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Full Length Research Paper

Ecological habitat assessment: the selection of a re-introduction site for yellow baboons (*papio cynocephalus*) in Kasungu national park, Malawi

Valentine Buh Ebua[1]*, Tsi Evaristus Agwafo [2] and Mpoame Mbida[1]

[1]Department of Animal Biology; Faculty of Science, University of Dschang
[2] Interdisciplinary Laboratory of Wildlife and Nature Protection, Department of Forestry, University of Dschang

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Four ecological habitats were identified as possible release sites for the re-introduction of rehabilitated Yellow Baboons into Kasungu National Park. The aim was to choose a site with the best habitat quality that could be viable to sustain a group of 28 yellow baboons in the wild after many years of captivity. Of the four sites chosen, one of the sites (Dwangwa) had existing baboons and it was surveyed to better understand the ecology of yellow baboons in the area thus acted as a prototype. Knowledge gained in this site guided us in carefully choosing the best release site from the other three sites: Lisanthu, Kachenje and Lower Lingadzi. Surveys were conducted for one year in all the four sites. Of the three potential sites, Lisanthu was the best because it provided sufficient food and water resources, had a low density of predators, was from a reasonable distance (21 Km) to the nearest human settlement, had good sleeping and predator avoidance sites for yellow baboons and could be adequately protected. Botanical surveys identified 24 tree species including more than 100 yellow baboon foods available with water in this site throughout the year. This site also had a low density of resident yellow baboon population. Although the area had experienced and had evidence of poaching, the implementation of conservation and the creation of a research and ranger camps in the Park in 2009 increased the level of protection both for yellow baboons and wildlife.

Key words: Ecological habitat assessment, yellow baboons, release site, re-introduction Kasungu National Park

INTRODUCTION

According to IUCN guidelines for re-introduction (1998) and Beck *et al*, 2007; re-introduction should only take place where the original causes of extinction have been removed because re-introduction is a particularly useful tool for restoring a species to an original habitat where it has become extinct due to human persecution, over-collecting, over-harvesting or habitat deterioration, but where these factors can now be controlled. One of the most widely discussed models of habitat selection is the *Ideal Free Distribution* developed by Fretwell and Lucas (1970). This theory predicts that animals will distribute equally in different patches depending on the habitat suitability, thus following an optimal foraging strategy. First, the theory assumes that animals are “ideal” which means that they are omniscient, are of equal competitive abilities and that they will always go to the more suitable territory in order to maximize their fitness. Secondly, animals are considered “free” meaning that they can enter any patch on an equal basis without restrictions or costs. However, these assumptions are hardly ever met in a natural environment.

Therefore, the *Ideal Free Distribution* theory has been reviewed in many studies and modified to include several factors such as interference, differences in competitive abilities (Parker & Sutherland 1986), perceptual constraints, and resource dynamics. Nevertheless, as the assumptions are often falsified, more field studies are needed to better understand the patterns of habitat selection. Moreover, as the way animals use their spatial environment is a complex system that depends on various factors changing over space and time, the understanding of the dynamics, distribution and

*Corresponding authors: E-mail: ebuaval@gmail.com

adaptation of animals stays one of the fundamental challenges in resilient ecology.

Food acquisition and predator avoidance are two main elements of the survival strategies of most animals. An optimal use of habitat is one way that allows animals to deal with these conflicting demands. Although some studies report that habitat choice is determined by food distribution (Batzli & Lesieutre 1991) others demonstrate that the predation risk plays a major role in the resilient behaviour of animals. Thus, habitat selection seems to be a trade-off between predators and the spatio-temporal distribution of limiting resources. More recently, Willems and Hill developed a single spatial model to quantify the effects of these two environmental conditions in a vervet population as well as the effect of the distance to water and the sleeping sites (2009).

Thanks to their model, they demonstrated that the ranging behaviour of the monkeys can be influenced both by predation risk and resource distribution as they avoided areas where the risk of predation was perceived to be high although they tried to increase their local resource availability by choosing the ideal habitat type. However, other factors that might influence the way in which an animal use its environment include vegetation density, landscape structure, topography, presence of conspecifics, water accessibility (Ernest & Mares 1986) or seasonality. Thus, this research focused on three factors that might influence the resilient ecology of baboons prior to their release: predation, food and water resources and sleeping sites (Altmann, 1974). This allows researchers to have a well understanding of the biology of our focal animals not forgetting a fourth factor the attitudes of the local people.

Habitat selection is the process that an animal uses to choose the habitat in which to live. This choice is first determined by the evolutionary costs and benefits of using each habitat types available in a home range, but it is also influenced by different factors at different levels of organization (Hutto 1985). Johnson defined four order of habitat selection (1980). The first-order selection corresponds to the description of the geographical or physical range of a species. The second-order selection determines the home range of an individual or a social group. The third-order selection indicates the habitat use within the home range. Finally, the fourth-order selection determines the core area of an animal where resources can be found, such as a feeding site or a sleeping site. As spatial scale might influence the utilisation of an environment by an organism, the choice of the scale for a release site is really important (Wheatley & Johnson 2009). Indeed, several authors have demonstrated in their studies that habitat selection can differ between two scales even within a species (Altmann and Altmann, 1970). Moreover, patterns of habitat selection being species-dependent, it has long been studied on several animals such as amphibian fish, reptiles birds, mammals and primates.

The selected release site needs to be sufficient to sustain the reintroduced individuals and support a self-sustaining, potentially increasing, population in the long run.

It is therefore necessary to estimate the carrying capacity of the release site and the risk of harm accruing to reintroduced animals from existing wild monkey troops, and vice versa. Potential impacts on the other existing animal (mostly predators) and communities will also be considered. Habitat selection by primates is observable by the non-random use of available vegetation types, with some used relatively more than others for different purposes, or some used exclusively (Fretwell and Lucan, 1970).

MATERIALS AND METHODS

Study Site

Kasungu National Park is Malawi's second largest (over 2,500km2) lying at approximately 1,100m above sea level. It is situated in the Kasungu Town, it's on grid reference 33º 30'East and 13º 03' South at about 127 kilometers North of Lilongwe, the Capital City in the Central Region of the Republic of Malawi as shown in figure 1. Kasungu District is bordered by Zambia to the West, Mchinji District to the Southwest, Dowa and Lilongwe districts to the South, Ntchisi and Nkhotakota districts to the East and Mzimba District to the North. Kasungu provides some of the best available game viewing in the country, particularly at the end of the dry season from August to November, a time when waters levels begin to dwindle forcing the animals to stay close to the remaining watering holes in the park.

The Park is warm from the months of September to May and cooler from June to August. Most years the park is closed during March, maybe earlier if the rains are heavy. Kasungu Township experiences a warm tropical climate which is influenced by the Inter-Tropical Convergence Zone (ITCZ) of the African Continent. The climate is dominated by distinct wet and dry seasons. Its temperature ranges between the average of 9 and 32 degrees Celsius. The monthly average temperature is 22 degrees Celsius. The hottest month is October with June as the coldest. Situated in the lowlands, Kasungu receives average annual rainfall of about 763 millimeters with most of the rains falling between December and March and the highest in February. The dominant winds that blow over the township are easterlies (Peters, 1969).

The topography is generally undulating. Its landform includes Kasungu Mountain located to the West of the Central Business District, (CBD), and Kasungu- Chipala to the North-north east. Kasungu Mountain is 1451.1 metres high. The township lies on gneiss formations belonging to the basement complex. The gneiss is mainly composed of metamorphosed rocks, sedimentary and igneous origins known collectively as the Malawi

Figure 1: Map of Kasungu National Park

Basement Complex. The dominant soil types are the lateritic soils. These are sandy loam soils reddish in colour. In some areas there are river and dambo colluviums, red clay and pure sandy soils. These are well-drained soils. These soils vary in thickness. The soil pH ranges from 5.5 to 7.6, suitable for growing maize, tobacco and legumes.

The park's vegetation consists mainly of Miombo woodland broken up by grassy river channels, known locally as Dambos. A number of rivers flow through the park, the most important of which are the Dwanga and the Lingadzi, A tributary of the Lingadzi, the Lifupa, dams as Lifupa Lodge which creates the spot for game viewing within the park, especially to see the resident hippos.

The vegetation consists of *Acacia-Piliostigma-Combretum* and *Brachystegia-Julbernardia* savannah woodlands on the Lilongwe and Kasungu plains respectively. *Panicum maximum* occurs along major rivers of Lilongwe, Lingadzi and Bua whereas *Brachiaria* spp. *Setaria sphacelata, S. longiseta* and *S. splendida* are found both on higher ground and dambos. *Setaria palustris* is found on dambos only. Most of these Setaria spp. are attacked by head smut (*Tiletia echnosperma*). *Macrotyloma* spp. occurring on the Lilongwe plain consist of both annual grabrescent and pubescent types. Kasungu has a great diversity of wildlife and bird species and it is also an important dry season grazing area for migratory wildlife. It has Elephant, Buffalo, Black Rhino, Hippo, Cheetah, Leopard, Wild Dog, Oribi, Puku, Roan, Sable and other Antelopes, though poaching is, even today, a big problem. Kasungu is famed for its population of elephants. It also boasts a large variety of buck, including sable, roan, kudu, impala and Hartebeest as well as buffalo and zebra. Predators in the Park include: hyena, wild dog, leopards and serval. Non human primates found in the area are Baboons and vervets.

Data collection

Wildlife surveys

To assist in calculating carrying capacity and to determine the suitability of this park as a reintroduction site, to determine the status and groups of baboons, their existing predator index and other wild animals, the line transect census method was used (Struhsaker, 1981; Whitesides et al., 1988 and Ebua *et al*, 2011). This technique has been used effectively to survey populations of River red colobus (*Procolobus rufomitratus*) within forest patches up to 5km2 in area in the Tana River delta region, Kenya (Butynski &Mwangi, 1994; Karere *et al*., 2004; Mbora, 2004). Line transects, following the methodology outlines below, aim to give a total count of all target individuals in the given range.

The observers spread themselves at intervals and move slowly and quietly along a prescribed route at the rate of 1-1.5 km per hour, stopping periodically to watch and listen for wildlife (in groups or solitary). Distance between researchers (intervals) varied on each plot depending on the density of foliage. Provided each researcher has visual contact with the researcher to their left and/or right then the total counts aimed for was achieved. Intervals vary in size from 10m in the most densely forested patches to 200m in the low density areas such as the golf course. Transects were walked, directed by a compass, in east to west direction followed by returning west to east transect in straight lines through the plot.

This action is repeated until the entire plot area (5Km2) is covered. When the undergrowth was dense to continue in a straight line, the observer attempted to circumnavigate the thick area and continues along the same course on the other side. Upon encountering a troop of monkeys, predators or other wildlife, the observers joined together and recorded the GPS location, time of discovery, troop size, sex composition, age composition and direction of movement (to assist in avoiding for double counts). Once the count is completed the team returned to their last survey mark and continued the line transect. Each transect in the four proposed release sites was conducted once a month from 06.00 - 18.00 for one year covering both seasons. A troop was defined as all individuals, separated by no more than 50m from another monkey. Sightings of isolated monkeys or other animals are referred to as 'solitaries', if the distance to the nearest neighbouring conspecific is farther than 50m.

Prior to the census period, all field researchers took part in a pre-survey training course led by the author, to standardize recordings of group counts, age and sex classes and G.P.S. usage (Peres, 1999).

Botanical surveys

The second stage of habitat assessment required botanical transects to be conducted within the four proposed release site. Traditional transect-quadrat method was used (Whites and Edwards, 2000) cited in Chan and Packer, 2006), with ten 50m x 50m quadrat to be conducted within each release site. The first aspect was to conduct a vegetative mapping and identification of the trees used by baboons either as food or sleeping sites. In each quadrat, using the feeding ecology data, key plant families were identified, not only in terms of overall contribution to diet but also in terms of relative importance seasonally and randomly mapped, making sure that at least three of the entire tree species if available were mapped in each release site. This was then followed by phenology.

Phenology

To produce a quantitative measure of food availability, the phenological patterns of relevant tree species, within each site was mapped and monitored on a monthly basis. Phenological assessment of the trees was completed on the first of every month +/-5 days. The relative abundance of leaf buds, young leaves, mature leaves, flowers, whole fruits, and seeds on each tree was determined using binoculars. Fruits composed of pulp and small seeds i.e. figs, or those with large seeds surrounded by pulp i.e. mango, were considered whole fruits. Unripe and ripe whole fruits were pooled due to difficulty in distinguishing ripeness in the upper canopy with confidence. The same was applicable to flower buds and flowers. Plant categories were scored at intervals of 0.5 on a scale of 0.0 to 5.0 with 5.0 representing the score for a tree with the plant category at its greatest possible abundance, i.e. when the canopy was maximally laden with that category. A food item availability index (FAI) was computed based on the monthly phenology scores (Dasilva, 1994) and tree species biomass values for each study group (Whites and Edwards, 2000).

Water resources

To determine areas with water sources that can last throughout the year in Kasungu National Park mostly during the peak of the dry (winter) season, the four release sites were monitored during the months of August and September which mark the driest period to see which has water available for the monkeys to drink. Information was also gotten from the park rangers through questionnaires as concerns available water resources in the sites.

DATA ANALYSES

Data was collected on handheld computers (Palm Zire 22 or TX, Pocket pc HP Travel Companion iPAQ rx5935) equipped with the Pendragon 5.1 software and transferred onto a computer through synchronization for further analyses. Data normality was evaluated through tests of skewness and kurtosis (Ebual *et al*, 2011). Highly skewed variables were subjected to a logarithmic transformation before conducting analysis of variance and regression analyses. Statistical analyses were also performed using an interactive calculation tool for chi-square tests of goodness of fit and independence (http://www.quantpsy.org/chisq/chisq.htm). Afterwards, we used an extended chi-square test described as the Neu's method (1974) which involves the use of a Bonferroni-z test to evaluate the habitat selection of a group.

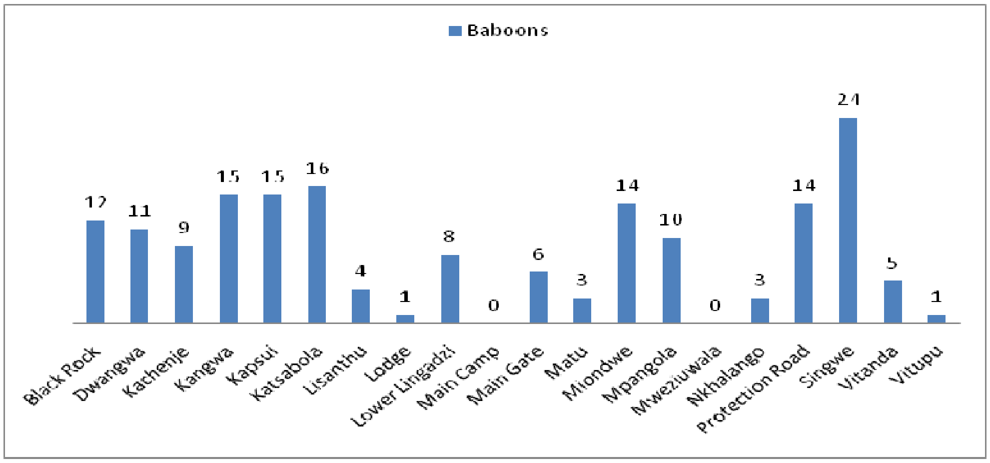

Figure 2: Showing places where baboons are found in the park and the number encountered in July 2010 (Source: Department of National Park and Wildlife-Malawi, 2011)

Table 1: Description of the overall data collected from the four proposed release sites for habitat assessment from May 2011 to April 2012 (one year)

	No of existing wildlife species (excluding predators)	**No of Baboons predators observed in the area**	**No of Fruit bearing Trees**	**Availability of water throughout the year**	**Distance from the nearest settlement**
Dangwa	12	3	18	10 months (November to September)	12 Km
Lisanthu	18	3	23	12 months (throughout the year)	21 Km
Kachenje	14	6	16	10 months (November to September)	22 Km
Lower Lingadzi	21	4	19	9 months (December to August)	30 Km

RESULTS

Historical perspectives and the protection of wildlife

The conflict between baboons and people for cultivated crops began with the immigration of non-malawians into Kasungu during the 1930s, and with the return of Moitanik and Uasin Gishu clans from northern Malawi in the 1940s, these tribes intermarried with predominantly farming tribes. Whilst Malawians groups campaigned against grass destruction, compensation for crop destruction but also brought large-scale tobacco and maize farmers into important baboon areas. This history underscores the dis-harmony between baboons and the people in park areas, which has resulted in depletion of baboon habitat. The magnitude of decline, which has been far greater been in Kasungu, is primarily because of a greater reduction of habitat, more poaching and heavier immigration through the Zambia borders. Baboons have been subjected to uncontrolled commercial hunting that in turn reduced their population size and changed their behaviour.

The park use to have the highest population of baboons in the country but because it is closer to Zambia, most of the poachers enter the boundary and hunt due to loose wildlife laws governing the protection of animals. Security and protection has been step up along the borders since 2005 and it has greatly reduced the level of poaching in the park.(Figure 2) shows the areas in the park where baboons have been identified with possible pros and cons.

During the group discussion and following the IUCN guidelines for a successful re-introduction, of the 20 sites in the national park where baboons have as home range, four (Table 1) where chosen for the study because they could satisfactorily (90 %) meet the guidelines. Only one

Table 2: Description of vegetative data (no of trees) collected per sites

Tree Species	Abbreviation	Dangwa	Lisanthu	Kachenje	Lower Lingadzi	
Strychnos spinosa	StS	55	51	66	59	
Brachystegia spicforia	BrS	79	45	60	45	
Burkea Africana	BuA	55	55	64	58	
Saba comorensis	SaC	51	52	57	60	
Cyperus notundus	CyN	52	111	12	54	
Tragia furialis	TrF	1	27	11	0	
Phoenix reclinata	Pre	0	1	51	51	
Garcia livingstonei	GaL	52	30	55	22	
Dobvyalis caffra	DoC	5	75	51	26	
Euphorbia ingens	Eup	51	54	53	62	
Alangium saviifolium	AlSa	56	70	33	52	
Cordia sinensis	CoS	31	3	0	0	
Diospyros mespiliformis	DiM	30	54	67	64	
Indigofera coluta	Inc	43	70	50	18	
Hibiscus micranthus	HiM	2	56	13	3	
Acacia robusta	ArO	63	27	23	29	
Hyphaene compressa	HyC	56	53	60	56	
Jasminum fluminense	JaF	61	16	14	5	
Digitara milanjiana	DiM	37	18	27	3	
Talinum portulacifolium	TaP	0	2	0	1	
Dobera glabra	DoG	55	57	64	54	
Tricus spp	Tri	50	57	64	59	
Phyllanthus maderaspatensis	PhM	13	21	9	0	
Terminalia spinosa	TeS	7	45	19	33	
Total		**905**	**1050**	**923**	**814**	**3692**

of the three (Lisanthu, Kechengje and Lower Lingadzi) would be selected as a release site.

A total of 3692 trees were mapped during the whole field session for the four sites using 24 tree species (Table 2) 7 of them were considered as abundant as all the groups had more than 50 trees for these species (Tri, DoG HyC, EuP, SaC, BuA, and StS), 6 species were considered as rare as they were not abundant in any groups (TrF, CoS, DiM, TaP, PhM and TeS) and 11 were abundant in some territories but not in others (BrS, Cyn, Pre, GaL, DoC, Alsa, HiM, ArO, JaF, InC). These species were considered as important key food tree species for the monkeys as shown by Vicki K. Bentley-Count (2009) who studies the feeding behaviour of Baboons for five years in the Tana River of Kenya and also what was directly observed in the field for one year. More detailed data were taken during few vegetation-surveys describing the percentage cover of trees, shrubs as well as percentage cover of grass and herbs.

Composition of the four sites and home range of the Baboons

For all the analyses, the 99% isopleths was used from the Brownian Bridge Movement Model in ArcGIS to estimate the home range sizes as it describe in a more precise and realistic way what was directly observed in the field. Average home range size was about 297.03 hectares. Dangwa had the biggest home range (389.35 ha), followed by Lisanthus (359.43 ha), Lower Lingadzi (255.21 ha) and finally the Kachenje, who had the smallest one (184.13 ha).

The percentage area of each site depending on the habitat type of the four sites was calculated from this vegetation map by using the mean of the twelve months . Three sites seem to be similar (Dwangwa, Lisanthus and Kachenje) whereas the last one is different (Lower Lingadzi).

Habitat selection of Baboons

Chi square tests were first performed to test whether baboons used their territories at random, which means that they used all habitat types in the same proportion. Then, the Neu's method (1974) was employed to calculate the 95% confidence interval, which tells the habitat preference and avoidance of each group.

For all these tests, a Bonferroni correction was needed. The observed value correspond to the number of GPS-data collected for each habitat whereas the expected value were calculated depending on the percentage area of each habitat under the condition that they used equally all the habitats. The columns "P_Exp" and "P_Obs" were needed to calculate the 95% Confidence Interval (95%-CI) thanks to the Neu's formula: *P_Obs-z*((P_Obs*(1-P_Obs)/Total_Observed)^0.5)).*It corresponds to a probability (expected or observed value of each habitat divided by the total). If the chi-square was not significant,

Table 3: Statistical analyses testing habitat selection in Dwangwa. As there is no donga forest in Dwangwa home range, only 9 habitat types were used in this analysis

DWANGWA							95 % CL		
Habitat	**Area %**	**Expected**	**Observed**	**Chi-2**	**P_obs**	**P_exp**	**Lower**	**Upper**	**Habitat**
River	3.303	43	17	15.7209	0.0331	0.0131	0.0043	0.0218	Avoided
Bare land	0.269	3	1	1.3331	0.0025	0.0008	0.001	0.0029	Neutral
Human Disturbance	0.588	8	1	6.125	0.0061	0.0008	0.001	0.0029	Avoided
Grassland	0.962	13	0	13	0.01	0	0	0	Avoided
Shrub land	3.342	44	5	34.568	0.338	0.0038	-9E-04	0.0086	Avoided
Bush land	46.583	607	221	245.463	0.4666	0.1699	0.141	0.1987	Avoided
Thicket	22.679	269	273	1.78716	0.2275	0.2098	0.1785	0.2411	Neutral
Woodland	14.06	183	550	736.005	0.1407	0.4228	0.3848	0.4607	Preferred
Riverine Area	7.997	104	233	160.01	0.0799	0.1791	0.1496	0.2086	Preferred
Total	99.783	1301	1301	1214.01					
Bonferroni corrected P (Q), n=9, z=0.0027778, z=2.773									

"Neutral" is written in the "Habitat selection" column. Inversely, if the test was significant, "Avoided" was written for a habitat used less than expected or "Preferred" for a habitat type used more than expected.

The analysis in the (Table 3) show that Baboons in the Dwangwa area; are not using their home range randomly ($\chi2=475.759$, df=8, $p<0.01$). Indeed, two habitats were used randomly whereas seven were selected. Baboons in this habitat preferred significantly the woodland and riverine area while it avoided the river, human disturbed area, the grassland, the shrubland and the bushland.

Similarities and differences between the three potential sites and Dwangwa area

In order to have a general idea of the habitat which would best suit the release troop, i.e. the site that has similar habitat preference like those baboons in Dwangwa, an effective size calculator found on internet was employed (http://www.chestnut.org/LI/downloads/ESWK.xls) it was also used by Stephanie Mercier in 2011 when she studies home range preference and avoidance between vervets groups in Mawana Reserve of South Africa. It permits to calculate the effect size (ES) of each habitat from the Chi-Square values using the following equation:

ES = SQRT ((4(chi-square))/ (n-(chi-square))),*

with n being the number of observations. A Chi-square test was performed to test whether all the selected release sites are the same way, which means that they will all have the same preference-avoidance for the habitat types but results show that the three release sites do not have the same preference and avoidance ($\chi2=3472.18$, df=24, $p<0.01$).

The baboon population living in the National Park seems to prefer the woodland, the riverine area and in a smaller proportion the donga forest while it avoids the river, the thicket, the shrubland and in a greater proportion the bushland. Although there are some similarities in the general habitat use between the three release sites, some differences might appear in the analyses of each site.

Then ten tests were performed to see which release site has characteristics that will favour the survival of the re-introduced baboons most. Thus a Bonferroni correction was used with α'= 0.05/10 = 0.005. Six out of ten habitats types differ between the groups; the river ($\chi2=38.583$, df=3, $p<0.0001$), human disturbed area($\chi2=35.373$, df=3, $p<0.0001$), thicket ($\chi2=105.02$, df=3, $p<0.0001$), woodland ($\chi2=734.627$, df=3, $p<0.0001$), riverine area ($\chi2=903.555$, df=3, $p<0.0001$) and the donga forest ($\chi2=2326.669$, df=3, $p<0.0001$

The results shows that out of the three release sites compared with Dwangwa, Lisanthu has similar characteristics or even more than Dwangwa in habitat types like Woodland and Riverine areas which are areas preferred by baboons in the park.

Sleeping sites

Since sleeping sites can be an important factor influencing the habitat use (Harrison 1983), it was important to look at which habitat types do the monkeys from the study site use as their sleeping sites(Figure 3 and 4). For that, the first point of the day as well as the last point in the evening was considered as the area of their sleeping sites since the monkeys are supposed to rest and sleep all the night.

First, a chi-square analysis was performed to see whether the baboons are using all the habitat types equally as their sleeping sites. Significant results indicate that the monkeys are not using the habitats types randomly to sleep in but they have some preferences ($\chi2=827.104$, df=9, $p<0.01$). Thus, additional chi-square analyses Bonferroni-corrected (with an α'= 0.05/ 6 = 0.00833) were performed to look at which habitat types is used as sleeping sites in Dwangwa.

Four habitat types have been identified by different researchers to be used as sleeping sites: thicket, woodland, Riverine area and the donga forest in Kenya

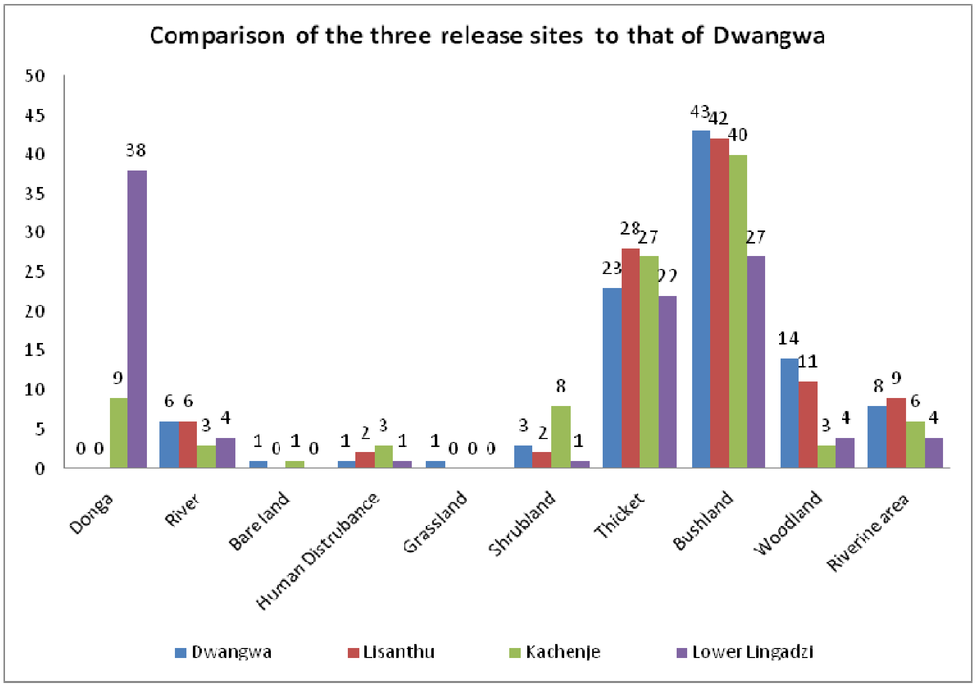

Figure 3: Comparing the three potential sites to chose the best suitable area for re-introduction in the park

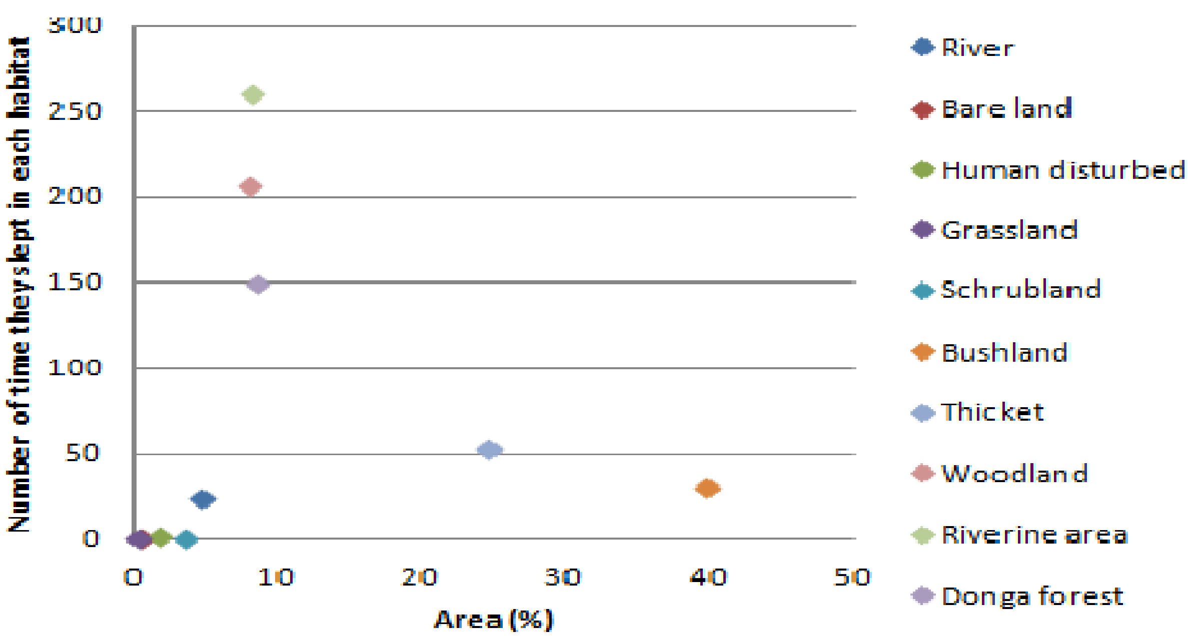

Figure 4: Graph showing the number of times the baboon slept in each habitat type depending on its percentage area.

and South Africa. Each group seems to have a preference for a certain habitat types.

In Dwangwa, two habitat types where preferred by the baboons (Woodland and Riverine areas). However, a Spearman rank correlation was realized thanks to SPSS PASW Statistic 18 to see whether the use of the habitats as a sleeping site could be correlated with their percentage area. A strong positive correlation was found between the number of times the baboons slept in each habitat with its percentage area (Spearman rank correlation, r=0.754, p=0.012, n=10). Although the significant correlation implicates that the number of sleeping sites is higher in the more abundant habitat types.

DISCUSSION

The main aim of this study was to select a release site for re-introduction. To do this, we selected four sites. In order to effectively know the ecology of baboons in Kasungu National park, one of this sites (Dwangwa) was chosen because it had a troop of baboons. Data collected on this site was used as a prototype to determine which of the other three sites (Lisanthu, Kachenje and Lower Lingadzi) could be suitable for our release troop. In order to have effective and accurate information, all the four sites were studied and data collected during the same period.

The decision to choose a suitable release site was a nightmare especially from the Malawian Department of Parks and Wildlife due to the old fashioned and previous methods of releases practiced by other programmes. Our methodology and new scientific approach was least understood but this led us to a three day discussion to assess the attitude and perception of the local people towards conservation, protection and management of National Park and its resources, discuss the re-introduction guidelines for a successful re-introduction and discuss the pros and cons of the four selected sites.

These sites were selected because they have water all round, a good view point and a near basement camp for the research team while the other sites were neglected because they either contained tse-tse fly, too far and inaccessible during rains, or close to the borders, large and very big existing troop of baboons more powerful than our release troop, too large sites with no exact data as of the précised location of baboons in the areas.

Habitat assessment

The vegetative data collected in the field was used to define ten habitats types that are present in the study sites and to describe their vegetative composition (bare land, bushland woodland, thicket, riverine areas, donga, human disturbed area, shrubland, grassland and river). Emphasis was laid on trees species considered important (used as food and sleeping sites) for the monkeys.

Twenty four trees were mapped and accurate vegetative data was gotten by using 5Km2 transect and also by observing all the species eaten by baboons in the field. Although the four sites were located in different places, the vegetative composition is similar, indeed Lisanthu had the best vegetation in terms of woodland and riverine areas preferred by baboons eventhough it's 35 Km away from Dwangwa. Lower Lingadzi was the least similar because it's on a slope with a lot of dongas, rocky and trees in the valleys.

Wildlife surveys in the areas for one year indicated that all the areas had baboons but with very small troops, during the driest months of the year, Lisanthus has streams with water all round and most wildlife will pass round for drinking. These three sites had predators but in very small numbers. The most common predators are birds of prey like eagles; pythons and leopards.

Re-introduction site selection: an optimal use very necessary for an animal survival

The results concerning a suitable habitat or site selection for our release troop of each site were significantly different in habitat types. The first difference of habitat types explained the ecology because baboons have to select a habitat offering them the best conditions, which in this case has shown to be woodland and riverine areas.

The choice of a release site can be explained by an optimal use of a home range, it serves logically that all animals will select a habitat having the best conditions. For baboons, it is important to have nice fruit trees that can serve as feeding, sleeping sites and predator avoidance (Altmann and Altmann, 1970 and Altmann, 1974). Thus they will all select habitats which increase the most their fitness. Inversely all animals will avoid areas having higher risk of predation, avoid open areas with scattered trees and such as bush land and human disturbed areas. The general trend of preferred habitat for baboons is a habitat with enough fruit trees for food and shelter like woodland and riverine areas and avoids rivers for most predators ambush prey, open areas like bare and bush land because they are easily picked up as prey (Altmann, 1974). These results are in line with Vicki (2009) in the Tana River in Kenya. As differences in habitat usage may reflect differences in the percentage of of the area available, the correlation between the number of times baboons used each habitat type depending on the food and shelter was analysed (Spearman rank correlation, r=0.7939, p=0.00613, n=10). A strong positive correlation shows that baboons used areas with more food as well as sleeping sites. However, habitat selection may have some cost, for instance by the fact that baboons in Dwangwa travel to their preferred sites. The benefits resulting from their choice is even better (Tsutsimi *et al*, 2011).

Implication for re-introduction, conservation, welfare and management

As the results have shown and quite obviously, the three release sites studied for re-introduction are not the same in percentages of habitat quality despite the fact that they constitutes almost the same habitat types of the areas. Lisanthu had the best ecological and fitness characteristics for the survival of baboons. Baboons have a preference by selecting some habitats to live, feed and sleep in at night. This can be explained by their ecological and an optional use of a habitat which increases the most their fitness.

This study took into consideration food resources, predator avoidance, sleeping sites in both seasons to choose a suitable release site for the baboons. Thus the well understanding of animal behavioural patterns in a habitat is important for ecological research, species survival, ecosystem management and biodiversity conservation and the release of wild population of animals.

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