to meat.

In DRC, even twenty years ago, primates poached at a rate of 26 tons per year (the equivalent of about 5,000 individuals) in two districts in the Ituri forest, partially to meet the demand for the commercial bushmeat trade (*Nasi, Taber & Van Vliet, 2011*; *Wilkie et al., 1998*). On the Mentawai islands (West Sumatra), Indonesia, there are six endemic primates, all listed by the IUCN as threatened, and four of them are regularly hunted (the pig-tailed snub-nosed langur, *Simias concolor*; the Mentawai langur, *Presbytis siberu*; the Siberut macaque, *Macaca siberu*; and Kloss’ gibbon, *Hylobates klossii*), with an off-take estimated at 4,800 to 9,700 per year (*Quinten et al., 2014*).

**Human-modified landscapes and infectious diseases**

Two diseases that originated in Africa, Ebola virus disease (EVD) and yellow fever (YF), are among the most virulent human IDs that have impacted primate populations. In the case of YF, African primates are more resistant to the virus than their Neotropical counterparts, among which howler monkeys are the most sensitive (*Bugher, 1951*; *Vasconcelos, 2017*). Thousands of howler monkeys died during an epizootic outbreak in 2008 and 2009 in the state of Rio Grande do Sul (*Almeida et al., 2012*), leading to the reclassification of the conservation status of *A. caraya* from Vulnerable to Endangered. A subsequent ongoing YF epizootic event that began in 2016 in southeast Brazil caused the death of thousands of primates of many species (*Bicca-Marques et al., 2017*). These YF epizootics in Brazil also highlighted the importance of effective communication between scientists and the mass media to avoid misinformation that often results in local people, who afraid of contracting the disease, kill primates (*Bicca-Marques & Freitas, 2010*; *Bicca-Marques & Calegaro-Marques, 2014*; *Bicca-Marques et al. 2017*). In the case of YF, primates are neither a vector for human transmission, nor a reservoir of the virus. Harming and killing wildlife, including primates, are illegal activities in Brazil, but go underreported (*Bicca-Marques & Freitas, 2010*; *Bicca-Marques et al., 2017*).

EVD and YF also illustrate the most prevalent modes of transmission of pathogenic viruses and protists infecting primates (e.g. contact-borne and vector-borne, *Pedersen et al., 2005*), and the challenges of controlling epizootics and the spillover to humans. EVD infection occurs via contact with the blood or body fluids of infected individuals (*Gogarten et al., 2017*). Given the current lack of a vaccine and of any other effective strategy of controlling EVD in wildlife (*Nunn & Gillespie, 2016*), avoiding the consumption of bushmeat is necessary to prevent spillover to people (*Chapman, Gillespie & Goldberg,* *2005*). In the case of the mosquito-transmitted YF, there also is no management strategy to guard potential New World primate hosts. However, a focus on the infectious agent (the virus) via human vaccination for YF should be sufficient to reduce people’s concerns with the disease and the consequent risk of human-directed aggression against primates. Public health campaigns focused on vaccinating large numbers of humans can contribute to decreasing disease spread or its speed in fragmented landscapes, although the role of the vector-reservoir mosquitoes (*Consoli & Oliveira, 1994*), humans, and other (non-primate) wild hosts remains poorly understood. Therefore, developing effective vaccines against pathogenic agents and promoting immunization campaigns represent a critical human public health strategy that has direct positive implications for wildlife conservation (*Bicca-Marques et al., 2017*).

Unfortunately, our knowledge of the influence of infectious diseases on primate conservation is highly biased toward diseases that also are lethal to humans. Great apes are especially vulnerable to such diseases (*Gilardi et al., 2015*). Information also comes mainly from wealthier countries that possess the human capital and the scientific expertise to investigate the causes of wild primate deaths. In this regard, the existence of wildlife disease surveillance programs and the quality of a country’s public healthcare programs have direct implications for primate conservation. The scarcity of information hampers our ability to develop holistic conservation strategies for Brazil, Indonesia and Madagascar. In DRC, the size of the country and lack of infrastructure also hinder any nationwide conservation strategy. In DRC, the ability of primates to survive at ecotourism sites or near human habitation as urban commensals, where direct contact with humans and domesticated animals is higher and where supplementation and feeding on garbage may be common, increases exposure to diseases. These risks are higher for more terrestrial species (*Bicca-Marques & Calegaro-Marques, 2014*) and their conservation implications are particularly serious for those with low reproductive rates. Forest degradation and fragmentation have increased the level of parasitism in some species of Malagasy lemurs (*Microcebus murinus*; *Raharivololona & Ganzhorn, 2009*, *Eulemur flavifrons*; *Schwitzer et al., 2010*). This fact must become a focus of conservation studies and conservation policy.

**Human population**

**Population density distribution in each country**

In Brazil, areas of high population density are concentrated near the Atlantic coast, which has lost almost 88% of its original forest (*Ribeiro et al., 2009*). In Indonesia, the islands of Java and Sumatra are the most densely populated regions. In contrast, population density is more evenly distributed across DRC and Madagascar, with a single major concentration in the areas surrounding the capital cities of Kinshasa and Antananarivo (Available maps at. http://worldpopulationreview.com/countries/ (accessed 21 January 2018).

**Ethnic groups in each country**

Each of the four countries is characterized by a multiethnic component. Below we provide a summary of each multiethnic society taken from estimates for 2010 from the CIA Factbook (available at https://www.cia.gov/library/publications/the-world-factbook/ (accessed 20 January 2018).

|  |
| --- |
| **Brazil**: white 47.7%, mulatto (mixed white and black) 43.1%, black 7.6%, Asian 1.1%, indigenous 0.4%. |
| **DRC**: over 200 African ethnic groups of which the majority are Bantu; the four largest tribes - Mongo, Luba, Kongo (all Bantu), and the Mangbetu-Azande (Hamitic) make up about 45% of the population. |
| **Madagascar**: Malayo-Indonesian (Merina and related Betsileo), Cotiers (mixed African, Malayo-Indonesian, and Arab ancestry - Betsimisaraka, Tsimihety, Antaisaka, Sakalava), French, Indian, Creole, Comoran. |
| **Indonesia**: Javanese 40.1%, Sundanese 15.5%, Malay 3.7%, Batak 3.6%, Madurese 3%, Betawi 2.9%, Minangkabau 2.7%, Buginese 2.7%, Bantenese 2%, Banjarese 1.7%, Balinese 1.7%, Acehnese 1.4%, Dayak 1.4%, Sasak 1.3%, Chinese 1.2%, other 15%. |

**Corruption, governance quality and primate conservation**

**DRC**

DRC has a patronage system where the profits of “unofficial economic activities” flow upwards to the top of the chain of command (*Baaz & Olssen, 2011*) and the chaos within different branches of this system serve to maintain the status quo that only benefits the wealthy few (*Nlandu Mayamba, 2012*). Negotiation is key to all interactions between State officials and the ordinary citizen (*Trefon, 2009, 2010, 2013*) and therefore environmental issues are not treated in the same way as in many other countries (Trefon, 2016).

**Brazil**

Recent political events in Brazil highlight the extreme level of government corruption in that country. Companies and people who committed crimes and environmental infractions in Brazil have donated almost $20 million USD to more than half of the House of Representatives in the last election, among those having receiving bribes is the current Minister of the Environment. See reports below documenting this situation.

http://www.nature.com/news/political-upheaval-threatens-brazil-s-environmental-protections-1.20955

http://reporterbrasil.org.br/2018/01/maioria-dos-deputados-recebeu-doacao-de-desmatadores-como-isso-reflete-na-sua-atuacao/

https://news.mongabay.com/2017/09/brazil-a-world-champion-in-political-and-environmental-devastation-commentary/

https://www.theguardian.com/commentisfree/2017/may/23/the-guardian-view-on-brazilian-corruption-the-public-deserve-a-voice

**Protected areas**

**Brazil**

In 1976, there were only two national parks in the Brazilian Amazon, but in that year the government produced a scientifically-based proposal for an Amazon-wide protected area network based on the biogeography of the region (phytogeographic regions and areas of endemism) (Brazil, MA-IBDF & FBCN, 1979; *Mittermeier et al., 2005*; *Rylands & Brandon, 2005*; *Wetterberg, Prance &* Lovejoy, 1981; *Wetterberg et al., 1976*). This was followed in 1990 by a conservation priority-setting workshop for the entire Amazon organized by the Brazilian Institute for the Environment (Ibama), the Brazilian National Institute for Amazon Research (INPA), and several international and national conservation NGOs (*Prance, 1990*; *Rylands, 1990*; *Rylands, Huber & Brown Jr., 1991*). Brazil’s Ministry of the Environment subsequently held priority-setting workshops for all of the country’s major biomes (1998-2000), including the primate-rich Atlantic Forest and the Brazilian Amazon, which determined the location of 900 priority areas for biodiversity conservation (*Brazil, MMA. 2002*; *Mittermeier et al., 2005*; *Rylands & Brandon, 2005*). In 2000, Brazil established a formal, unified system for federal, state and municipal parks and reserves (the National System for Protected Areas – SNUC).Parks and reserves were used as the keystone—contiguous protected areas of differing categories for the establishment of biodiversity corridors—(*Anonymous, 2003; Ayres et al., 2005*). Of note for the Amazon is the program for the creation of protected areas in the 23 Amazonian eco-regions identified by and supported by the World Wildlife Fund – Brazil and The World Bank—the Amazon Protected Areas (ARPA) program of the Brazilian Ministry of the Environment (*Ferreira et al., 2001*). The SNUC aimed to increase the area of the Amazon rainforest under federal protection to 500,000 km². In 2005 it was estimated that there were 478 Brazilian federal and state strictly protected areas, totaling 37,019,697 ha, and 436 sustainable-use protected areas, totaling 74,592,691 ha (*Rylands & Brandon, 2005*).

**DRC**

DRC has 11% of its land within 90 protected areas and plans to increase the coverage to 17% (following Aichi Target 11: *CBD, 2011*). Five of the PAs are World Heritage Sites, but all are classified as In Danger. Some are extremely large: the Salonga National Park is over 36,000 km2. All are key for wildlife conservation. However, several primate species are either outside PAs or most of their population is found only within PAs (both gorilla subspecies in DRC fall into this category). Those PAs that are the recipients of international funding are reasonably well-staffed and resourced, but if a PA has no partner organization, it tends to be rapidly hunted out or in the savannahs of the south, converted to smallholder agriculture.

Starting in 2000, twelve very large conservation landscapes were created throughout Central Africa. Each contained one or more protected areas at their core, surrounded by community lands and logging concessions. This has proven to be the most successful model for wildlife conservation in the region in general, including for primate conservation (*Yanggen et al 2010, USAID 2012*). These landscapes cover 685,400 km2 (almost 40% of the Congo Basin) and include over 30 protected areas (*CBFP, 2006*); because of its large size, DRC has six of the twelve landscapes. This approach was instigated by USAID’s CARPE program and is now in its third phase, as part of the wide-reaching CBFP (Congo Basin Forest Partnership that brings many organizations and all the range states together under one umbrella). The inclusion of this landscape approach is now being applied to DRC’s carbon reduction program (*Fobissie, 2015*), and should benefit primates by maintaining old-growth forests.

**Community managed forests, habitat restoration and landscape connectivity**

Considering the widespread transformation of primate habitats to anthropogenic vegetation, there is a need for more work to be done on landscape approaches to primate conservation that include a mosaic of land-use practices where more flexible primate species (e.g. chimpanzees but not bonobos and gorillas; *Hockings et al., 2015*) can survive if they are not hunted(this would not be possible in DRC as all wildlife is hunted for meat and there is almost no domestic animal protein alternative widely available). Primate behavior does not always conflict with human interests, and interdisciplinary research has the potential to greatly improve our understanding of the complexities of human-primate interactions in shared landscapes (*McLennan et al. 2017; Mukul & Saha, 2017*; *Newmark et al., 2017*) (see Text S1for specific examples of primates in agroecosystems in the four countries).

A global review showed that 57 primate taxa from Mesoamerica, South America, Sub-Saharan Africa (including Madagascar), and Southeast Asia, used 38 types of agroecosystems as temporary or permanent habitats and that about 40% of the primates recorded in these agroecosystems were classiﬁed as threatened (*Estrada et al., 2012*). At present, it remains unclear how long primate populations can survive and reproduce successfully in agroecosystems and therefore caution must be used before advocating this as a sustainable solution to primate population decline. Notwithstanding, in Brazil’s southern Atlantic Forest, groups of the black and gold howler monkeyare present in eucalyptus plantations and black-fronted titi monkeys (*Callicebus nigrifrons*) are reported to inhabit eucalyptus in Canareira State Park (Sao Paulo, Brazil). In both cases, the primates use eucalyptus trees as sources of food (*Trevelin et al., 2007*). Shaded-cacao agroforestry, known in Brazil as cabruca, is the predominant habitat type throughout the eastern portion of the distribution of the endemic and endangered golden-headed lion tamarin (*Raboy et al., 2010*).

In eastern Madagascar, seven sympatric species of Strepsirhini (Gmelin’s woolly lemur, *Avahi laniger*; Geoffroyi’s dwarf lemur, *Cheirogaleus major*; Eastern lesser bamboo lemur, *Hapalemur griseus*; Indri, *Indri indri*; common brown lemur, *Eulemur fulvus*; weasel sportive lemur, *Lepilemur mustelinus*; rufous mouse lemur, *Microcebus rufus*) are reported to live in eucalyptus plantations. Some of these species use the plantations mainly for resting and to travel from one patch of native forest to another, but others feed on leaves, fruits, and ﬂowers in these agroforests, including the ﬂowers of *Eucalyptus sp*. (Ganzhorn, 1987). The same study reports groups of Verreaux’s sifaka (*Propithecus verreauxi*) as permanent residents of mixed mango (*Mangifera indica*) and vavaloza trees (*Stereospermum arcuatum*) where they feed on the fruit and leaves of mangos and on the ﬂowers and leaves of *S. arcuatum*. Other primates present in these mixed plantations include *A. laniger*, *L. mustelinus*, and *E. fulvus*. (*Ganzhorn, 1987; Ganzhorn & Abrahams, 1991*). Black lemurs (*Eulemur macaco macaco*) were reported living in mixed plantations of mango, coffee, coconut, and papaya in northwestern Madagascar. They feed on mangos, papayas, palm fruits, and ﬂowers of the Dypsis palm (*Dypsis* spp.), and cross berry fruits (*Grewia* spp.) (*Simmen et al., 2007*). Sheth’s dwarf lemurs were found to live in vanilla plantations in northern Madagascar (*Hending et al., 2017*).

In Indonesia, Bornean orangutans can survive, at least temporarily, in logged forests, *Acacia* plantations, and oil palm plantations (*Meijaard et al., 2012*). In natural rubber and oil palm plantations in Sumatra, seeds, leaves, flowers, and bark are used as a food source by orangutans (*Pongo abelii*) and purple-faced leaf monkeys (*Trachypithecus vetulus*) (*Ancrenaz et. al. 2015*; *Harich & Treydte, 2016*). In Gulung Palung National Park, Kalimantan, maroon leaf monkeys (*Presbytis rubicunda*) and agile gibbons (*Hylobates agilis*) are found in agroforests (*Salafsky, 1993*). Maroon leaf monkeys, southern pig-tailed macaques *(Macaca nemestrina)*, and siamangs (*Symphalangus syndactylus*) are present in rubber (*Hevea brasiliensis*) and dammar (*Shorea javanica*) agroforests, and in durian (*Durio zibethinus*) agroforests in Sumatra where they occur in similar densities as they do in primary forests (*Michon & de Foresta, 1995*). Dian’s tarsiers (*Tarsius dentatus*) in Sulawesi, Indonesia, occupy mixed-species plantations of cacao and gliricidia (*Gliricidia sepium*) with interspersed patches of dense shrub, bamboo (*Bambusa* spp.), Cogon grass (*Imperata cylindrical*), and corn outside of native forests (*Merker, Yustian & Mühlenberg, 2005*). It appears that limited human disturbance does not pose a major threat to Dian’s tarsiers. In Batang Serangan northern Sumatra, a small population of Sumatran orangutans are reported living for several decades in a mixed agroforest system composed of oil palm (*Elaeis guineensis*), rubber trees (*Hevea brasiliensis*), and remnant forest. They feed on jackfruit and durian, among others introduced food items (*Campbell-Smith et al., 2010*). In addition to orangutans, other primates living in this agroecosystem are Thomas’s langur (*Presbytis thomasi*), common long-tailed macaques (*Macaca fascicularis fascicularis*), southern pigtailed macaques (*Macaca nemestrina*), Lar gibbons (*Hylobates lar*), and Grifﬁth’s silver langurs (*Trachypithecus villosus*) (*Campbell-Smith et al., 2010*). Overall, these data suggest that some primates can exploit certain types of agroecosystems when faced with anthropogenic habitat loss, fragmentation, and degradation. However, this may not be a viable long-term solution in the face of continued loss of forest habitat (*Estrada et al., 2012*).

**Primate rewilding**

In addition to the IUCN guidelines for reintroduction of wildlife (*IUCN/SSG, 2013).* The IUCN has published *Guidelines for Nonhuman Primate Re-introductions* in 2002, *Best Practice Guidelines for the Re–introduction of Great Apes* in 2007 (in English, French and Bahasa Indonesia), and *Gibbon Rehabilitation, Reintroduction and Translocation Guideline*s in 2015. All can be downloaded from the IUCN Library Portal.

**Socially‒oriented conservation actions for averting local extinction threats to primates**

**DRC**

In DRC, a number of international conservation NGOs are working in and around all of these conservation landscapes, with coordination offices in the capital. Some of these NGOs have been working in DRC for over 30 years. Many of the small, locally-based environmental NGOs across DRC, are usually focused on a particular reserve and the surrounding community lands, or even on one village or town. Their activities are small-scale and tend towards conservation education /advocacy, and small agricultural and microfinance development activities, although in general they collaborate with international NGOs, who are able to leverage funding for such partnerships. In DRC, the large NGOs organize regular wildlife surveys in DRC’s protected areas and their buffer zones, collecting data on large mammals and human impact. As research assistants, Congolese University graduates find their feet as field officers, researchers, and project and program managers. Sustainable-livelihood programs, land-use planning, and improved governance are integral components of these conservation landscape projects.

In DRC, the Centrede Rehabilitation ​des Primates ​​de Luiro was created in 2002 by two Congolese Institutions; Institut Congolais pour la Conservation de la Nature (ICCN) and the Centre de Recherché en Sciences Naturelles (CRSN). The Centre for the Rehabilitation for Primates is an important conservation tool for Primates in DRC. Currently (2017) they care for 72 chimpanzees and 92 monkeys of 11 different species, all of them victims of the pet trade and poaching. Without centers like this, no confiscation would be possible, therefore the CRPL is a key factor for law enforcement.  The education and sensitization programs of CRPL reach more than 3.000 people per year. CRPL is an accredited sanctuary of the [Pan Africans Sanctuary Alliance](https://www.pasaprimates.org/" \t "_blank)(PASA) and [Global Federation of Animals Sanctuaries](http://www.sanctuaryfederation.org/gfas/" \t "_blank)(GFAS) (see https://www.lwiroprimates.org/about for details)..

**Brazil**

Primate conservation in Brazil has benefitted from the International Committees for Conservation and Management (ICCM) – forums of institutions and specialists involved in the conservation of threatened species –, first, in the early 1980s, as informal groups, and later from the 1990s as official organizations to advise the Brazilian Government. This involvement has been crucial for threatened and charismatic species of the Atlantic Forest, such as the lion tamarins and the muriquis. The pioneer ICCMs were those for the lion tamarins, which promoted strategic planning for the conservation of the four *Leontopithecus* species and stimulated the creation of national NGOs commited to their conservation (*Holst et al. 2006*; *Rambaldi et al. 2008, 2012*; *Kierulff et al.2012*). The NGO Associação Mico-Leão-Dourado (AMLD, Golden Lion Tamarin Association) was created in 1992 specifically for promoting the conservation of the golden lion tamarin (*Leontopithecus rosalia*), including habitat protection, metapopulation management, forest restoration, conservation education, sustainable ecotourism, and scientific research (*Oliveira, Grativol & Ruiz-Miranda, 2008*; *Kierulff et al., 2012*). The metapopulation management program – including reintroductions, supplementations, and translocations – of golden lion tamarins, for instance, is probably the world’s most successful primate project of this kind, and currently the wild population has increased to *ca* 3,200 individuals from an estimated 100 to 200 in 1975 (*Coimbra-Filho & Mittermeier, 1976*; *Kierulff et al., 2012*). This program functioned with the support of the Centro de Primatologia do Rio de Janeiro (CPRJ) was was created in 1979 by Adelmar Coimbra-Filho. This was conceived as a governamental center to manage golden lion tamarins in captivity focusing on their reproduction and reintroduction (*Coimbra-Filho, 2004*; *INEA, 2015*). This species became nationally known in 2002, when it was first depicted on the 20 reals (the Brazilian currency) bill. Two congenerics of golden lion tamarins, the black (*L. chrysopygus*) and the black-faced (*L. caissara*) lion tamarins have been the focus of the Instituto de Pesquisas Ecológicas (IPÊ, Institute for Ecological Research), also founded in 1992. The leading role played by IPÊ in research, management and conservation projects for these species also has played a critical role in their conservation (*Rambaldi et al., 2008*; *Rezende, 2014*).

The creation, in 1994, of the Instituto de Estudos Socioambientais do Sul da Bahia (IESB), benefited research and conservation for the golden-headed lion tamarin (*L. chrysopygus*) (*Rambaldi et al., 2008*) and the yellow-breasted capuchin monkey (*Sapajus xanthosternos*) (*Kierulff et al., 2005*) in the Atlantic forest of Southern Bahia State. More recently, the Instituto Pri-Matas para a Conservação da Biodiversidade (Pri-Matas, Pri-Mates Institute for Biodiversity Conservation) has invested several years of work in removing an invasive population of the golden-headed lion tamarin (*L. chrysomelas*) from forests near (*ca* 50 km away from) the distribution of the golden lion tamarin in the State of Rio de Janeiro. This has served to eliminate a potential source of hybridization, resource competition, and disease spillover that would compromise the conservation of golden lion tamarins (*Kierulff, 2010*). The Bicho do Mato Instituto de Pesquisa (Bicho do Mato Research Institute) in collaboration with the Antwep Zoo has, since 2011, led projects on ecology and behavior of the golden-headed lion tamarin (*L. chrysomelas*) in different habitats in Bahia, Brazil. The initiatives for conservation of the muriquis (*Brachyteles* spp.) followed some of the well successful efforts targeting the lion tamarins, such as a Population and Habitat Viability Analysis (PHVA) and the creation of a ICCM (*Rylands et al., 1998; Talebi et al., 2011*). Also, some NGOs were founded specifically to promote research, education and conservation projects for the muriqui. The Pro-Muriqui Institute ([promuriqui.org.br](http://promuriqui.org.br/" \t "_blank)), founded in 2000 by recommendation of the Muriqui PHVA 1998 and led by the Conservation Breeding Specialist Group, acts to coordinate and execute southern muriqui research within the large extensions of forest still existing in São Paulo State (*Talebi et al., 2011*). The Preserve Muriqui institute ([http://www.preservemuriqui.org.br](http://www.preservemuriqui.org.br/" \t "_blank)) leads the conservation efforts of the Caratinga Biological Station-Private Reserve Feliciano Miguel Abdala in the state of Minas Gerais (*Strier, 2007*).  While the Muriqui Instituto de Biodiversidade ([https://www.facebook.com/muriquibiodiveridade/](https://www.facebook.com/muriquibiodiveridade/" \t "_blank)) has, since 2015, led projects mainly in the state of Minas Gerais.

In the Brazilian Amazon, uacaris (*Cacajao calvus*) have received the special attention of the Mamirauá Institute since the pioneer work of Ayres (1986) who also contributed to conservation efforts targeting the pied tamarin (*Saguinus bicolor*) (*Ayres, Mittermeier & Constable, 1982*). The latter species has been the focus of the ICCM since the late 1990s.  The strategies for the conservation of threatened primates in Brazil are currently organized as part of National Action Plans (NAPs), coordinated by the Centro Nacional de Pesquisa e Conservação de Primatas Brasileiros (CPB, National Center for Research and Conservation of Brazilian Primates) of the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio, Chico Mendes Institute for Biodiversity Conservation), which is part of the Brazilian Environment Ministry, and implemented by several institutions including NGOs, universities and other governamental and private organizations (*Jerusalinsky, 2016*). Examples of these NAPs are those for the muriquis (*Jerusalinsky et al., 2011*), the pied tamarins, and the Atlantic forest mammals (*Escarlate-Tavares, Valença-Montenegro & Jerusalinsky, 2016*), which include 13 primate species.

From the 1960s, some initiatives – such as CITES and resolutions from the *World Association of Zoos and Aquariums* (WAZA) – were decisive in reducing the illegal trade of threatened primates such as the lion-tamarins (*Leontopithecus* spp.), which were previously highly commercialized mainly in zoos or private colections (*Ballou et al., 2002*).

**Indonesia**

In Indonesia, in 2005 a group of local conservationists initiated a project in Central Java to conserve the Javan surili (*Presbytis comata*) (*Setiawan et al., 2010*) ,and Javan gibbons (*Hylobates moloch*) (*Setiawan et al., 2012*). In 2012 an official protection team, Swaraowa was founded (*http://swaraowa.com/about-us/*). Swaraowa works with local communities to promote sustainable conservation of Javan gibbon through the shade grown coffee project. These gibbons are distributed outside of conservation area and face high levels of human activities and anthropogenic disturbance. The Coffee and Primate Conservation Project is a grassroots initiative to develop a sustainable economy for conservation, namely shade grown coffee, as one of the non-timber forest products in this area. This initiative has the potential to result in a sustainable ecological and economic model to protect endangered primates and their habitat, as well as provide a source of income for the local community.

Also, in Indonesia, in 2011 the Little Fireface Project (*http://www.nocturama.org/en/welcome-little-fireface-project/*) was established to examine the multi-faceted problems facing wild slow lorises (*Nekaris, 2016*). A long-term field project was started in Garut, West Java, where the Critically Endangered Javan slow loris (*Nycticebus javanicus*) is endemic. Little Fireface is the local Sundanese name for slow lorises. Java wide surveys have been conducted, and weekly conservation education sessions are held and assessed (*Nekaris et al., 2018*). Conservation is targeted to a wide range of audiences and stakeholders, with annual training sessions for law enforcement officers and coordinated biannual events in villages close to wild slow loris populations. These events are designed to increase pride in this endemic species (*Nekaris, 2016*).

**Madagascar**

In Madagascar, two university ‘departments’ focus their training programs on primatology, namely the "Anthropologie Biologique et Evolution” of the University of Antananarivo and the "Ecologie des Primates" of the University of Mahajanga. Their main objectives are to provide students with in-depth knowledge of the natural history of primates, especially lemurs, so that they can understand the biological and economic importance of this taxon for the country, undertake research endeavors, and promote conservation efforts.

(See: https://www.univ-antananarivo.mg/IMG/pdf/lesystemelmd\_universitedetana.pdf

lemurconservationnetwork.org/how-to-help/support-research/

https://www.univ-mahajanga.edu.mg/fste/masters/)

**Invasive species**

Primate species released outside of their natural range threaten other species including native primates. The problem is localized to some regions but has increased in the last several years, sometimes with serious consequences to the native primates. Introduced primates often compete for resources with native species, hybridize, or result in the local extirpation of native species. In Rio de Janeiro, Brazil, introduced marmosets (White-tufted-ear or common marmoset *Callithrix jacchus* and Black-tufted-ear marmoset *Callitrix penicillata*) compete for food with golden-lion tamarin, *Leontopithecus rosalia* (*Oliveira, & Grelle 2012; Ruiz-Miranda et al., 2006*). Hybrids between the two invader marmosets and the native buffy-tufted marmosets (*Callitrix aurita*) have been recorded in the wild in Rio de Janeiro and São Paulo States (*Detogne et al., 2017; Carvalho et al., 2013; Melo et al., 2015; Nogueira et al.,2011; Port-Carvalho & Kierulff, 2009*). *C. aurita* is classified as Vulnerable by IUCN/SSC Red List and the Brazilian Official List of Threatened Species, and in some protected areas part of some of wild population are considered to be hybrids (*Brasil, 2014; Detogne et al., 2017; Carvalho et al., 2013; The IUCN Red List of Threatened Species, 2017; Nogueira et al., 2011*). It was estimated that the range of *C. aurita* is likely to be reduced by at least 50% within the next 18 years due to habitat loss and introduction of invasive marmosets (*Detogne et al., 2017; Norris et al., 2011; Pereira et al., 2008*). Another example in Rio de Janeiro is the introduction and invasion of exotic golden-headed lion tamarins *Leontopithecus chrysomelas* (Golden-headed lion tamarin) within the natural range of *Leontopithecus rosalia* (Golden lion tamarin) (*Kierulff, 2010*). Both species are classified as “Endangered” on the IUCN/SSC Red List and the Brazilian Official List of Threatened Species (Brasil, 2014; The IUCN Red List of Threatened Species, 2018). Currently, the two species are separated in different forest fragments, but these fragments are not far from each other.. The chances are high that the two species will hybridize, as has been documented in captivity (*Coimbra-Filho & Mittermeier 1976*). There also is a risk that the golden-headed lion tamarins will introduce diseases previously absent from the golden lion tamarin population. Invader species also impact biodiversity negatively by consuming the eggs and chicks of endangered forest birds and may compete with native birds for resources. In Indonesia, crab-eating macaques (*Macaca fascicularis*) introduced into Tinjil Island and Papua*,* feed on sugar and other crops, negativelyaffecting agriculture and livelihoods local farmers (*Global Invasive Species Database, 2018*). These monkeys can be aggressive to humans and these areas of primate-human conflict generally result in the extermination of the primate population.

**Primate societies**

Because of the recent growth in trained primatologists in the four countries, their conservation concerns have recently led to the creation of professional societies that can more effectively articulate conservation concerns with local governments, NGOs and communities. Some of these scientific associations have partnered with continent-wide societies such as the African Primatological Society https://www.facebook.com/.African.Primatological.Society, the Latinoamerican Society of Primatology (http://www.slaprim.org/) and globally with the International Primatological Society (http://www.internationalprimatologicalsociety.org/affiliatedsocieties.cfm). These partnerships are likely to result in regional and global action in favor of primate conservation (see

https://www.conservationevidence.com/data/index)

Below we list such societies.

**Brazil:** The Brazilian Society of Primatology (http://www.primatologia.org.br/) is a well-established society.

**Indonesia:** The main Indonesian society doing primate conservation is ProFauna (http://www.profauna.net/en/about-profauna/what-is-profauna#.WnHkWWnwaM8) which used to be  Konservasi Satwa Bagi Kehidupan (founded in 1934 in Java).

**Madagascar:** The Malagasy Primatological Society (GERP (Groupe d’étude et de recherche sur les primates de Madagascar; http://lemurconservationnetwork.org/organization/gerp/:

http://gerp.squarespace.com. In general, this is a great resource for (most) organizations involved in lemur conservation: http://lemurconservationnetwork.org/about/

In 1994, ten Malagasy primatologists dedicated to protecting wildlife established a research institution in the form of an association called Groupe d'Etude et de Recherche sur les Primates de Madagascar (GERP). This organization has grown considerably and is now comprised of researchers, teachers, students, founding members, donors, and consultants. Today, GERP has 111 members including 15 foreigners. The main goal of GERP is to share knowledge and skills in order to preserve biodiversity for future generations (http://gerp.squarespace.com/who-we-are).

**DRC:** no society exists.

**Other regional associations**

Southeast Asian Primatological Association: http://seapa.atspace.com/

Section on Great Apes: http://www.primate-sg.org/section\_great\_apes/

Section on Small Apes: http://www.gibbons.asia/

The Silvery Gibbon Project: https://silvery.org.au/

Orangutan Foundation Intl: https://orangutan.org/

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