Living in the matrix: investigating the effects of human activities on the socio-ecological adaptations of the chimpanzee (*Pan troglodytes schweinfurthii*) in a forest-farm mosaic, Uganda.

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Introduction

In order to effectively respond to and manage the effects of human-induced rapid environmental change (HIREC) on wild primate species, including changing resource availability and distribution and increases in human-wildlife interactions, it is vital to gain an understanding of primate responses to a variety of anthropogenic pressures. This study investigates the relationship between human habitat disturbance and chimpanzee socio-ecological flexibility, with the aim of identifying and predicting chimpanzee responses to different human habitat uses and developing novel approaches to improve negative human-chimpanzee interactions.

I compare two communities of eastern chimpanzees *(Pan troglodytes schweinfurthii)* in Uganda inhabiting forests with differing levels of anthropogenic exposure. One community (Waibira) inhabits protected, continuous forest with minimal human disturbance within the Budongo Forest Reserve, and the other (Kasongoire) lies 18km to the southwest in unprotected and heavily fragmented forest with a variety of anthropogenic pressures. The main aim of this research is to examine how anthropogenic habitat modifications (e.g. farming and deforestation) and activities (e.g. setting snares) affect the social structure, behaviour and ranging of wild chimpanzees at these two sites.

The grant from the PSGB Conservation Working Party was part of the funding needed to conduct a pilot study, which took place between 1st October and 6th December 2014. The principal objectives of the pilot study were to:

1. Assess habituation level of the chimpanzees in each community and fine-tune behavioural data collection methods.
2. Identify as many chimpanzees as possible in Kasongoire and learn the chimpanzee IDs at Waibira.
3. Assess levels of human activities at both the sites and, if time allowed, begin setting up habitat transects.
4. Hire and train a local research assistant in Kasongoire.
5. Organise logistics for the main study period.

Please refer to Table 1 for how the time was spent over the pilot. It became clear during the pilot phase that the chimpanzees at Kasongoire were less well habituated than I had expected. This, combined with losing 15 days fieldwork due to injury and returning to the UK early due to a family emergency, meant I did not have a sufficient sample size to conduct an analysis of the pilot data. Therefore, I present findings and observations relevant to the objectives of the pilot study and the conservation implications of my research question, and describe how this pilot study was crucial for the successful execution of my main data collection period (25th June 2015 – 30th May 2016). Since there is already an established research station at Budongo (Waibira community) whereas Kasongoire is a new site, I concentrated the majority of my research effort at Kasongoire, which is reflected in this report.

Table 1. Distribution of time spent on different tasks and activities during the pilot study

Task	Days spent on each activity		
	Waibira	Kasongoire	Other (Kampala/Masindi)
Locating and following chimpanzees	8	16	-
Training assistant	-	4	-
Habitat surveys	1	3	-
Village meeting	-	1	-
Arranging logistics (visas, permits, equipment, food, accommodation)	-	-	8

Findings

Chimpanzee habituation levels

The biggest challenge was increasing habituation levels and identifying chimpanzees in Kasongoire, a network of unprotected forest fragments with high exposure to anthropogenic disturbances (Figure 1a). Over a period of 16 days in the forest I was able to identify 22 independent individuals, composed of 8 adult males, 10 adult females (of which just 4 were seen regularly), 2 adolescent males and 2 adolescent females, and have created an ID spreadsheet using photographs. However, although the community had previously been followed and part-habituated it became clear during the pilot that only a core group of individuals (mainly the adult males) were habituated to researcher presence: on several occasions new individuals were seen who were extremely cautious. These individuals, almost all adult females and their offspring, were much more elusive and had previously been ranging in other areas of the forest and surrounding forest fragments: during days mapping the forest edge and anthropogenic disturbances, signs of crop-feeding by chimpanzees were noted and these had clearly not been from the group members we had been following the previous day.

Over the short time period of the pilot study, the core group of individuals I was able to find regularly, identify and follow comfortably were ranging solely within a small specific area of the forest close to Kasongoire village, covering just 1.1km^2 (see Figure 1b). The same males in this party were seen almost every day (16 days of observation) and sugarcane (*Saccharum officinarum)* was consumed by all males on each day for >2hours. On these days I did not observe an adult male consume any wild fruits perhaps explaining these restricted ranging patterns since mature sugar was highly abundant and hence the chimpanzees did not range far. These individuals also spent a portion of every day grooming and resting in the open area outside the forest edge (Figure 2): in the main study period I will analyse the frequency and location of time spent outside the forest in order to highlight areas and times of potential interactions with humans.

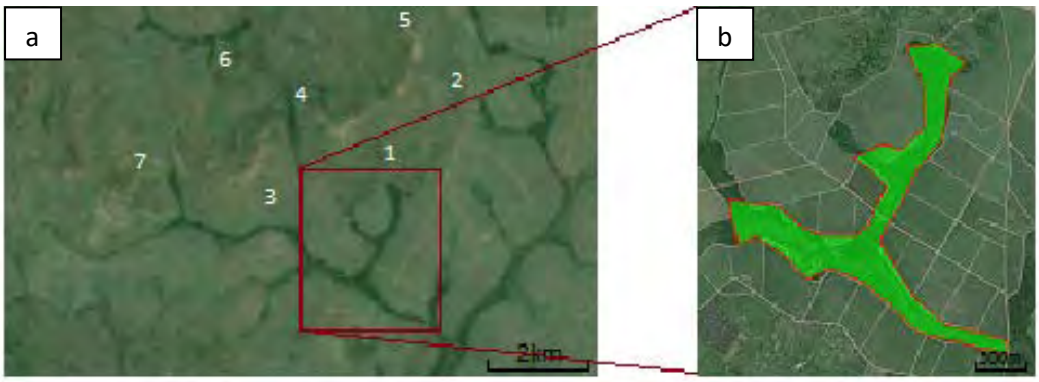

Figure (1a): Map of Kasongoire parish. The following villages correspond with the numbers in the map: 1. Kasongoire, 2. Kisagura, 3. Nyakyaju, 4. Waipachu, 5. Kiryamyongo, 6. Kimanya B, 6. Kyabijwenge; (1b): area of forest utilised by the chimpanzees followed during the pilot study.

The sugarcane, grown primarily by Kinyara Sugar Works Ltd, dominates the landscape and is grown continuously from the outskirts of Budongo Forest Reserve southwest to Hoima District, and southeast past Kasokwa Forest Reserve, encompassing an area of over 500km^2. The results of this pilot indicate that it has become a major part of the Kasongoire chimpanzees' diet, at least for part of the year, and appears to largely replace wild fruits. As a result of this important finding, this study will monitor wild fruit abundance and availability along with sugarcane cycle stage to understand how the sugarcane specifically impacts the ranging, behaviour and socioecology of the Kasongoire chimpanzees.

Figure 2. Kasongoire adult male chimpanzees grooming outside the forest, in the gap between a large sugarcane crop and the edge of the forest fragment.

Habitat surveys

Over the 2 months, my assistant and I walked a total of 540x10m of habitat transect lines in Kasongoire and recorded a total of 199 stems belonging to at least 7 families and 15 species (Table 2). The vegetation in the Waibira home range has been monitored previously; therefore I focussed my habitat pilot surveys at Kasongoire. However, for the main study the habitat will be surveyed in both forests. Several species of plants were unidentified and others were seen but did not fall within the transect sampling area. During the main study period I will be assisted by a trained botanist with extensive experience of Kasongoire forest and will collect voucher samples for later identification at either the BCFS or Makerere University Herbarium.

A variety of habitat types can be found within the small forest area at Kasongoire, including mixed swamp forest which is dominated by the wild date palm *Phoenix reclinata* (65% stems), although this extremely high density may perhaps be reflective of the area sampled (primarily mixed swamp forest) and not representative of the network of forest fragments as a whole.

The species richness found was much lower than in Budongo Forest (Table 3) and also much lower than Bulindi, another highly fragmented riverine forest 17km southwest of Kasongoire. Whilst further sampling will alter these preliminary results, this finding might reflect the high level of habitat degradation and may explain the high occurrence of cultivar feeding over wild food items by chimpanzees at Kasongoire. Almost all of the above species are feeding trees, yet data collected on phenology showed that only a couple of important fruit trees (*Ficus bubu)* were fruiting during the pilot study.

Table 2. Tree species recorded in transects surveys at Kasongoire forest, including the total no. of stems (≥10 cm DBH), mean DBH (±standard error), mean height, stem density ha $^{-1}$ with comparative data from Budongo included in brackets, from McLennan & Plumptre, 2012.

Family	Species	n (N=199)	Mean DBH	(±SE)	Mean height	Stem density/ha (Budongo)
Anacardiaceae	*Pseudospondias microcarpa*	17	24.79	(4.90)	12.47	31.48 (0.9)
Arecaceae	*Phoenix reclinata*	130	16.21	(0.25)	8.55	240.74
Cecropiaceae	*Myrianthus holstii*	4	17.90	(3.18)	4.50	7.41
Euphorbicaceae	*Macaranga schweinfurthii*	8	16.48	(2.23)	7.89	14.81 (0.8)
Moraceae	*Ficus sp.1*	10	18.43	(1.83)	10.74	18.52
	Ficus sp.2	1	14.32	-	7.00	1.85
	Ficus sp.3	3	18.78	(6.21)	8.61	5.56
	Ficus bubu	1	39.79	-	12.20	1.85
	Ficus sur	1	26.74	-	14.20	1.85 (2.3)
	Ficus variifolia	6	12.68	(0.84)	8.16	11.11
	Milicia excelsa	3	14.96	(2.43)	6.80	5.56
Ulmaceae	*Celtis spp.*	5	24.64	(5.35)	10.51	9.26 (17.3-47.3)
Unknown	*Unknown sp.1*	4	32.79	(9.00)	11.48	7.41
	Unknown sp.2	3	32.79	(6.49)	11.33	5.56
	Unknown sp.3	3	25.46	(7.93)	9.10	5.56

Human activities and habitat disturbances

The level of logging at Kasongoire appears high, even in comparison to Bulindi, which is also experiencing a high level of anthropogenic pressure (Table 2). Tree stumps were primarily located within 50m of the forest edge. Small scale logging by sugar cane guards for firewood, mainly *Phoenix reclinata*, was an almost daily event and men from several kilometres away came on a couple of occasions to cut larger trees, including *Pseudospondias microcarpa* and *Myrianthus holstii*. There was also evidence of logging directly at the forest-farm interface where the forest meets Kasongoire village, which was almost certainly carried out by local villagers. We were unable to identify some of the stumps, although one stump was from a large *Ficus mucuso*, a tree that is abundant in the home range of Waibira chimpanzees but rare in that of the Kasongoire community. All of the logged species we identified in this short pilot study were important feeding trees for chimpanzees in this region.

At an introductory meeting with villagers at Kasongoire, strong concerns were expressed about the area at the forest-farm interface since it is where women and children go to fetch water and do their washing and they are afraid of chimpanzee attacks. They also show an awareness that forest loss over the past few decades had led to a much higher rate of human-chimpanzee interactions.

Table 3. Tree species diversity, density and stump density recorded at Kasongoire forest, compared with data from Budongo and Bulindi forests (McLennan & Plumptre, 2012).

	Kasongoire	Budongo	Bulindi
H'=	**1.46**	3.8	3.1
Total Tree density ha^{-1}	**368.5**	446.1	467.5
Stump density ha^{-1}	**14.8**	?	11.2

Figure 3. Examples of deforestation in the Kasongoire forest fragments. Left: A pile of *Phoenix reclinata* cut down by forest guards; right: a truck loaded with *Pseudospondias microcarpa* and *Myrianthus holstii*.

Therefore future work needs to focus on linking these two ideas in the minds of the villagers: that current forest clearance – small-scale but constant and especially close to areas where women and children frequent – will likely increase negative interactions with chimpanzees. I have been invited by local leaders to talk in the village schools during the main study, which will provide an opportunity to discuss both deforestation and behaviour around the chimpanzees to help avoid future attacks and improve perceptions of the chimpanzees by the villagers.

Snare injuries

A high proportion of the chimpanzees in the Waibra community were afflicted by snare injuries: one third of all individuals have disfigured or missing limbs. In contrast, whilst there is a far higher level of anthropogenic disturbance at Kasongoire, the incidence of snare injuries in this community appeared lower, although further contact with new individuals and better viewing and photographic records in the main study will confirm the proportion of chimpanzees affected. Whilst the Waibira chimpanzees are not in direct proximity with a village, humans are still utilising the area and there is hunting pressure even within the protected area.

It is worth noting that since the pilot study, the Budongo Conservation Field Station (BCFS) veterinary team attended to a chimpanzee in a snare in Kasongoire. I did not witness a single snare trap during the pilot and this is the first call-out to Kasongoire in some time. There are very few animals left in the Kasongoire forest fragments to hunt whereas blue duiker and bush pig, for example, are common in Budongo Forest. Therefore I am interested why the snare was set – for hunting or as a crop protection tactic. BCFS has a snare removal program which records the location of all snares found and I will record the location of all encountered traps (snares, man-traps or other methods) at Kasongoire and Waibira. I will also investigate if there is a correlation between the number of snares located and crop seasons, with the intention that these results will directly inform the BCFS snare removal and conservation outreach programmes.

Revisions to methods

My pilot study provided important information on the chimpanzee communities (such as demography) and the types of habitat exploited by the chimpanzees, but also highlighted that some of my original methods were not feasible. The main difficulty stemmed from a large proportion of chimpanzees at Kasongoire (especially the females with offspring) not being as fully habituated to human presence as I had been previously informed.

Therefore, my approach in the main data collection phase of the research will involve collecting data on a core group of individuals instead of randomly selected individuals in the community. This will ensure that I can conduct full-day follows to examine chimpanzee activity budgets, habitat use,

ranging and behaviours of interest including vigilance behaviours (e.g. bipedality) and signs of anxiety (e.g. rough self-scratching). To ensure that I record the habitat use of the whole community, I will record nests (including decay stage), knuckle prints, and signs of wild food and crop feeding during the habitat surveys.

Looking forward: Human-chimpanzee interactions and implications for chimpanzee conservation

Through monitoring the locations of human activities in the forest, including logging, setting snares, collecting water and crop-guarding, and chimpanzee ranging and habitat use, I will be able to highlight areas with high potential risk of human-chimpanzee interaction. I hope that my long-term presence there and increased interactions with the local community will have a positive influence on the way that chimpanzees are perceived locally and decrease the level of human activities which are detrimental to the forest.

Citation

McLennan M. R. & Plumptre A. J. 2012. Protected apes, unprotected forest: composition, structure and diversity of riverine forest fragments and their conservation value in Uganda. *Tropical Conservation Science* 5(1):79-103.