Online ISSN: 2588-3526
Journal of Wildlife and Biodiversity
Volume 6 (3): 1-11 (2022) **(**http://www.wildlife-biodiversity.com/**)**
Scientific Report

Cameroon-Nigeria Chimpanzee (*Pan troglodytes ellioti* Matschie, 1914) distribution and habitat affinities in Bakossi National Park

Ettagbor Hans Enukwa[1*], Mbua Abang Augustine[2], Louis Njie Ndumbe[3], Kato Samuel Namuene[4]

[1]Higher Technical Teachers Training College, Bambili. University of Bamenda. Department of Civil Engineering and Forestry Techniques

[2]National Advanced School of Engineering, Maroua. Department of Environmental Science

[3]Higher Technical Teachers Training College, Kumba, University of Buea. Department of Agriculture. P.O. Box 294 Buea Road, South West Region, Cameroon

[4]Faculty of Agriculture and Veterinary Medicine, Buea, University of Buea. Department of Forestry and Wildlife

*****Email: etagha@yahoo.com

Received: 01 March 2022 / Revised: 10 May 2022 / Accepted: 25 May 2022/ Published online: 25 May 2022. Ministry of Sciences, Research, and Technology, Arak University, Iran.

How to cite: Enukwa, E.H., Augustine, M.A., Ndumbe, L.N., Namuene, K.S. (2022). Cameroon-Nigeria Chimpanzee (Pan troglodytes ellioti Matschie, 1914) distribution in Bakossi National Park, Journal of Wildlife and Biodiversity, 6(3), 1-11. DOI: https://doi.org/10.5281/zenodo.6582417

Abstract

This study explores the extent to which habitat characteristics are affecting nest-group encounter rates of Chimpanzees in the southeast part of the BNP. We carried out a reconnaissance recce survey at a sampling intensity of 85% of 1×1sq km per grid cell. Accordingly, field operations included accessing the data collection zone within the Southeast section from the East to the South and then to the North. Reconnaissance recce walks were done within a 1km×1km grid cell. Compass, secateurs, GPSs, and Cyber trackers were used to orientate field operations. All nests irrespective of the distance from the reconnaissance recce walks, feeding signs, tree nest-group count, tree height, and water points were recorded in the cyber tracker. GPS ID and waypoints collected irrespective of the distance within the recce survey cell were recorded. For 28 surveyed grid cells, four nest sites of mixed ages containing 34 recent and eight old nests were recorded. Chimpanzee presence/signs were only recorded in the montane forest (encounter rate of 1.2/Km), and in areas of close (visibility of 5 – 10m) to open (visibility of 10 – 15m) canopies, with no sign observed in areas of highly open canopies (visibility of >15m). Also, these areas fall within an altitude of 1235 to 1325 m asl. with the presence of available water especially from waterfalls. The presence of available food for chimpanzees was also recorded in this area, and all the nests observed were tree nests. This indicates that the montane forest area provides favorable habitat conditions for chimpanzees than the sub-montane forest and montane grassland where no sign of this specie was observed.

Keywords: Habitat, nest-group encounter rates, reconnaissance “recce” walks, sampling intensity

Introduction

Chimpanzees occur at high densities within the dense tropical forest and woodland savanna across equatorial Africa (Hughes et al. 2011; McManus 2005; Morgan et al. 2011; Ndimbe et al. 2016). Chimpanzees are divided into four subspecies: the western chimpanzee (*Pan troglodytes verus*), the central chimpanzee (*Pan troglodytes troglodytes*), the eastern chimpanzee (*Pan troglodytes schweinfurthii*), and the Nigeria–Cameroon chimpanzee (*Pan troglodyte ellioti*). *P. troglodyte ellioti* ranges from Cameroon, west of the Sanaga River, to Nigeria, with population estimates of between 6,000 and 9,000 individuals (Morgan et al., 2011; Oates et al., 2016). Different habitat conditions influence the population structure of Chimpanzees, and presently, the characteristics of habitats are affected by climate change (Sesink-Clee, 2015). The montane forest of Bakossi National Park constitutes a major habitat of the Nigeria-Cameroon Chimpanzee (*P. troglodytes ellioti*) and it is also one of the main contributors to the environmental service found in the South West Region of Cameroon. Indicators of the presence and abundance of the Cameroon-Nigeria Chimpanzees include direct observations, nests (nest-group encounter rate), dung, feeding remains, vocalization, footprints, tools, carcasses, and verbal information provided by local people. Nevertheless, the main forms of habitat fragmentation and disturbance affecting the distribution and population size include poaching, trapping, development of new farmlands, and illegal camping (Curtis et al., 2018; Estrada et al., 2017; Haddad et al., 2015).

The growing love for bush meat; high circulation of illegal bushmeat trade; the high dependency on bushmeat as a protein source; the need for more farmland due to a poor land acquisition procedure at local levels; uncontrolled access to resource use and illegal exploitation due to low-level law enforcement presence means restricted range species habitat such as the Cameroon-Nigeria Chimpanzee among other Great Apes is systematically been fragmented and disturbed. To determine the site-specific conservation status and value of *P. troglodytes ellioti* group(s), assessing prospects and potentials of the cluster readiness of hosting the most critically endangered Cameroon-Nigeria Chimpanzee which deserves maximum protection from which other species will benefit, is crucial through systematic bio-monitoring surveys to gather quality data capable of generating appropriate data sets on the distribution trends of Chimpanzees and other large mammals in the park, whilst streamlining co-management interventions and management strategies in the cluster. Accordingly, wildlife monitoring is critical in developing plans for protected areas management and other surrounding areas. The basic principle of reconnaissance or « recce » walks is to walk in a pre-determined direction taking the path of least resistance through the survey area.

Many studies were carried out on the Nigeria-Cameroon chimpanzee in the dry and gallery forests of Nigeria in Gashaka-Gumti National Park (Knight, 2015), in Cameroon at Ebo Forest (Morgan, 2006), and has had so far failed to address the relationship between abundance and habitat characteristics.

This research work, therefore, aims at obtaining relevant information on, the distribution of Chimpanzees about habitat conditions.

Materials and methods

Study site selection and description

The Bakossi National Park covers an area of 29,320 ha and ranges in altitude from 300m to 1895m a.s.l. giving rise to three main vegetation types: the Sub-Montane Forest, the Atlantic Forest of the North West type which is not dominated by the Caesalpiniaceae species but with semi-deciduous elements, and the Atlantic Biafran forest rich in Caesalpiniaceae. This accounts for the huge floral variety of the area, characterized by a high level of endemism, and determines the variety of habitats and the corresponding diversity of fauna species. The South East Cluster conservation zone is located in UTM zone 32 between 09.711735 and 09.684463 E and 05,010871 and 05.025119 N, which has a surface area of 4950 ha, with a core conservation zone covering a surface area of 4258 ha and a limited access zone of 692 ha. The cluster conservation zone as defined within the Bakossi National Park decree of creation, and the Cluster Conservation and Development Agreement (CCDA) takes into consideration some natural features on the ground and cut across various micro-zones, particularly peak heights.

Experimental considerations

The designed data collection of 6km×6km took into consideration the steep nature of the area, the season, and proposed recce points generated at the center of each grid cell to be used for data collection. The habitat conditions recorded include vegetation type, water points, canopy cover, fruit types, and tree nest types from one grid cell to another. For nest observation, the following attributes were taken into consideration:

- **Fresh nest:** all leaves in the nest are green and generally feces or urine odors are underneath the nest.
- **Recent nest:** drying leaves of different colors, green may dominate, but no dung and no urine odor underneath the nest.
- **Old nest:** structure still roughly intact with the majority of leaves brown.
- **Decay nest:** nest with holes showing few or no leaves, but still identifiable by bent twigs.

A field data collection sheet was designed and used to collect all data that was then imported into the excel file.

Survey coverage

Surveys for mammals and human signs were conducted over a total of 61.06km. The mean distance walked along each recce was 2.18km.

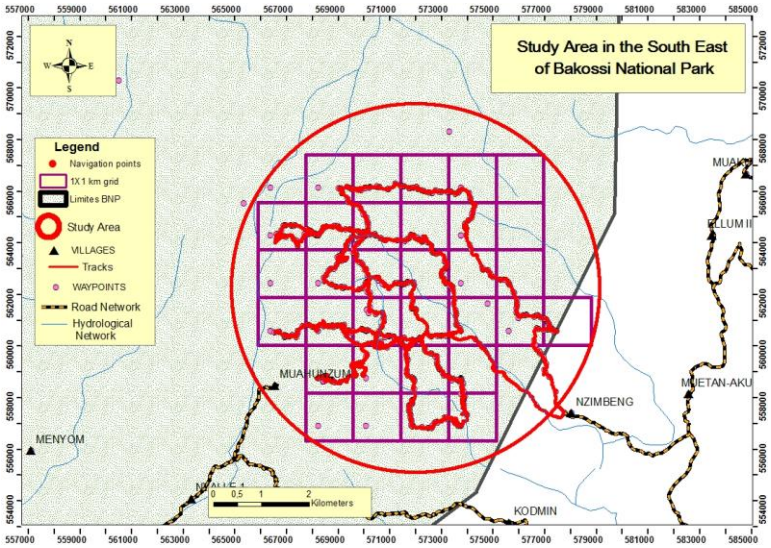

Figure 1**.** Map of paths walked during the recce walks survey.

Data collection and survey technique

The basic principle of reconnaissance or « recce » walks is to walk in a pre-determined direction taking the path of least resistance through the survey area (Walsh and White 1999). With altitude range from 300m to 1895m, and to ensure equal but random coverage of the survey area, a sampling intensity of 85% was designed within the limits of the data collection zone of 6km×6km in the core conservation zone of 4258 ha in the study area where grid cells associated with recce points were over-laid tangential to the topography. ARC-GIS 10.2 software was used and a network of recce points was generated and used. Other considerations while designing the reconnaissance recce walk were the peak period of rainfall in the area, logistics, and most especially the rugged and steep nature of the terrain. The resulting reconnaissance recce points and grid cells were systematically randomly overlaid using ARG-GIS 10.2 28 grid cells were determined and surveyed (Fig. 2). The software program generated geographic coordinates which were downloaded to a GPS (Garmin® GPSMAP64s) and used in the field to provide us with the bearing for each reconnaissance recce walked. We navigated to the start point of a reconnaissance recce then used the "go-to" function of the GPS to determine the bearing for the targeted direction, stop check, examine and record habitat conditions within a reconnaissance "recce" walk of 1km interval for every profile grade encountered on topography, animal signs, and human signs, canopy cover of each of the 28 grid cells selected within the 85% sampling intensity area. Data were recorded using the Cyber-tracker / software program installed in the cat android phone hardware units (principal observer)/data collection sheets. The units were ruggedized for use under extreme conditions in the field. Data was collected at all times at an interval of 1km between grid cells diagonally up to a proposed recce point and the start of the nest recce point.

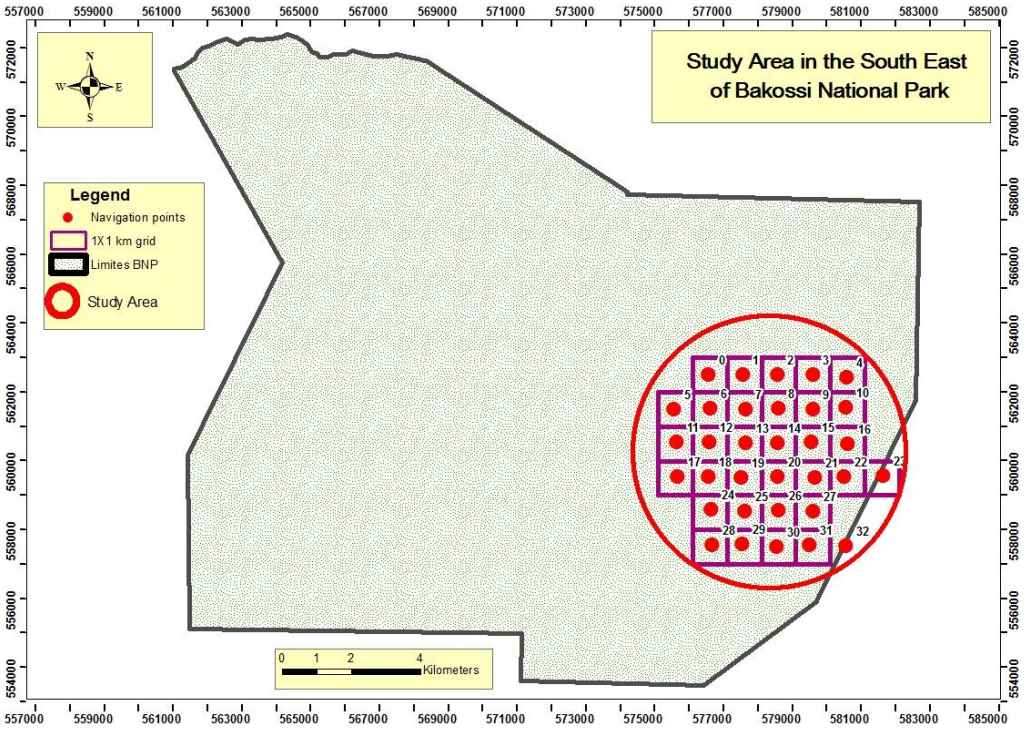

Figure 2. Map of the study area in the South East Cluster of Bakossi National Park

Methods selection

There are at least seven currently recognized methods for surveying large mammals (Buckland et al. 2001). The reconnaissance recce walk was chosen because it is unbiased and will be able to collect data on multiple animal species and human signs but specifically, they are important for the monitoring of arboreal primates and certain signs of human activity such as traps which will otherwise be missed with the camera and acoustic surveys (Plumptre, 2017). It also contributes quality data in the identification of key sites for the conservation of a single species such as *P. troglodytes ellioti* and also as a guide of an important habitat type within which the species is known to occur (Mc Graw 1998; Van Krunkelsven et al., 2000). Therefore, the reconnaissance or "recce" walks was used. Recces were walked by a team of four principal people each responsible for a different area of the data collection technique: (a) A wildlife specialist for the expert identification, recording, and interpretation of data; (b) A locally recruited guide (normally a hunter) with good knowledge of the area, led the team through the forest using secateurs to open a small passage when necessary. This guide was allocated the principal task of using the compass and guiding the team with the pre-determined bearings; (c) The team leader and the assistant team leader followed the guide. We observed and recorded in the cyber tracker Cat/Cyrus, Android all the signs observed. We also listened to calls made by Chimpanzees and recorded them. d) Closely behind the team leader came a second observer. The second observer was prepared to point out any missed sign from the ground but was allocated the principal task of spotting tree nests. We were then followed by the support team (porters, camp keeper). The GPSs MAP 64s were capable of detecting satellites even under cloudy weather. At the start of each day and the center of each grid cell visited, a waypoint and the corresponding proposed recce points grid cell number were recorded. In addition, the GPS MAP 64s were set to "track log" at one-minute intervals, which recorded the actual route of the survey teams at all times during the field day. All information on signs seen within any perpendicular distance between the observer and the object of either side of the center of the reconnaissance recce walks and all tree nests, dungs, ground nests whatever distance from the sweep recce proposed point, were recorded. Human signs such as cartridge shells, rubbish, and traps were noted and a waypoint was recorded regardless of the distance to the sweep recce proposed point. If animals themselves were

sighted every effort was made to identify the species, count group size, and record age-sex classes if feasible. All chimpanzee nests spotted were assigned to species (chimpanzee) wherever possible using visible evidence of species or noted as tree-nest when the species could not be determined. In addition to the age of the ape nest, the nest site habitat type, several nests, and the presence or absence of dung were also recorded.

Data analysis

Data was downloaded from the cyber tracker Cat Android units to a computer. The database produced provides an exact record of the geographic location, time, environment, and type of each sign recorded in the field. Tracklogs from the sweep recces walked were exported from the Cyber tracker software to Excel and then finally to Arc GIS 10.4 where the recce points and grid cells walked in the field were superimposed on the same topographic map with the recce survey points produced. Data were analyzed using Cyber Tracker software, Arcmap10.4, R-statistics, and Excel.

Results and discussion

Influence of relief and food availability on the distribution of Chimpanzees

In this study, the encounter rate of the nest group with Chimpanzee's nest site stands at 0.9/Km, and 0.3/Km for feeding signs. Chimpanzees' nest group was encountered at an altitude range of 1235-1325m in the southwest portion of the study area which is drained with a steep waterfall, sharp steep wall, tall tree nests, and the presence of *Cola urceolata* k.schum.

Table 1**.** Slope type evidence and encounter rates of *P. troglodytes ellioti*

Sign	Altitude(m)	Habitat	Frequency	Encounter rate/km
Feeding	1235	Montane Forest	18	0.3
Nest	1325	Montane Forest	55	0.9

Table 1 shows that the Nigeria-Cameroon Chimpanzee prefers an altitude range of 1235-1325m a.s.l, which is tangential to a rugged steep wall, a fast-flowing waterfall, and an abundance of fleshy fruits of *Cola uceolata* k.schum, *Garcinia lucida, Garcinia kola,* and *Garcinia manni* which represent suitable tree species for the construction of Chimpanzee tree nests. The particularity of this area is that no anthropogenic activities were recorded during the survey. This finding is in line with that of Serge et al. (2018) who recorded higher Nigeria-Cameroon Chimpanzee nests abundance in areas with steeper slopes and relatively higher altitudes around the Mbam-Djerem National Park.

Vegetation type and distribution of Chimpanzee

The presence of 55 mixed ages nests of *P. troglodytes ellioti* subspecies were recorded within a steep waterfall and a steep rugged wall with an altitude range of 1235m-1325m a.s.l. 47 recent and 8 old nests were detected through nest count (Fig. 3), feeding (Fig. 4), absence of dung, and tree nest height ranging from 8m-41m in the montane forest in the South Western portion of the study area. The most commonly encountered hot spot activity for the groups recorded in the nest site were heaps of the *Cola urceolata* at the banks of the waterfall.

Table 2. Nest-group evidence and Encounter rates

Habitat	Species	**Sub-nest site count**	**Frequency**	**Slope(m)**	**Encounter rate/km**
Montane forest	Chimpanzee (Nest)	5	55	1325	0.9
	Feeding		18	1235	0.3
Sub Montane	0	0	0	0	0
Montane Grassland	0	0	0	0	0

As can be seen in table 2, 55 tree nests of mixed ages were detected and recorded. 85.455% were recent and 14.55% were old and encountered at 0.9/km, solely in the montane forest, with no nest recorded in the Sub-montane and Montane grassland vegetation. Feeding signs were also recorded solely in the montane forest (encounter rate: 0.3), giving an overall encounter rate of chimpanzees in the area to be 1.2/Km. All the nests recorded were tree nests, and this is consistent with the findings of Dutton (2012) who recorded the majority of Chimpanzee nests on trees around Ngel Nyaki Forest Reserve. Chimpanzees mostly build their nests in mature forest vegetation (Kamgang et al., 2018). and at high elevations (Njukang et al., 2019).

(a)

(b)

Figure 3. Chimpanzee nest observed and recorded in the study area: (a) stands for the new nest; (b) for old nest

Figure 4. A heap of *Cola urceolata* eaten by Chimpanzees

Effect of canopy structure on the distribution of Chimpanzee

The different phenology observed such as leaf litter cover, saplings/bush, lianas, herbs, and grass with scoring grids ranging from open and closed canopy associated with a visibility range of 5-15m exclusively in the montane forest are attributes of the Chimpanzee nest-group encounter site in the South

Western portion of the study area. The convention is, therefore, to select from the canopy cover classes of open, close, and very open and aligned them with the visibility range observed during the survivor to situate the exact canopy structure harboring *P. troglodytes ellioti.*

Table 3. Canopy cover scoring grid for Chimpanzee-group encountered

Habitat	**Species**	**Sign**	**Canopy cover class**	**visibility**	**Canopy Cover (%)**
Montane Forest	Chimpanzee	Nest/ Feeding	Open	10-15m	50
			Close	5-10m	25
			Very open	> 15m	75+

Chimpanzee-group encountered signs were detected in the montane forest, within canopy cover classes of open and close respectively (50% and 25%). Tukey`s test revealed that there exists a significant association between animal class (Chimpanzee**),** several feedings remain dung, nests, calls, and canopy cover class, with the significant difference determined at the level of visibility ($P<0.00001$, $F=2905$). In this regard, there is a need for maximum protection of the close canopy harboring *Pan troglodyte ellioti* and other Great Apes. This is because, the more canopies are closed, the more indices of chimpanzees and other Great Apes are detected. Chimpanzees tend to build their nest in areas with a low degree of human pressure (Last and Muh 2013; Njukang et al. 2019), which usually corresponds to areas of reduced visibility. Robin et al. (2021) reported a higher density of chimpanzees in areas similar to our findings in the Ebo Forest Reserve, concluding that the intact forest of Ebo provides a comfortable habitat for Chimpanzees.

Other wildlife encounters

Vegetation type and distribution of other mammals

The presence of seven large mammal species was recorded, three small mammals, two rock fowls, and seven unidentified species during the survey. These mammals were detected by sight, dung, feeding sign, footprint, vocalization, and nests. The most commonly encountered species for the reconnaissance recce walks survey was red duiker (42.97%) and the least red-eared monkey (0.19%), pangolin (0.79%), and drills (0.79%). For the small mammals, the most commonly encountered species were the porcupine (15.44%) and the least mongoose (0.59%). Animal feeding (feeding sign), footprints, dung, direct sighting, and vocalization were the most frequently recorded signs for the recce walks in the study area. The red duiker had a higher encounter rate (2.17) followed by the red river hog (1.03) than other mammals, and these were mostly in the Sub-montane forest (Table 4).

Table 4. Habitat Structure Evidence for Chimpanzees, other Mammals, and Encountered Rates

Habitat Type	**Frequency**	**Element**	**Common Name**	**Encounter Rate (ER)/km**
Montane Forest	477	Monkey	Drill	0.04
			White-nose monkey	0.06
			Preuss'monkey	0.08
			Red-eared monkey	0.01
		Ape	**Chimpanzee**	**1.2**
		Unidentified primate	Unidentified primate	0.42
Sub montane Forest	35	Antelope	Blue duiker	**0.21**
			Red duiker	**2.17**
		Another large mammal	Red river hog	**1.03**

Montane Grassland	1		Pangolin	0.04
Water	97	Another small mammal	Porcupine	0.78
			mongoose	0.03
		Other		0.09
Total				5.05

Wildlife signs (65.41%) were recorded in all parts of the study area. The chimpanzee (1.78%) and drill (0.79%) were restricted to the southwestern and southern parts of the area while the pangolin (0.79%) was only recorded in the northern part of the area. The study area is rich with duikers (47.12%), especially the red duiker (42.97%) which stands as the highest mammal encountered and mongoose (0.59%) the lowest small mammal recorded across montane, and submontane forest drained by rivers, streams, and brooks in the study area.

Conclusion

P. troglodytes ellioti was recorded entirely in the montane forest with all nests recorded being tree nests. This area also provided available food and water that is required by the animals. This indicates that the montane forest provides a more favorable habitat for chimpanzees than the sub-montane forest and the montane grassland. There is therefore a great indication that there is a significant correlation between habitat conditions and *P. troglodytes ellioti* lone group in the South Western portion of the South East Cluster Conservation Zone of the park.

References

Astaras, C., Linder, J, M., Wrege,P., Orume, R.D,.&Macdonald, D.W. (2017). Passive acoustic monitoring as a law enforcement tool for Afro tropical rainforests. Frontiers in Ecology and the Environment, 15(5), 233-234.

Barve, N., Kiran, M.C., Vanaraj, G., Aravind, N.A., Rao, D., Shaanker, R.U., Ganeshaiah, K.N., Poulsen, J.G. (2005) Measuring and mapping threats to a wildlife sanctuary in southern India. Conservation Biology 19, 122-130

Bethan, J.M., John, N.S., Ekwoge, E.A. (2012). Attempted Predation by Nigeria-Cameroon Chimpanzees (Pan troglodytes ellioti) on Preuss's red colobus (*Procolobus preussi*) in the Ebo forest, Cameroon. Folia Primatologica 83:329-331.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L., Thomas, L. (2001). Introduction to distance sampling: Estimating abundance of biological populations, Oxford University Press, Oxford, UK, 432 pp.

Curtis, P.G., Slay, C.M., Harris, N. L., Tyukavina,A., & Hansen, M.C.(2018). Classifying drivers of global forest loss. Science, 361(6407), 1108–1111. https://doi.org/10.1126/science.aau3445.

Dutton, P.E. (2012). Chimpanzee (*Pan troglodytes ellioti*) ecology in a Nigerian montane forest. PhD Thesis, University of Canterbury.

Ekwoge, E.A., Bethan, M.J. (2008). Four years of preliminary research and conservation of the Nigeria-Cameroon Chimpanzee (*Pan troglodytes ellioti*). Pan Africa News 15(2):26-29

Estrada, A., Garber, P. A., Rylands, A. B., Roos, C., Fernandez-Duque, E., et al (2017). Impendingextinctioncrisisoftheworld'sprimates:Whyprimatesmatter.ScienceAdvances,3(1),e1600946.https://doi.org/10. 1126/sciadv.1600946.

Haddad, N. M., Brudvig, L. A., Clobert, J., Davies, K. F., Gonzalez, A., et al (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems. Science Advances, 1(2), e1500052. https://doi.org/10.1126/ sciadv.1500052.

Hughes, N., Rosen, N., Gretsky, N., & Sommer, V. (2011). Will the Nigeria-Cameroon chimpanzee go extinct? Models derived from intake rates of ape sanctuaries. InV. Sommer & C. Ross (Eds.), Primates of Gashaka: Socioecology and conservation in Nigeria's biodiversity hotspot (pp. 493–523). New York: Springer Science+Business Media.

Kamgang, S. A., Bobo,K. S., Maisels, F., Ambahe,R.D. D., Ongono, D. E.A., etal(2018). The relationship between the abundance of the Nigeria-Cameroon chimpanzee (*Pan troglodytes ellioti*) and its habitat: A conservation concern in Mbam-Djerem National Park, Cameroon. BMC Ecology, 18(1), 40. https://doi. org/10.1186/s12898-018-0199-3.

Knight, A., Chapman, H.M., Hale, M. (2015). Habitat fragmentation and its implications for Endangered chimpanzee *Pan troglodytes* conservation. Oryx. https ://doi.org/10.1017/S0030 60531 50003 32.

Last, C., & Muh, B. (2013). Effects of human presence on chimpanzee nest location in the Lebialem Moné Forest landscape, south-west region, Cameroon. Folia Primatologica, 84(1), 51–63. https://doi.org/10. 1159/000346305.

Plumptre, A. (2017). Bio-monitoring methodology and protocol, for implementation in PSMNR-SWR Phase IV. Mission report: June 2017.Unpublished internal document.

McManus, E. (2005). Federal Republic of Nigeria. InJ. Caldecott & L. Miles(Eds.),World atlas of great apes and their conservation (pp. 378–383). Los Angeles: University of California Press.

Morgan, B.J. and Abwe, E.E. (2006). Chimpanzees use stone hammers in Cameroon. Curr Biol. 16(16):632–3. https ://doi.org/10.1016/j.cub.2006.07.045

Morgan, B., Adeleke, A., Bassey, T., Bergl, R., Dunn, A., Fotso, R., Gadsby, E., Gonder, K., Greengrass, E., Koulagna, D. K., Mbah, G., Nicholas, A., Oates, J., Omeni, F., Saidu, Y., Sommer, V., Sunderland-Groves, J., Tiebou, J., & Williamson, E. A. (2011). Regional action plan for the conservation of the Nigeria-Cameroon chimpanzee (*Pan troglodytes ellioti*). IUCN/SSC Primate Specialist Group and Zoological Society of San Diego.

Ndimbe, M. S., Morgan, B. J., Marino, J., & Abwe, E. E. (2016). Population density estimate of the Nigeria Cameroon chimpanzee (*Pan troglodytes ellioti*) in the Ebo forest. Cameroon: Unpublished report.

Njukang, A. P., Angwafor, T. E. I., Akwanjoh, S. R., Lebga, A. K., & Chuo, M. D. O. (2019). Effects of anthropogenic activities on chimpanzee nest location in the Tofala Hill Wildlife Sanctuary (THWS), South West Region, Cameroon. International Journal of Forest, Animal and Fisheries Research, 3(1). https://doi.org/10.22161/ijfaf.3.6.1.

Oates, J. F., Doumbe, O., Dunn, A., Gonder, M.K., Ikemeh, R., Imong, I., Morgan, B. J., Ogunjemite, B., & Sommer, V. (2016). *Pan troglodytes ssp. Ellioti*: The IUCN Red List of Threatened Species 2016. e.T40014A17990330. https://doi.org/10.2305/IUCN.UK.2016-2. RLTS.T4001 4A179 90330.en

Robin C.W., Ekwoge, E.A., Daniel, M.F. et al. (2021). Mammal distribution and trends in the threatened Ebo 'intact forest landscape', Cameroon. Global Ecology and Conservation 31. https://doi.org/10.1016/j.gecco.2021.e01833

Sanz, C., Morgan, D., Strindberg, S. Onononga, J.R. (2007). Distinguishing between the nests of sympatric chimpanzees and gorillas. Journal of Applied Ecology 44:263-272.

Serge, A.K., Kadiri., Fiona, M. et al. (2018). The relationship between the abundance of the Nigeria-Cameroon chimpanzee (*Pan troglodytes ellioti*) and its habitat: a conservation concern in Mbam-Djerem National Park, Cameroon. BMC Ecology 18:40

Sesink-Clee, P.R., Abwe, E.E., Ambahe, R., Anthony, N.M., Fotso, R., Locatelli, S., Maisels, F., Mitchell, M.W., Morgan, B.J., Pokempner, A. (2015). Chimpanzee population structure in Cameroon and Nigeria is associated with habitat variation that may be lost under climate change. BMC Evol Biol. 15:2. https ://doi.org/10.1186/s1286 2-014-0275-z.

Tranquilli, S, Abernethy, K., Amsini, F., Asamoah, A., Balangtaa, C. & Campbell. (2014). Protected areas in tropical Africa: assessing threats and conservation activities. PloS one 9(12),e114154.

White, L. and Edwards, A. (2000). Conservation research in the African rain forests – a technical handbook. Wildlife Conservation Society.