

# The socio-economics of artisanal mining and bushmeat hunting around protected areas: Kahuzi–Biega National Park and Itombwe Nature Reserve, eastern Democratic Republic of Congo

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**Abstract** In the Democratic Republic of Congo artisanal and small-scale mining is estimated to provide a source of livelihood for 14–16% of the population, or 8–10 million people. In the eastern part of the country it is one of the main threats to large mammal species and their habitats, including forest elephants *Loxodonta cyclotis* and great apes, such as the Critically Endangered Grauer's gorilla *Gorilla beringei graueri* and the Endangered eastern chimpanzee *Pan troglodytes schweinfurthii*. We used semi-structured questionnaires to survey mining communities in and around Kahuzi–Biega National Park and the Itombwe Nature Reserve to understand better the socio-economics of artisanal mining in the region, as well as the impacts of mining on bushmeat hunting. Minerals exploited at the sites surveyed included cassiterite, gold, coltan and wolframite, and most mines were controlled by armed groups. On average, miners earned significantly higher revenue than non-miners. However, mining was seen as a short-term activity and most miners were in favour of leaving the sector for better opportunities. Almost all respondents stated openly that they consumed bushmeat regularly because of the lack of alternatives and believed that bushmeat hunting had caused declines and local extinctions of some large mammal populations, including great apes. Respondents stated they would reduce their consumption of bushmeat if domestic meats became more available. We recommend that future interventions should target mine sites to address bushmeat hunting, by improving access to sustainable meat sources, establishing micro-financing mechanisms to help miners leave the mining sector, and working towards de-militarizing these sites to facilitate law enforcement.

**Keywords** Artisanal mining, bushmeat, chimpanzees, DRC, Grauer's gorillas, Itombwe, Kahuzi–Biega, livelihoods

## Introduction

Artisanal and small-scale mining refers to mining conducted with minimal or no mechanization (Hentschel et al., 2002). Driven by the global demand for raw materials used in electronics and jewellery, it is estimated that artisanal and small-scale mining affects the livelihoods of 100 million people globally, mainly in developing countries, with 13–15 million people being directly dependent on it (Hentschel et al., 2002; Dorner et al., 2012; Dranginis, 2014). In the Democratic Republic of Congo alone, the World Bank (2008) estimated that artisanal and small-scale mining provides a source of livelihood for 14–16% (8–10 million people) of the population, including 2 million miners. The environmental impacts of such mining are widely recognized, and its effects on bushmeat hunting, deforestation, land degradation and water pollution have been studied (Tarras-Wahlberg et al., 2000; Hentschel et al., 2002; Hilson, 2002; Kitula, 2006; Ingram et al., 2011; Hayes & Perks, 2012). The social impacts, both positive and negative, have also been documented (Joyce & MacFarlane, 2002; Kitula, 2006; Hilson, 2009; Matthysen & Montejano, 2013; Bashwira et al., 2014; Hoedoafia et al., 2014). Artisanal and small-scale mining is thought to be a particularly attractive livelihood option for people from both rural and urban areas because it generates quick and high economic returns compared to traditional livelihoods, while requiring low specialized knowledge and start-up costs (Kelly, 2014).

The eastern region of the Democratic Republic of Congo is a major source of gold, cassiterite (tin ore), coltan (columbite and tantalite) and wolframite (tungsten) (D'Souza, 2003; IES, 2008; de Koning, 2011; Dorner et al., 2012). In Kahuzi–Biega National Park, in South Kivu province, artisanal and small-scale mining is one of the main threats to Grauer's gorilla *Gorilla beringei graueri* and its habitat, as it is mainly conducted in areas that are not accessible to rangers because of the presence of armed groups and militia. The gorilla population is declining as a result of bushmeat hunting associated with mining activities (Amsini et al., 2008; Nelleman et al., 2010; Plumptre et al., 2015). In the Itombwe Nature Reserve further south, the forest is being cleared to create or expand mining sites (Weinberg et al., 2012). Despite there being many reports on mining in eastern Democratic Republic of Congo, few have investigated

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the miners and the connections between mining, livelihoods and bushmeat hunting (Heemskerck, 2005; Geenen, 2014). Here we update the current information on the state of artisanal and small-scale mining in and around Kahuzi–Biega National Park and the Itombwe Nature Reserve, and attempt to provide a better understanding of some of the connections between mining and bushmeat hunting.

## Study site

Kahuzi–Biega National Park, a World Heritage Site, is not only the most important protected area for the conservation of the endemic Grauer's gorilla but also harbours other threatened species, including forest elephants *Loxodonta cyclotis*, eastern chimpanzees *Pan troglodytes schweinfurthii* and many others that are endemic to the Albertine Rift (Plumptre et al., 2007). The Park was first gazetted in 1970 and was extended to 6,700 km<sup>2</sup> in 1975. The Itombwe Nature Reserve, located south-east of the Park in the Itombwe Massif, is a crucial site for biodiversity conservation, with high numbers of endemic and threatened species (65 and 30 known species, respectively; Ilambu et al., 1999; Plumptre et al., 2007, 2014, 2015). These two protected areas lie within the Albertine Rift region, the most biodiverse region in Africa (Plumptre et al., 2007). They are located in South Kivu province and include areas managed by traditional chiefs and various administrative sectors. There are human settlements around or within the boundaries of both protected areas. We surveyed four areas (*groupements*, local geographical entities that encompass several villages) in the region: Lulingu, Nzovu and Bunyakiri around Kahuzi–Biega National Park, and Itombwe within the Itombwe Nature Reserve (Fig. 1).

## Methods

Data were collected during September–November 2014 through interviews with community members who were directly involved in mining (i.e. miners), in the mining supply chain (e.g. mineral traders) or indirectly involved by being present at mining camps (e.g. miners' families, individuals running small businesses). We conducted semi-structured interviews that covered characteristics of mine sites, mineral value chains, the demography of miners, motivations for mining, revenues earned from mining, livelihoods, bushmeat hunting and consumption, and perceptions of changes in wildlife populations. With the exception of four mines, we were unable to interview individuals directly at the mine sites because of insecurity and the presence of armed groups (Cuvelier, 2010). Instead, the surveys were conducted in 147 villages near to mine sites. Upon arriving at a village, interviewers met with local leaders to inform them about the study. Snowball sampling techniques were used to identify

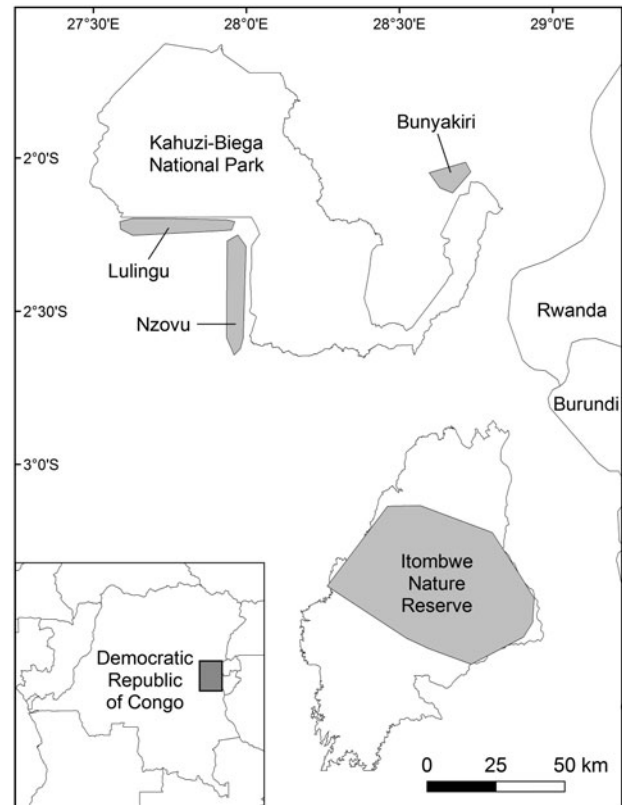


FIG. 1 Location of four *groupements* around Kahuzi–Biega National Park and Itombwe Nature Reserve in eastern Democratic Republic of Congo where interview surveys were conducted.

individuals who conducted mining and were knowledgeable about the sector (Newing et al., 2011). As part of the snowballing process an initial contact was made with a key informant to develop a list of potential respondents (Goodman, 1961). This process was repeated with each respondent until as many respondents as possible were interviewed within the time available. Surveys were conducted in Swahili by trained local researchers and trained students from regional universities. The questionnaire was divided into two parts, the first focusing on mining and the second on bushmeat hunting. Sample sizes differ between the two parts of the questionnaire because a number of respondents felt comfortable discussing bushmeat hunting but not mining, and were unwilling to take the first part of the questionnaire. The section on mining was administered to 613 respondents, with 42% of interviews conducted in Itombwe ( $n = 256$ ), 33% in Lulingu ( $n = 200$ ), 16% in Nzovu ( $n = 101$ ) and 9% in Bunyakiri ( $n = 56$ ). Of the 613 respondents, 80% were active miners and 20% were not involved in mining but lived in the villages where interviews took place. The section on bushmeat hunting was administered to 727 respondents, with 35% of interviews conducted in Itombwe ( $n = 254$ ), 29% in Bunyakiri ( $n = 212$ ), 20% in Lulingu ( $n = 145$ ) and 16% in Nzovu ( $n = 116$ ). The data

TABLE 1 Sizes of the mine sites where survey respondents reported they had worked.

Site area (km <sup>2</sup> )	% of respondents (n = 601)
≤ 2.5	31
10	21
20	4
30	11
≥ 40	32

were analysed using *R v. 3.1.2* (R Development Core Team, 2014). All statistical tests were considered significant at  $P = 0.05$ . Mineral values at various stages in the supply chain were compared based on local selling prices reported by respondents, and the global market price in March 2015 (InfoMine, 2015).

## Results

### Characteristics of mine sites

The most exploited minerals included cassiterite (65% of responses), gold (21%), coltan (16%) and wolframite (16%). All four were exploited in 24% of the sites. Wolframite was reported to be extracted in mine sites in Bunyakiri only. Miners in Lulingu and Nzovu exploited cassiterite significantly more than other minerals, whereas miners in Itombwe predominantly extracted gold and cassiterite (Fisher's exact test:  $P < 0.001$ ).

Mining sites were defined as distinct areas where mining was taking place, without linkages to other mining areas. Excavation areas in mining sites ( $n = 39$ ) ranged from  $< 2.5$  km<sup>2</sup> to  $> 40$  km<sup>2</sup> (Table 1) and mine sites in Itombwe were significantly larger than in other *groupements* ( $\geq 40$  km<sup>2</sup> on average;  $\chi^2$  test:  $\chi^2 = 169.4$ ,  $df = 12$ ,  $P < 0.001$ ). Most sites had been active for c. 20 years, ranging from  $< 1$  year to  $> 80$  years of activity (Fig. 2a), and were reported to employ a mean of 60 mine workers per site (Fig. 2b). The mining sites in Lulingu had been active for significantly longer (41 years, on average) than those in other *groupements* (Kruskal–Wallis rank sum test:  $H = 160$ ,  $df = 3$ ,  $P < 0.001$ ).

Seventy-five percent of the individuals surveyed stated that they were working at mines that had no legal authorization from a government agent. Mining sites that had authorization involved multiple certifiers, mostly agents and individuals. Agent certifiers were generally individuals with some sort of mandate (legal or illegal), who then leased the site to others for exploitation.

### Value chain

The price of minerals varies depending on where in the supply chain they are sold, with the lowest reported prices

found at mine sites (Table 2). Differences between prices at mine sites and global market prices were greatest for coltan (USD 158 per kg) and least for gold (USD 3.4 per g). Most miners sold their minerals at the mine site (64.5%) and at villages nearby (20.5%); others took the minerals as far as Bukavu and Goma cities (15%), where they could get better prices for gold.

### Demography of miners

Nearly all respondents were men (99%), aged 26–45 and married, with either a secondary (51%) or primary education (33%), and had families of 6–10 individuals. Among the interviewees, 80% were directly involved in mining (74% miners,  $n = 397$ ; 6% mineral traders,  $n = 30$ ). The others were farmers (9%), hunters (4%), teachers (3%) and nurses, taxi drivers, retailers and park rangers (1% each). All the park rangers surveyed ( $n = 6$ ) were engaged in small businesses in mine sites in Lulingu and Nzovu, around Kahuzi–Biega National Park. One of them also admitted to being a hunter. Although not quantified in this survey, women and children were present at mine sites but were involved in other activities besides mining, including household activities and food preparation.

### Motivations for working in mines

The main reasons miners had left their previous occupations were to support their families, for personal survival (i.e. to earn enough money to meet their most basic needs) or for direct economic gain. Some of the miners surveyed were students who had dropped out of school and joined mines to earn money to continue their education (14%). Notably, 3% of the respondents ( $n = 17$ ) were ex-rangers from Kahuzi–Biega National Park, most of whom became miners ( $n = 10$ ), traders ( $n = 3$ ), farmers or hunters ( $n = 2$  each). Significantly more individuals chose to exploit minerals as an additional livelihood to support their family (42%), with a minority reporting being motivated by personal gain (20%;  $\chi^2$  test:  $\chi^2 = 113$ ,  $df = 4$ ,  $P < 0.001$ ).

Most miners reported that they spent  $< 6$  months at a site before moving to another (54%,  $n = 275$ ), whereas 15% ( $n = 74$ ) said that they usually spent  $> 6$  months and up to 2 years at a site. The remaining 31% ( $n = 159$ ) reported that they worked at a site for  $< 1$  month before moving. This is because many mining sites start off as prospecting sites and develop if minerals are found or continue to be found but are otherwise abandoned.

Individuals that considered leaving the mining sector (64% of interviewees) indicated that they would support themselves through small businesses (39%), livestock rearing (28%) and agriculture (14%), but 15% declared that they would have no way of supporting themselves. Among

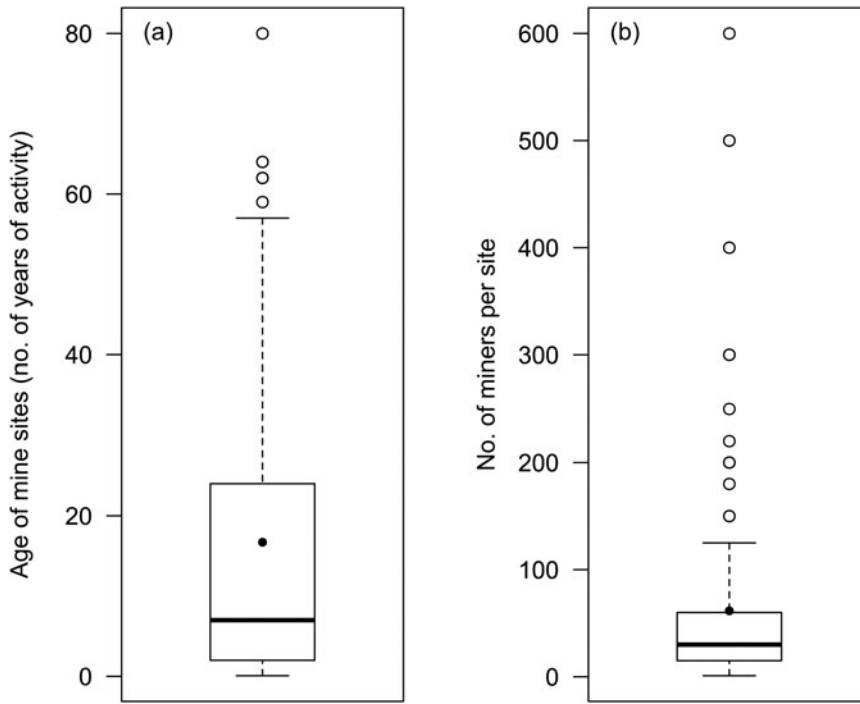


FIG. 2 Characteristics of mine sites (n = 39), based on 445 responses from interviews conducted in four *groupements* around Kahuzi–Biega National Park and Itombwe Nature Reserve (Fig. 1). (a) Number of years mine sites had been active; (b) number of mine workers per site. The filled circles indicate the mean values.

TABLE 2 Mean sale price of cassiterite, coltan and gold at various points along the value chain. Blank cells indicate no data.

Point of sale	Mean price (USD kg <sup>-1</sup> )		
	Cassiterite (n = 589)	Coltan (n = 48)	Gold (n = 227)
Mine site	2.7	19.8	34.0
Village trader	3.3	22.6	34.5
Large urban centre	3.0		36.6
Global market value (March 2015)*	17.4	177.8	37.4

\*InfoMine (2015)

the four *groupements* surveyed, Bunyakiri had the highest proportion of miners who considered leaving the mining sector (80%) and Itombwe had the lowest, although the majority of miners there would still prefer to leave mining (57%;  $\chi^2$  test:  $\chi^2 = 13.6$ ,  $df = 3$ ,  $P = 0.004$ ). Respondents' motivations to leave the sector were similar to those that brought them there, including finding an alternative activity that provided better benefits for them and their families. Many miners were motivated to leave because of the risks and difficulty of the work involved. Reported risks included landslides (87%), wounds sustained from mining activities (10%), and fatalities from fights at the mine sites, including over mineral finds (3%).

### Miners' revenues and livelihoods

On average, miners earned significantly higher monthly revenues than non-miners (Wilcoxon rank sum test:

$W = 5,283$ ,  $P < 0.001$ ). The mean reported revenue for a miner was c. USD 116 per month, with some individuals earning up to c. USD 1,000 per month, whereas the mean reported revenue for a non-miner was USD 62 per month. Individuals who controlled mine sites and collected taxes from other miners earned the most, and these individuals often belonged to, or had strong connections to, the military or militia.

Approximately half (52%) of the miners interviewed conducted additional economic activities along with mining, including small business enterprises (80%), hunting (68%) and agriculture (10%). When miners were asked which livelihood activity their family was most dependent on, 72% stated mining, whereas 13% relied primarily on agriculture, 13% on commerce and 2% on hunting.

### Bushmeat hunting methods

Of the 727 individuals surveyed, 57% stated that bushmeat hunting occurred at the mine sites. Individuals who were involved in hunting included hunters (35%), miners (14%), local militia/military (5%) and other members of the local population (2%). However, a large proportion of respondents (44%) were not willing to say who hunts, highlighting the sensitivity of talking about the people involved in bushmeat hunting, because of the illegality of the activity. It is likely that the actual number of hunters was higher than reported. Respondents were asked whether hunting took place in the Park/reserve, in farms, in forest neighbouring the village, or in abandoned farms. Many stated that hunting took

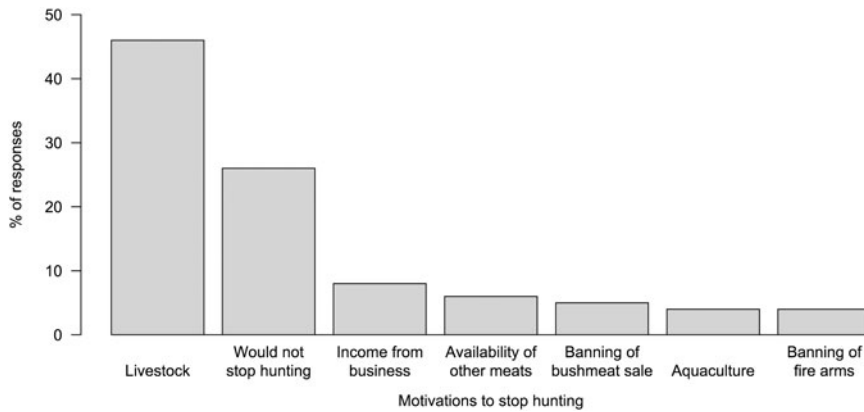


FIG. 3 Interviewees' responses when asked what would make them hunt less often or stop hunting.

place both outside (47% of responses) and inside protected areas (41%); others were not sure or were not comfortable stating where it occurred (12%). Hunting was reported to be conducted all year round, mainly using dogs, followed by firearms, spears, snares (nylon and metallic) and nets.

#### Motivations for hunting

Half of respondents stated they knew of miners who were involved in hunting. The main motivations for hunting were for both personal consumption and the bushmeat trade (49%), and for personal consumption only (31%). A minority of respondents (4%) stated that they hunted only to sell. Motivations for hunting differed significantly between *groupements*: in Bunyakiri personal consumption was the only reported motivation, whereas in Itombwe, Nzovu and Lulingu consumption and sale were more commonly reported (Fisher's exact test:  $P < 0.001$ ).

The main motivation to consume bushmeat rather than domestic alternatives was its availability (68%), followed by taste (57%) and cost (23%). Motivations differed significantly between the *groupements*: respondents in Itombwe and Lulingu mostly consumed bushmeat because of its availability, whereas respondents in Bunyakiri mainly consumed because of taste preferences, and in Nzovu mostly because it was cheaper than domestic meat ( $\chi^2$  test:  $\chi^2 = 246$ ,  $df = 6$ ,  $P < 0.001$ ).

When miners were asked what would make them stop hunting, responses included having a secure income (e.g. from business), having their own livestock or practising aquaculture as a source of income and protein, greater availability of domestic meat, and enforcement of regulations (e.g. banning of firearms and the sale of bushmeat; Fig. 3). Some individuals (26%) stated that they would not stop hunting as it was part of their culture. Responses differed significantly between the *groupements*: in Bunyakiri, Lulingu and Nzovu respondents were most likely to stop hunting if they had their own livestock to provide a source of meat and revenue, whereas those in Itombwe indicated they

would be more inclined to stop if regulations against hunting were enforced or if other meat sources were available (Fisher's exact test:  $P < 0.001$ ). The proportions of respondents who were not willing to stop hunting were highest in villages in Bunyakiri and Itombwe (44 and 27%, respectively).

#### Species exploited

Most hunting appeared to be opportunistic and indiscriminate. Targeted species included porcupines *Atherurus africanus*, the Gambian rat *Cricetomys gambianus*, duikers *Cephalophus* spp., and smaller primate species. Chimpanzees appeared to be the main threatened species hunted at mine sites, in particular in Bunyakiri (6% of responses) and in Itombwe (5%). Many respondents (68%) reported that some species that were previously present around mine sites were no longer found there, including gorillas (34%), chimpanzees (30%), elephants (27%), other primate species (15%), and buffalos *Syncerus caffer* (7%). No time scale was mentioned, and as many miners had only been around the mine site for a short period of time, this can be taken as anecdotal evidence only. The main causes for the disappearance of these species were believed to be hunting driven by the demand for bushmeat (38%), loss of habitat (16%), hunting with guns (3%), and other human activities (2%). When asked whether great apes still existed near the mine sites, 26% of respondents stated that they did (65% mentioned chimpanzees and 35% gorillas), despite the large perceived effect that hunting has had on great apes.

Twenty-four percent of respondents reported using wildlife for medicinal purposes, the most exploited species being porcupines (against intestinal worms and blood loss), tortoise species (blood loss) and Gambian rats (stomach pain and kwashiorkor, a form of severe malnutrition), followed by snakes (rheumatism and blood loss), pangolins *Manis* spp. (blood loss), chimpanzees (kwashiorkor and poison antidote), buffalos (skin illnesses and ring worm), caracals *Caracal caracal* (skin illnesses and poison antidote) and moles (scabies).

## Discussion

Our findings confirm the ongoing presence of mining in the region, both within and around protected areas. Other studies have shown that artisanal and small-scale mining sustains large numbers of people who are exploiting cassiterite, gold, coltan and wolframite, largely illegally, with most mines being controlled by armed groups (Matthysen & Montejano, 2013).

Our findings indicate that the price of coltan around Kahuzi-Biega National Park has increased since D'Souza's (2003) study, from USD 10–15 per kg to c. USD 20 per kg. Our results are consistent with those of other studies from North and South Kivu provinces, which found that artisanal mining could provide an individual worker with USD 80–150 per month; this explains the attractiveness of mining compared to other livelihoods, given that the national mean income is USD 2–2.5 per day and 80% of the population relies on a daily income of < USD 1 (Kitula, 2006; Bryceson & Jønsson, 2010; Hilson, 2010; Perks, 2011; Global Witness, 2012; Hoedoafia et al., 2014). Differences in global and local market prices between gold and coltan are related to their value chains and to the global demand: coltan is taxed more than gold along its transport from mine sites to processing sites, and the international demand for coltan is higher, driven by the technology industry (D'Souza, 2003; World Bank, 2008; de Koning, 2011). Our demographic results further support trends found across the region, showing that mining attracts people from various professional and social classes and drives people's movements to some extent as they move to mine sites (D'Souza, 2003; Hilson, 2009; Jønsson & Bryceson, 2009; Perks, 2011). Further research is needed to provide a better understanding of these migrations. The results also suggest that mining is an opportunistic occupation, as found in other studies, in which miners in the region were found to be seasonal and mobile workers with multiple livelihood activities (D'Souza, 2003; Kitula, 2006; Jønsson & Bryceson, 2009; Kwai & Hilson, 2010; Global Witness, 2012). Those who conduct other livelihood activities in addition to mining are likely to invest some of their earnings from mining in those livelihood activities. Providing alternative, sustainable sources of income to communities in villages around the protected areas, or within the Reserve in the case of Itombwe, could therefore incentivize people to refrain from engaging in mining activities. As most miners do not perceive mining as a long-term livelihood, it is necessary to find ways to support miners to engage in other, more stable livelihood activities (Jønsson & Bryceson, 2009; Kwai & Hilson, 2010), while addressing the economic or safety-related barriers that prevent miners from leaving the sector (D'Souza, 2003).

The debate over conflict minerals in the Democratic Republic of Congo has been widely reported, and it has

been acknowledged that the abolition of artisanal mining would result in the loss of livelihoods of millions of small-scale miners, while fuelling conflict as armed groups battle to retain the resource for revenue (D'Souza, 2003; Cuvelier, 2010; Ingram et al., 2011; de Koning, 2011; Matthysen & Montejano, 2013; Geenen, 2014). The ultimate aim is for mining in the eastern Democratic Republic of Congo to be conflict and bushmeat free, following an equitable rule of law, with the elimination of human rights abuses, respect for indigenous rights and land rights, and without damage to the environment and biodiversity (de Koning, 2011; Dranginis, 2014). To begin working towards this, there is a need to demilitarize mine sites (de Koning, 2010, 2011; Matthysen & Montejano, 2013), and this will require the involvement of the Congolese government, civilian authorities, peacekeeping troops, the private sector and international donors to succeed in the long term (Global Witness, 2011). Subsequent steps would include improving governance while closing gaps in infrastructure, rule of law and practice (IPIS, 2012; Dranginis, 2014; Geenen, 2014).

Given the linkages we have shown between artisanal mining and bushmeat hunting in protected areas in the eastern Democratic Republic of Congo, of which the negative impacts on great ape species are known (Plumptre et al., 2015), there is an urgent need to reduce people's reliance on mining, address the root drivers of bushmeat hunting and work towards the demilitarization of mine sites to facilitate enforcement of environmental laws within protected areas.

## Recommendations for conservation

If the impacts of artisanal and small-scale mining on species of conservation concern are to be minimized then certain threats related to mining need to be addressed. We make the following recommendations:

- (1) Our results show that bushmeat hunting to supply meat to mining sites is widespread, and therefore conservation initiatives are needed to reduce bushmeat hunting in mining areas through providing a sustainable meat supply. We found significant differences between *groupements* in motivations for hunting and preferences for bushmeat vs domestic meat, and therefore interventions should be designed at this level if they are to address the root drivers of bushmeat hunting. The different motivations for hunting between the *groupements* may be explained by differences in access to markets: in more isolated areas people are likely to hunt bushmeat for supply to mining sites rather than for their own consumption only. In cases where hunting is mainly for personal consumption, motivated by a preference for the taste of bushmeat, alternative meats would have to be cheaper than bushmeat to

encourage a change in consumption behaviour (Wilkie & Carpenter, 1999). Further studies should be conducted in Itombwe and Lulingu, where the likelihood of people stopping hunting was highest, to ensure the drivers of bushmeat hunting are well understood and can be addressed effectively, while taking into account the people who would not stop hunting because of taste and cultural preferences (Wilkie & Carpenter, 1999).

- (2) Most of the miners interviewed indicated they would be willing to leave the mining sector if they could find alternative sources of revenue, and therefore we recommend establishing micro-financing mechanisms to help those who are interested in leaving the sector to engage in profitable income-generating activities, by contributing to start-up costs, while supporting individuals in times of need (Perks, 2011). Micro-credit schemes have been implemented by the Wildlife Conservation Society and the Institut Congolais pour la Conservation de la Nature in some communities around Kahuzi–Biega National Park, giving credit recipients opportunities to engage in sustainable livelihoods, including livestock raising, and thus reducing pressures on the Park's natural resources (Hammill et al., 2008). One way this has been implemented effectively is through establishing community cooperatives, which strengthen the coordination and management of community initiatives by creating a platform through which livelihood interventions can be conducted. There is a need to scale up these interventions to the lowland areas of the Park and also around the Itombwe Nature Reserve.
- (3) We found that most mines were controlled by armed groups, and therefore we suggest there is a need for increased governmental support for the demilitarization of mines by removing and prosecuting rebel groups and Congolese military units engaged in illegal activities in mining areas (de Koning, 2010; Global Witness, 2011), particularly those that are located within and around protected areas. Without political support for negotiating with rebel factions to give up their weapons, military units, including peacekeeping troops, would need to intervene to disarm them (Global Witness, 2011). The demilitarization of mine sites would improve security and facilitate patrols by protected area rangers to enforce conservation laws and reduce illegal activities in the protected areas.

Since the research was conducted, the Wildlife Conservation Society has launched a micro-credit project in five sites located close to mining areas around Kahuzi–Biega National Park, aimed at providing beneficiaries with the means to engage in sustainable livelihoods while increasing the availability of domestic meat. Upon receiving micro-credit,

project beneficiaries are presented with several livelihood options, including guinea-pig production, which has been used extensively in the region to improve food security (Maass et al., 2014) and reduce the reliance on bushmeat. With appropriate scaling up, improved access to inexpensive domestic meat will extend beyond the household level to mine sites. A monitoring and evaluation plan has been developed and will be used throughout the project to ensure that it achieves its intended objectives of reducing bushmeat hunting and consumption in mine sites around protected areas. In 2016 the Wildlife Conservation Society began working with the mining sector to determine how to engage governmental actors in the region to remove armed groups and military units from mining sites. We believe this set of actions will reduce the impact of artisanal and small-scale mining on wildlife around protected areas in the region, and serve as a model for similar conservation efforts elsewhere.

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### Author contributions

DK designed the study, trained data collectors and organized the data collection and entry. AK cleaned the data and conducted preliminary analysis and writing. CS analysed the data and led the publication of the article. AJP raised funding for the study and contributed to the data analyses. All authors contributed to the writing of the article.

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