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## Chimpanzee Distribution around the Northern Boundary of the Mahale Mountains National Park, Tanzania

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### INTRODUCTION

The Mahale Mountains National Park in Tanzania, established in 1985 (Government Notice 262 1985), conserves wildlife including chimpanzees (*Pan troglodytes*) (Itoh *et al.* 2012). An analysis of satellite images suggested that the area inside the northern park boundary had been deforested, but the situation was ambiguous because the boundary on the map did not reflect the location of landmarks in this area (*ibid.*). Based on a park policy to make the boundary known to local people, a 20-m wide strip along the boundary has been cleared of trees and beacons and park signs have been placed on the border (Figure 1). The aim of this study was to clarify the distribution of chimpanzees and other large mammals inhabiting the area around the northern park boundary.

### METHODS

This study was conducted in the Mahale Mountains National Park, which is located on the eastern shore of Lake Tanganyika (Nishida 1990). The northwest side of the Mahale Mountains is covered by forest (the Kasoje

Forest), which is the main habitat of the Mahale study unit-groups (*ibid.*). However, most of the area in and around the park is covered by miombo woodland and bamboo bush (Kano 1972; Figure 2). There are several rivers in the woodland and bush, and riverine forests are found along some rivers. The Karobwa Hills, which are located to the east of the park, are also covered with miombo woodland, bamboo bush, and forest and are known chimpanzee habitat (Kano 1972; Ogawa *et al.* 2006).

From 2008 to 2014, we conducted surveys around the northern boundary of the park (Figure 3A). The survey distance was measured by GPS (Garmin GPSmap60Cx), and the total distance was 100.7 km (inside the park: 17.2 km, along the park border: 25.5 km, outside the park: 58.0 km; Table 1).

We recorded the numbers and the positions of chimpanzee beds and large mammals observed during our surveys. When we found animal feces, we identified the species based on the shape and size of the droppings. The positions of beacons were also measured using GPS.

We adopted Kano's method to estimate the population density of chimpanzees: density ( $/\text{km}^2$ ) = (number of beds detected)/(survey distance [km]) (width of survey route [0.14 km]) (detectability [70%]) (bed duration [180 days]) (Kano 1972). Although two studies have been conducted to measure the bed decay rate at the west side of the Mahale Mountains (Ihobe 2005; Zamma & Makelele 2012), no data regarding bed decay rates are available for the remainder of Mahale. To compare the results of the present study with those of the previous study (Kano 1972), we used 180 days for our measure of bed duration.

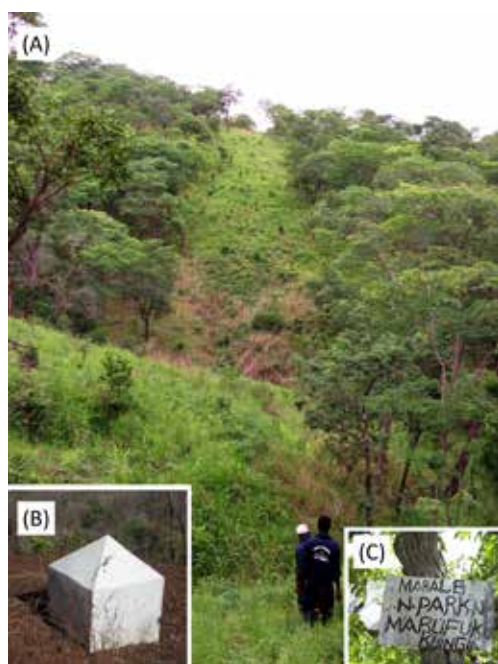


Figure 1. Park boundary. (A): A 20-m wide strip along the park border, (B): A white beacon about 1 m in height, and (C): A park sign.

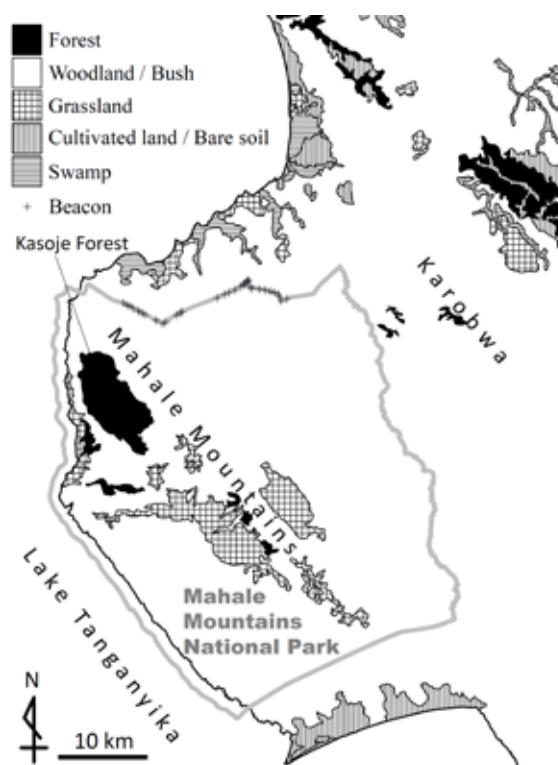


Figure 2. A vegetation map around the Mahale Mountains National Park based on "Land-cover and land-use" maps (Ministry of Natural Resources and Tourism, The United Republic of Tanzania 1996). The border of the park is drawn based on the positions of beacons and the border measured in this study.

## RESULTS

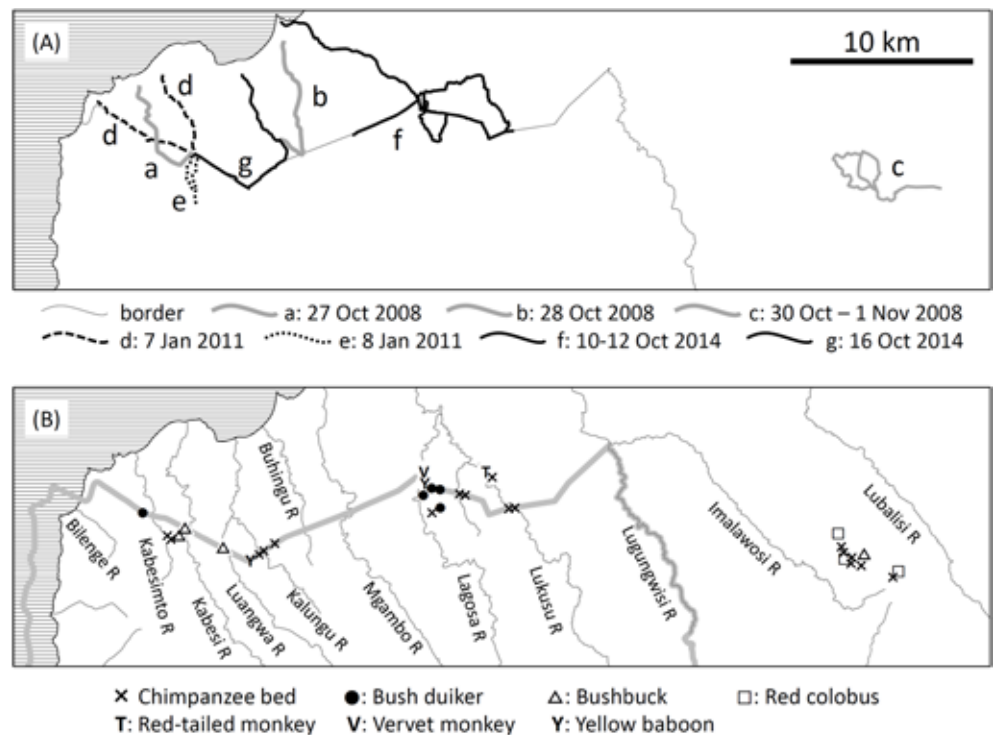
We found a total of 88 chimpanzee beds during our surveys (Table 2). The beds were distributed continuously from inside to outside the park, and the beds around the boundary were found near the riverine forests of the Kabesimto, Kalungu, Lagosa, and Lukusu Rivers (Figure 3B). The estimated population densities of chimpanzees were 0.078/km<sup>2</sup> along the boundary and 0.046/km<sup>2</sup> inside the park. The estimated density outside the park was 0.038/km<sup>2</sup>, but the density around Karobwa (route c: 0.13/km<sup>2</sup>) was higher than that around the other routes at the north of park boundary (0.0027/km<sup>2</sup>).

We observed yellow baboons, bushbucks, bush duikers and bats inside the park and on the park boundary, and red colobus, red-tailed monkeys, vervet monkeys, and bushbucks outside the park (Figure 3B, Table 3). We also confirmed several species of mammals used the habitat based on the fecal evidence (Table 3).

## DISCUSSION

We estimated the chimpanzee population around the northern park boundary to be similar to that in Ugalla (0.08/km<sup>2</sup> [Kano 1972]; 0.10/km<sup>2</sup> [Yoshikawa *et al.* 2008]). This similarity is understandable because both the study area and Ugalla is covered with miombo woodland, and the availability of food in these two areas is considered similar. In contrast, the estimated density inside the park is lower than that on the park boundary. This may have been affected by the selection of our survey routes. Ogawa *et al.* (2013) noted that chimpanzees inhabiting miombo woodland preferred to make beds around forests and/or slopes. The survey routes on the boundary consisted of straight-lines crossing valleys with riverine forests and ridges with slopes, but flatter routes were selected for our surveys inside the park to facilitate walking. Thus, we may have underestimated the population density inside the park.

The chimpanzee density in the area outside the northern park boundary was estimated to be lower than that of Karobwa. In western Tanzania, the human population is concentrated to the shore of Lake Tanganyika, and the northern area has been affected by human activity such as deforestation (Itoh *et al.* 2012). The position of chimpanzee beds along the Lukusu River outside the northern park boundary (Figure 3B) was about 10 km from the shore, and Karobwa is located about 26 km from the shore. Outside the protected area, more chimpanzees are thought to inhabit the area distant from the lakeshore, where human activity is low.



**Figure 3. (A): The location of the survey routes, and (B): The water system and the locations of chimpanzee beds and mammals observed during the survey.**

**Table 1. The length of the survey routes (km).**

route	inside <sup>1</sup>	border <sup>2</sup>	outside <sup>3</sup>	total
a	3.2		3.4	6.6
b			8.0	8.0
c			16.1	16.1
d		7.3	5.0	12.3
e	8.6			8.6
f	5.4	10.6	19.3	35.3
g		7.6	6.2	13.8
total	17.2	25.5	58.0	100.7

1: Inside the park. 2: Along the park border. 3: Outside the park.

**Table 2. The locations and numbers of chimpanzee beds.**

route <sup>1</sup>	inside/outside <sup>2</sup>	position <sup>3</sup>	altitude (m)	N
a	inside	6°02'50.4" S, 29°47'07.0" E	911	1
a	inside	6°02'56.9" S, 29°47'12.5" E	928	7
c	outside	-	-	37
f	outside	6°01'05.4" S, 29°56'41.6" E	905	2
f	boundary	6°01'36.0" S, 29°55'47.1" E	891	12
f	boundary	6°01'38.9" S, 29°55'56.9" E	950	14
f	inside	6°02'04.3" S, 29°57'23.7" E	950	4
f	inside	6°02'03.6" S, 29°57'13.0" E	924	1
f	inside	6°02'11.2" S, 29°54'58.0" E	895	1
g	boundary	6°03'24.3" S, 29°49'49.7" E	998	1
g	boundary	6°03'17.3" S, 29°49'58.0" E	1000	7
g	boundary	6°03'06.0" S, 29°50'16.9" E	1108	1
total				88

\*1: See Table 1 and Figure 3 in detail. \*2: Inside or outside the park or along the park boundary. \*3: Based on the geodetic datum Arc 1960.

It was thought that chimpanzees did not reside between the Mahale Mountains and the Karobwa Hills (Kano 1972). The results of the present study suggest that the riverine forests between these two sites are also suitable habitat for chimpanzees. Thus we assume that the two populations, *i.e.* those in the Mahale Mountains and the Karobwa Hills, can be connected by chimpanzees inhabiting the stepping-stone-like riverine forests, but 18 km between the Karobwa Hills and the riverine forest on the Lukusu River remain unexplored (Figure 3B). As Nakamura & Fukuda (1999) found chimpanzee beds around the middle part of the eastern park boundary, the connection of the two populations will be clarified by more information about the area around the eastern park boundary.

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**Table 3. Mammals observed or confirmed by fecal evidence on each survey route.**

English name	species name	direct observation		fecal evidence	
		inside the park & boundary	outside the park	inside the park & boundary	outside the park
yellow baboon	<i>Papio cynocephalus</i>	f		f	
red colobus	<i>Procolobus rufomitratus</i>		c	g	
red-tailed monkey	<i>Cercopithecus ascanius</i>		f		
vervet monkey	<i>Chlorocebus pygerythrus</i>		f		
bushbuck	<i>Tragelaphus scriptus</i>	a, g	c	f, g	b
bush duiker	<i>Sylvicapra grimmia</i>	d, f		f, g	f
buffalo	<i>Syncerus caffer</i>				c
roan antelope	<i>Hippotragus equinus</i>			f, g	c, f
waterbuck	<i>Kobus ellipsiprymnus</i>			f	f
bushpig	<i>Potamochoerus larvatus</i>			a, b	c, d
elephant	<i>Loxodonta africana</i>			f	
leopard	<i>Panthera pardus</i>			a	g
civet	<i>Civettictis civetta</i>			f	
hyena	<i>Crocuta crocuta</i>				f
bat	unidentified		f		

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#### <NOTE>

### Elementary Technology Correlates with Lifetime Reproductive Success in Wild Chimpanzees, but Why?

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#### INTRODUCTION

In evolutionary ecological terms, if females ‘convert’ resources into offspring, then accessibility and utilizability of resources must be essential to female reproductive success. Acquiring and processing resources depends on a multitude of factors, from competition (inter- and intra-specific, contest *vs.* scramble, *etc.*) to technique (discerning, disarming, extracting, *etc.* prey). For chimpanzees (*Pan troglodytes*), much is known about these factors in a general sense: Chimpanzee females compete mostly indirectly by occupying core home ranges within neighbourhoods within group territories (Pusey *et al.* 1997; Williams *et al.* 2002; Emery Thompson *et al.* 2007). Key