



APPRAISAL OF REPERCUSSION OF WESTERN TREE HYRAXES (*Dendrohyrax dorsalis* (Fraser, 1855)) ON LAND USE PATTERN IN CROSS RIVER NATIONAL PARK NIGERIA

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ABSTRACT: Understanding and appraising the impacts of land use pattern on the density of rare species is crucial in conservation of renewable natural resources. The western tree hyrax (*Dendrohyrax dorsalis*), widely distributed in tropical rainforest ecosystem and its distinct call behaviour among forest nocturnal animal in West Africa, would have been one of the least researched mammals in Nigeria. This study investigates the influence of land use pattern on density and calling behaviour of the species. Line transects surveys was employed in four different land use types Core forest, Buffer forest, Farm fallow and Plantation to evaluate the distribution and density of *D. dorsalis*. The transect survey show that the hyraxes densities varies across the four different land use for a total of 64km of transects walked 10.45ha^{-1} close-canopy, 8.13ha^{-1} secondary forest, 3.43ha^{-1} and zero in the plantation forest. Mean density of calling individuals for the four different land use type varies from 15.6ha^{-1} in a core zone, 12.1ha^{-1} in a buffer zone, 5.1ha^{-1} in a farm fallow and 0.00ha^{-1} in a plantation. The calling individuals within the forest are associated to forest canopy cover. The results clearly revealed that the species largely depend on primary forest for survival and navigation. Thus, call for urgent conservation concern that needs management action especially in the study area.

Keywords: Tree Hyrax, Call behaviour, Land use, primary forest

1. INTRODUCTION

There are no major conservation threats to *Dendrohyrax dorsalis*, although they are presumably sensitive to severe habitat fragmentation as a result of deforestation, (Butynski *et al.* 2015). They occupy the niche of arboreal folivore, sometimes sharing this guild with sympatric primates. Tree hyraxes often occur at low densities and are predominantly nocturnal. The eastern tree hyrax (*Dendrohyrax validus*) is solitary and defends territories vigorously using loud calls by both sexes (Kingdon 1971) making them inherently difficult to study. Hyraxes are hunted for meat and skin and more rarely for medicine and rituals (Marshall *et al.* 2008; Milner 1994). They are primarily caught in snares when they descend to the ground. They may also be extracted from their holes using a stick, or forced from their trees by cutting or burning and then killing with

spears or dogs. Unlike West Africa, bush meat and associated products are typically consumed or sold locally (Marshall *et al.* 2008).

The western tree hyraxes (*Dendrohyrax dorsalis*) is solitary and defends territories vigorously using loud calls by both sexes (Kingdon 1971), only occasionally are found in groups of two or three. They are nocturnal and generally feed at night. It has been noted by (Kingdon 1971) that this species is an especially adept climber. In captivity they have been observed to climb up the edge of an open door with ease, as well as being able to quickly scale smooth tree trunks. *D. dorsalis* has a patchy distribution and its density is highly variable between sites of land use. The species is threatened throughout its range by destruction of forest habitat, fire, and hunting (Kingdon 1997). Some lowlevel illegal logging still continues; however, fire and hunting are the most

immediate threats. Hyraxes are hunted for meat and skin and more rarely for medicine and rituals (Topp-Jørgensen *et al.* 2008). The species are primarily caught in snares when they descend to the ground and also be extracted from their holes using a stick, or forced from their trees by cutting or burning and then killing with spears or dogs (Topp-Jørgensen *et al.* 2008).

Most forms of disturbance are undetectable or only marginally detectable using remote methods (Peres *et al.* 2006). Assessing the consequences of disturbance by ground surveys is crucial in wildlife management. Fully quantifying the effects of disturbance would require painstaking work due to the massive number of species involved. However, basic criteria for assessing ecosystem health and habitat composition and structure are rarely determined (Balmford *et al.* 2003). Selection of key species as “indicators,” “guilds,” or “functional types,” can assist in making more rapid assessments (Skorupa 1986). Determining the impact of disturbance on such species is also of importance in determining habitat requirements for management.

A common approach has been made by (Gaylard and Kerley 2001) to estimate hyrax latrine density. The study showed that the latrine density of hyrax in the West Kilombero Scarp Forest Reserve was far greater than in the heavily hunted New Dabaga / Ulangambi Forest Reserve. A second study in South Africa also showed that den preference of *D. arboreus* is closely linked to diet (Gaylard and Kerley 2001). The study aim is to determine the sensitivity of *D. dorsalis* to land-use pattern (human disturbance). If *D. dorsalis* is a forest-dependent species, negative correlation with land use pattern (disturbance) would be expected. The relative density and behaviour from four land use type in one of the Nigeria’s most important areas for biodiversity could be determined.

2. METHODS

2.1 Study Area

The Oban Hills Sector of Cross River National Park was carved out of Old Oban Group Forest Reserve in 1991 and located in the Cross River State, Nigeria. It lies within Latitude 5° 15' and 05° 25'N and Longitude 8° 30'N and 08° 45'E in the south-eastern corner of Nigeria (Uwem 1997). The Cross River National Park covers an area of about 3,000km² of primary tropical rainforest. It is sub-divided into Oban East and Oban West ranges with annual rainfall of 3,000mm in the southern parts and 2,500mm in hilly and mountainous areas from March to November with a peak in June/July.

The Park has been included as a centre of diversity (New National Park Project 2008). Based on an extensive forest inventory in the Oban Hills area, Uwem (1997) distinguished five forest types in the park area. These are; High forest: a two storey forest with emergent trees. Disturbed forest: but with the lower storey characterized by very small crowns (secondary growth) and the upper storey never closed. Ridge forest: represented by two poorly defined open storeys with stray emergent, the soil is generally shallow and the stands are less dense and lower than that of the high forest. Low forest: transition from high forest to swamp forest on flat ground with poor drainage, the single storey has an uneven canopy and some emergent. Swamp forest: forms a single storey forest with under-storey and emergent on flooded soils which dry up during the dry season.

2.2 Data collection

Observers spent time familiarizing themselves with the forest structure and location/height of trees likely to contain hyrax before each count. This allowed observers to consider the likelihood of a call being outside of the 50 m radius, e.g., by considering the angle of the slope to the call, versus the location of known trees. The survey was initiated from the first call heard within the census radius. For each call, the time, compass direction and a distance estimate were recorded. To minimize error in distance estimation, all observers practiced estimating distances against distances measured using a tape measure and range finder. At the end of every count, the minimum number of calling individuals within the 50 m radius was calculated as the number of calls that certainly came from separate individuals. This minimum estimate was largely based on common sense, using the spatial and temporal proximity of calls. Wherever hyrax was present in or near plots, counts were repeated at least once (up to four repetitions), to verify the estimate.

Finally, hyrax calls were recorded to estimate relative density and to detect possible behavioural changes in night time activity induced by hunting. We made 92 night time (18.30-22:30 h) repeated walks along a 2 km transect in undisturbed CRNP, walking at a pace of 1 km h⁻¹. All observations of hyrax were recorded, noting whether visual or vocal. Assessment of the relationship between canopy structure and hyrax was carried out at 10 sites settlement with 3 sites Obung/Netim, 3 in Aking and 4 in Ifumkpa respectively. This study was conducted in the two ranges of the Park with the permission of National Park Service. Four villages were purposely selected from the ranges with two villages from each of the ranges. From the Oban west Obung/Old-Netim (05°

21° 25'N, 08° 26' 24"E and Ifumkpa (05° 31' 56.7"N, 008° 17' 30.4"E), and in Oban east, Aking (05°25' 67"N, 08° 38' 10"E) and Ekang (05° 40' 00"N, 08°49' 00"E) were selected based on their proximity to the Park. Three observers carried out line transect surveys in the dry season between January and March 2013. The study was repeated thrice and means density of calling individuals was calculated for use in all analyses. The proportion of sky obscured by branches of tall trees within a 50m radius was used. The broad category was adopted rather than a continuous scale to minimize bias from estimating cover by eye.

- a) Farm fallow (<25% canopy cover): These sites had few mature trees, dense vines entangling regenerating trees, and few arboreal pathways between trees—4 transects.
- b) Semi-open canopy (45-60% canopy cover) These sites had a mix of regenerating and mature trees, dense shrubby vegetation, and some arboreal pathways between canopies 8 transects.
- c) Closed canopy (>75% canopy cover) these plots included mature, closed canopy forest with numerous arboreal pathways 8 transects.

A total of 32 transects of 2km each were established using stratified sampling technique. With eight from each of the four land use types (core, buffer, farm fallow and plantation) in the study locations at 600m intervals to ensure that transects are placed sufficiently far apart to avoid an object from being detected on two neighbouring transects (Buckland *et al.* 2001). For each of the eight (8) transects in the land-use types nocturnal survey was conducted between 18.30-22.00hours with the aid of headlight/maglight. Transects were surveyed in the evening across different land-use habitats. Each transect was traversed at an average speed of 1-1.5km/hr. Perpendicular and sighting distance were measured to the nearest metres from transect to the position of animal of interest sighted. For each observation, time, sex, number of individuals, perpendicular distance, sighting distance and the position of the observer were recorded using laser 1200 long range precision range finder distance tape in meters for all measurement taken (Buckland *et al.* 2001).

2.3 Data analysis

Data were analysed using Software package Distance 6.0. Land-use type was used as covariate in modelling

detection probability for the tree hyrax sighted during the survey. Perpendicular distances were measured to the nearest metre from the line to the position of each detected object of interest (Buckland *et al.* 2001), and densities were calculated using *DISTANCE 6.0*. To estimate detection probability, half normal and hazard rate keys were fitted to pooled data from each habitat and for all study sites combined for nocturnal data, and to pooled data from all habitats (and all sites) data. The half normal key with cosine adjustments was selected for the nocturnal survey, whereas hazard rate keys with cosine adjustments were selected for all remaining analyses. Model selection was based on the Akaike information criterion (AIC), model with minimum AIC were considered suitable for the observations, and chi-squared goodness of fit tests. Due to a visible drop in detection probability near the zero line in most data sets, distance data had to be grouped to eight or ten metre distance classes, in order to obtain good fit.

3. RESULTS

The density of hyrax per hectare across different land use pattern range from 2.063/km² in fallow, 4.68/km² in the buffer zone and 6.25/km² in core zone while none in the plantation respectively. A total of one hundred (100) sighting of the species were made in core zone (close-canopy forest), 80 were sighted in the buffer and farm fallow recorded thirty-three (34) and none were sighted in the plantation respectively (Table 1). *D. dorsali* individuals calls per hectare was very high in the core zone of the park, buffer zone experience moderate human disturbance, high disturbance in the farm fallow with the plantation been experience very high human disturbance (Fig.3). Mean density individuals calls from the land use type were 15.6ha⁻¹ for core zone, 12.1ha⁻¹ for buffer zone, 5.1ha⁻¹ for farm fallow , and 0.00ha⁻¹ for plantation (Figure.2). The density in the core zone area was highly significant. One-way ANOVA *z-test*: $\chi^2=4.12$, for core $p=0.022$; buffer $p=0.046$, farm fallow $p=0.065$, buffer vrespectively.

Relative density was significantly higher in close canopy forest than secondary forest and farm fallow (*z-test*: core: $t=15.401$ $df=53$ $p=0.001$; Buffer: $t=9.334$ $df=49$ $p=0.001$; farmfallow: $t=4.109$ $df=17$ $p=0.001$). As no hyraxes were heard calling in plantation, density was not estimated.

Table 1: Abundance and density of western tree hyrax across different ecosystem in Oban sector

Habitat	N	% of total sighting	DS	N	MER	Dkm ⁻²	CI	AIC	P density
Core forest	100	46.73	22.856	7782	1.72	42.53	0.85989-3.4355	289.548	<0.001
Buffer forest	80	37.38	1.5573	1105	1.59	3.02	0.45995-5.5224	268.613	<0.001
Farm fallow	34	15.89	0.7128	202	0.59	1.45	0.22165-15.905	84.601	<0.001
Plantation	-	-	-	-	-	-	-	-	-
Total	214	100							

Significance of density differences (*P*-value) N.B: *n* = observation; MER = mean encounter rate (nm^{-1}); DS = density, CI = confidence interval; AIC = akaike information criterion.

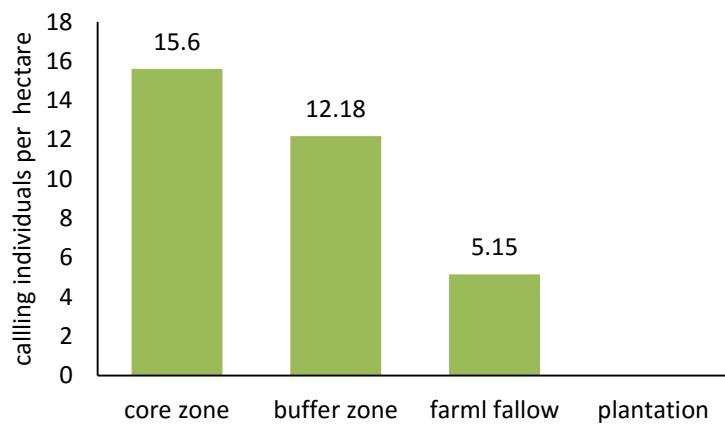
Table 2: Estimate of western tree hyrax density in Oban sector

Species	N	% of total sighting	N	MER	Dkm ⁻²	CI	AIC	MCS	DS
Tree Hyrax	214	100	84641	1.3021	32.934	20.673 - 52.468	268.14	1.87	17.318

Table 3: Density of hyrax calls visual/vocal observations per transect walked in Oban sector

Method	Land-use/Transect			
	Core	Buffer	Farm fallow	Plantation
Density per km	10.42	4.68	2.063	0.00
Hyraxes seen per transect walk	6.25	8.13	3.43	0.00
Proportion of transect walks during which Number of calls	100(0.95)	80(0.71)	34(0.28)	0(0.00)

(mean ± 95 % confidence interval)

Figure 1: *D. dorsalis* calling individual density per hectare at different land-use pattern in Oban Hills Sector of Cross River National Park.

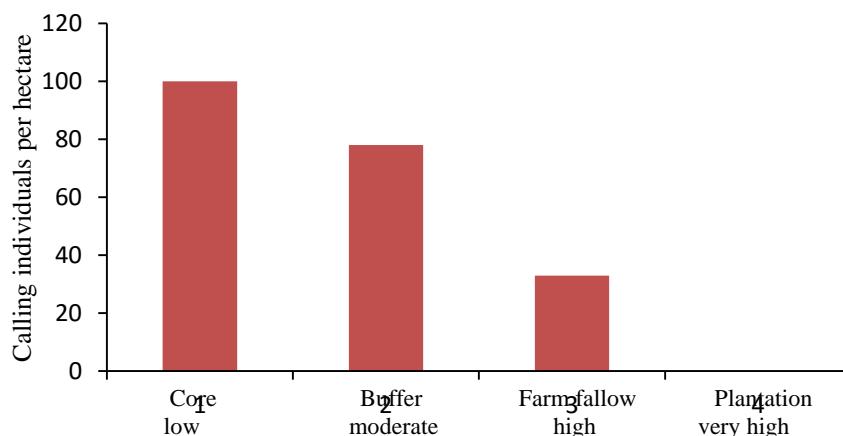


Figure 2: Density of calling individuals (mean \pm 95 % confidence interval) of *D. dorsalis* from transect counts in forests with low, moderate, high or very high levels of disturbance.

4. DISCUSSION

Primary data on western tree hyrax (*Dendrohyrax dorsalis*) abundance and distribution in Oban hill sector of cross River national park were obtained and analysed with *DISTANCE* software to estimate density by fitting several possible methods. The density of hyrax per hectare across different land use pattern shows $6.25/\text{km}^2$ in core zone, $4.68/\text{km}^2$ in the buffer zone and fallow $2.063/\text{km}^2$ while none in the plantation zone. The observed differences between land use patterns are due to human impacts. The land use pattern with lowest density of *D. dorsalis* per hectare was the most degraded and hunted. Marshall *et al.* (2007) carried out a study on improving the conservation status of the Udzungwa Mountains Tanzania's second Nature Reserve stated that hunting and habitat degradation tend to occur together, these two forms of disturbance are often hard to separate. A similar pattern was obtained by Elmer *et al.* (2008) the Udzungwa Mountains, Tanzania where *D. validus* is more abundant in undisturbed closed canopy forest than in more open forest. Hunting levels were not thought to vary between these same sites as all were distant from human settlements, with extensive areas of more accessible forest in between. The overall group density for hyrax was more than double in core zone than that of fallow zone, and almost twice of buffer zone. This indicates that the mean encountered rate per kilometer (MER) (km^{-1}) walked for the land use zones were approximately 1.72, 1.59 and 0.52 for core, Buffer and farm fallow respectively. Gaylard and Kerley (2001) suggest that tree hyrax density is limited by cavity bearing trees used for shelter. Preferred shelter trees are large, part of the upper

canopy, partly decayed, have several entrance holes, and are usually of dietary value. Home range size has been shown to increase with a decrease in tree density. The density of calls (mean \pm 95 % confidence interval) of *D. dorsalis* from transect counts in core forests, buffer and farm fallow with high levels of disturbance are 15.60, 12.18 and 5.15 individual's ha^{-1} respectively. Given that there were many individual calls in core zone no calls were heard at the plantation site. Disturbance therefore seems to shape the activity pattern, making it more difficult to hear calls. Previous studies by Elmer *et al.* (2008) on tree hyraxes in undisturbed forest revealed calls were frequently heard and observed basking on branches during the day. However, no animals were observed during the daytime in the hunted forests and few calls were heard during daytime. Hunting therefore seems to shape the activity pattern, making it more difficult for the hunter to locate the species during the day. Similar result was obtained were none individual calls of *D. dorsalis* were heard in plantation zones.

5. CONCLUSION

From this study, the following conclusions can be made:

1. Increasing forest reduction and the consequent exposure of the hyrax to more degraded conditions and competition, especially with other species, could be a threat. The hyrax is likely to be completely out-competed as it struggles to survive in conditions that are less conducive to an arboreal existence due to land use problems.
2. For conservation of the species and their habitats to be more effective, a multidimensional approach needs to be taken in order to include

- socio-economic problems in addition to the basic ecological issue.
3. Different models of land management that involve current technologies in agriculture, agroforestry and veterinary sciences need to be considered and implemented to allow development enterprises to proceed alongside conservation efforts.
 4. The habitat variables observed in the two forest types especially plantation forest have greater implications to the survival status of the species in the park.

REFERENCES

- Balmford A, Green RE and Jenkins M (2003). Measuring the changing state of nature. Trends in Ecology and Evolution 18:326–330.
- Buckland ST, Anderson DR, Burnham KP, Laake JL and Thomas L (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Population. Oxford University Press, New York.
- Butynski T, Dowsett-Lemaire F and Hoeck H (2015). *Dendrohyrax dorsalis*. The IUCN Red List of Threatened Species 2015
- Elmer JT, Andrew RM, Henry B and Ulrik B P (2008). Quantifying the response of tree hyraxes (*Dendrohyrax validus*) to human disturbance in the Udzungwa Mountains, Tanzania.
- Gaylard A and Kerley GIH (2001). Habitat assessment for a rare, arboreal forest mammal, the tree hyrax *Dendrohyrax arboreus*. *African Journal of Ecology*, 39:205-212.
- Marshall JE, Brink AR and Pedersen UB (2008). Quantifying the response of tree hyraxes (*Dendrohyrax validus*) to human disturbance in the Udzungwa Mountains, Tanzania. *Tropical Conservation Science* 1 (1):63-74.
- Kingdon J (1971). *East African Mammals*, vol. 1. Academic Press, New York.
- Kingdon J (1997). The Kingdon Field Guide to African Mammals. Academic Press, London, UK.
- Marshall AR, Aloyce Z, Mariki S, Jones T, Burgess N, Kilihami F, Massao J, Nashanda E, Sawe C, Rovero F and Watkin J (2007). Tanzania's second Nature Reserve: improving the conservation status of the Udzungwa Mountains? *Oryx* 41(4):429-430.
- Milner JM (1994). Relationships between the forest dwelling people of South-West Mau and the tree hyrax, *Dendrohyrax arboreus*. *Journal of East African Natural History*, 83(1):17- 29.
- New National Park Protects World's Rarest Gorilla. Science daily. No. 28, (2008).
- Peres CA, Barlow J and Laurance WF (2006). Detecting anthropogenic disturbance in tropical forests. Trends in Ecology and Evolution 21:227-229.
- Skorupa JP (1986). Responses of rainforest primates to selective logging in Kibale Forest, Uganda. In: K. Benirschke (ed.) Primates: The Road to Self-Sustaining Populations. Springer-Verlag, New York, 57-70.
- Topp-Jørgensen JE, Marshall AR, Brink H and Pedersen UB (2008). Quantifying the response of tree hyraxes (*Dendrohyrax validus*) to human disturbance in the Udzungwa Mountains, Tanzania. *Tropical Conservation Science* 1 (1):63-74.
- Uwem EI (1997). Small farmers and Forest loss in Cross River National Park. *The Geographical Journal* 163
- Whitmore TC and Sayer JA (1992). Tropical Deforestation and Species Extinction. Chapman and Hall, London.