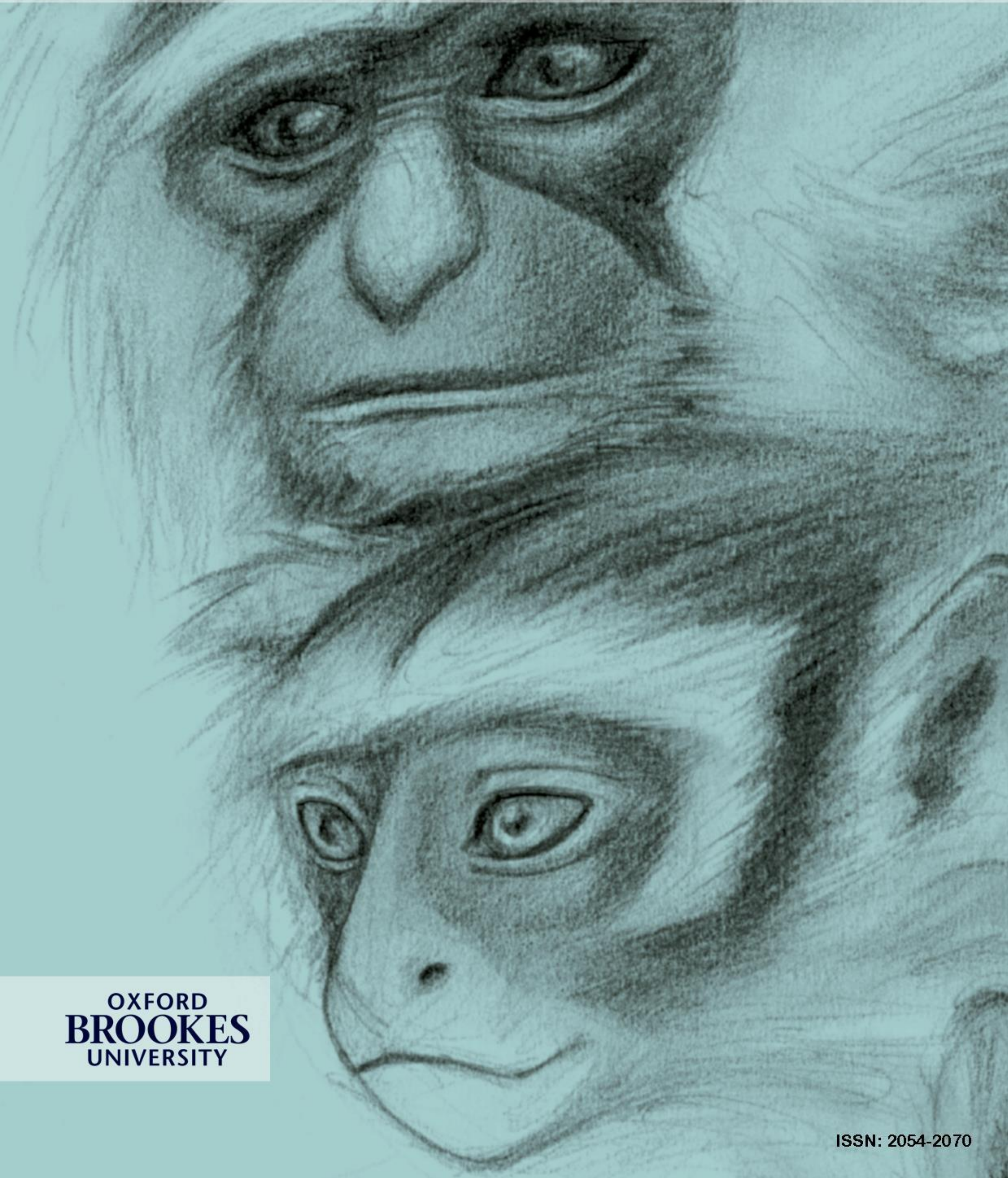
Journal of the MSc in Primate Conservation

Canopy

Volume 16
Issue 1
Winter 2015



OXFORD
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ISSN: 2054-2070

Canopy
Journal of the Primate Conservation
MSc Programme
Oxford Brookes University

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Letter from the editors

Welcome to the 2015 Winter Edition of Canopy, the in-house journal of the MSc in Primate Conservation at Oxford Brookes University.

For Indonesia, this year brought one of the ecological disasters of the century. Forest fires are not a new phenomenon in Borneo, however owing to a drought exaggerated by an El Niño event this year, the intensity of the fires have put both wildlife and humans at extreme risk. The effects of these fires will have lasting effects on the wildlife of Borneo through deforestation and habitat fragmentation. Deforestation is no new topic within the realm of primate conservation, but this devastating event highlights the importance of habitat preservation to protect primates globally.

In this Issue, we have selected articles that address the topic of habitat fragmentation and it's relevance to the conservation of primate species. As human populations grow, it is essential to understand how to improve the outlook of species living in landscapes that are, or are soon to be fragmented. The articles in this issue look at forest fragmentation, the use of corridors within a matrix of forest and non-forest habitats and ways in which zoos can create awareness in an effort to contribute to ongoing conservation efforts.

We hope that you find this issue of Canopy informative, as it explores an important issue to both Primate Conservationists and the species that we study.

Best wishes,

The Editors

Regine, Magdalena
Alexandra, Nicholas
& Martina

Letter from the Module Leader

Welcome to the first of two issues in this sixteenth volume of Canopy, the journal of the MSc in Primate Conservation at Oxford Brookes University. This issue is dedicated to the theme of habitat fragmentation and the nonhuman primates who live in human influenced landscapes.

I'm writing this in the run up to the 2015 United Nations Climate Change Conference in Paris, the outcomes of which will be especially significant given the environmental tragedy unfolding in Indonesia currently. The fires raging across Indonesia are causing unimaginable damage to forests, and are directly linked with slash and burn activities to clear land for plantations. Indeed, the daily emissions from these fires are estimated to be greater than those of the US economy (Global Fire Emissions Database and CAIT, WRI, Oct 16, 2015), directly threatening health and survival of people and wildlife. Energy efficiency, renewables and forest protection are key to reducing the world's carbon outputs. Successful international emissions regulation, and implementation of effective measures to achieve this, could bring real benefits to the natural environment, reducing biodiversity loss and harmful habitat change. But, this must be achieved in parallel with supporting economic development in lower income countries, reducing poverty and improving health security for the World's poor. However, the rapid expansion of plantations in Indonesia is linked to the country's economic development, generating income by servicing ever-expanding global markets for cheap commodities such as oil palm, pulpwood and timber. How then to balance international development needs alongside protecting habitat and climate? This remains perhaps the single biggest challenge for conservationists during the 21st century.

The papers in this issue examine some of the impacts of habitat fragmentation and change on a variety of different primate species. There is no doubt that habitat loss and fragmentation impacts the long-term survival of primate populations, and this is reflected in some of the papers included here. However, as demonstrated here, some species appear able to accommodate to anthropogenic change. This provides us with an excellent opportunity to learn more about primate capacity for behavioural and ecological flexibility, and their capacity to accommodate to rapidly changing environments. Such knowledge has scientific merit as well as conservation value. However, in no way should this be considered a justification for not trying to protect habitat or vulnerable species whenever possible.

Professor Kate Hill
Module Leader, MSc Primate Conservation

Assessing fragmentation characteristics at Bulindi, western Uganda: implications for primate conservation in a highly fragmented landscape

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Forest fragmentation is a landscape-scale process that denotes the loss of habitat and its subdivision into a variable number of patches dispersed within a matrix of modified habitat (Suanders *et al*., 1991; Laurance & Cochrane, 2002). Fragmentation science is its own crisis discipline and often deals with species living under very bleak circumstances. In terms of conservation biology, habitat loss and fragmentation are among some of the most active fields of research (Laurance & Cochrane, 2002). Nonhuman primates (hereafter 'primates') that inhabit these disrupted landscapes utilise a skill set that differs from those that reside in continuous less-disturbed habitat (Marsh, 2013). Despite a growing body of research, there still exists a lack of information regarding how different primate species respond to fragmentation. In the past, studies focusing on primates occupying fragmented habitats have involved fragments protected from anthropogenic disturbance (Tutin et al., 1997; Struhsaker *et al*., 2004). In truth, most fragmented forests are not protected with some considered open-access by local citizens (Chapman *et al*., 2007). Fragments change in size, structure and composition as landowners utilise the forest for timber extraction, grazing or farming. It is therefore imperative that research efforts focus on the types of forest fragments that are most likely to support individual species (Onderdonk & Chapman, 2000). The identification of the factors influencing the presence of species in fragmented habitats is fundamental to the development of effective conservation and management strategies (Arroyo-Rodriguez *et al*., 2008).

Understanding the ecological value of small forests provides an opportunity to make important conservation gains, particularly for species whose ranges are not situated within a protected area (Chapman *et al*., 2007). The purpose of this study was to further current understanding of the ecological flexibility of black-and-white colobus (*Colobus guereza*) within a forest-farm mosaic in Western Uganda. I hypothesized that a relationship existed between fragmentation characteristics (fragment size, habitat disturbance, and tree composition) and primate population abundance. The dual objective of this study was to compare the ecological condition of a system of riverine forest fragments with data collected in 2006/2007 (McLennan, 2010; McLennan & Plumptre, 2012). One of the developing issues associated with the study of primates in fragmented landscapes is the constant change of conditions over time (Marsh, 2013). Cumulative research in fragmented landscapes is vastly more informative than single short-term projects. Consequently, the secondary aim of this study was to portray Bulindi as a potential site for long-term fragmentation research and as an area of conservation significance.

Using Spearman's rank correlation, the study revealed no significant relationship between colobus abundance and fragmentation characteristics. The lack of significant results could represent the need for auxiliary information on a range of different fragmentation characteristics. Forest fragments are highly dynamic and variable landscapes that are in a constant state of fluctuation (Marsh, 2013). Human factors could adversely affect colobus occupancy through actions such as hunting. The planting of crops immediately adjacent to forest fragments might inspire crop-raiding, which in term could lead to further human-primate conflict (Pienkowski *et al.*, 1998). The study also did not address the density of colobus food trees within each of the seven forest fragments. Dietary stress has been linked to immune suppression leading to increases in parasitic infestation. For this reason the relationship between black-and-white colobus abundance and food availability merits further investigation at Bulindi.

The conservation of forest fragments is of great importance for the long-term preservation of wildlife. An assessment of the current ecological condition of forest fragments at Bulindi, revealed a dramatic decrease in fragment area. This can be attributed to extensive and on-going human activities, including logging and clearance for agriculture (McLennan, 2010). Overall tree density increased by approximately 40% between the surveys conducted in 2006/2007 and 2014. Higher tree density was expected as severely disturbed landscapes, such as Bulindi, are often characterised with high tree densities dominated by smaller sized trees (Williams-Linera, 1990; Denslow, 1995; Oliveira-Filho *et al.*, 1997). Extensive human activities produce openings in the canopy that enable the proliferation of pioneer and light demanding species (McLennan, 2010). Relatively few trees surpassed 30m in height and this suggests that many medium to large specimens have been removed due to human exploitation. This has serious implications for the persistence of resident primate populations as previous studies have shown a positive correlation between large tree size and primate abundance (Mbora & Meikle, 2004).

Fragmentation science is now at the precipice of its development and faces large scale challenges. Long-term research in areas maintaining populations under the most calamitous of circumstances is vital to furthering understanding of factors influencing primate survival. Based on the cumulative analysis of ecological surveys, it is clear that the primate communities residing at Bulindi are enduring dire conditions. From a conservation perspective, urgent management protocols are required in order to protect the remaining forest fragments. The future of Bulindi depends critically on further investigation into the ability of primates to cope with fragmentation and the interactive management of both ecological and anthropogenic requirements. The wise use of earth and its resources is the foundation of conservation and the lasting of good men.

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Can zoos effectively raise awareness about coltan mining, gorilla conservation and influence visitors to recycle mobile phones?

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Coltan mining in Central Africa particularly the Democratic Republic of Congo has contributed to the population decline of the gorilla. This is mainly from habitat loss and an increase in bush-meat consumption by miners, among many other reasons (Nellemann, 2010). Coltan is an abbreviation of columbo-tantalite an ore containing both niobium and tantalum. It is rare, as dense as steel, highly resistant to corrosion and heat, it can also store and release an electrical charge. These properties make it a vital material for capacitors in portable electronics such as mobile phones (Hayes & Burge, 2003).

One conservation initiative to tackle the effect of coltan mining on the environment is to recycle old mobile phones, as well as other electronics, this will reduce the demand for further coltan extraction. Mobile phones at their End of Life stage (EoL) are classified as Waste Electrical and Electrical Equipment (WEEE) and are also known as electronic waste (e-waste) (Ongondo & Williams, 2011). There is a lack of public awareness surrounding small WEEE recycling and more awareness raising campaigns and education initiatives are needed (Darby & Obara, 2005).

With nearly 600 million people visiting zoos worldwide. Zoos have an opportunity to influence the public's behaviour, attitude and knowledge (Palmer & Suggate, 1996) regarding this subject. Many zoos have taking this opportunity and do try to educate their visitors about this conservation issue.

Evaluation and assessment of Conservation Education is important for its enhancement and future developments. If zoos can make the slightest difference to the visitors behaviour, attitude and knowledge. This can have a big impact on the success of conservation initiatives.

The aim of this study was to determine whether such zoo campaigns can influence visitors to recycle mobile phones and enhance their knowledge on coltan mining and gorilla conservation. To determine this interview questionnaires were carried out at two zoos; Paradise Wildlife Park and Bristol Zoo Gardens. Paradise Wildlife Park does not raise awareness about this conservation issue. Whereas Bristol Zoo does through their educational gorilla talk and campaign poster at the gorilla exhibit. The talk and poster discuss the effect of coltan mining on the gorillas and encourage mobile phone recycling.

The questionnaire was split into two different segments; the first asking factual questions i.e. How many mobile phones do you own that are no longer in regular use? Where the visitors were given options to select. With the second segment the visitors were asked to respond with the most appropriate answer on a 6-point Likert scale from strongly agree to strongly disagree with unsure and neutral options. These question were related to knowledge and attitude i.e. the mining of components for mobile phones can increase the bush meat trade of primates and I am willing to recycle a mobile phone. These interviews were conducted at the exit of the zoo on visitors that were leaving. Adults (18+) were targeted for the interviews either individuals or groups where if possible all adult members were interviewed.

A comparison was made between the different zoo visitor's responses. The comparison was between the visitor's knowledge, attitude and willingness to recycle. This was used to determine whether visitors at the different zoos had similar or dissimilar responses where conclusions can be drawn on the effects Bristol Zoo had. To establish a relationship between the zoo and the responses given the chi-squared test for association was carried out.

100 questionnaire interviews were completed, 50 at both study sites. 65% of the visitors interviewed had mobile phones that were no longer in regular use. The majority stated they had these mobile phones because they didn't know what to do with them. With 52% of the visitors interviewed having previously recycled. The findings of this study showed there were more visitors at Bristol Zoo who were willing to recycle their old/unused mobile phones than Paradise Wildlife Park. However the statistical test was not significant $X^2 = 2.837$ $df = 1$ $p = 0.092$. At both sites the majority of visitors were not aware of coltan, though more visitors at Bristol Zoo were. A relationship was established between the study site and the responses $X^2 = 4.000$ $df = 1$ $p = 0.046$. Paradise Wildlife Park visitors were less knowledgeable about habitat loss from coltan mining and its effects on the gorillas. A relationship was established between the study site and the responses $X^2 = 11.960$ $df = 1$ $p = 0.001$. Bristol Zoo Visitors were more knowledgeable about how mining can cause an increase in the primate bush meat trade. Where a relationship was established between the study sites and the responses $X^2 = 9.470$ $df = 1$ $p = 0.002$.

These results show with encouragement and knowledge of recycling methods more people will start to recycle rather than stockpile there mobile phones. Darby & Obara (2005) found in general people are willing to recycle mobile phones and other small WEEE but it is the lack of knowledge and convenient services that is stopping them. Though more knowledge on coltan and its effect on gorillas was found among Bristol Zoo visitors, there is no way to tell if the increase in knowledge had an actual effect on the behaviour of those interviewed.

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Habitat corridor utilisation by the gray mouse lemur (*Microcebus murinus*) in the littoral forest fragments of south eastern Madagascar

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Madagascar's littoral forests are amongst the worlds' most threatened ecosystems, with the majority of the remaining forests only existing in small fragments in Southern Madagascar. Deforestation is the main cause of habitat loss and fragmentation in Madagascar, with logging, clearing land for cattle grazing and slash and burn agriculture being common practices across the island (Styger *et al.*, 2007; Klanderud *et al.*, 2010).

One of the most detrimental effects of habitat fragmentation is that it causes animal populations to become isolated (Kruess & Tscharntke, 1994). Therefore many studies reiterate the importance of the inclusion of habitat corridors in conservation strategies, as they have been shown to provide vital links between such fragmented populations (Saunders *et al.*, 1991; Ramanamanjato, 2001; Ganzhorn *et al*., 2007; Irwin, 2010). Habitat corridors can be defined as linear strips of vegetation or habitat, consisting of either native or introduced plant species, which connect at least two previously isolated

Figure 1: The Mandena habitat corridors included in this study. Left: CM15T-Tok. Centre: CM16-M20. Right: CM13-M15

fragments (Hobbs, 1992; Dawson & Nature, 1994). They can serve several conservational functions such as providing supplementary faunal habitats, shelter, acting as migration vectors and as important medians for seed dispersal and reducing water and wind damage (Hobbs, 1992**;** Bollen & Donati, 2006). The utilisation of such corridors could help to enhance the genetic diversity of such isolated populations by re-establishing a genetic flux between sub-populations which could then form a metapopulation (Weidt, 2004).

In Madagascar, secondary regeneration is particularly slow and exotic plantations are faster and cheaper to establish; therefore it is essential to determine the effectiveness of these corridors in fragmented habitats (Ramanamanjato, 2001**;** Irwin 2010). This is particularly important in littoral forest habitats which grow on poor, sandy soil. During this study we assessed the use of corridors with varying exotic tree composition by the grey mouse lemur (*Microcebus murinus*) in littoral forest fragments.

The study was conducted in the littoral forest fragments of Mandena, south-eastern Madagascar 24^{o} 95'S 46^{o} 99'E. Traps baited with banana were laid in trapping grids in 3 corridors (CM16-M20, CM15T-Tok and CM13-M15) (Fig. 1) and their surrounding forest fragments (M16, M20, M15T, Tok, M13 and M15). Each grid incorporated 40 trapping stations, which had two traps. Four days were spent trapping at each site except the corridors which were repeated for a further four days. Captured animals were marked with Trovan transponders. An animal's movement across the trapping grids was noted when it was recaptured in a different habitat area to where it was initially captured. The distance moved was measured using the distance between trapping points (25m apart).

CM15T-Tok had the highest capture rate of *M. murinus* with 11 individuals (an average of 1.37 individuals per night) (Fig. 2). This area had a low proportion (35%) of exotic plant species and the highest diversity of under-story (DBH less than 5 cm) (Table 1). In addition CM15-Tok had the highest density of under-story with 600 plants per ha with a DBH between 5 and 10cm and of 7000 per ha with a DBH less than 5cm. The surrounding forest fragments had higher capture rates of *M. murinus* with M15T having an average of 2.25 individuals per night and Tok having 3.5 individuals per night.

In comparison, fragments M13 and M15 had the highest number of *M. murinus* per area with an average of 4.25 individuals per night. Despite this, only 3 *M. murinus* were captured in the adjoining corridor CM15-M13, making an average of 0.37 individuals captured per night.

We captured 3 (an average of 0.37 per night) *M. murinus* in CM15-M13. This corridor had the highest proportion of exotic trees (100%

for all plant DBHs) and the lowest species diversity (of 2 for each tree size).

No individuals were captured in CM16-M20 and only 2 animals were captured in M16 (an average of 0.5 per day). Although M20 had a relatively high number of captures (11), with an average of 2.75 captures night. CM16-M20 had a much lower percentage of exotic trees with DBH less than 5cm (29%) and a higher diversity of trees less than 5cm DBH in comparison to CM15-M13(7). The main differences between these two corridors is the density of the under story with M15-M13 being much denser for trees with a DBH lower than 10cm and CM16-M20 having a higher density of trees more than 10cm.

The number of animals captured in the forest fragments was significantly higher than the numbers in the corridors (χ^2= 8.099, p=0.017). There was no significant difference between the sex ratio of the animals captured in the forest to those captured in the corridor (Fisher's exact test p=0.16), with a roughly equal number of males and females captured in both areas. Around half of these animals were then recaptured in a different habitat area. A higher number of these were males. The distance they moved between trapping sites ranged from 25m to 200m, with females (169 m) moving on average further than the males (103 m).

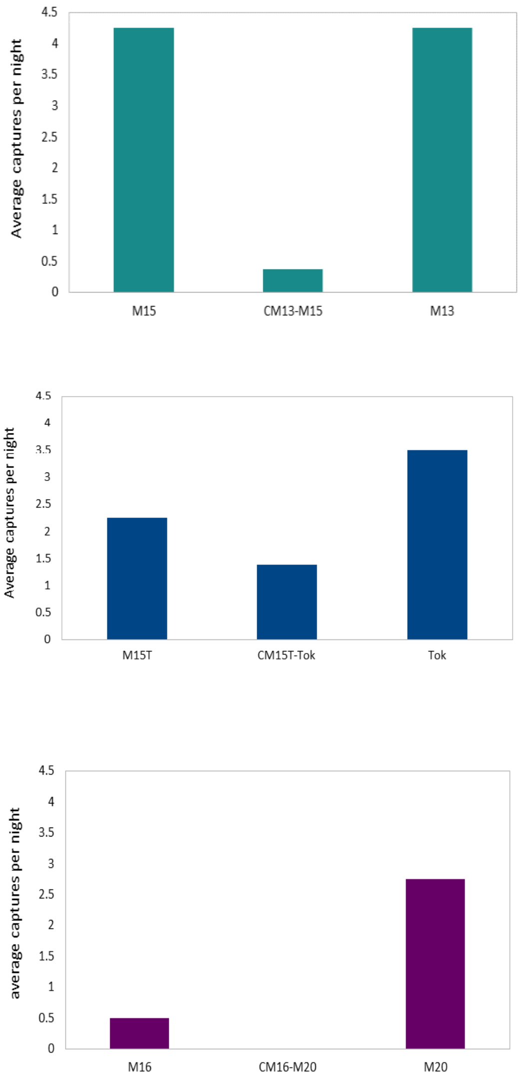

Figure 2: The average number of *M. murinus* captured per night in each study site.

Table 1: The comparative vegetative structure of the habitat

Area	DBH	Overall diversity	% exotic trees	Density (per ha)
CM15-M13	>10	2	100	155
	5>x>10	2	100	600
	<5	2	100	5000
CM15T-Tok	>10	4	98	230
	5>x>10	2	100	400
	<5	12	35	7000
CM16-M20	>10	1	100	280
	5>x>10	1	100	200
	<5	7	29	4500

Despite *M. murinus* often being described as being a disturbance tolerant species, previous studies have found that they are unable to survive in secondary habitats or utilise non-native areas (Ganzhorn, 1998; Ramanamanjato & Ganzhorn, 2001). A high number of *M. murinus* individuals were captured in the Mandena forest fragments which have varying levels of degradation. In spite of Ramanamanjato and Ganzhorn (2001) finding no endemic species utilizing the non-native plantations and other secondary habitats surrounding the Mandena forest fragments, we found a relatively high number of *M. murinus* in the CM15T-Tok habitat corridor and a few using the CM13-M15 corridor. These corridors vary in their exotic plant composition with CM13-M15 being solely exotic and CM15T-Tok consisting of a mixture of native and non-native species.

Our findings imply that the density and diversity of the under-story of the habitat corridor is more important to *M. murinus* then the presence of endemic plant species, with individuals being caught even in the exotic corridor. This is not surprising when the small size of these lemurs and the high aerial predation risk is taken into account (Rahlfs & Fichtel, 2010). Interestingly these findings diverge from the findings of other authors who consider the inclusion of endemic tree species in habitat corridors to be highly influential for their success (Ramanamanjato & Ganzhorn, 2001).

Unpublished data, by Ramanamanjato and Lahann mentioned by Ramanamanjato and Ganzhorn (2001), also found *M. murinus* to be using some of the secondary habitats which boarder M15 and M16, including *Eucalyptus robusta* plantations, without undergrowth. Furthermore, evidence exists of *Microcebus* sp. utilising exotic tree plantations in other areas of Madagascar (J. Ganzhorn pers. comm). Such findings suggest that it is possible to link isolated sub-populations of *Microcebus* sp., with secondary habitat corridors composed of native or non-native plant species or a mixture of both.

Although many *M. murinus* were found to have moved across habitats, the distances, time of year and their mixed sexes suggest that it is highly unlikely that these animals were dispersing during our study (Schliehe-Diecks *et al.,* 2012). This suggests that the corridors are used all year round by both sexes. Such movements through the corridor overlap enough to allow the chance of individuals from different fragments to mate, therefore making the possibility of a genetic flux existing relatively high. Female *M. murinus* inhabiting secondary habitats have been shown to be unable to go into hibernation during the dry season, possibly explaining the balanced sex ratio observed (Ganzhorn & Schmid, 1998).

Our findings suggest that habitat corridors composed of exotic or mixtures of exotic and native plant species can be effective vectors for the movement of gray mouse lemurs. Vegetation plots revealed that the main differences observed between the three corridors is the density of the understory, with the corridor with the highest density having the highest capture rate. Therefore the density of the understory appears to be more important to these small lemurs then the presence or absence of native plants.

Although *M. murinus* were found to move from the corridors into the fragments and vice versa, no animals were found to have crossed from one fragment to another via the corridor. In spite of this, the amount of overlap between the movements of individuals suggests that the likelihood of genetic flow across the fragments via the corridor is highly likely.

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Infectious disease of veterinary significance throughout the orangutans range (*Pongo* species)

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Maintaining self-sustaining captive, semi-captive and free ranging orang-utan (*Pongo* sp.) populations requires mature individuals in optimum general and reproductive health (Muehlenbein *et al.,* 2009). Keeping the species disease free is challenging due to their continuous exposure to extreme anthropogenic pressures and susceptibility to anthrozoonotic pathogens (Munson & Montali, 1990).

Microbes ubiquitously co-inhabit a wide variety of environments, colonizing almost every ecological niche throughout the orang-utans range (Scherlach *et al.,* 2013). Interactions between fungi and bacteria can have dramatic effects on the survival, colonization and pathogenesis of these organisms, regulating the coexistence and survival of an abundance of species. In some instances, bacteria provide fungi with compounds that may enhance the production of fungal virulence determinants, whilst other bacteria produce factors that may inhibit pathogenesis by repressing fungal filamentation (Scherlach *et al.,* 2013). Bacterial infections pose a major concern to orang-utan health as they have the potential to cause and complicate existing disease (Woodford *et al.,* 2002). The colonization of bacterial pathogens such as methicillin-resistant staphylococcus aureus (MRSA) may be persistent in humans, and is a notable occupational health issue for veterinary personnel, posing a significant risk of disease transmission in naïve orang-utan populations to which they are trying to conserve (Radhouani *et al*., 2014). Fungal infections are becoming more frequent, highlighting that a sinister shift in epidemiology is occurring. There has been a rise in the incidence of invasive mould infections and increased non-albicans strains of *Candida* spp. causing invasive disease. The emergence of less susceptible bacterial/fungal strains, resistant to the broader-spectrum antimicrobial agents due to overutilization is a growing veterinary and public health concern (Woodford *et al*., 2002; Martin *et al.,* 2003). Orang-utans are not usually exposed to clinical antimicrobial agents but increasing human orang-utan interactions have the potential for acquired antimicrobial-resistance, which may be detrimental to orang-utans living in rich microbial habitats in which antimicrobials are selecting for resistance (Radhouani *et al.,* 2014). Thus antimicrobial resistance should be viewed as an ecological problem.

Forest reserves and diverse fauna throughout the orang-utans range represent environments that are more favourable to the ecology of arboviruses, providing optimum conditions for their development and dissemination (Moreli & da Costa, 2013). Arboviruses have the potential to rapidly adapt to new vectors and hosts due to high genetic plasticity and mutation rates and are of clinical importance to orang-utan health as they have the potential to cause fatal epidemics (Woodford *et al.,* 2002; Coker *et al.,* 2011). The control of mosquito populations is the main defence against arbovirus transmission and combined source pesticide application,

Figure 1. Juvenile male orang-utan interacting with tourists at the Sepilok Orang-utan Sanctuary in Sabah, Malaysian Borneo.

biological control methods and public education produce the optimal control strategy (Alphey *et al*., 2010).

Orang-utans are extremely vulnerable to anthroponotic disease and pathogens endemic to humans have the potential to decimate orang-utan populations, due to the orang-utans decreasing genetic diversity, slow reproductive rate, naive immune systems and small isolated populations (Muehlenbein, 2013). Ecotourism unites conservation with the local indigenous communities and sustainable travel, functioning as a powerful tool for orang-utan conservation (Muehlenbein *et al.,* 2009). Intensive, unmonitored use of these habitats by tourists can have deleterious effects on orang-utan well-being, including increased stress levels leading to immunosuppression and lowered reproductive success, and regular exposure to a diversity of potential infectious pathogens (Muehlenbein *et al.,* 2009). Local indigenous people interact with orang-utans as conservation staff of rehabilitation centres, national parks and international non-governmental organizations (NGOs), and often have the closest and most regular contact with captive and semi-captive orang-utans (MGVP, 2007; Muehlenbein *et al.,* 2009). They also have regular interaction with young children, domestic animals and the least access to regular health care, increasing the disease risk substantially (MGVP, 2007). Resident expatriates work with orang-utans as researchers and veterinarians and many different levels of human-orang-utan contact is occurring (MGVP, 2007). Each group has a different geographical background, access to health care is variable and different levels of contact with people, domestic animals and wildlife is occurring, making it very difficult to hypothesise which group poses the biggest health risk to orang-utan health (MGVP, 2007; Muehlenbein *et al.,* 2009).

The implementation of an active surveillance system at the interface of rural populations and orang-utan habitats is essential, especially where poverty increases the risk for pathogen transmission (Chomel *et al.,* 2007). The challenges to implement successful orang-utan conservation projects are becoming more complex and a multidisciplinary approach is required involving professionals trained in human and veterinary medicine, microbiology, parasitology, entomology and wildlife biology, to gain a full understanding of pathogen epidemiology and the mechanisms of virulence and pathogenesis (Powers *et al.,* 2007; Coker *et al*., 2011).

To reduce the impact of anthrozoonotic disease among human and orang-utan populations, it is essential to understand which pathogens are involved, the route of transmission, the clinical manifestation and the diagnostic methodologies available (Muehlenbein, 2013). Emerging infectious diseases in orang-utan populations are a major threat to both human health and to biodiversity conservation (Kooriyama *et al.,* 2013). The control of anthrozoonotic infections will ultimately rely on the collaboration between veterinary professionals and human health care providers, and changes in the behaviour and policies of field researchers, park personnel, government officials, local indigenous communities and tourists (Loeffler, 2008). Furthermore, the Malaysian and Indonesian government need to develop the financial and economic tools to enable continuous economic development, but not at the expense of the remaining orang-utan populations (Meijaard *et al.,* 2012).

The pandemic spread of infectious disease poses a major threat to orang-utan conservation due to the potential high mortality rate associated with such an event (Garcia *et al.,* 2004). The diversity of emerging infectious diseases in combination with increased frequency of disease outbreaks may be a major contributing factor to the ultimate extinction of the orang-utan (Bonner, 2013).

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Landscape configuration influencing the presence of red howler monkeys (*Alouatta seniculus*) in bamboo forest fragments of the Colombian Coffee Region

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The Coffee Region of Colombia has been one of the most transformed areas in the country due to the colonization and extensive use of lands in agribusiness activities (Etter & van Wyngaarden, 2000; Armenteras *et al*., 2003). As a result, part of the original vegetation remains in isolated patches (Kattan & Álvarez-López, 1996). Many of these remnants are characterized by the presence or dominance of *Guadua angustifolia* (Poaceae: Bambusoideae) (Gomez-Posada & Londoño, 2002), a bamboo species suggested as an alternative for the economic growth of the region due to its variety of uses in the construction industry (Kleinn & Morales-Hidalgo, 2006). However, some populations of red howler monkeys (*Alouatta seniculus*) remain within these fragments, known as guaduales, and are isolated due to habitat loss and fragmentation (Defler, 2010). As agriculture is the world's most extensive industry (New, 2005), it is necessary to analyse the capability of many species to persist in new domesticated ecosystems (McNeely, 1995) in order to integrate the conservation of biodiversity with prevailing socioeconomic trends (Boshier *et al*., 2004). This perspective can be vital for megadiverse countries, especially those who, like Colombia, are developing nations, where high levels of inequality and poverty remain significant challenges.

The present study is a continuation of previous researches focused on the demographic and behavioural responses of *A. seniculus* to habitat transformation (Gómez-Posada, 2007), a project led by Dr Carolina Gómez-Posada. This study aims to identify which landscape attributes, both natural and urban, influence the presence of howler monkeys in guaduales. The presence of this species in the 28 selected fragments (Fig. 1) was evaluated between 2011 and 2013 by intensive search of direct signs (direct encounter or recording of vocalisations) and indirect signs (faeces). These patches are located in the central mountain range of the Andes, between 900 and 1,200 m of altitude, and are currently immersed in a matrix of pastures and plantations, particularly of citrus, coffee and plantain. The majority of these areas (N=26) are privately owned and under either two different types of guadua extraction: domestic (N=13), aimed to supply material exclusively for the basic needs of a property; or commercial (N=13), which corresponds to a logging process regulated by the authorities. The other two fragments are part of the reserve La Montaña del Ocaso, which became a protected area in 2000, and does not allow the extraction of guadua. La Tebaida (department o f Quindío); and (3) Montenegro (department of Valle del Cauca). Fragments of the last two areas are under two types of guadua extraction: either domestic or commercial. The presence of *A. seniculus* was recorded in 13 of the 28 studied fragments (Fig. 1). Of the eight parameters proposed as patch attributes, area, shape, and distances to the nearest village, principal road, regional airport, river, and patch , only the distances to the nearest river and airport influenced significantly the presence/absence pattern. Drinking from water sources is an infrequently observed behaviour in howler monkeys (Giudice & Mudry, 2000). Few cases of ground level sources, such as ponds for *A. guariba* (Miranda *et al*., 2005) and ground pools for *A. caraya* (Bicca-Marques, 1992), have been registered.

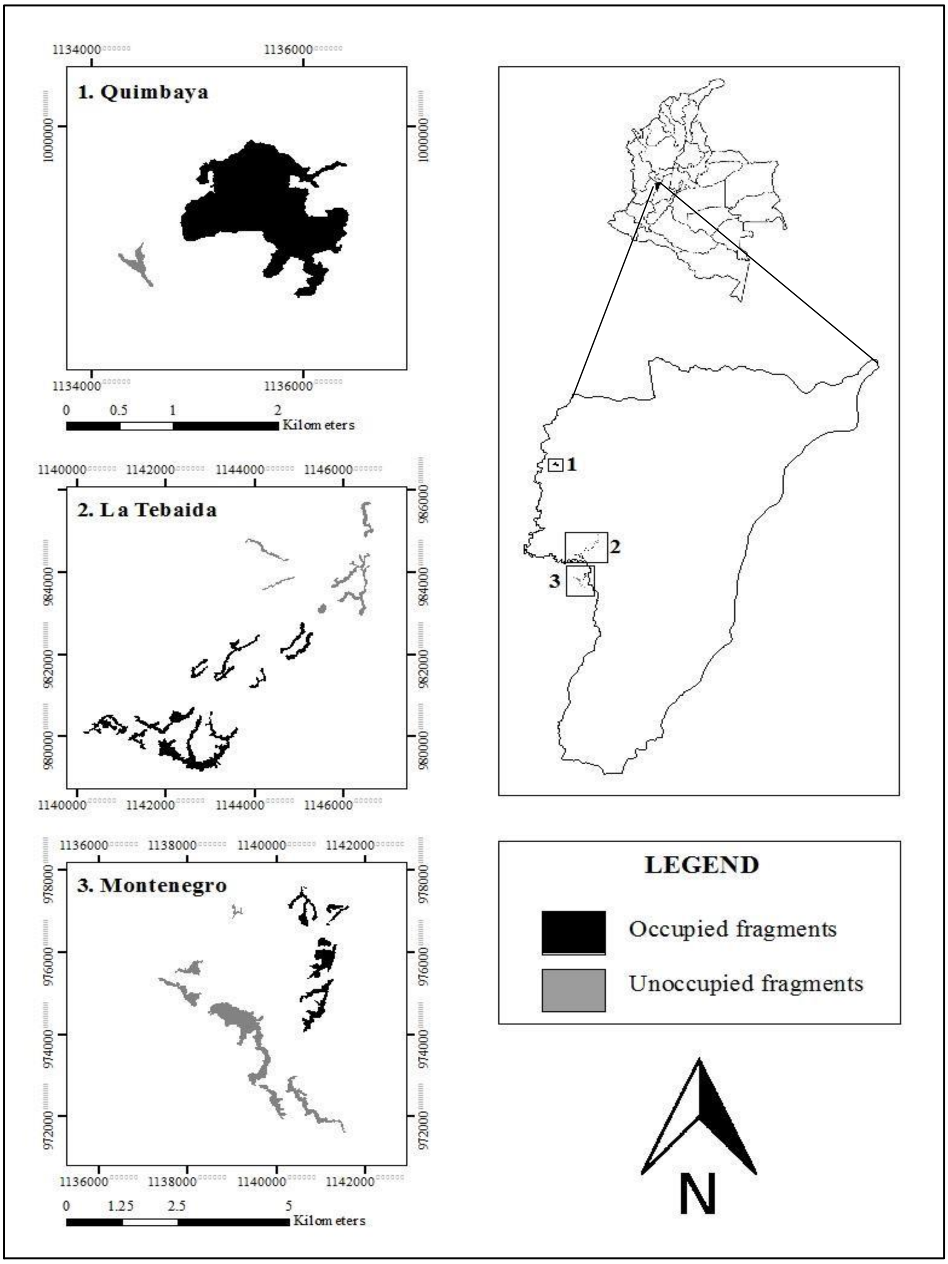

Figure 1: Studied fragments in the Colombian Coffee Region. Guaduales are located in three main municipalities: (1) Quimbaya (department of Quindío) – which includes the reserve La Montaña del Ocaso; (2) La Tebaida (department of Quindío); and (3) Montenegro (department of Valle del Cauca). Fragments of the last two areas are under two types of guadua extraction: either domestic or commercial.

In guaduales, howlers use the ground level only for soil eating (unpublished data). Therefore, the significant influence of the river on the presence of howlers may be related to their habitat, which is an important hydric reservoir (Rojas *et al*., 2013) with a high content of organic matter in the soils (Rojas *et al*., 2013) that could promote the growth of important plant species in the diet of the monkeys. Although guaduales are always associated with water bodies (Camargo & Kleinn, 2010), these benefits may depend on the scale, being higher in areas near rivers compared to guaduales bordering small streams or creeks. As the main river divides the mountainous region and the valley, the landform of the area where the significant river is located could promote a more stable habitat in comparison to the fragments of the abrupt areas, which are more vulnerable to landslides, especially after the extraction of guadua. Howlers were also present in fragments located near the regional airport. This occupancy pattern may be influenced by the sampling method, the majority of the studied patches were grouped in an area adjacent to this urban attribute. The biophysical conditions of the fragments and the permits required for sampling determined this methodological design.

Although some landscape attributes affect the presence of *A. seniculus* in guaduales, this primate species tolerates a varied range of environmental conditions and disturbances (Defler, 2010). Therefore, if the current configuration of the landscape, and the anthropogenic processes occurring in the Coffee Region have no negative impact on wildlife, guaduales could be promoted as agroecosystems for wildlife conservation, particularly for *A. seniculus,* while providing economic benefits to their owners.

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The effects of habitat alteration and fragmentation on Yucatan black howler monkey (*Alouatta pigra*) vocalizations in Balancan, Tabasco, Mexico

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Among factors which pertain to the protection and conservation of primates; hunting, habitat conversion, and forest fragmentation have been recognized as the most dangerous threats to the continued survival of countless species (Cowlishaw & Dunbar, 2000). In fragmented habitats we tend to find an abundance of smaller trees, in comparison to continuous forests (Arroyo–Rodriguez & Mandujano, 2006). As forests become more fragmented, old – growth trees begin to disappear while pioneer species emerge and abundant secondary growth develops, including the proliferation of lianas and vines which further increases tree mortality near forest edges (Laurance, 1991; Benitez-Malvido, 1998; Laurance *et al*., 1998). This can create a cycle of further degradation and contraction of fragments as tree mortality caused by the influx of secondary growth around fragment edges can promote clearing which ultimately harbor more disturbance – adapted secondary and pioneer flora species (Arroyo–Rodriguez & Mandujano, 2006). Within fragments alterations to the configuration and composition of the forest itself can increase gaps in the canopy, an alteration which can affect the microclimates of various levels of the forest altering the habitat as a whole (Camargo & Kapos, 1995).

Along with changes to environmental and climatic factors within a forest fragment, such alterations can effect communication between animals living within fragmented habitats. Morton (1975) mentioned that the physical restraints of a habitat can impose selection pressures on the structure of animal vocalizations. Based on this idea, Martin and Marler (1977) suggested the Sound Window Hypothesis. The Sound Window Hypothesis is based on the idea that avian songs are selected for long distance propagation in their natural habitat. When applied to vocalizations of other organisms, we know that low frequency sounds are degraded more rapidly than high frequency sounds at ground level as a result of ground effect. Adversely, the short wavelengths of high frequency sounds allow for the sound waves to be absorbed or scattered more readily by various strata in a forested environment (Cosens & Falls, 1984). Based on these ideas, auditory signals must compete with physical and meteorological constraints of an environment to maximize their efficient propagation within a habitat. The aim of this study is to determine whether or not variations in habitat structure and configuration as they relate to fragmentation and habitat degradation have an effect on the propagation of vocal signals of a long calling primate species.

The study site, Estacion de Investigacion Primatologica y Vida Silvestre, is located at Rancheria Josefa Ortiz de Dominguez, Balancan, Tabasco, Mexico. It is a privately owned ranched situated approximately 6.5 km South-East (N 17 46.918’, W 091 30.353’) of Balancan town along the southern bank of the Usumacinta River. Data collection took place between 06:00 – 10:00 and 15:00 – 19:00 hours from May 16th to June 17th, 2014. The time range in which data was collected was chosen as it was associated with the approximate times of sunset and sunrise in the region at the time of year when the study was being conducted, 06:30 and 19:30 respectively. Such times were important as *Alouatta pigra* are generally more vocal at these times, in what are often referred to as the dawn and dusk choruses (Oliveria & Ades, 2004). Three forest fragments were selected as the sites for both vegetation density and vocalization data collection. The fragments range in physical size as well as in the number of monkeys located within the fragment. Between the 3 fragments there were a total of 26 groups, comprised of 108 individuals ranging in size from a single satellite male to 12 individuals. Vocalizations of *A. pigra* individuals were recorded using an Olympus LS-100 Multi – Track Linear PCM Recorder. The distance from the source of the vocalization was determined using a Garmin GPSMap 62s GPS. The process was repeated at various distances from the source of a vocalization in each of the 3 fragments. Vegetation density within each fragment was measured on the basis of two components; number of trees per hectare, and visibility through the understory vegetation.

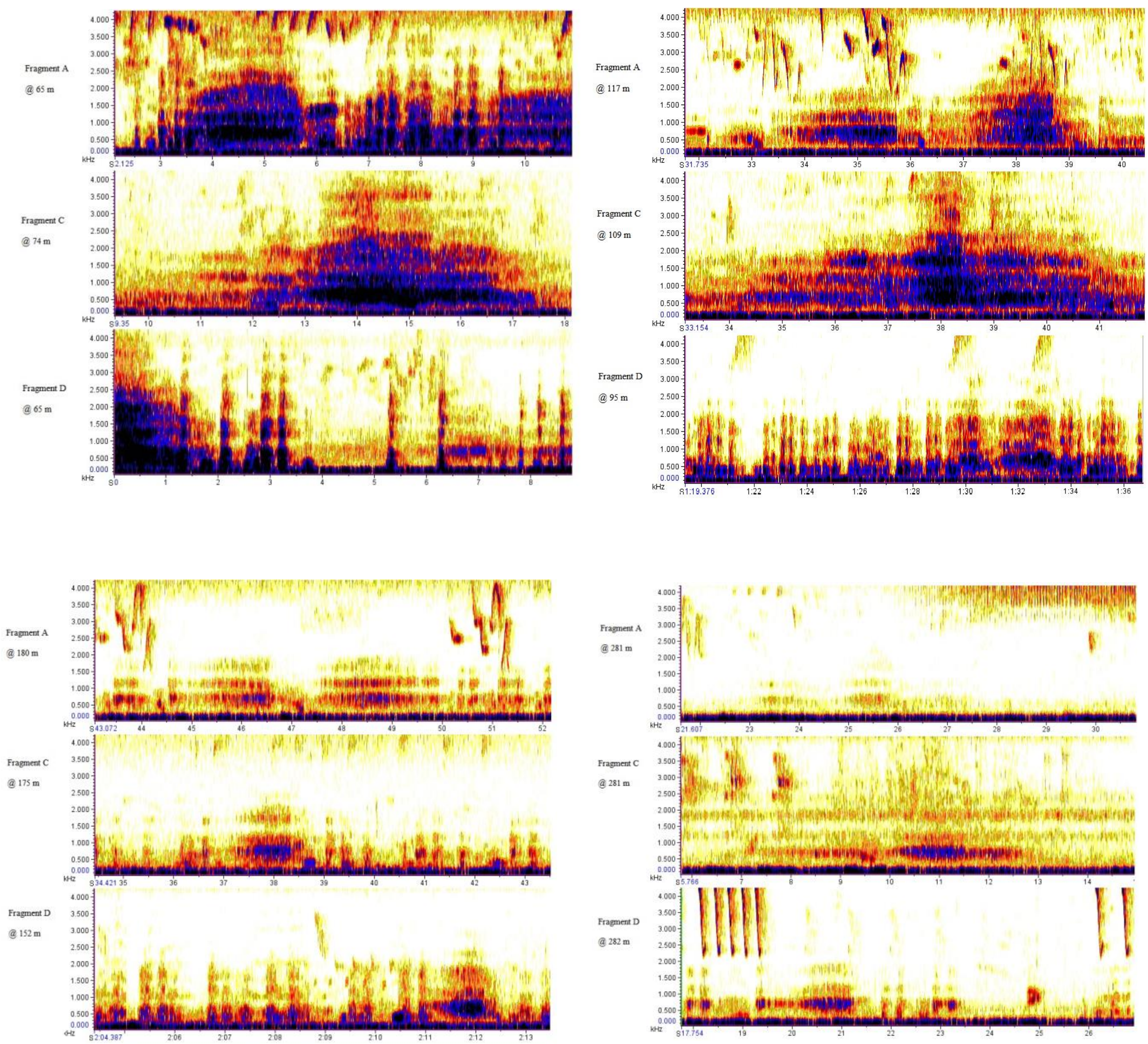

Figure 1: Sonograms representing vocalizations at varying distances in all 3 fragments.

The components were measured using 10m x 10m quadrats and the cover-board method, respectively (MacArthur & MacArthur, 1961).

A Two-Way ANOVA Test was conducted as a means of measuring the statistical significance of location and distance from the source of the vocalization on the maximum amplitude of the recording.

Furthermore, the significance of location and distance on the bandwidth of the vocalization was also determined by observing the highest and lowest frequencies recorded. There was a statistically significant interaction between the effect of distance from the source of a vocalization, F (3, 27) = 35.042, $p > 0.0005$ and location, F (2, 27) = 5.910, $p = 0.007$ on the high end frequencies of the vocalizations. Similarly, there was a statistically significant interation between both distances, F (3, 27) = 19.635, $p >$ 0.0005 and location, F (2, 27) = 13.874, $p >$ 0.0005 on the low-end frequencies of the vocalizations. As for the effect of location and distance on the maximum amplitude of the vocalizations, the role of distance as a factor effecting attenuation was statistically significant, F (3,27) = 49.580, p > 0.0005 while the role of location was not significant F (2,27) = 0.619, p = 0.546.

For high-end frequencies, simple main effects analysis stated there was a significant difference between the effect of distance from the source on the frequency when comparing short range, mid–short-range, and mid-long-range distances. Comparatively, there was no significant difference between the effect of mid – long and long distance on high frequencies ($p = 0.678$). When applied to low end frequencies, the same simple main effects analysis shows that there is no significant difference between short – mid and long – mid distances ($p = 0.824$), short – mid and long distances ($p = 0.473$), or long – mid and long ($p = 0.957$). A similar pattern to that of the high end frequencies is present in the attenuation of the auditory signal.

Given that much of bioacoustics research finds its foundations in the Sender-Propagation-Receiver model (Pijanowski *et al*., 2011), the varying rates of signal degradation may be an important consideration for inter-group communication and vocally mediated reciprocity. Generally speaking, the medium in which a vocalization travels through and the physical environment present within that medium can affect and alter an auditory signal. This is to say, in a forested habitat such as that at Estacion de Investigacion Primatologica y Vida Silvestre, trees and understory vegetation can bend, reflect, and absorb sound waves, thus increasing the rate of degradation in a fragment with greater vegetation densities. Furthermore, alterations to microclimates within the bounds of a specific fragment caused by alterations to the forest composition and configuration can affect and alter vocalizations ability to propagate through a fragment (Morton, 1975; Forrest, 1994; Camargo & Kapos, 1995; Penna & Solis, 1998). The ability of the receiver to hear and interpret an acoustic signal is just as important as the production and propagation that signal. This relies heavily on the cognitive ability of the receiver to decode the content of the signal and auditory anatomy of the receiver to hear the vocalization in the first place (Forrest, 1994).

It is apparent that forest composition and configuration have an effect on species ability to communicate over distances. If small changes in the composition or density of a fragment can alter propagation of vocal signals, it is important to minimize the impact that we have on the structure of forest fragments.

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Assessing silvery-brown tamarin (*Saguinus leucopus*) presence in four privately owned cattle ranches in Caldas, Colombia

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Primate populations are affected worldwide by deforestation as 90% of primate species live in forests (Mittermeier & Cheney, 1987). Forest fragments influences any remnant population's viability, density, behaviour, persistence, and their conservation management (Marsh, 2003). As a consequence of deforestation, many fragments are left with different shapes and sizes (Baskent & Jourdan, 1995), causing them to become dispersed in a matrix of disturbed habitats (Opdam & Wiens, 2002). Many of these fragments are left surrounded by non-forest habitats, which can lead to the primates becoming isolated from other populations and causing deleterious genetic consequences (Ewers & Didham, 2006). The silvery-brown tamarin (*Saguinus leucopus*) is endemic to Colombia and is restricted to the departments of Bolivar, Antioquia, Caldas, and the northern portion of Tolima (Bairrao & Wormell, 2012).

Almost all of the forests found in the eastern side of the department of Caldas have been cleared for cattle ranching. In the foothills, some gallery forest and secondary forest remain with the majority of fragments immersed into a matrix of pasture (Roncancio-Duque *et al.*, 2012). There is very limited

Figure 1: Map showing *Saguinus leucopus* distribution in Colombia (IUCN, 2008)

knowledge on the habitat characterisation of *S. leucopus*, partly due to the challenging terrain of their remaining habitat, which obstructs human observers from studying groups (Alba-Mejia *et al.,* 2013). Data on the habitat characterisation of *S. leucopus* is restricted to three published studies; research in the department of Antioquia (Cuartos, 2001), Tolima (Poveda & Sanchez-Palomino, 2004) and most recently studies in fragments of different sizes in Caldas (Roncancio et al., 2008). This pilot study aimed to better understand how the tamarins are using the habitats in four privately owned cattle ranches in the department of Caldas. The aim was to gather baseline data for Conservación Titi Gris, which is a group of biologists working along Rio la Miel advocating the importance of conserving the silvery-brown tamarin.

Questionnaires were distributed at the ranches to help understand the species' presence and land use. The questionnaires were created to determine if the cowboys and the surrounding residents of the ranches had noticed a difference in population size and habitat use. The questionnaire allowed us to assess if the tamarins are in fact venturing out of the fragments, despite increased predation, to travel to other fragments. Many questionnaires were orally dictated because of the high level of illiteracy in the region due to extreme poverty.

Most participants (64.7%) said they usually saw the tamarins in groups of five individuals; 33.3% claimed to see them in groups of ten, while 1.97% claimed to see only one tamarin at a time. Tamarin sightings were common, with 41.2% having occurred during the last week, 39.2% during the last month, and 19.6% having seen the tamarins that very same day. The majority of the participants (52.94%) saw the tamarins outside of the forest fragment while 47.05% saw the tamarins inside of the forest fragments. Nine out of the 51 participants were unable to tell if the tamarins had undergone a population change. Their responses were excluded as it they did not provide us with any data. For the rest of the participants, 16.6% claimed they believed the population number had increased while 52.3% claimed they had noticed a population decline. Whereas 21.4% said they believed the population had remained stable since they first encountered them.

Despite their arboreal lifestyle, the tamarins are descending to the ground to move in between fragments. It is possible these tamarins are utilizing other forest fragments in other cattle ranches, as many cowboys did state they saw them crossing fences in between properties. However, the landscape features that enable their versatility in crossing matrixes remain unknown as well as the features that constrain movement patterns. The ability to cross over to other fragments is common for tamarins. *Saguinus bicolor* has been observed to cross four-lane motorways in the city of Manaus, Brazil. Unfortunately, these motorway crossings have resulted in several fatalities, as the tamarins do not seem to comprehend the danger in crossing these roads (Gordo *et al.,* 2013).

Saguinus ventures out of the forest fragment are well documented but the reasons behind their route choice remains unknown. The species' versatile nature does offer hope in that it can continue to survive in these highly fragmented and disturbed forests but their survival cannot be ensured until conservationists better understand what habitat factors significantly impact their ability to thrive. This species is in need of many more biological and ecological studies. Without these future studies, conservationists are working with relatively small amounts of data. It is recommended the tamarins are tracked with radio collars in these ranches so their movements can be better understood. Agroforestry conservation management is also needed in the ranches in order to sure the features that enable movement between fragments remain.

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Why is Borneo burning?

This year, the El Niño warm current has strongly accentuated the dry season and peat fires have now become an annual threat in Indonesia. But why is this?

As elsewhere, Indonesian peat fires need both an ignition source and a dry fuel to burn. Peat swamp forests in Borneo naturally have a saturated substrate that is drying out due to irrigation and dry weather, which becomes a flammable fuel source. Fires are then sparked, sometimes unintentionally through carelessness but the huge majority are suspected to be purposely lit. Big industry (as palm oil) is frequently blamed by both media and politicians, and not without reason, as some cases have shown that companies use fire to clear land cheaply and easily. However, recent studies indicate that small holders may actually start more fires than large companies. Large companies can more easily develop, implement and coordinate fire prevention policies. Thus, the challenge for small and poor landholders is great, but urgent (Read more on the blog of OuTrop).

How can you help to protect the orangutans from forest fires?

You can support the OuTrop campaign, stay informed and spread the word via social networks (see below)! The Orangutan Tropical Peatland Project (OuTrop) works to protect some of the most important areas of tropical rainforest in Borneo, including the peat swamps of Sabangau, home to the world's largest orangutan population. OuTrop teams monitor the behavioural ecology of the forest's flagship ape and cat species, carry out biodiversity and forestry research, work with local partners to develop conservation solutions and improve capacity for conservation in the region.

OuTrop
ORANGUTAN TROPICAL PEATLAND PROJECT

University Events

Seminar Series

The seminar series is a weekly event which events guest speakers to present their research. We are currently in the process of recruiting speakers for our spring semester. If you are interested in attending or presenting please do not hesitate to get in contact with us. Contact details are provided within the contents pages

28 Sept	**Dr Kimberly Hockings** (Oxford Brookes University / Centre for Research in Anthropology, Portugal)
5 Oct	**Alejandra Duarte** (Nacional School of Anthropology and History, Mexico)
12 Oct	**Dr Christos Astaras** (WildCRU, University of Oxford)
26 Oct	**Dr Susan Cheyne** (OuTrop)
2 Nov	**Nigel Hicks** (Orangutan Veterinary Aid)
9 Nov	**Dr Christoph Schwitzer** (Bristol Zoological Society)
16 Nov	**Dr Zanna Clay** (University of Birmingham)
23 Nov	**Andrew Walmsley** (Andrew Walmsley Photography)
30 Nov	**Dr Susana Carvalho** (University of Oxford)
7 Dec	**Dr Caroline Bettridge** (Manchester Metropolitan University)

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