

How Do Primates Survive Among Humans? Mechanisms Employed by Vervet Monkeys at Lake Nabugabo, Uganda

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Introduction

Between 2000 and 2012, it is estimated that 2.3 million km² of forest was lost globally and in the tropics forest loss increased by 2101 km² per year (Hansen et al. 2013). As a result, in most countries degraded forests now exceed areas covered by primary forests (FAO 2005). It is estimated that in the 1990s secondary forests replaced at least one of each six hectares of primary forest deforested in the 1990s (Wright and Muller-Landau 2006) and that secondary forests now represent 35 % of all remaining tropical forests (Emrich et al. 2000). Cropland in tropical countries

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expanded by 48,000 km² per year between 1999 and 2008, largely at the expense of forest (Phalan et al. 2013), suggesting that many tropical areas that once were forested habitats are currently or will become a mixture of agricultural land and regenerating forest. One estimate suggests that approximately one billion hectares of additional agricultural land, primarily in developing countries, will need to be converted to agriculture by 2050 to meet the demands of the growing human populations—an area larger than Canada (Laurance et al. 2014).

Given these trends in land use, the conservation opportunities potentially available in degraded or severely humanized landscapes are dramatically increasing. However, the field of primatology has only recently turned to evaluating the conservation value of habitats other than old-growth forest and has rarely evaluated the most dramatically modified habitats. This bias likely stems from the historical objectives of the field. In early studies of primate behavioural ecology, there was an emphasis placed on studying primates in their natural environment, often with the goal of understanding the selective pressures that shaped their social organization (Struhsaker 1975; Terborgh 1983). Possibly, the need for information on the conservation of primates and because of recent interest in the transmission of diseases among humans and non-human primates, there has recently been a shift towards researching very disturbed habitats (Jones-Engel and Engel 2006; Chapman et al. 2007; Pozo-Montuy et al. 2013). In fact, a recently published book on primates in fragments (Marsh and Chapman 2013) had chapters dealing with primates in villages (Carretero-Pinzón 2013), large cities (Gordo 2013), around Buddhist temples (Aggimarangsee 2013), and in sacred forests (Cameron and Gould 2013). There are now a number of studies in Central America that focus on highly modified landscapes, such as those that demonstrate that howler monkeys walk along barbed wire among forest fragments, forage in isolated trees, or use introduced *Eucalyptus* plantations (Serio-Silva et al. 2006; Bonilla-Sanchez et al. 2012; Hagell et al. 2013; Pozo-Montuy et al. 2013). It is these sorts of highly disturbed habitats that we consider here.

In the past, conservation biologists have typically responded to change and attempted to take corrective action after negative situations have occurred (Caughley 1994; Chapman and Peres 2001); however, it would be much more effective if researchers were able to predict negative change prior to it occurring and proactively prevent population declines. This makes sense, as it is typically easier to prevent declines rather than rebuild populations, which typically involves restoring parts of the population's ecosystem. Furthermore, population decline itself results in negative situations where factors such as the risk of disease spread through small populations or loss of genetic potential must be considered in conservation/management plans. To predict declines, and not simply respond to change, conservation biologists must find general patterns across taxa and locations. However, finding such generalities has proven difficult. For example, Chapman et al. (2000, 2010) censused primates in logged and unlogged areas of Kibale National Park, Uganda, and found that red colobus (*Procolobus rufomitratus*), blue monkeys (*Cercopithecus mitis*), redtail monkeys (*C. ascanius*), and grey-cheeked mangabeys (*Lophocebus albigena*) were all negatively affected by logging, but black-and-white colobus

(*Colobus guereza*) appeared to do well in some disturbed habitats. In contrast, just a few hundred kilometres away in Budongo Forest Reserve, Plumptre and Reynolds (1994) found that black-and-white colobus, blue monkeys, and redbelt monkeys were more abundant in logged than in unlogged areas. Given such variable responses, it may be valuable to look for new means of identifying the mechanisms primates use to respond to habitat degradation. Therefore, it seems reasonable to suggest that understanding the mechanisms species use to survive in highly humanized landscapes can aid in the construction of general management plans.

The objective of this research was to investigate the mechanisms that allow vervet monkeys (*Chlorocebus pygerythrus*) to survive and prosper in the highly modified humanized landscape surrounding Lake Nabugabo Field Station, Uganda. Our study group lived in a highly modified landscape where private land owners have extensive agricultural plots, grazing areas, and trees are left in marginal agricultural land. There was one main dirt road that was not heavily used by cars, but was frequently used by small motorbikes. The monkeys cross this road at least twice a day; often by using over-hanging trees, but occasionally by running across it. The human population density in the area is 229 individuals/km², and the area has a population growth rate of 2.2%. The majority of these people in the district practise small-scale agriculture, but around Lake Nabugabo fishing is also an important economic activity, but fish stocks are declining (Vaccaro et al. 2013). With the decline in fish stocks former fisherman return to agriculture, causing its intensification, and making charcoal from local trees, thus is increasing deforestation (Vaccaro et al. 2013).

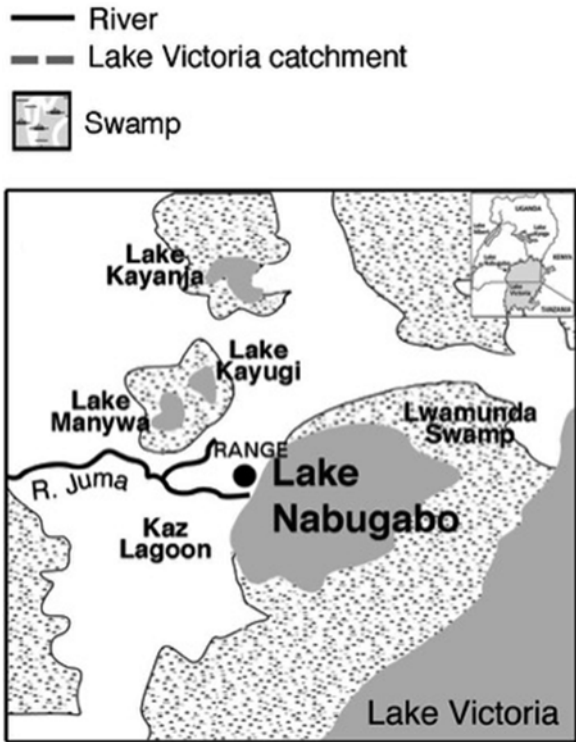
Methods

Study Site and Subjects

This study was conducted at Lake Nabugabo, Masaka District, central Uganda (0°22'-12°S and 31°54'E). Lake Nabugabo (8.2×5 km) is a satellite lake to Lake Victoria lying at an elevation of 1136 m (Fig. 1). The lake was formerly a bay of Lake Victoria, which became isolated from the main lake by an extensive swamp and sandbar approximately 5000 years ago (Stager et al. 2005). Now, much of the lake's perimeter consists of a dense wetland (Chapman et al. 2003), but the landscape on the west side of the lake is modified by humans and is a matrix that includes grasslands, patches of forest, areas with natural regenerating vegetation, farmer's fields, and a few buildings.

One habituated group of vervet monkeys called M group was the subject for this study. At the beginning of the study in June 2011, the group contained 22 individuals (2 adult males, 7 adult females, 1 subadult male, 6 subadult females, 2 juveniles, and 4 infants). By July 2012, the group contained 24 individuals (2 adult males, 5 adult females, 3 subadult males, 3 subadult females, 11 juveniles and infants). Finally, when what we report on here ended in May 2014 the group contained 30 individuals (5 adult males, 8 adult females, no subadult males, 3 subadult females, 14 juveniles and infants).

Fig. 1 A map of the location of Lake Nabugabo in Uganda, and the home range of the group next to the Lake, with the colour of the grid cell indicating how frequently the group used that cell



Behavioural Observations

The M group was followed by either the investigators or field assistants from June 2011 to April 2014 (46 months), for approximately 9 h per day (7:30 to 16:00), 10 days a month. During group contact, scan samples were taken every 30-min on general activity data with detailed data on foraging (e.g. food species, part, height from ground while foraging, and when possible, feeding rate). In addition, 2 months of intensive dawn to dusk follows were completed by JAT from June to July 2012 for 5 days per week (41 days) to calculate detailed rates of interactions and behaviours involving interactions with people and their crops. In addition to focusing on a study of the vervet monkeys' cognitive abilities (Teichroeb and Chapman 2014; Teichroeb et al. in press), during these intensive observations we were able to obtain very accurate data on the crop-raiding rate per hour, food raiding from kitchens, feeding by tourists, and events that cause alarm in the animals, such as approaches by people or being chased by dogs. The vervet group was scored as scared by people or their actions when they fled, reversed their travel direction, or alarm called in response to the event involving people (Table 1). During regular observations, data were also collected

Table 1 Rates of interactions among the vervet monkeys of Lake Nabugabo, with people and dogs during 41 days of intensive dawn-to-dusk observations that focused on these interactions

Interaction	Freq.	Rate (h)	Mean duration
Crop raiding	17	0.0407	38.8 min
Food raiding from a restaurant	1	0.0024	15 min
Fed by tourists	1	0.0024	45 min
Scared by adults	5	0.0120	
Scared by children	9	0.0216	
Scared by dogs	45	0.1078	
Dogs/children sent to chase monkeys out of crops ^a	4	0.0096	

^aEvents also included in the “scared by children” and “scared by dogs” rows

continuously on an ad libitum basis on the groups’ interactions with people, their crops, dogs, or any other human disturbance. Finally, diaries were kept to record all important events, such as births, deaths, immigration, emigration, major fights or dominance disputes, wounding, dog attacks, and negative human actions taken against the group.

Phenology of Non-crop and Crop Foods

To evaluate the temporal variation in food availability, we constructed a phenology trail system in June 2011. This system (see Chapman et al. 2005 for a detailed description of this system) involved monthly monitoring of the phenological state of an average of 74 individuals from 27 tree or shrub species that previous ad libitum observations made over 20 years indicated were eaten by the monkeys in this area. If a tree on the phenology trail was cut down by the local community members, a new individual of that species of roughly the same size was added in the subsequent month or second month as it took time to find suitable replacements. We attempted to monitor five individuals of each species, but for nine species of fruiting trees, only one tree of that species occurred in the group’s home range. Thus, we monitored an average of 2.7 individuals per species (range 1–5 individuals). At the end of the monthly collection of behavioural data, we recorded the amount of ripe fruit, unripe fruit, flowers, mature leaves, and young leaves for each of the individually marked trees. DBH of each tree was recorded and used as an index of fruit production (Chapman et al. 1992).

People planted crops along one stretch of forest edge within the group’s home range and the vervets frequently raided these crops (see below). This was the only area where crops were close to the safety of trees and thus the only area crop raiding was possible without the vervet monkeys placing themselves in great danger from free ranging dogs. To quantify crop availability and stage of ripe-

ness, one observer measured all vegetation types along this stretch of forest. This included fallow land (grass and bushland), the crop species, and its stage of ripeness. Behavioural observations of crop raiding was used to inform us of the particular stages where each crop was a suitable food (e.g. vervets eat beans as soon as the stems are emerging and once the bean fruit is ripe but rarely this plant in other states).

Ranging

Every 15 min the location of the group was determined using a grid cell system overlaid on a Google Earth Image of the area. The image was of a high enough resolution that many individual trees known to the observers could be identified on the image, enabling us to accurately determine the location of the group at all times. The cells were approximately 36×36 m. The frequency of use of each cell was determined over the course of the study. To quantify ranging, first the google image was georeferenced to the local grid system using ArcGIS (ESRI Version 10). Here, the origin of the coordinates was selected to be identical to the hand-drawn Cartesian coordinate system superimposed on the original image. Therefore, the bottom left corner of the image served as the 0,0 point, whereas the *X* and *Y* coordinates matched the values of the 1 cm long co-ordinates along the map (i.e. one unit of the georeferenced image (36 m) was equal to 1 cm).

Subsequently, the *X* and *Y* locations for each observation, as recorded in the field, were extracted from an excel file and converted to a GIS layer containing points representing each observation in ArcGIS. Further, a GIS layer was created where each cell of the hand-drawn grid system was converted into a polygon. We then counted the total number of observations (as points in the GIS layer) per cell of the hand-drawn grid. This total count is shown using equal-interval choropleth mapping, where darker hues highlight cells with higher number of observations.

Results

Behaviour

For animals (excluding infants), approximately one third of their activity budget involved feeding (34.3 %). They also travelled a great deal (21.2 %) and spent approximately 18.3 % of their time resting (Fig. 2). The average amount of time spent playing was 5.5 %, but this high value was driven by play of sub-adults who spent 4.5 % of their time playing, while adult males only spent 0.4 % of their time playing. Clear differences among age and sexes were

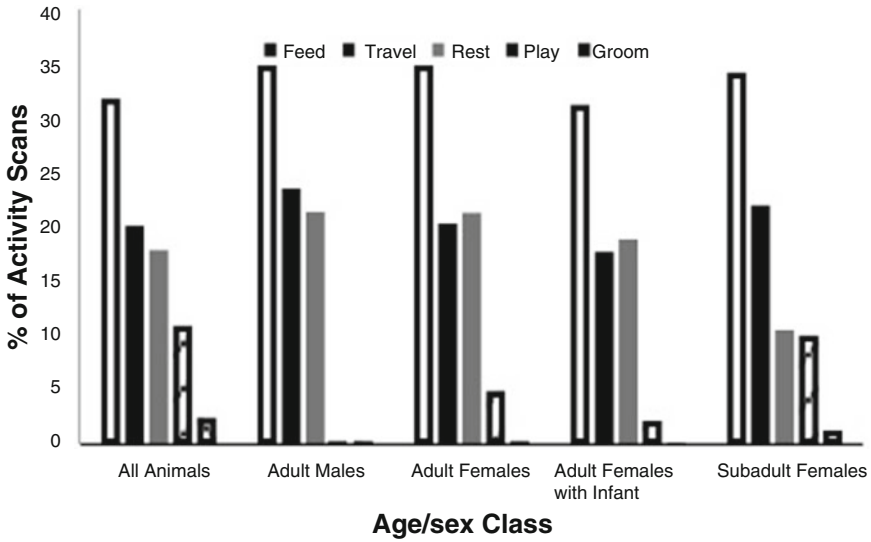


Fig. 2 The average activity pattern of a group of vervet monkeys living in the very humanized landscape near Lake Nabugabo Research Station, Uganda

evident as was variation associated with whether or not a female had an infant. There was little seasonal variation in the group’s activity pattern (data not shown), which may have been driven by the fact that, with the exception of a peak of rain in April, rainfall was not highly variable resulting in relatively constant fruit production as proxied by the proportion of trees on the phenology trail bearing fruit (Fig. 3).

Diet

The group was observed feeding on 4690 food items. The animals frequently fed on an item rapidly and only ate one or a very few of these items, except when they fed in large fruiting trees. The 3757 instances where we positively identified the food item indicated that they are very reliant on fruit, which made up 77 % of the plant parts consumed (59 % ripe, 17.9 % unripe) and 69 % of all feeding events, including those feeding events on insects (Fig. 4). Flowers (7.6 %) and young leaves (4.0 %) made up only a small portion of the plant diet. Insects, were relatively important in their diet making up 10.6 % of feeding events and the vervets ate a great variety including dragon flies, termites, cicada, beetles, and many insects that could not be identified as the vervets typically grabbed the insect and rapidly ingested it. In 20 % of these events, the item could not be positively identified as a particular plant species and the item (e.g. fruit, young leaves, and flowers) could not be recognized in 83 % of the unidentified events because

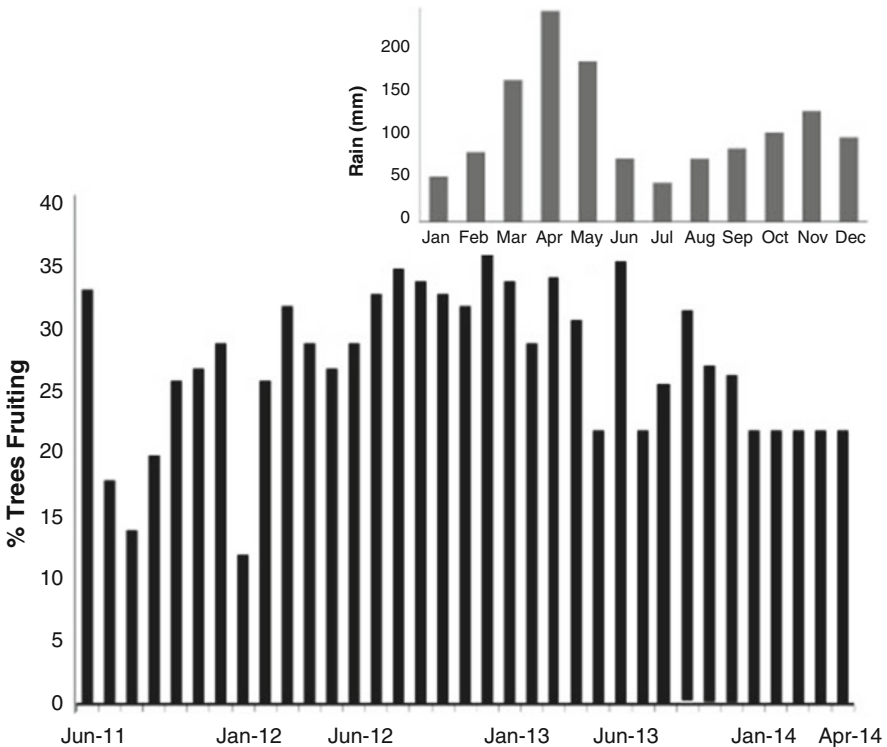


Fig. 3 The percentage of vervet monkey plants (trees and shrubs) that were fruiting between June 2011 and April 2014 (46 months; on average 74 plants were monitored each month) in the Lake Nabugabo area of Uganda. Inlaid into this figure is the average monthly rainfall of 2010 and 2011

the animal was obscured from clear view, but could be seen to be eating (11%), or the event was of very short duration (6%).

Given the degraded nature of their home range, it was surprising that their plant diet was fairly rich and 49 species of food items (e.g. soil) made up 90% of the diet (Table 2). The five most important plant species were *Pseudospondias microcarpa* (8.9%), *Lantana camara* (7.7%), *Maecosopsis eminii* (6.3%), *Ficus natalensis* (5.2%), and *Pycanthus angolensis* (4.5%). The vervets primarily ate the fruits of these species when seasonally available, with the exception of *Lantana camara*, which is an exotic shrub that fruits year round. Just these five species made up a third of the group's plant diet.

Of the plants eaten, 17 were native, 16 were exotic to the region, 9 were edible crops planted for human consumption, and 7 were species of trees planted for fuelwood. It is likely that a number of the native tree species were also planted because many of them are good timber trees useful for the construction of boats. As might be expected for a degraded habitat where large trees are extracted for timber for building or for the construction of boats, the average size of the trees (shrubs, like *Lantana camera*, excluded) was small (mean = 38.2 dbh, median = 32, range = 2 to 144, $n=2191$ (Fig. 5); compare to Bonnell et al. (2012).

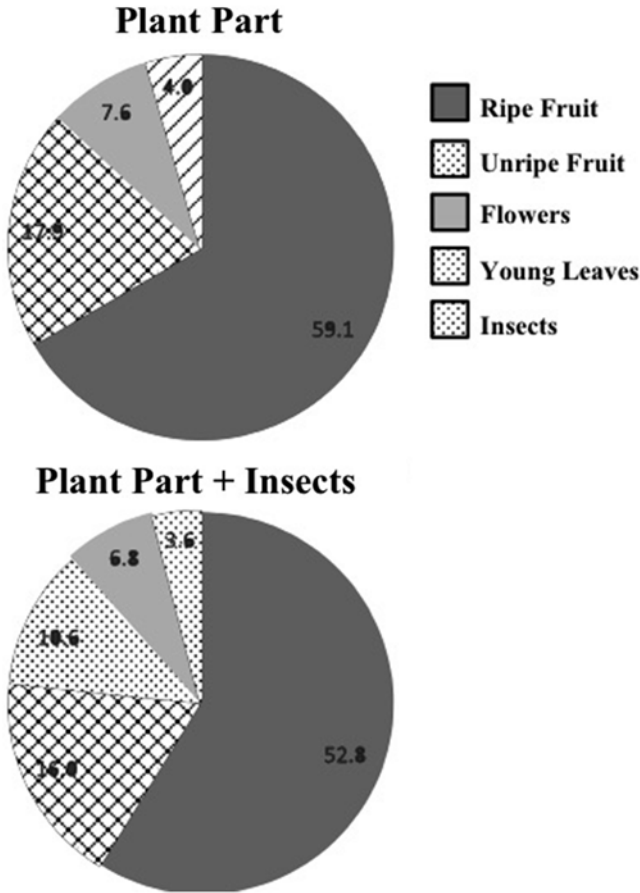


Fig. 4 The percentage of scans where a vervet monkey of the Lake Nabugabo, Uganda study group were observed feeding on different plant parts between June 2011 and April 2014 (46 months), excluding (a) and including (b) foraging on insects

Ranging

Summing the number of cells used indicates that the group used an area of 11.6 ha. The intensity of grid cell use (Fig. 6) was highly variable from 1 (areas of open pasture that the group ran through) to 312 (a forested area with many fruiting trees). In general, the areas of most intense use were forested areas far from crops. The group frequently travelled along the very edge of the lake on a cliff side, which likely made a very safe travel route where dogs, their only terrestrial predator, could not access them on the ground.

Table 2 The food species and frequency of consumption of items eaten by the vervet monkeys of Lake Nabugabo, Uganda

Species	Common name	Total	Frequency	Cumulative percent
<i>Pseudospondias microcarpa</i>		333	8.9	8.86
<i>Lantana camara</i>		290	7.7	16.58
<i>Maesopsis eminii</i>		236	6.3	22.86
<i>Ficus natalensis</i>	Fig	195	5.2	28.05
<i>Pycnanthus angolensis</i>	African nutmeg	168	4.5	32.53
<i>Rauvolfia vomitaria</i>		143	3.8	36.33
<i>Elaeis guineensis</i>	Oil palm	119	3.2	39.50
<i>Syzygium</i>		118	3.1	42.64
<i>Garcinia huillensis</i>		107	2.8	45.49
<i>Pachystela brevipes</i>		84	2.2	47.72
<i>Manihot esculenta</i>	Cassava	81	2.2	49.88
<i>Harungana madagascariensis</i>	Haronga	73	1.9	51.82
<i>Ficus congensis</i>	Fig	70	1.9	53.69
<i>Alchornea cordifolia</i>		67	1.8	55.47
<i>Baikiaea isignis</i>		62	1.7	57.12
<i>Securinega virosa</i>		61	1.6	58.74
<i>Beilschmiedia ugandensis</i>		60	1.6	60.34
Soil		60	1.6	61.94
<i>Mangifera indica</i>		58	1.5	63.48
<i>Blighia unijugata</i>		57	1.5	65.00
Dead wood		57	1.5	66.52
<i>Senna siamea</i>		55	1.5	67.98
<i>Ficus exasperata</i>	Fig	49	1.3	69.28
<i>Senna</i> sp.		47	1.3	70.54
<i>Lantana camara</i>		47	1.3	71.79
<i>Teclea nobilis</i>		44	1.2	72.96
<i>Hibiscus sabdariffa</i>	Hibiscus	43	1.1	74.10
<i>Kisuula</i>	Local name	42	1.1	75.22
<i>Kakupa</i>	Local name	41	1.1	76.31
<i>Prunus africana</i>		38	1.0	77.32
Red Berry	Local name	35	0.9	78.25
<i>Calistamom citrus</i>	Bottle brush	34	0.9	79.16
<i>Psidium guava</i>	Guava	33	0.9	80.04
<i>Jacaranda</i>	Jacaranda	32	0.9	80.89
<i>Trichilia emetica</i>		30	0.8	81.69
<i>Mussapiem</i>	local name	29	0.8	82.46
<i>Dovyalis macrocalyx</i>		28	0.7	83.20
<i>Carissa edulis</i>		27	0.7	83.92
<i>Ekebergia senegalensis</i>		25	0.7	84.59
<i>Ipomea batatas</i>	Sweet potato	25	0.7	85.25

(continued)

Table 2 (continued)

Species	Common name	Total	Frequency	Cumulative percent
<i>Monodora myristica</i>		24	0.6	85.89
<i>Morus alba</i>	Mulberry	24	0.6	86.53
<i>Zea mays</i>	Corn	23	0.6	87.14
<i>Grevilia robusta</i>		23	0.6	87.76
<i>Spathodea campanulata</i>		22	0.6	88.34
<i>Musa</i>	Banana	22	0.6	88.93
<i>Balanites wilsoniana</i>		18	0.5	89.41
<i>Citrus sinensis</i>	Orange	18	0.5	89.89
<i>Antiaris toxicaria</i>		17	0.5	90.34

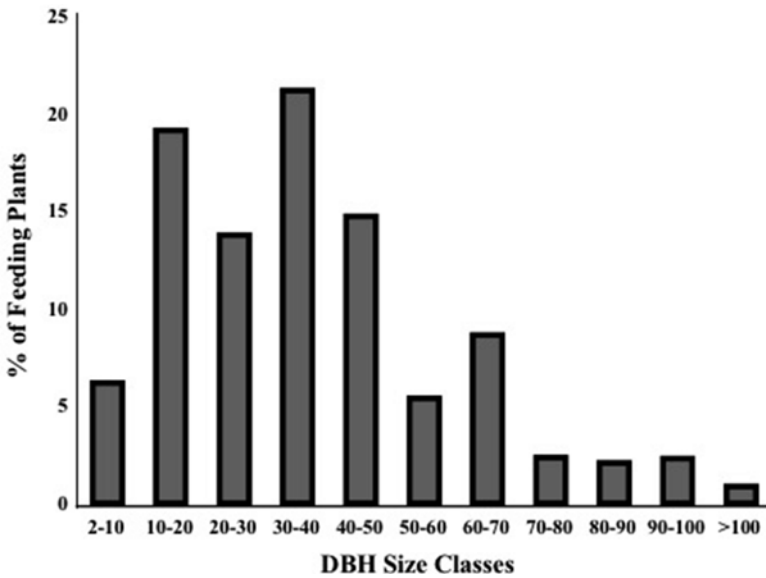


Fig. 5 The average size (DBH) of food trees used by the vervet monkeys of Lake Nabugabo, Uganda. The categories go from 2 to 10, 10.1 to 20, 20.1 to 30, etc., but the 0.1 was omitted for simpler presentation

Interactions with Humans

The vervet monkeys of Lake Nabugabo live in a humanized landscape and interactions with people and associated animals and products are frequent. We focused on these interactions during 41 days of observations. The monkeys raided crops approximately once every second day for a mean duration of 38.8 min per day (Table 1). The group was scared by people or dogs 59 times (on average 1.2 times a day).

Over the entire 46 months, more dramatic events occurred on rare occasions. These included seven animals who were poisoned by bananas baited with herbicide with the

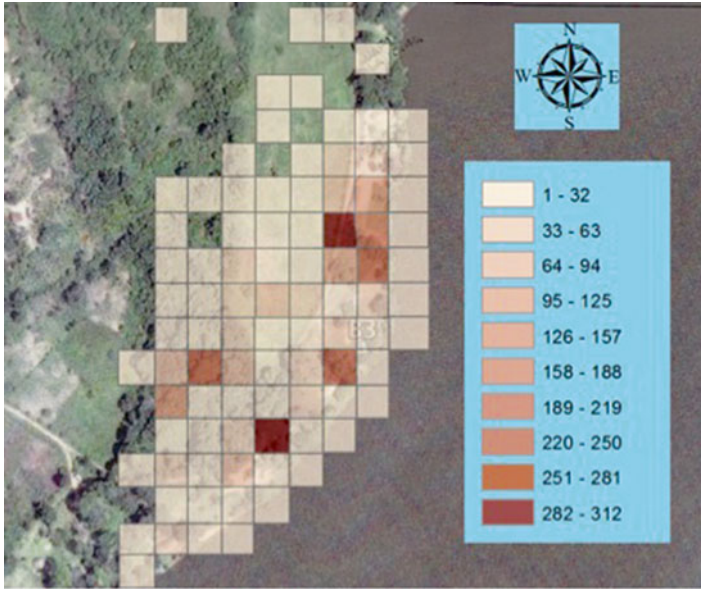


Fig. 6 The range of the vervet monkeys study group at Lake Nabugabo, Uganda. The cells were approximately 36 m by 36 m and the intensity of the colour indicate the intensity of grid cell use

intention of decreasing crop raiding, one animal who was speared because the hunter liked the skin, two animals that were captured and kept as pets (both eventually escaped and joined groups), one animal was electrocuted on power lines and died (two animals were electrocuted and survived), and two animals that were killed by dogs.

The vervet's landscape was also dynamic. In 2011, two areas were cleared for the production of charcoal (~3600 and ~6600 m²), while numerous small areas were left to regenerate or were regenerating for a year or more only to be cleared again for agriculture. A much larger area was cut in a neighbouring forest reserve for timber and charcoal, and it is possible that this could occur in our study site. It is the cutting of large trees that likely has the most serious impact on the vervets because many of their most frequently eaten foods came from species that only bear fruit once they reach a large size (Table 2).

Discussion

As different regions experience forest loss due to anthropogenic land conversions and climate change, understanding the adaptive behaviours that facilitate the use of fragments and landscapes like Nabugabo becomes critical to predicting which species will be most threatened in the future. The vervets of Lake Nabugabo were very capable of surviving in this type of environment and the increase in group size and the numbers of infants and juveniles at the end of the study suggests that they can at times even prosper in highly humanized environments. This is despite some very

negative interactions with the local human community that included such events as the intentional poisoning of seven animals, the spearing of another, and the constant danger of dogs. Given their ability to persist in this humanized landscape, the question is what are the mechanisms they use to respond to habitat degradation and the dangers that this environment presents? We suggest that mechanisms to deal with disturbance might be most evident in severely degraded habitats such as the one we studied.

Activity budgets can be variable depending on group size and composition (Isbell and Young 1993; Henzi et al. 1997, 2013); nonetheless behavioural patterns at the human-modified Lake Nabugabo were not very different from those reported for vervets at other less disturbed sites (Table 3). This might be because crop raiding and food obtained from other human sources was still a relatively small part of the diet at Nabugabo compared to foods eaten from the forested areas. When human food has been found to make up >50% of the diet, vervets have been reported to feed for a smaller proportion of the day and rest and socialize more (Saj et al. 1999). This is a pattern also observed in other primate species living in environments, where human food sources are readily available (e.g. *Papio anubis*, (Forthman-Quick 1986); *P. cynocephalus*, (Altmann and Muruthi 1988); *Macaca sylvanus*, (Fa and Southwick 1988); *M. mulatta*, (Marriott 1988; Jaman and Huffman 2013)). Presumably these animals benefit from having easily accessible, high-calorie food sources and can spend less time searching for resources compared to populations living in areas undisturbed by humans.

Two mechanisms that vervets use to adapt to humanized landscapes become apparent from our data. The first is that they appeared to be able to prosper using the food they had available to them. This was generally much reduced compared to that found in old-growth tropical forest (Chapman et al. 2002), but not reduced relative to woodland (Struhsaker 1967, 1976) where they also thrive. As a result, we suggest that their evolution in areas such as riverine forests and woodlands may have pre-adapted them to survive in degraded humanized landscapes. They have a generalized digestive system and show great variability in their diets depending on where they are located (Lee 1984; Clemens and Malaoiy 2009). Additionally, they raid crops (Naughton et al. 2011) and take advantage of occasional opportunities, such as food handouts from locals or tourists. We would like to point out that Lake Nabugabo is somewhat of an idiosyncratic or unique setting; likely all areas are atypical in some way. For example, a number of the large food trees are on land owned by relatively wealthy land owners who have positive attitudes towards nature and can afford to have these attitudes (e.g. this land owner is not struggling to get school fees for their children for the next year). One of the best examples of this is that one of the largest and most frequently used *Pseudospondias microcarpa* trees (the most frequently eaten plant) is on the land of the Lake Nabugabo Field Station, and we have no intention or need to cut the tree down.

The second mechanism that likely facilitated the survival of the vervets in this humanized landscape is the sentinel behaviour of the males; a relatively unique behaviour for a primate. During sentinel behaviour typically males will take a prominent position, often relatively high in a tree on the forest edge and scan for approach-

Table 3 Mean activity budgets for vervets (*Chlorocebus pygerythrus*) in anthropogenically disturbed versus undisturbed environments

Site	Disturbed?	Human food	N	Feed	Rest	Travel	Social		Reference
							Total groom	play	
Samara, South Africa	N	Low	2	31.7	33	24.6	10	NR	Pasternak et al. (2013)
Blydeberg, South Africa	N	Low	1	42	17	15	26	NR	Henzi et al. (2013)
Windy Ridge, South Africa	N	Low	1	32.8	30.6	18.4	NR	6	Baldellou and Adan (1998)
Amboseli, Kenya	N	Low	3	40	32	25	5	NR	Lee (1984)
Amboseli, Kenya	Y	High	1	18.9	43	16.5	20	NR	Brennan et al. (1985)
Entebbe Zoo, Uganda	Y	High	1	26.3	44.3	14.2	11	NR	Saj et al. (1999)
Nabugabo, Uganda	Y	Medium	1	34.3	18.3	21.2	x	X	This study

ing predators, giving alarm calls if a predator is seen (Cheney and Seyfarth 1981; Horrocks and Hunte 1986). We know the free ranging dogs are dangerous for our population as two animals were killed by dogs. Mortalities caused by domestic dogs have also been described for *Alouatta pigra* (Ramírez-Julián et al. in prep) and *Cebus nigrinus* (Oliveira et al. 2008) populations. Thus, the vervet's antipredator behaviour may reduce human-related mortality.

The question that logically stems from this research is: "what can be done to promote conservation in these very humanized landscapes?" Redtail monkeys (*Cercopithecus ascanius*) and mangabeys (*Lophocebus albigena*) were once common in this area, but are now only found in distant forest reserves, but maybe this situation can be changed. Angolan colobus monkeys (*Colobus angolensis*) are still found in the larger forest patches. In such situations, for any conservation initiative to be successful, community involvement becomes critical. The conservation model of Juan Carlos Serio-Silva and colleagues (including CAC) for the howler monkeys of the fragmented habitats of the Municipality of Balancán of Mexico provides a possible roadmap for a conservation approach (Ramírez-Julián et al. in prep), but it will have to be adjusted to the local situation. First, it would be critical to work at all political levels to obtain agreements concerning forest conversion and prohibitions against negative human activities, such as poisoning. Second, in Mexico they established a protected area for the howler monkeys. This is possible in the Nabugabo region as some government controlled forest reserves still exist. However, these areas would have to receive adequate protection against further extraction of any sorts (Mugume et al. 2015). Third, it would be necessary to promote environmental education and to inform the community of the perspective that wildlife, including vervets, and the forest are important and of value. This will be difficult given the crop-raiding behaviour of the monkeys. One element the community may relate to is the fact that the vervets disperse the seeds of many of the important timber and fruiting trees in the region. The fourth element of the Mexican plan was to make the official declaration of the importance of primate widely known to the local community. This involved a celebration that involved popular lectures, workshops offered simultaneously, for children and adults, cultural activities such as dancing, singing, poetry, theatre, painting of a mural, and movies (all primate related). Fifth, in Mexico school children planted trees to help connect fragments and limit terrestrial locomotion in an effort to limit predation by dogs. Limiting terrestrial locomotion may not be critical for the more terrestrial vervets, but planting food trees away from crops may help both sustain the population and draw the vervets away from crops. Finally, since there is tourism in the area around the lake, training field guides to take tourists for local guided walks would increase the exposure of the importance of the vervets and other primates and their habitat, providing much needed jobs and revenue for the community.

It is our hope that these activities will be initiated in the near future and will connect the results of the research to real conservation that will operate on a landscape level on privately owned land. This outreach and the fate of the monkeys are being monitored so we can determine the value of this conservation model.

Acknowledgments Funding was provided by Canada Research Chairs Program, Wildlife Conservation Society, Natural Science and Engineering Research Council of Canada, National Geographic, Fonds Québécois de la Recherche sur la Nature et les Technologies, and the National Science Foundation. Permission to conduct this research was given by the National Council for Science and Technology and the Uganda Wildlife Authority. We would like to extend a special thanks to the field assistants; Matovu Ponsiano, Livingstone Katwere, and Maxine White. We thank Lauren Chapman, Cynthia Liu, and Kathleen Godfrey for helpful comments on the research.

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