Assessment of the Population of Wild Ruminants in a Fragmented Forest Habitat: Case Study of Abayum Forest, Ikom Cross River State, Nigeria

Article · January 2016

DOI: 10.9734/JAERI/2016/14516

4 authors, including:

James Bukie
Federal University of Agriculture, Makurdi
15 PUBLICATIONS **11** CITATIONS

SEE PROFILE

Augustine Ogogo
University of Calabar
22 PUBLICATIONS **85** CITATIONS

SEE PROFILE

Journal of Agriculture and Ecology Research International
6(1): 1-7, 2016; Article no.JAERI.14516
ISSN: 2394-1073

SCIENCEDOMAIN *international*
www.sciencedomain.org

Assessment of the Population of Wild Ruminants in a Fragmented Forest Habitat: Case Study of Abayum Forest, Ikom Cross River State, Nigeria

Abang Neji Tawo[1], James Oshita Bukie[2], Augustine Ugar Ogogo[3*] and Francis Ebuta Bisong[1]

[1]Department of Geography and Regional Planning, University of Calabar, Calabar, Nigeria.
[2]Department of Wildlife and Range Management, University of Agriculture, Makurdi, Nigeria.
[3]Department of Forestry and Wildlife Resources Management, University of Calabar, Calabar, Nigeria.

Authors' Contributions

This work was carried out in collaboration between all authors. Author ANT designed the study and collected the field data. Author JOB analyzed the data and wrote the first draft of the manuscript. Author AUO restructured the write up and managed the literature searches. Author FEB wrote the discussion and conclusion. All authors read and approved the final script.

Article Information

DOI: 10.9734/JAERI/2016/14516
Editor(s):
(1) Ahmed Esmat Abdel Moneim, Department of Zoology, Helwan University, Egypt and Institute of Biomedical Research Center, University of Granada, Spain.
Reviewers:
(1) Edson Gandiwa, Chinhoyi University of Technology, Zimbabwe.
(2) Emuobonuvie Amy Emerhi, Delta State University, Asaba Campus, Nigeria.
(3) Edward Missanjo, Malawi College of Forestry and Wildlife, Malawi.
(4) Chapungu Lazarus, Great Zimbabwe University, Zimbabwe.
(5) Anonymous, Laurentian University, Canada.
Complete Peer review History: http://sciencedomain.org/review-history/12899

Original Research Article

Received 1st October 2014
Accepted 19th October 2015
Published 5th January 2016

ABSTRACT

Aims: To study the effect of forest fragmentation on population density and species diversity of wild ruminants in Abayum forest.
Study Design: Stratified random sampling for the fragments and simple random sampling for interview of hunters.
Place and Duration of Study: Abayum forest, Cross River State, Nigeria. (Latitude 6.00° and 6.15ℕ and longitude 8.30° and 8.45℈ of Green which Meridian). Data on forest fragmentation was

**Corresponding author: Email: auogogo@yahoo.com;*

collected for a seven year period (2000 to 2007) while data on the population of wild ruminants was collected in two seasons (rainy season and dry season) for one year between March 2010 and April 2011.

Methodology: A random sample of 14 fragments representing 35% sampling intensity was carried out. Number of fragments over a seven year period, size of fragments and their corresponding population of wild ruminants were investigated. Interview of 50 randomly selected hunters in the area was conducted. The fragments were grouped into three viz: 1st, 2nd and 3rd order and samples randomly taken from each. Wildlife population census was carried out through indirect methods such as animal droppings, traits or tracts, feeding habitats and noise.

Results: The number of fragments increased at the rate of 87.5% in 7 years or 12.5% per annum. Human activities such as permanent crop cultivation, settlement, bush burning and logging were the main causes of forest fragmentation. Correlation of the population density of wild ruminants with fragment sizes gave r = 0.375 in duikers, r = 0.611 in other antelopes and r = 0.649 in bushbucks.

Conclusion: Fragment size determined the population of big wild ruminants. Other factors such as hunting pressure, bush burning and farming also contributed in the determination of the population of ruminants in any fragment.

Recommendation: It was recommended that the Cross River State Forestry Commission should be well funded to enforce the anti-deforestation law of Cross River State thus reducing forest fragmentation. Farmers in the area should be taught to adopt intensive farming and agro-forestry systems rather than the shifting cultivation method they practice presently, to help conserve the remaining forest fragments.

Keywords: Forest fragmentation; ruminant population; abayum forest; Cross River State; Nigeria.

1. INTRODUCTION

Forest fragmentation through anthropogenic activities is the main cause of wildlife population loss [1-4]. According to Tawo [5] and Ogogo et al. [2], Abayum Forest is among the remaining forest Ecosystems in Cross River State, Nigeria. The forest is however, being seriously fragmented.

According to Hogan [6], habitat fragmentation involves alteration of habitat resulting in spatial separation of habitat units from a previous state of greater continuity. In many modern landscapes, however, human activity has resulted in loss and fragmentation of habitats and as a result has caused artificial barriers to species migration [7]. Loss of functional connectivity following habitat loss and fragmentation could drive species decline [1], cause the reduction of the population of wildlife by reducing the migratory routes through the modification of the habitat. Wildlife species are restricted to small patches of land resulting in crowding effects leading to increased inter and intra specific competition [8,2]. Additionally, the size of a fragment limits the number of species in it with smaller fragments supporting smaller populations which become vulnerable to extinction [9].

A number of authors [10-12,2] have pointed out that added to limited space, environmental factors such as diseases, prolonged drought, fire, flood and food scarcity which would have posed no threat of extinction in large populations may become catastrophic in small isolated populations.

The study aimed at determining the effect of habitat fragmentation on the population of wild ruminants in Abayum Forest, Ikom Local Government Area, Cross River State Nigeria from the year 2000 to 2007.

2. MATERIALS AND METHODS

2.1 The Study Area

The study was carried out in Abayum forest, Ikom Local Government Area, Cross River State, Nigeria. It lies between latitude 6.00° and 6.15°N and longitude 8.30° and 8.45°E of Green which Meridian. It was approximately 106.2 km^2 in size. It is bounded in the North-West by Ogoja Local Government Area, North-East by Boki Local Government Area and South-East by Etung Local Government Area.

The study area has a tropical climate with distinct rainy and dry seasons. It has a mean annual rainfall of 258 mm per annum with mean

temperature of 25.5℃ and relative humidity of 89-94 percent [13,2]. The vegetation is made up of rainforest which has been reduced to secondary forest due to intensive cultivation, bush burning and other varied human activities. Some areas still have relics of tropical high forest with others having derived savanna [2].

2.2 Data Collection

Data collection followed the method used by [2]. The areas covered included Onyenghe, Egonenkor Esaja, Ayukasa, Mile V, Njamatoe, Abinti, Nto, Nyerenkpor, Ndom and Nkomtap. Data on number and sizes of fragments from 2000 to 2007 were collected from satellite images obtained from Geodev communication company of France. A map of the area was prepared for each year and the number of fragments counted. Population and status of ruminants was obtained through indirect census and interview of hunters.

The forty fragments were stratified into first, second and third order fragments in line with the method used by [2]. The first order fragments were greater than or equal to 10 km^2, second order fragments were greater than or equal to 1km^2 and third order fragments, were less than or equal to 0.03 km^2. Apart from the first order fragments that were few and were all selected, the second and third order fragments were randomly sampled at 30 percent sampling intensity based on the number of fragments in each order. Three plots, two plots and one plot each were selected from first, second and third order fragments, respectively. Each of the plots measured 50 m x 50 m with transects of 5 m intervals established for the careful observation of foot prints, droppings, trails or tracts, and eating habits of ruminants [14,15].

A total of twenty one plots were sampled. Data on population distribution were collected from plots and were summed up fragment by fragment and divided by the size of the fragment to obtain population density of ruminants. Both young and old hunters were interviewed. Data obtained included type of ruminants common in the area, various hunting methods and gears used, frequency of catching a particular species of ruminants and the species most preferred by the local inhabitants of the area. Five persons were randomly selected and interviewed in each of the ten villages, bringing the total number of those interviewed to 50.

2.3 Data Analysis

Correlation and regression analyses were used to analyse the data. Frequency and percentage tables were used in the presentation of results. Each table contained information on the research questions asked following the objectives of the study.

3. RESULTS AND DISCUSSION

Due to the variety of habitats in the area, the following species were identified: Bushbuck (*Tregelaplus scriptus*), Roan antelope (*Hippotragus equinus*) and Blue duicker (*Cephalophus monticolar*) The intense exploitation of bush buck for food and skin for decoration has contributed greatly in the reduction of the population of this species of wild ruminants in the study area.

Table 1 shows that the number of forest fragments rose from 18 in 2000 to 40 in 2007. Thus in seven years, there was 87.5% increase. Human settlement in the form of private homes, religious houses, educational and health institutions constituted 40% of activities that caused forest fragmentation. Agriculture accounted for 20% leaving 10% for logging and over hunting. Hunting was named by 50% of the respondents as being responsible for the drop in wild ruminant population (Table 2).

Table 1. Number and sizes of fragments between 2000 and 2007

Fragment size (km^2)	Year 2000	%	Year 2007	%
≥ 10	2	11.1	2	5
≤ 1 – 10	3	16.7	3	7.5
< 0.030 -1	13	72.2	35	87.5
Total	18	100	40	100

Data source: Ogogo et al. [2]

Agricultural activities constituted 20% leaving 10% to logging. Fifty percent of the respondents gave over hunting as the primary reason for the drop in wild ruminants population (Table 2). This high hunting incidence was also observed by [16] in Jos Wildlife park. This was at variance with the observations of [17] in the protected Okomu National Park. Over hunting and unsustainable farming activities resulted in wildlife habitat degradation. Thirty percent of the respondents attributed the decline in wild ruminant population to this.

Table 2. Human activities leading to fragmentation

Activities	Frequency	%
Settlement expansion	20	40
Agricultural activities	10	20
Timber exploitation	10	20
Cattle grazing	5	10
Bush burning	5	10
Total	50	100

According to Amos et al. [1], loss of functional connectivity following habitat loss and fragmentation could drive species decline. This was also the observations of [8,2]. [18] stated that thousands of scientific studies now show unequivocal evidence for the impacts of patch area, edge effects, patch shape complexity, isolation and landscape matrix contrast on community structure and ecosystem functioning.

Ten percent of the respondents attributed the reduction in wild ruminant population to chemical use and forest fragmentation (Table 3).

In recent times, farmers in the area have resorted to using herbicides for land clearing and weed control. Decrease in the numerical strength of the labour force of each family following the increased number of children from each family who are pursuing higher education. The children have to leave the village to bigger townships where higher institutions of learning are located. Weed control using herbicides is also cheaper since the weeds take a longer period of time to regrow after being killed by herbicides. This however results in the disappearance of certain plant species. The animals including ruminants are affected due to the disruption of the food chain. Moreover, some of these chemicals persist in the environment and ultimately find their way into human food and water sources thereby endangering human health.

Table 3. Reasons advanced by hunters for the decline in wild ruminant populations

Reasons	Frequency	%
Excessive hunting	25	50
Farming activities	15	30
Use of chemicals as bait	5	10
Fragmentation	5	10
Total	50	100

Note: Reasons used in this table followed those of Ogogo et al. [2]

Clearly, the population of wild ruminants decreased as the forest fragment increased (Table 4). For example, the biggest fragment with size 19.52 km^2 had population density of 2532 Antelopes, 1732 Duikers and 0 (zero) Bush buck while the smallest fragment with size 0.12 km^2 had population density of 803 antelopes, 803 Duikers and 0 (zero) Bush bucks.

In a few cases however, small fragments contained a higher population of certain ruminants. For example a fragment as small as 0.18 km^2 had 5200 duikers whereas a fragment as big as 0.74 km^2 had only 402 duikers. Secondly, some fragments though large did not contain population of certain ruminants. This could be attributed to the availability of certain resources like cover, food, water, absence of predators and less hunting pressure in that

Table 4. Fragment sizes and population density of ruminants

S/N	Fragment size (km^2)	Population of other antelopes	Population of duikers	Population of bush buck
1	19.52	2532	1732	0
2	16.69	1332	6932	0
3	3.62	2000	3200	0
4	2.99	2000	1200	0
5	2.61	6200	2640	600
6	0.74	2400	402	0
7	0.62	4399	4399	800
8	0.62	3203	5200	0
9	0.43	400	1201	0
10	0.43	7200	1601	0
11	0.18	1201	5200	0
12	0.17	1198	201	0
13	0.15	4399	4399	0
14	0.12	803	803	0

fragment. Vegetation cover and other resources desired by ruminants were not evenly distributed in all the fragments.

The population of big game animals (bush buck and other antelopes) had a significant correlation with the sizes of the fragments (0.649 and 0.611 respectively, $P < 0.01$, Table 5.) with larger fragments having larger populations of the two species and vice versa. This was also observed by Ogogo et al. [2] for rodents population.

The number of bush bucks was highly positively correlated with the number of other antelopes ($r = 0.68$, $p < 0.01$) but a low relationship between the former and duikers. The population of duikers also had a low positive correlation with fragment size ($r = 0.375$, Table 5). This suggests that bigger game animals are more vulnerable to fragmentation that the smaller animals like duikers since their minimal area is larger than that of the duiker [19].

This could also be explained by the fact that people in the study area preferred antelope and Bush bucks meat and skins to those of duikers whose skins are less decorative. This trend has been shown to be common with the people of Boki, Ikom and Etung Local Government Areas [20]. Prediction equation of sizes of fragment and ruminant population is shown in Table 6. The low values of R^2 indicated that only a small fraction of the variation in ruminant population can be attributed to fragment size. Other factors such as climate change, hunting pressure and predation could account for the rest of the values. Further, the low R^2 means that fragment size alone cannot be used to predict the population of wild ruminants in any fragment. A multiple regression involving other factors would be better.

The high percentage (90%) of the rural populace who preferred bush meat to other protein sources could account for the decrease in wildlife population in the area by these results. Urban dwellers equally prefer bush meat to domestic livestock.

This is supported by the fact that hotels and restaurants that serve bush meat are heavily patronised, indicating that their customers enjoy this delicacy.

The primary cause of decrease and extinction of wildlife populations from studies and long term observation was given by [14,21,22] to be small population size. This according to them predisposes small population to vulnerability of extinction as predicted by many other researchers.

According to [23], species with large bodies such as elephants are more vulnerable to extinction due to their small population and very long gestation period (22 months).

Table 5. Correlation of fragment size and ruminant population (Pearson correlation coefficient)

	Fragment size (km^2)	Other antelopes/km^2	Duikers/km^2	Bush bucks/km^2
Frag size Pearson Correlation	1	-.149	.257	-.134
	14	.611*	.375	.649*
Other Antelopes Pearson correlation	-.149	1	0.78	.483
	.611*	14	.797*	.680*
Duikers Pearson correlation	.257	0.78	1	.171
	.375	.791*	14	.560*
Bush buck Pearson correlation	.134	.483	.171	1
	.649*	.680*	.560*	14

*Note (1): * Correlation significant at 0.01 level (2 tails). Note (2): The first value in each cell is the Pearson correlation, while the second value gives the significance at two tail test*

Table 6. Prediction equation of sizes of fragments and ruminants population (y) from fragment size(x)

Ruminant species	Prediction equation	R^2
Antelopes	Y = 2973.747+650.577x	0.22
Duikers	Y = 2487.368+653.259x	0.22
Bush bucks	Y = 119.004+81.730x	0.12

Apart from body size, [23] observed that wildlife migration also accounts for extinction of species since some individuals trying to return to their habitat get killed by hunters. Additionally, species that are restricted to particular habitat and breeding sides are vulnerable to extinction.

Species that occupy isolated habitats with peculiar characteristics where populations are most times small, may be predisposed to extinction as a result of environmental changes like forest fragmentation.

4. CONCLUSIONS AND RECOMMENDA-TIONS

Forest fragmentation results in the decline and extinction of local populations of wildlife. There is also a reduction in the biodiversity since the smaller the fragments, the fewer the number of species.

Human activities like permanent crop cultivation, urbanization, annual bush fires, logging and emergence of new settlements in areas that had none or that were difficult to reach by visitors have brought about forest fragmentation.

Additionally, the use of sophisticated weapons and baits to hunt large mammas has placed wild ruminant populations at the risk of extinction in recent times than it was previously.

Fragmentation of forest has changed large tracts of forest land to disjointed patches that inhabit few species which are at the risk of extinction. It was recommended that the Cross River State Forestry Commission should be well funded to enforce the anti-deforestation law of the State. The forest dwelling people in this area should be taught modern methods of farming such as intensive farming and agro-forestry systems rather than the shifting cultivation method they practice presently, to help conserve the remaining forest fragments

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Amos JN, Harrison KA, Radford JQ, White M, Newell G, Nally RM, Sunnucks P, Pavlova A. Species and sex connectivity effects of habitat fragmentation in a suite of woodland birds. Ecology. 2014;95(6):1556-1568.
2. Ogogo AU, Bisong FE, Tawo AN. Habitat fragmentation and the population status of rodents in Abayum forest, Ikom, Cross River State, Nigeria. Natural Science. 2013;5(8):914-918.
3. Janzen DH. Tropical dry forest: The most endangered major tropical ecosystems. In: Wilson EO, Ed. Biodiversity, National Academy Press, Washington D.C. 1998;130-151.
4. Quesada M, Stoner MK. Threats to conservation of tropical dry forest in Costa Rica. In: Frankie GW, Amota, Vinco SB, Eds. Biodiversity conservation in Costa Rica: Hearing the lessons from a seasonal dry forest. University of California Press, Berkery; 2004.
5. Tawo AN. The effect of habitat fragmentation on biodiversity of rodents and wild ruminants in the forest of Ikom Local Government Area, Cross river State, Nigeria. Unpublished. Ph.D. Thesis, Department of Geography and Regional Planning, University of Calabar, Nigeria; 2011.
6. Hogan C. Habitat fragmentation. Encyclopaedia of Earth Sciences; 2014. Available:http://www.earth.org/view/article/153225
7. Collingham YC, Huntley B. Impacts of habitat fragmentation and patch size upon migration rates. Ecological Society of America. 2000;10(1):131-144.
8. Ellsaad JA, Ellam MFT. Zoogeography: The geographical distribution of animals. New York; 1993.
9. MacArthur, Wilson. The theory of Island biogeography. Princeton University Press, Princeton; 1963.
10. Roo RB. Organization of plant anthropoid association in simple and diverse habitats: The fauna of collards (*Brassica oleracea*). Ecological Monographs. 1973; 43:95-120.
DOI: 10.2307/1942161
11. Raupp MJ, Denno RF. The influence of patch side on a guild of sap-feeding insects that inhabit the salt march grass (spartina patterns). Environmental Entomology. 1979;8:412-417.

12. Connor EE, Courtacy AC, Yoder JM. Individual area relationship: The relationship: Between animal population density and area. Ecology. 2000;81:234-748.
13. Cross River Agricultural Development Programme (CRADP). Report on Wetland soils of Cross River State, Nigeria. Government Press, Calabar; 1992.
14. Ogogo AU. Wildlife Management in Nigeria, objectives, principles and procedures. 1st Edition, median Communications, Calabar; 2004.
15. Burton M. Guide to the mammals of Britain and Europe. Treasure press, London. 1990;256.
16. Ijeomah HM, Ogogo AU, Ogbara D. Analysis of poaching activities in Kainji Lake National Park. Canadian Center of Science and Education. 2013;3:51-61.
DOI: 10.5539/Emvr
17. Ajayi S, Eniang EA, Bukie JO. Effects of hunting activities on the populations of white-throated monkeys (*Cercoputhecus erythrogaste)* in Okomu National Park Edo State, Nigeria. CRUTECH Journal of Science, Engineering and Technology. 2012;1(2):1-6.
18. Didham RK. Ecological Consequences of habitat fragmentation. In els John willey and Sons ltd; 2010.
Available:http://www.els.net
19. Ogogo AU. Wildlife Management in Nigeria, objectives, principles and procedures. 2nd Edition, Median Communications, Calabar; 2008.
20. Edet DI, Akinyemi AF. Importance of wildlife and non-timber forest products of the cross river rainforest, Nigeria. In: Practical Issues in Forest and Wildlife Resources Management. Ijeomah HM, Aiyeloja AA, (Eds.) Green Canopy Consultant Port Harcourt. 2014;471-502.
21. Chapungu L, Takuba N, Zinhiva H. A multi-method analysis of forest fragmentation and loss: The case of ward 11, Chiredzi District of Zimbabwe. African Journal of Environmental Science and Technology. 2014;8(2):121-128.
22. Diamond JM. "Normal" extinction in isolated populations. In: Niteck MH, Ed, Extinction, University of Chicago, New York. 1984;191-245.
23. Leigh EG. The average lifetime of a population in a varying environment. Journal of Theoretical Biology. 1981;90: 213-239.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/12899