

Impact of Logging on Non-Logged Species in the Moist Forest Region of South Eastern Nigeria

Oluyemi Ayorinde Akintoye [1*], Francis Ebuta Bisong[1], Pius Bekwuapu Utang [2], Elizabeth Andrew-Essien[1]

[1] Department of Geography and Environmental Science
University of Calabar, Nigeria

[2] Department of Geography and Environmental Management
University of Portharcourt , Nigeria
*E-mail of the corresponding author : oluwayemijubilee@yahoo.co.uk

Abstract
The study examined the effects of logging intensities on the quality, stocking levels and damage to non-logged species. Data was collected using stock inventory methods (SIM) in the tropical rainforest of Ekukunela, Cross River State in South Eastern Nigeria. Four experimental plots of one hectares each were laid in the forested areas with different logging intensities (lightly logged, moderately logged, intensively logged) and a control plot which has not been logged (Primary forest).Only tree species up to 30 cm dbh and above were enumerated. The findings show that increasing logging rates directly reduced the quality and quantity of non-logged forest species in the sample plots. The highest number and best quality of species enumerated, were found in the unlogged tropical rainforest plot. Increased government and community participation in forest management, more effective training, better funding, and improved monitoring of logging practices were recommended,
Key words: Community forestry, Logging intensities, Stocking levels, Unlogged species, Tropical rainforest.

1. Introduction

Efforts toward the effective management of tropical rainforests for sustainable timber extraction and the need for the mitigation of the impacts of logging on biophysical and socioeconomic environment have in recent times reached an unprecedented proportion. Perhaps this great concern is based on the fact that tropical rainforests (selvas) are of inestimable value, because of their complex ecosystems and distinctively high biodiversity. Their high species richness is probably the most outstanding characteristics, and at least 60 percent of all known species of plants (about 155,000 out of 250,000), about 90 percent of all the world's non-human primates, about 40 percent of all the birds of prey , and about 80 percent of all the insects have been identified to inhabit the tropical rainforests, globally (Park, 1992:25-27). These rainforests also provide natural resources for wood products (fuel wood and timber), and numerous non-timber forest products (NTFPs) (Balogun, 1994:2).

Ticktin (2004) has comprehensively highlighted the issues concerning the increasing use of Ntfps for commercial trading (Kuipers ,1997;Lange 1998) : increasing dependence by households on NTFPs (Iqbal , 1993) ; the problems of overexploitation of NTFPs (Rebelo and Holmes , 1988; Vásquez and Gentry, 1989 ; Cunningham , 1993; Clay 1997; Rawat,1997; Tiwari, 2000): and the social, economic and political conditions for sustainable exploitation of NTFPs (Parks, Barbier and Burgess , 1998; Kline, Alig and Johnson, 2000; Shackleton ,2001; Amacher ,2002) These gives an international perspective of the NTFPs utilization and sustainability problems.

Due to the high species richness of the tropical rainforest, only a few selected economic tree species are actually felled through logging for timber. There are usually damage to the surrounding flora and soil, and induced erosion and distorted hydrological patterns. Poor practices, which are associated with these problems, include chain saw operations and bulldozing. These cause very high destructions to the forests through unsustainable activities, such as dragging trees roughly through the forests. Consequently, unlogged flora species, are destroyed, either out rightly or by causing severe or minor injuries ,which affect their qualities (Parks, 1992).

Years ago, Cross River State (CRS) of Nigeria had about 31 percent of the remaining threatened rainforests of Nigeria. It also harbors the largest remnant of comparably unlogged tropical rainforests (Balogun, 1994). The proportion of forests owned by CRS has since dwindled considerably. The present estimate is varied, according to estimators and estimation methods.

Although the Cross River National Park (CRNP) with a forested land of about 4,000 sq km was established in 1994, the depletion of the rainforests, within and outside its delineated boundaries, through commercial logging, and other factors of deforestation have increased alarmingly. This precious vegetation, in the recent past, become the commercial logging targets of multi-national logging and wood processing firms like Hanseatic Nigeria Ltd (German), Kisari Investment Co. Ltd (Belgian) and most recently Wempco Agro-forestry Co. Ltd (Hong Kong/Chinese). Parks (1992) has indicated that commercial logging poses serious threat to tropical forests and account for a quarter of annual loss of primary (Undisturbed) rainforests around the world.

Sting and Dutilleux (1989) pointed out that almost one third of total forest trees are destroyed to make logging access and log retrieval roads and tracts. Further, several damage to Tropical Rain Forests (TRFs) are caused by the accidental damage , to unselected surrounding tress, during felling operations, due to the close canopy and stand arrangement of TRF trees. More damage are inflicted during the dragging of logs on the forest grounds by heavy machines and vehicles. Another factor is the large-scale wastage of wood, resulting from the clearance of larger than required forest areas. The Worldwide Fund for Nature (1988) indicates that at times, less than 5 percent of the cut or damaged trees are actually utilized.

One major way in which logging can impact rural household is in the consequences on NTFPs stocking rates, which affects household income and forest resources availability for domestic uses. Laird (1999:51-60) pointed out that timber and NTFPs are in several ways inter-related. Timber species often have very valuable non-timber uses; however logging can reduce the availability of such flora species, which are locally or regionally consumed NTFPs. Destructive logging operations have the potentials of causing direct damage, to species in residual stands, as well as those , which constitutes the under-storey and ground cover of forests, many of which are very important NTFPs.

The paper thus, focuses mainly on the identification of the impact of logging on non-logged species in the tropical rainforests of Ekukunela in Ikom Local Government Area (LGA) of Cross River State. Specifically, the paper examined the possible impact of logging on the quantity and quality of unlogged stands of tree and NTFPs species, in the selected Tropical Rain Forests (TRFs) within Ikom L.G.A.

2. Study Area

The study area for this study is the rainforests of Ekukunela community, located in 06.00’ 27’’N and 08.33’ 37’’ in Ikom LGA of Cross River State in Nigeria. Ikom L.G.A is bounded in the North-West by Ogoja LGA, in the North-East , it shares boundry with Boki LGA, in the Eastern flank with Etung LGA, while the Southern boundary is shared with Obubra LGA.

The physiographic characteristics of the particular rural community, selected for study are very similar to that of the entire Ikom L.G.A. The soil is podzolic and lateritic. The dominant local soils include the forest soils, which coincides with the high forest belt in Southern Nigeria. The soils are highly leached by rainfall, and very much deficient in nutrients, resulting in poor acidic and deep soils, best protected by thick rainforest vegetations (Asuquo, 1987).

The climate is the tropical humid type. This area experiences annual rainfall ranging between 2500-2750 millimeters. There are two district seasons, which include the rainy or wet season (May to October) and dry season (November - April). The temperature ranges between 25^{o}C – 27^{o}C in January, while in July, it is relatively high. Humidity in January is about 75-95 percent and becomes relatively dryer towards the end of the year (Asuquo, 1987). Such very high rainfall and high temperature, over most part of the year, usually result in very humid evergreen vegetation, with very distinctive structure, complex ecosystem and remarkably high biodiversity (Park, 1992:1-12). The vegetation is typically tropical rainforest, with unique combinations of plants and animals. Based on studies by Dun et al (1994) Ikom LGA (which by then included the present Etung LGA) has a percentage forest cover by type, made up of tropical forest (39 percent), swamp forest (0 percent) mangrove forest (0 percent), other forest types (5 percent) and other land-use (56 percent).

The various sequences of tropical high forest are attained. The highest tree layers are about 24 metres high; the middle tree layers and between 8 and 24 metres high: while the third layer of trees are about 5 to 11 metres high. The shrub layer follows at about 4.5 metres above ground level. The ground level is usually dark due to little availability of sunlight at such depth. Here mushrooms may thrive. The various types of hardwoods logged in these tropical rainforests include the following species: Terminilia Ivorensis (Black Afara) Brachystegia toxisperma (Mimusop), Nauclea diderrichii (Opepe), Milicia excelsa (Iroko), Pycnanthus anagolensis (Ilomba), Brachystegia spp (Achi), Piptadoniastrum africanum (Small Leaf), Brachystegia spp (Achi), lophira alala (Iron Wood or Ekki), Pterocapus osun (Red Camwood), Gossweilorodendron spp (Agba), Guiarea thompsonii (Guarea), Cieba pantandra (Silk Cotton).

The TRFs in the study areas, are thus characterized by multiple species and varieties of vegetation. As such , several species of animals dwell in these humid forests. Some of these animals, such as the Guenon Monkeys (Cercopithecus sclateri) are endemic to Nigeria, and especially the Cross River Rainforest area.
The rich biodiversity of TRFs means that selected tress are not concentrated in an area, but are scattered. Although up to 2500 different species may be present, in a small area of TRF, only about 100 species may be logged. However, even unselected trees are sometimes inevitably cut down.

3. Data Collection Method

This research employed the Participatory Rural Appraisal (PRA) method and Stock Inventory Method (SIM). The latter involves direct field measurements, including delineation of sampling plots and species enumeration. The participatory rural appraisal methods used include: Direct Observation, Transect Walks and Participatory Transects, and Seasonality Calendar.
The stock inventory method (SIM) was used to collect data from the forests with different levels of logging intensities, and from a primary forest in the study area. The measurements and data collection were carried out in four sample plots of one-hectare (m^2) each. The plots were located in an unlogged high forest, lightly logged high forest, moderately logged high forests and intensively logged high forests, within the same area. The pre-stipulated criteria for plots located included the present level and intensity of log extraction, extent of canopy gap opening and extent of forest structure alteration, as well as a logging duration, which ranges between 1-2 years.
The stock data collected include the population of timber , NTFPs yielding trees and other NTFPs including climbers and shrubs. Data were also collected on the appearance and conditions of the population of flora species . The criteria adopted for the determination of species quantity and quality include such indicators as “Good”, “Bruised”, “Broken”, and “Destroyed” (dead). The species indicated as “Good” are derived, after the number of species encountered in sample plots classified as “Bruised”, “Broken” and “Destroyed” have been deducted from the total population of species encountered in individual plots. The total population of plant species encountered, in each one-hectare plot is the stocking rate for the plot.
The quantitative statistic techniques used in data analysis, include frequencies , percentages , statistical means and Analysis of Variance (ANOVA).

4. Results and Discussion

Table 1 shows the percentages of each species found in the respective sample plots. The results of the statistical mean test are presented in table 2, while the results of Analysis of Variance are presented in table 3.
Table 2 presents the statistical means of differences in the effects of logging on quality of NTFPs species in three logged sample plots and species in an unlogged sample plots Table 2 shows that the unlogged tropical rainforest has the highest statistical means of 3.33052, for enumerated species identified as “Good” and 59 .6 percent of plant species, also falling within the “Good” class. However, in the intensively logged tropical rain forest plot, the mean value of “Good” species has fallen to 0.2316, while this classification accounts for only 4.2 percent of enumerated species in that sample plot.
For “Bruised” species , table 2 shows mean values of 0.3895 (the highest for the category) and 0.3474 respectively, in lightly logged and moderately logged rain forest plots. The lowest observation of bruised species is in the unlogged TRF plot, with a statistical mean of 0.1474 and a mere 13.0 percent representation. This shows that the level of damage, as represented by “Bruised” species is lowest in the unlogged forests. Surprisingly, this is also low in the intensively logged TRF plots, which has a statistical means of 0.5452 and a percentage representation of 22.2 percent. Perhaps this is due, to the fact that human activities, accessibility and physical contacts, with plant species by forest users, in intensively logged forests, are very high and more frequent. Thus, bruises most easily transform to higher level of damage. As such less bruised species are encountered
The trends in tables 2, shows that there are relatively low level of damage and quality of enumerated species, as far as reduction in the population of species encountered. This suggests that there is a considerable reduction in quality and quantity of N.T.F.Ps and unlogged tree species with increase in logging intensity.
The results of the statistical means, as in table 2 , indicate that, there is a gradual reduction in the mean value, from the quality indicator “Good” to “Destroy”. It is observed that the total mean value, for plant species graded “Bruised” in the different plots has fallen to .2842. A further reduction in total mean value, is recorded for plant species graded “Broken” with .2528. Comparatively the least total mean value, is obtained from the group of plant species, found to be “Destroyed”, with .1474. It should be noted that, if the rapid fall in plants total population (stocking rate), in each plot and under each logging intensity, are compared with the percentage or proportion, which are bruised, broken and destroyed, it would be glaring, that there is a significant decrease, in the quality of

encountered species, in the sample plots, with increase in logging intensity. Notably in table 2, the value for "Good" plant species, diminished from a 3.3053 high mean value, in the unlogged TRF plot, to a .2316 low mean value, in the intensively logged forest plot. This shows that the population of "Good" flora species, decreased rapidly from unlogged TRF plot. There is a total reverse in the trend, since instead of decreasing from the unlogged TRF plot, as earlier noticed, the means value for individual plots increased gradually, towards the intensively logged TRF plot, from a value of .1471 to .2526. This shows that, the populations of bruised fauna species, increases as logging intensity increases.

Table 2, further reveal that the quantity of plants classified as "Broken", is lowest in the unlogged plot (.1684). However, the highest mean value is observed in the lightly logged plot (.3895). The moderately logged plot, has the second highest value with .3474. But the value of .2526 for the intensively logged plot, is still considerably higher than what was observed for the unlogged plot. This shows us that the quality of plant species decreases with increases in logging intensity, however with a peak in level of damage in the lightly and moderately logged plots. Similarly, although the lowest population of "broken" plants was recorded in the unlogged plot (.1684), a peak of .3368 is observed in the lightly logged forest. These may be because, although the level of canopy gaps and quantity of extracted tress may qualify this plot to be classified as lightly logged, logging operations such as tree felling and skidding may have caused higher damage to unlogged tree stands, and other plant populations in the forest environment.

In the same vein, although there is a trend of increasing damage from the unlogged plot to the logged plots, the highest mean value is also observed in the lightly logged plot. The reason for this may be due to the assumptions made in the two previous sub tables.

The percentage of total sum, which gives a per-proportion value of the total enumerated plant species (stocking population) throws more light on this statistical analysis result. The table generally shows a decrease from unlogged plot (59.6 percent) to the lowest value of 4.2 percent, a trend, which is a replica of the observations from the individual quality means.

Table 3, presents the results of the analysis of variance (ANOVA) highlighting statistical differences in the distribution of plant species in sample plots, with different logging intensities, based on data collected from the stock survey in Ekukunela forest area.

We observe that in table 3 (A) the F-value for the group of encountered plants classified as "Good" in all the four plots is very high at 16.4100, while the p-value is .000. Since the p-value is lower than 0.05 this relationship is considered highly significant. Thus it could be concluded for this group, that there is a significantly difference in the quality of NTFP distribution in the four plots. As such logging intensity seems to affect NTFPs quality.

In table 3 (B) the F-value for the ""Bruised" group is 3.542 , while the p-value is 0.17. This shows a high significant difference in the quality of NTFP's distribution, among the four plots, with different logging intensities, since the p-value is relatively low, while the F-value is high. This could be interpreted to mean that logging intensity significantly affects the distribution and quality of NTFPs in the sample plots.

Table 3 (C) shows that the F-value for the group of encountered plant species classed, as "Broken" is 1.709, while the p-value is .165. The difference in the quality and distribution of NTFP species in the four plots, with different logging intensities ,is thus not too significant, although there is a weak relationship. The relationship in table 3 (D), is high (.727), while the p-value is .547. There is no considerable difference in these values, as indicated in three previous groups.

However, the general trend is that there exist considerable differences in the distribution and quality of NTFPs in the four plots with different logging intensities. That is there is a statistically significant relationship between logging intensity and the quantity, as well as quality of non-logged forest species in the study area .

Detailed information on the distribution, with respect to quality and quantity (in percentages) of individual species, can be found in table 3. This shows increasing levels of biodiversity depletion, as logging intensity increases in the sample plots.

5. Conclusion

Generally, the entire research focused on the impingement of logging intensities on non-logged species in selected forest areas within Ekukunela , in Ikom Local Government Area of Cross River state . The stock survey methods were used to collect relevant qualitative and quantitative data.

The aim was to examine relationship between logging intensities and qualities and qualities of non-logging fauna species in sample plots.

The study shows that increasing logging intensity, significantly reduce the population and qualities, of unlogged NTFPs and tree species.

6. Recommendations

Based on the findings of this research, the following recommendations have been proffered for implementation:-

Efforts should be made by the necessary institutions, to encourage participatory forest management strategies, merging the ideas and priorities of government, non-governmental organizations, foreign donors, forest communities and other stakeholders.

Forest communities should be allowed to retain a major portion of the revenues and royalties from forest exploitation, to encourage forest communities' roles as custodians of the forest.

Training courses on appropriate methods of timber harvesting and conveyance out of forest sites should be taught to loggers.

Logging instructions and guidelines should be recommend, while cultural and silvicultural operations, which promote considerable regeneration of log yielding trees and NTFPs species should be encouraged.

Tree markings should be carried out to identify matured and removable trees and direction of tree felling, in order to limit destructions to residual stands. The harvesting of only matured trees should be enforced.

References

Amacher, G.S. (2002) Forest Policies and Many Governments. *Forest Science, 48* ,146– 158.

Asuquo, F. A. (1987). Soils and Vegetations of South – Eastern Nigeria. Lagos, Prestige Press Limited.

Balogun, P. (1994). The impact of Social and Economic Issues on Forestry in Cross River State, Nigeria, Calabar ,Cross State River Forestry Department.

Clay, J.W. (1997) The Impact of Palm Heart Harvesting in the Amazon Estuary. *Harvesting Wild Species: Implications for Biodiversity Conservation* (ed. C.H. Freese), pp. 283–314. John Hopkins University Press , Baltimore, MD.

Cunningham, A.B. (1993) African Medicinal Plants. Setting Priorities at the Interface between Conservation and Primary Healthcare. People and Plant Working Paper 1. UNESCO, Paris, France.

Dunn R., Otu D. O., Wong J. (1994) " Report of the Reconnaissance Inventory of High Forest and Swamp Forest Area of Cross River state, (Oversea Development Administration Assisted) Calabar, Nigeria.

Iqbal, M. (1993) International Trade in Non-Wood Forest Products. An Overview. Food and Agriculture Organization, Rome, Italy.

Ikom Local Government (1998) Ikom Local Government : Cross River State: On The Saddle, Calabar, Cross River State.

Kline, J.D., Alig, R.J. & Johnson, R.L. (2000) Fostering the Production of Non-Timber Services among Forest Owners with Heterogeneous Objectives. *Forest Science*, **46**, 302–311

Kuipers, S.E. (1997) Trade in Medicinal Plants. Medicinal Plants for Forest Conservation and Health Care (eds. G. Bodeker, K.K.S. Bhat, J. Burley and P. Vantomme), pp. 45–59. Food and Agriculture Organization, Rome, Italy.

Laird S. A. (1999) The Management of Forest for Timber and Non- Wood Forest Products in Central Africa , In Sunderland T. C. H., Clark L. E. and Vantomme P. (eds) Non-Wood Forest Products of Central Africa Current Research Issues and Prospects for Conservation and Development ,Based on the Outcome of the International Expert Meeting on Non-Wood Forest Products in Central Africa Held at the Limbe Botanic Garden, Cameroun 10 – 15 May 1998, Rome Food and Agricultural Organisation.

Lange, D. (1998) Europe's Medicinal and Aromatic Plants. Their Use, Trade and Conservation. TRAFFIC International, Cambridge, UK.

Park C. C. (1992) Tropical rain forests. London, Routledge,

Rawat, G.S. (1997) Conservation Status of Forest and Wildlife in the Eastern Ghats. *India Environmental Conservation*, **24**, 307–315.

Rebelo, A.G. and Holmes, P.M. (1988) Commercial exploitation of *Brunia albiflora* (Bruniaceae). *South African Journal of Botany*, **45**, 195–207.

Shackleton, C.M. (2001) Re-examining Local and Market Oriented Use of Wild Species for the Conservation of Biodiversity. *Environmental Conservation*, **28**, 270–278.

Sting .A. and Dutilleux J (1989) Jungle Stories: The Fight for the Amazon, London, Barrie and Jenkins.

Ticktin , T (2004) The Ecological Implications of Harvesting Non-Timber Forest Products, British Ecological Society, *Journal of Applied Ecology*, 41. 11- 21

Tiwari, B.K. (2000) Non-Timber Forest Produce of Northeast India. *Journal of Human Ecology*, **11**, 445–455.

Vásquez, R. and Gentry, A.H. (1989) Use and Misuse of Forest Harvested Fruits in the Iquitos Area. *Conservation Biology*, **3**, 350–361.

World Development Report (1992) Development and the Environment, New York, Oxford University Press.

Worldwide Fund For Nature (1988) Conservation of Tropical Forests Special Report 1, Switzerland, World Wildlife Fund.

Table 1: Percentages highlighting differences in the distribution of plant species in sampled rainforest area with different logging intensities

Serial Number	Species	Unlogged forest (%)				Lightly logged forest plots (%)				Moderately logged forest plots (%)				Severely logged forest plots (%)				Total for all forest plots (%)			
		Good	Bruised	Broken	Destroyed	Good	Bruised	Broken	Destroyed	Good	Bruised	Broken	Destroyed	Good	Bruised	Broken	Destroyed	Good	Bruised	Broken	Destroyed
1	Afzeila africana	100.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	25.00	25.00	0.00
2	Albisia zygia	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00	100.00	0.00	0.00	71.43	14.29	14.29	0.00
3	Alchomea condiflora	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	83.33	16.67	0.00	0.00
4	Akstonia booneli	50.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.6	0.00	33.33	0.00
5	Alstoniaa congensis	0.00	0.00	0.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.0	0.00	0.00	50.00
6	Ankhodeista vogeli	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	50.00	50.00	0.00	0.00	100.00	0.00	0.00	37.50	37.50	25.00	0.00
7	Baillonella tozisperma	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
8	Barphia nitiada	100.00	0.00	0.00	0.00	40.00	20.00	20.00	25.00	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	72.22	11.11	11.11	5.56
9	Barteria fistulosa	100.00	0.00	0.00	0.00	25.00	25.00	25.00	25.00	0.00	0.00	50.00	50.00	0.00	100.00	0.00	0.00	41.67	25.00	16.67	16.67
10	Blighia sapila	100.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00	66.67	33.33	0.00	0.00	0.00	0.00	100.00	0.00	72.73	9.09	18.18	0.00
11	Bombax buonopozense	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	5.00	0.00	0.00
12	Brachystegia euyooma	66.67	0.00	33.33	0.00	66.67	0.00	33.33	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	57.14	14.29	28.57	0.00
13	Cananim schweinfurthil	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00
14	Ceiba pentandra	100.00	0.00	0.00	0.00	33.33	33.33	33.33	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.43	14.29	14.29	0.00
15	Chew cola	50.00	25.00	0.00	25.00	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	100.00	0.00	44.44	22.22	22.22	11.11
16	Chrysophyllum albidium	100.00	0.00	0.00	0.00	66.67	3.33	0.00	0.00	25.00	50.00	0.00	25.00	50.00	50.00	0.00	0.00	58.33	33.33	0.00	8.33
17	Cola acminata	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	100.00	0.00	71.43	14.29	14.29	0.00
18	Cola argentea	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	60.00	20.00	20.00	0.00
19	Cola gigantean	100.00	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	50.00	50.00	0.00	0.00	55.56	33.33	11.11	0.00
20	Cola lepidota	50.00	50.00	0.00	0.00	50.00	50.00	50.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	62.50	12.50	25.00	0.00
21	Cola nitida	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00	33.33	33.33	33.33	33.33	33.33	22.22	11.11
22	Cola pachycarpa	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00
23	Cola edulis	66.67	33.33	0.00	0.00	0.00	0.00	100.00	0.00	100.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	50.00	25.00	12.50	12.50
24	Cylicodiscus gabunensis	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	75.00	0.00	25.00	0.00

25	**Dacroydes edulis**	75.00	25.00	0.00	0.00	0.00	66.67	0.00	33.33	100.00	0.00	0.00	0.00	0.00	50.00	0.00	0.00	50.00	33.33	8.33	8.33
26	**Detaanium microcarpum**	50.00	0.00	50.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	50.00	50.00	50.00	14.29	28.57	28.57	28.57
27	**Dalium guineese**	50.00	0.00	0.00	50.00	0.00	50.00	50.00	0.00	0.00	33.33	3.33	33.33	0.00	0.00	0.00	100.00	11.11	22.22	22.22	44.44
28	**Diosoynos classiflora**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	50.00	0.00	50.00
29	**Diospyros piscatorial**	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
30	**Dracaena arborea**	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	60.0	40.00	0.00	0.00
31	**Drypetes floribunda**	33.33	33.33	33.33	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	33.33	33.33	16.67	16.67	20.00	40.00	40.00	0.00
32	**Elaesis guineensis**	63.64	0.00	27.27	9.09	75.00	0.00	25.00	0.00	85.71	14.29	0.00	0.00	0.00	0.00	0.00	0.00	64.29	10.71	17.88	7.14
33	**Enantia chlorantha**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
34	**Erthrophleum suaveolens**	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
35	**Ficus spp**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	100.00	0.00	0.00	0.00
36	**Funtumia elastic**	83.33	0.00	0.00	16.67	50.00	25.00	0.00	25.00	0.00	50.00	50.00	0.00	50.00	0.00	50.00	0.00	50.00	14.29	14.29	21.43
37	**Garcinia mannii**	100.00	0.00	0.00	0.00	75.00	0.00	25.00	0.00	100.00	50.00	50.00	0.00	0.00	0.00	50.00	0.00	66.67	8.33	25.00	0.00
38	**Garcinia kola**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
39	**Gmelina arborea**	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00
40	**Hylodendron gabunesnse**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	50.00	100.00	0.00	0.00	50.00	0.00	0.00	0.00	87.50	12.50	0.00	0.00
41	**Irvingia gabonensis**	100.00	0.00	0.00	0.00	66.67	33.33	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	50.00	0.00	66.67	22.22	11.11	0.00
42	**Itallea ciliate**	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00
43	**Lophira elarta**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
44	**Lovoa trichiliodes**	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
45	**Mammea Africana**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
46	**Massuloria acuminate**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	100.00	66.67	11.11	11.11	11.11
47	**Milicia excelsa**	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.00	25.00	0.00	0.00
48	**Monkey cola**	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
49	**Monodora brevipes**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	83.33	0.00	16.67	0.00
50	**Monodora myristica**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
51	**Morinda lucida**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	33.33	0.00	0.00
52	**Musanga cecropiodes**	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	20.00	20.00	60.00	0.00
53	**Naculea diderrichii**	0.1000	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
54	**Newbouldia laevis**	50.00	0.00	50.00	0.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	25.00	50.00	0.00
55	**Omphalocarpus elatum**	0.00	100.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	25.00	50.00	25.00
56	**Panda oleosa**	100.00	0.00	0.00	0.00	50.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	50.00	25.00	12.50	12.50
57	**Parkia bicolor**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
58	**Pentaclethra macrophylla**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
59	**Piptadeniastrum Africanum**	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	33.33	0.00	0.00
60	**Poga oleosa**	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	0.00	33.33	0.00
61	**Pterocarpus milbraedii**	50.00	0.00	50.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	66.67	0.00
62	**Pterocarpus osun**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
63	**Pterocarpus soyaaxii**	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
64	**Pterygota macrocarpa**	50.00	0.00	0.00	50.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	0.00	0.00	33.33
65	**Pycnanthus angolensis**	80.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	16.67	16.67	0.00
66	**Raphia Africana**	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
67	**Raphia hooteri**	100.00	0.00	0.00	0.00	20.00	40.00	20.00	20.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	54.55	27.27	9.09	0.00
68	**Raphia vinifera**	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.00	0.00	25.00	0.00
69	**Ricinodendron heudelotii**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	100.00	0.00	0.00	60.00	40.00	0.00	0.00
70	**Spondias mombin**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
71	**Straudtia stipitata**	80.00	0.00	20.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.43	14.29	14.29	0.00
72	**Terminalia ivorensis**	0.00	0.00	0.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	0.00	0.00	33.33
73	**Tetrapleura superba**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
74	**Tetrapleura tetraptera**	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00
75	**Treculia Africana**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
76	**Uapaca togoensis**	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
77	**Xylopia aethiopica**	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
78	**Xylopia quintassi**	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	60.00	20.00	20.00	0.00
79	**Xylopia rubescens**	66.67	0.00	33.33	0.00	100.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	100.00	0.00	0.00	0.00	62.50	12.50	25.00	0.00
80	**Zanthoxylum zanthoxyloides**	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00
81	**Erenosphatha macrocarpa**	86.67	4.44	4.44	4.44	90.00	0.00	4.76	4.76	50.00	100.00	30.00	10.00	25.00	37.50	25.00	12.50	77.38	7.14	952	5.95
82	**Gnetum Africana**	87.50	0.00	12.50	0.00	0.00	50.00	30.00	20.00	100.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	63.64	15.15	15.15	6.06
83	**Gongronema latitollium**	100.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00
84	**Laccosperma secondiplora**	94.74	5.26	0.00	0.00	64.29	14.29	7.14	14.29	62.50	12.50	25.00	0.00	0.00	25.00	25.00	50.00	78.13	9.38	6.25	6.25
85	**Momordica augustisepala**	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00	50.00	0.00	0.00	63.64	18.18	9.09	9.09
86	**Afromomum hanburyi**	100.00	0.00	0.00	0.00	25.00	25.00	25.00	25.00	25.00	0.00	25.00	50.00	0.00	0.00	50.00	50.00	52.94	5.88	17.65	23.53
87	**Afromomum melegueta**	80.00	0.00	20.00	0.00	50.00	0.00	0.00	50.00	66.67	33.33	0.00	0.00	0.00	0.00	0.00	0.00	70.00	10.00	10.00	10.00
88	**Capolobia lutea**	100.00	0.00	0.00	0.00	66.67	33.33	0.00	0.00	50.00	0.00	50.00	0.00	0.00	0.00	100.00	0.00	76.92	7.69	15.38	0.00
89	**Costus afer**	75.00	0.00	0.00	25.00	100.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	50.00	0.00	50.00	60.00	20.00	0.00	20.00
90	**Heinsia crinata**	100.00	0.00	0.00	0.00	25.00	25.00	25.00	25.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	55.56	22.22	11.11	11.11
91	**Kaskanthera africanium**	100.00	0.00	0.00	0.00	60.00	13.33	13.33	13.33	42.86	14.29	14.29	28.57	20.00	20.00	20.00	40.00	69.57	8.70	8.70	13.04
92	**Marantaceae**	100.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	50.00	0.00	0.00	50.00	100.00	0.00	0.00	0.00	66.6	11.11	0.00	22.22

Table 2: Statistical means of differences in the effect of logging intensity on quality of non-timber forest product stands.

	Forest type logging intensity	Quality	Mean	N	Std deviation	% of total sum	% of total N
A	Unlogged tropical rain forest	Good	3.3053	92	5.8420	59.6%	25.0%
		Total	3.3053	92	5.8420	59.6%	25.0%
	Light logged tropical rain forest	Good	1.2316	92	2.3855	22.2%	25.0%
		Total	1.2316	92	2.3855	22.2%	25.0%
	Moderately logged tropical rain forest	Good	0.7789	92	1.2731	14.0%	25.0%
		Total	0.7789	92	1.2731	14.0%	25.0%
	Intensively logged tropical rain forest	Good	0.2316	92	0.5545	4.2%	25.0%
		Total	0.2316	92	0.5545	4.2%	25.0%
	Total		**1.3868**	**368**	**3.4220**	**100.0%**	**100.0%**
			1.3868	**368**	**3.4220**	**100.0%**	**100.0%**
B	**Forest type logging intensity**	**Quality**	**Mean**	**N**	**Std deviation**	**% of total sum**	**% of total N**
	Unlogged tropical rain forest	Bruised	0.1474	92	0.4368	13.0%	25.0%
		Total	0.1474	92	0.4368	13.0%	25.0%
	Light logged tropical rain forest	Bruised	0.3895	92	0.7336	34.3%	25.0%
		Total	0.3895	92	0.7336	34.3%	25.0%
	Moderately logged tropical rain forest	Bruised	0.3474	92	0.5004	30.6%	25.0%
		Total	0.3474	92	0.5004	30.6%	25.0%
	Intensively logged tropical rain forest	Bruised	0.2526	92	0.5452	22.2%	25.0%
		Total	0.2526	92	0.5452	22.2%	25.0%
	Total		**0.2842**	**368**	**0.5704**	**100.0%**	**100.0%**
			0.2842	**368**	**0.5704**	**100.0%**	**100.0%**
C	**Forest type logging intensity**	**Quality**	**Mean**	**N**	**Std deviation**	**% of total sum**	**% of total N**
	Unlogged tropical rain forest	Broken	0.1684	92	0.4979	59.6%	25.0%
		Total	0.1684	92	0.4979	59.6%	25.0%
	Light logged tropical rain forest	Broken	0.3368	92	0.5576	22.2%	25.0%
		Total	0.3368	92	0.5576	22.2%	25.0%
	Moderately logged tropical rain forest	Broken	0.2632	92	0.5302	14.0%	25.0%
		Total	0.2632	92	0.5302	14.0%	25.0%
	Intensively logged tropical rain forest	Broken	0.2421	92	0.4775	4.2%	25.0%
		Total	0.2421	92	0.4775	4.2%	25.0%
	Total		**0.2526**	**368**	**0.5181**	**100.0%**	**100.0%**
			0.2526	**368**	**0.5181**	**100.0%**	**100.0%**
	Forest type logging intensity	**Quality**	**Mean**	**N**	**Std deviation**	**% of total sum**	**% of total N**
	Unlogged tropical rain	Destroyed	0.1158	92	0.3532	19.6%	25.0%
		Total	0.1158	92	0.3532	19.6%	25.0%

D	Light logged tropical rain forest	Destroyed	0.1789	92	0.4608	30.4%	25.0%
		Total	0.1789	92	0.4608	30.4%	25.0%
	Moderately logged tropical rain forest	Destroyed	0.1158	92	0.3821	19.6%	25.0%
		Total	0.1158	92	0.3821	19.6%	25.0%
	Intensively logged tropical rain forest	Destroyed	0.1789	92	0.4608	30.4%	25.0%
		Total	0.1789	92	0.4608	30.4%	25.0%
	Total		**0.1474**	**368**	**0.4165**	**100.0%**	**100.0%**
			0.1474	**368**	**0.4165**	**100.0%**	**100.0%**

Table 3: Analysis of variance highlighting statistical differences in the effects of logging on quality of non-timber forest product stands.

		Good	**Sum of squares**	**Df**	**Means square**	**F**	**Sig.**
A	Qty* Forest Type Logging Intensity	Between Groups (combined) Within Groups	513.818 3924.316	3 376	171.273 10.437	16.410	.000
		Total	**4438.134**	379			
		Good	**Sum of squares**	**df**	**Means square**	**F**	**Sig.**
B	Qty* Forest Type Logging Intensity	Between Groups (combined) Within Groups	3.305 120.000	3 376	1.102 .319	3.452	.017
		Total	**123.305**	379			
		Good	**Sum of squares**	**df**	**Means square**	**F**	**Sig.**
C	Qty* Forest Type Logging Intensity	Between Groups (combined) Within Groups	1.368 100.379	3 376	.456 .267	1.709	.165
		Total	**101.747**	379			
		Good	**Sum of squares**	**df**	**Means square**	**F**	**Sig.**
D	Qty* Forest Type Logging Intensity	Between Groups (combined) Within Groups	.379 65.368	3 376	.126 .174	.727	.537
		Total	**65.747**	379			