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Impact of Logging on non Timber Forest Products (ntfps) in the Rainforest of South Eastern Nigeria

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Abstract *This study examined the impact of logging intensity on forest diversity in Iwuru, Akamkpa Local Government Area of Cross River State, South Eastern Nigeria. Specifically, it considered the effects of logging intensity on availability of non-timber forest products (NTFPs), which include timber species and non-timber tree species as well as shrubs and climber species with NTFPs values. The study depended largely on the collection of primary data through direct field measurements carried out during forest inventory exercises in sample plots with lightly logged, moderately logged, severely logged and unlogged tropical rainforest in the study area (Iwuru). The unlogged sample plots were of various sizes depending on the type and quantity of samples to be considered. The collected data were analysed using two types of analytical statistical models, that is, statistical means and analysis of variance (ANOVA).From the statistical mean analysis, the mean value for NTFPs ascribed as "good" decreases from unlogged sample plots (31.40), through lightly logged (13.68) to moderately logged (4.71) and intensively logged plots (0.79).However, more species recorded as "minimal", "moderate" and "severe" were in highly logged plots. The result from the analysis of variance indicates a relatively high f-value of 4.749 and very low p-value of 0.003 indicating a significant relationship between logging and availability of NTFPs. It is established that logging intensity significantly affects the quality and quantity of NTFPs. The policy implications of findings are explored.*

Keywords: *logging impacts, non-timber forest products, rainforest, cross river state, Nigeria*

1. Introduction

Tropical rain forests including those found in Cross River State are very rich in biodiversity. Such forests thus possess very wide varieties of economic trees with timber and non-timber forest products (NTFPs) yielding species, and several climbers and shrub species, which are vital sources of natural resources and household incomes for rural populations. These highly diverse varieties of species are also of great importance to regional and world economics (ODA, 1993; Park, 1992; CTA, 1994; CTA, 1995; Kokwara, 1994: Bisong, 1999; Ajake, 2000 and Balogun 1994).

According to Park (1992:57) commercial logging is a major disturbance of forest area and biodiversity. He stated that, "commercial logging poses a serious threat to tropical forests and is responsible for a quarter of the annual loss of primary rainforests around the world". Laird (1999) also indicated that logging operations directly affects both present and future harvests of timber and non-timber forest products (NTFPs) as well as reduce species and forest structural diversity. Park (1992) further noted that selective logging methods are almost as destructive as clear-cut logging methods. In the selective logging operations, there is the need for access to selected trees of mature age through access and log-retrieval roads or routes. This results in considerably high destruction of neighbouring and immature plants and tree species in the forest environment. This usually occurs because of the high species diversity. The loggable trees are thus often scattered, resulting in the need to destructively search through forests. The close arrangements and interconnectivity in the forest structure also result in induced bruising, breaking and destruction of surrounding forest species. The possible consequences on fauna diversity through habitat losses are usually very high (Gomez – pompa et al, 1972; Plumwood and Rontley 1982; Bowonder, 1987: world wide fund for Nature 1988: Sting and Dutilleux 1989; Cross 1990: Park 1992, Balogun 1994 and Bisong 1999).

Significant biodiversity losses could have ecological, economic, biotechnological, socio-cultural, educational and nutritional repercussions not only on local economies and human populations where they occur, but also on the entire human race.

In view of the above, it is clear that there is a dire need to examine the impact of logging operations on the THFs of Cross River State which has about forty percent of the remaining THFs of Nigeria and about seventy-five percent of its population inhabiting those forest areas. For this purpose Iwuru community in Akamkpa local government area (LGA) has been selected.

The pertinent questions to be asked are numerous and they include the following:-

- What are the contributions of logging intensity to the quality and quantity of NTFPs of tree, shrub and climber classes?
- What logging strategies are appropriate for the minimization of damage to forest vegetation structure and composition?

The major purpose of this research is to identify the impact of logging operations on NTFPS diversity in the tropical rain forests (TRFs) of Iwuru Community in Akamkpa local government area (LGA). Logging shall be taken as the selective or non-selective extraction of economic trees for timber. Not included in this study is the impact of logging on fauna species.

As such the specific objective of this study include:-

1. To examine the effects of logging operations on the quality and quantities of non timber forest products in tree, shrubs and climber species in the tropical rainforests of Iwuru Community.
2. To recommend possible approaches to the minimization of the negative effects of logging in the study area.

The null hypothesis tested in this study states:

"That logging intensity has made no significant contribution to the stocking rate and quality of non-timber forest products in Iwuru."

1.1 Logging and non-Timber Forest Products (NTFPS)

Park (1992) has pointed out that the rainforests provides (apart from timber which can be extracted through logging operations) other wealth for people such as fruits, foodstuff, industrial raw materials and medicine. Thus, a wide spectrum of goods and services can be obtained from the rich store house of the rainforests. Kemp et al (1993) indicated that the role of non-timber forest products (NTFPs) is very important to the long-term conservation of the forest resources and genetic diversity. According to FAO (1984 and 1985) the concern for NTFPs as regards in situ conservation of genetic resources can be dually considered. Firstly for the contributions to the conservation and management of forest resources and secondly because of their intrinsic values as part of the genetic diversity of the ecosystems.

John 1992, Dykstra and Heinrich 1992 and Whitmore 1991 in Laird (1999) acknowledged that logging operations have direct effect on present and future harvests of timber and NTFPs. This can result in the reduction in species and distortion of forest structural diversity. Based on studies by Johns 1988 and uhl and Viera 1989 carried out in Eastern Amazon, for instance, it was observed that in order to log $52m^3$/ha or eight trees, logging operations destroyed 26% of other tree stands. The consequences on the growth of NTFPs, soil compaction and fertility and topsoil are very high.

Logging roads construction inflicts direct damage to forest species, with badly planned logging operations taking up between 6-20 percent of forest area for road network (uhl and Vieira 1989; Johns 1992: Johnson and Lindgreen 1990 in Laird, 1999). The most severe damages by logging roads to non-timber forest products is through the access roads which opens the forests, wildlife and NTFPs diversity to exploiters (Wilkie et al, 1992, Caldecott 1989).

Laird (1999) pointed out that selective logging systems cause damage which is usually patchy because of varying population densities of traded NTFPs, while such species with limited geographical ranges, poor dispersal ability and few seedlings in the understorey have little survival chances if exposed to high logging intensities. Such damage is highest in rare and specialized species. However logging operations can promote the well being of some NTFPs species which thrives better in disturbed forests and roadsides.

2. Method

2.1. Study Area

The study area selected for this study include the tropical rain forests of Iwuru community (Latitude 05^{o} 24' 03" and longitude 08^{o} 13' 19") in the Akamkpa local government area (LGA), South-eastern Nigeria. Akamkpa local government area of Cross River State (CRS) has its administrative headquarters in Akamkpa. (Latitude 5^{o} 18' 45" and Longitude 8^{o} 21' 10").

The climate of Iwuru and indeed the whole Akamkpa LGA is tropical humid in nature. The rainfall is usually between 250 to 500 millimeters from November to April. Between the months of May and October precipitation rises above 2000 millimeters. Annual rainfall ranges between 2000-3000 millimeters. The temperature ranges between 25^{o}c-27^{o}c around January, but in July it hovers slightly above 30^{o}C. Humidity is about 75-95 percent in January, but towards the end of the year humidity reduces gradually to culminate in the harmattan period (Asuquo 1987).These unique combinations of high rainfall, humidity and temperature have interplayed to develop an equally unique, highly complex and most diversity rich vegetation which is ever green all year round.

The vegetation is evergreen tropical rainforest which is a form of closed forest of which both the tropical moist deciduous, deciduous and semi-deciduous forests found outside West Africa also belong.

The tropical rainforest is a unique community of plants and animals (park, 1992). This ecological zone in Iwuru is thus highly rich in biodiversity like all other Tropical Rain Forests (TRFs). The average tree heights range between 50 to about 65 metres and sometimes above this latter height.The forest is home to highly valuable tropical hard woods and non-timber forest products on which the rural and regional economies depend.

2.2. Method

This research depended on only primary data collection. This is obtained from field measurements carried out in the tropical high forests of the study area. Thus, secondary data were not utilized for the testing of hypotheses.

2.2.1. Stock Inventory Method

The study of field measurement adopted for this study is the stock Inventory Method (SIM). Field observations and measurements were carried out on twenty-four types of sample plots with different logging intensities. This ranged from the Unlogged plot for control, to the lightly, moderately and severely logged plots. Measurements on each of these plots were the number of forest trees felled, number and levels of trees damaged, number of trees and seedlings (natural regeneration) affected as well as quantity and quality of non-timber forest products in logged and unlogged plots laid in the tropical rainforests of the study area.

2.2.2. Sampling Technique

The stratified random sampling technique was employed for the collection of primary data in order to ensure that relevant areas with different logging activities were sampled. A total of 24 sample plots were laid with Unlogged, lightly logged, moderately logged and severely logged plots having six each. Fig. 1 shows the layout of the plot. Each plot was one-hectare (100m x 100m). Trees from 30cm dbh and above were considered while seedlings from 5cm and above in height were enumerated.

3. Classification of Plots

Plots were classified into Unlogged, lightly logged, moderately logged and severely logged. The level of canopy cover and the number of trees (30cm and above) per hectare influenced this classification. For instance, a plot was classified as unlogged when there was 90 – 100% canopy cover and the availability of about 150 trees with dbh 30cm and above. Lightly logged plots had about 70% canopy cover with about 120 trees with dbh 30cm and above. For moderately logged plots, the canopy cover was about 50% with about 70 trees of the prescribed dbh per hectare. Severely logged plot had about 40% canopy cover with about 35 trees of the said dbh per hectare.

Figure 1. *Layout of Sample Plots of One Hectare each for the collection of data on Impact of Logging on Forest Regeneration, Stocking, Non-Timber Forest Products (NTFPs) and Damage to Unlogged trees.*

100m

1 (U)	10 (L)	11 (U)	(S) 20	(L) 21
(S) 2	(M) 9	(U) 12	(S) 19	(U) 22
(M) 3	(S) 8	(S) 13	(M) 18	(M) 23
(L) 4	(U) 7	(S) 14	(L) 17	(M) 24
(M) 5	(L) 6	(L) 15	(U) 16	

I-16	Plot numbers
U	Unlogged plots
L	Lightly logged plots
M	Moderately logged plots
S	Severely logged plots.

Source: *Researcher's Field Work Design*

3.1. Classification of the Level of Destruction of Plants by Logging

Indicators for quality of plants sampled were "Good", "Minimal", "Moderate" and "Severe". A plant was regarded as "Good" where there was no visible sign of injury on it. The term "Minimal" was used where there was a slight injury on the plant e.g. slight debarking while "Moderate" was applied where at least a branch of the plant was broken and "Severe" where the plant was uprooted or killed. The extent of damage to trees in the sampled plots were used as indicators to determine the quantity (stocking level) and quality of NTFPs in the sampled plots.

4. Flora/Fauna Species, non Timber Forest Products (NTFPS) And Their Utility Value

Tables 1 and 2 respectively show some NTFPs, flora/ fauna species and their use value. NTFPs commonly occur in the logging sites and are depended upon by communities for food, drink, snacks and construction purposes. The medicinal value of the forest management (flora/ fauna) are also indicated.

Table 1. *Non-Timber Forest Products Found In Iwuru Tropical High Forests and Their Uses*

S/n	Botanical names of non-timber forest products (NTFPS)	Venacular (Efik)	Common names	Uses
1.	*Gnetum africanum*	Afang	Salad	Vegetable
2.	*Labianthera africanum*	Editan	-	Vegetable
3.	*Hensia erenata*	Atama	-	Vegetable

4.	*Pipers guineenses*	-	Hot leaves	Spice/vegetable
5.	*Tomatococus species*	Nkong	Wrapping leaves	Wrapping leaves
6.	*Gondronema species*	Utasi	-	Vegetable
7.	*Mitragyna species*	Owen	Wrapping leaves	Wrapping leaves
8.	*Pycnanthus angolenses*	Abakang	-	Edible fruits
9.	*Elaes guineensis*	Eyop	Palm tree	Edible fruits, oil and wine, broom
10.	*Raphia hookerii*	Ukot	Raphia palm	Wine and building mats
11.	*Raphia vinifera*	Ukot	Raphia palm	Wine and building mats
12.	*Cocos nucifera*	Isip-mbakara	Coconut	Beverages, fruits and building mats
13.	*Pterocarpus santaliniodes*	Mkpa	-	Vegetable
14.	*Bombax species*	Ukim	Silk cotton	Vegetable
15.	*Ceiba species*	Ukim	Silk cotton	Vegetable
16.	*Coula edulis*	Ekom	-	Edible fruits.

Source: *Researcher's Field Data*

Table 2. *Flora and Fauna Species Found In the Study Area and Their Medicinal Uses*

S/n	Scientific names of economic plant and animal species found in iwuru forests	Venacular names (Efik)	Common names	Uses
1.	*Drypetes flouribounda*	-	Drypetes	Bark is used for the treatment of heart diseases
2.	*Enantia chlorenta*	-	-	Bark is used for the treatment of malaria fever
3.	*Monrinda lucida*	Mbubuk ikon	-	Root and bark are used for the treatment of malaria fever
4.	*Alstonia boonei*	Ukpo	-	Bark is used for the treatment of sexually transmitted diseases
5.	*Cnestis ferruginia*	Uten Ebua	-	The root is used as an aphrodisiac
6.	*Schomato-phytum magnificum*	-	-	This is used in the production of anti-snake venum
7.	*Fagara species*	Ukek		The bark of this plant suppresses sickle cell anaemia
8.	*Milicia excels*	Ofriyo	Iroko	Has anti-fungal action
9.	*Garcinia mannii*	Okok	Chewing stick	Has anti-bacterial properties which prevents tooth decay
10.	*Carica papya*	Pawpaw	Pawpaw	Treatment of boils, swellings and malaria fever
11.	*Nauclea latifolia*	-	Opepe	Leaves used to remedy stomach infections
12.	*Elaesis guineensis*	Eyop	Palm tree	Leaves used to treat cough. Kernel oil is used in preparation of antidote against poison, juvenile epilesy, convulsion and Skin diseases are treated with preparations from palm trees
13	*Bryophyllum pinnatum*	-	-	The leaves are used to cure respiratory diseases such as asthma, whooping cough and bronchial problems
14	*Harungana Madgascarienses*	Oton	-	Leaves are used to cure skin infections while latex are used to cure fresh wounds

15	*Sida acuta*	-	-	Used as laxative for pregnant women
16	*Python sebae*	Ibom	Royal Python	Oil is used in the treatment of boils, eczema, scabies, facture diarrhea, dysentry and other intestinal infections
17	*Python reguis*	Asabo	Rock Python	As above
18	*Lizards*	Ekpok	-	Used in the treatment of respiratory diseases
19	*Farm cercopithecidae*	Ebok	Monkeys	Skin used in the treatment of whopping cough
20	*Panthera pardus*	Ekpe	Leopard	Skin, used in chieftaincy matters

Source: *Researcher's Field Data*

5. Impact of Logging Itensity on non-Timber Forest Products

The data in Table 3A to 3D was obtained from a stock inventory survey of non –timber forest products (NTFPs) in the tropical rainforests of Iwuru. The sample plots of one-hectare sizes each include plots, which are unlogged, lightly logged, moderately logged and intensively logged. Only tree species of 30cm dbh and above as well as shrubs and climbers with NTFPs values were enumerated.

Both the statistical means and Analysis of Variance (ANOVA) were adopted in analyzing the data, which was used to test the null hypothesis, which states "that logging intensity has made no significant contribution to the stocking rate and quality of non-timber forest products in Iwuru".

The indicators for quality include such parameters as "*Good*" where there appears to be no visible injury to encountered plant species, "*Minimal* "where there is visible sign of body injury to an encountered plant species; "*Moderate*" where at least a branch of an encountered plant species was broken; and "*Severe*" where the enumerated individual species has been uprooted or is dead.

Based on the results of the statistical mean analysis of data in Table 3 as presented in table 4(A), we observed that the mean value for the total number of NTFPs found to be "Good " in Unlogged tropical rain forest sample plot is 31.400. This diminished to 13.6889 in the lightly logged tropical rainforest sample plot. The mean value further reduced from 4.7111 in the moderately logged tropical rainforest sample plot. to 0.7889 in the intensively logged tropical rainforest sample plot.

This shows a significant reduction in the quantity and quality of NTFP species graded as "Good" as logging intensity increases. This is corroborated by the percentage of total sum in table1 which shows distinct reduction from 52.1 percent in the Unlogged sample plot to 1.3 percent in the intensively logged sample plot. Both the columns presenting values on standard deviations and sum of totals also indicate similar trend.

Table 3A. *Quantity and quality of non-timber forest species enumerated in sample plot with different logging intensities*

S/n	SPECIES	UNLOGGED PLOT				LIGHTLY LOGGED PLOT				MODERATELY LOGGED PLOT				SEVERELY LOGGED PLOT			
		Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe
1.	*Irvingia gabonensis*	6	1	0	0	4	2	1	1	2	2	0	0	0	0	0	0
2.	*Pterocarpus osun*	4	1	1	1	3	1	2	0	1	1	0	0	1	0	1	0
3.	*Garcinia cola*	3	1	2	0	1	0	1	0	2	0	1	0	1	1	0	0
4.	*Raphia vinifera*	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
5.	*Cola acuminata*	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0

S/n	SPECIES	UNLOGGED PLOT				LIGHTLY LOGGED PLOT				MODERATELY LOGGED PLOT				SEVERELY LOGGED PLOT			
		Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe
6.	*Dacroydes edulis*	4	2	0	1	3	1	0	1	2	0	1	0	0	0	0	0
7.	*Ricinodendron heudoliti*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
8.	*Pentaclethra macrophylla*	3	1	0	0	3	3	0	0	2	1	0	1	0	0	0	0
9.	*Chrysophyllum giganteum*	1	0	0	0	2	1	0	1	1	0	0	0	1	0	1	0
10.	*Garcinia mannii*	2	1	0	0	2	0	0	0	2	0	1	1	0	0	0	0
11.	*Tetrapleura tetraptera*	1	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0
12.	*Afzelia africana*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13.	*Poga oleosa*	5	1	1	0	3	1	1	0	2	0	1	0	1	0	0	1
14.	*Cola lepidota*	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
15.	*Milicia excelsa*	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
16.	*Canarium schweinfurthii*	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
17.	*Cala nitida*	3	1	0	0	4	2	2	0	1	0	1	0	2	2	0	0
18.	*Enantia chlorantha*	2	0	0	0	2	1	0	0	0	0	0	0	1	0	1	0
19.	*Diospyros classiflora*	1	0	0	0	2	0	0	0	2	1	0	0	0	0	0	0
20.	*Baillonella toxisperma*	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1
21.	*Cylicodiscus gabunensis*	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
22.	*Diospyros piscatonal*	2	1	0	0	2	1	0	1	0	0	0	0	0	0	0	0

Source: *Researcher's Field Data*

Table 3B. *Quantity and quality of non-timber forest species enumerated in sample plot with different logging intensities*

S/n	SPECIES	UNLOGGED PLOT				LIGHTLY LOGGED PLOT				MODERATELY LOGGED PLOT				SEVERELY LOGGED PLOT			
		Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe
23.	*Alstonia booneii*	2	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
24.	*Spondias mombin*	1	0	0	0	1	0	1	0	2	1	0	0	1	0	0	1
25.	*Treculia africana*	3	0	1	1	1	0	0	0	2	0	1	1	0	0	0	0
26.	*Treculia africana*	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0

27.	*Xylopia aethiopica*	3	1	0	1	1	0	0	0	1	0	1	0	0	0	0	0
28.	*Cola pachycarpa*	6	2	0	0	2	0	0	0	3	0	0	0	2	1	1	0
29.	*Massuiaria acumnata*	8	1	1	1	6	2	1	1	2	1	0	0	3	0	1	0
30.	*Elaeis guineensis*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31.	*Momodora myristica*	3	0	0	0	2	0	0	2	1	0	0	0	0	0	0	0
32.	*Cola edulis*	3	1	0	0	1	1	0	0	2	0	0	0	1	1	0	0
33.	*Coula edulis*	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
34.	*Ceiba pentandra*	4	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0
35.	*Dryptes floribunda*	3	2	0	0	2	0	0	0	2	0	1	0	1	0	1	0
36.	*Morinda lucida*	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
37.	*Itallea citiata*	2	1	0	1	0	0	0	0	2	0	0	0	1	0	1	0
38.	*Parkia bicolor*	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
39.	*Raphia africana*	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0
40.	*Dialim guineense*	1	0	0	0	1	0	0	0	1	1	0	0	1	0	1	0
41.	*Lophira elata*	3	2	1	0	1	0	1	0	0	1	0	0	0	0	0	0
42	*Piptadenistrum africanum*	3	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0
43.	*Pterocarpus milbaedii*	2	0	1	0	2	2	0	0	1	0	1	0	0	0	0	0
44.	*Pycananthus angolensis*	6	1	0	1	3	0	0	0	3	0	2	0	2	0	0	1

Source: *Researcher's Field Data*

Table 3C. *Quantity and quality of non-timber forest species enumerated in sample plot with different logging intensities*

S/n	SPECIES	UNLOGGED PLOT				LIGHTLY LOGGED PLOT				MODERATELY LOGGED PLOT				SEVERELY LOGGED PLOT			
		Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe
45.	*Musanga cecropioides*	3	0	0	0	3	2	0	0	1	0	1	0	0	0	0	0
46	*Alstonia congensis*	2	1	0	0	1	0	0	1	2	2	0	0	0	0	0	0
47.	*Ficus species*	2	0	0	1	2	0	1	0	1	0	0	1	1	1	0	0
48	*Omphalocarpum elatum*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.	*Baphia nitida*	7	1	0	1	4	2	1	0	1	0	1	0	2	0	2	0
50.	*Nauclea diderrichii*	2	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1

51.	*Newbouuldia leavis*	1	0	0	0	2	0	0	0	2	0	0	0	1	0	0	1
52.	*Panda oleosa*	3	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
53.	*Sacoglottis gabonensis*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
54.	*Alchornea cordifolia*	1	0	0	0	3	1	0	1	1	1	0	0	1	0	1	0
55.	*Blighia sapida*	2	0	0	3	1	0	3	0	2	0	1	0	0	0	0	0
56.	*Staudtia stipitata*	7	0	1	0	6	2	0	1	3	0	1	0	1	0	0	1
57	*Zanthoxyum zanthoxyloides*	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
58.	*Albizia zygia*	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
59.	*Erythrophleum saveolens*	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0
60.	*Gnelina arborea*	1	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0
61.	*Hylodendron gabunense*	8	2	1	1	4	1	1	1	4	2	0	1	2	0	2	0
62.	*Anthocleista vogelii*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63.	*Diospyros species*	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
64.	*Lovoa trichiloides*	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0
65.	*Mammea africana*	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
66.	*Terminalia ivorensis*	1	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0
67.	*Barteria fistulosa*	2	0	1	0	1	0	1	0	0	0	0	0	1	0	0	1

Source: *Researcher's Field Data*

Table 3D. *Quantity and quality of non-timber forest species enumerated in sample plot with different logging intensities*

S/n	SPECIES	UNLOGGED PLOT				LIGHTLY LOGGED PLOT				MODERATELY LOGGED PLOT				SEVERELY LOGGED PLOT			
		Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe	Poptn	Minimal	Moderate	Severe
68.	*Bombax buouopozense*	1	0	1	0	2	0	0	0	0	0	0	0	1	0	0	1
69.	*Pterygota macrocarpa*	2	1	0	0	4	2	0	0	2	0	0	2	0	0	0	0
70.	*Cola gigantea*	2	0	0	1	1	0	1	0	1	0	0	0	1	1	0	0
71.	*Distemonanthus benthamianus*	2	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0
72.	*Dracaena arborea*	1	0	0	1	0	1	0	2	0	1	0	0	0	0	0	0

73.	*Monodora brevipes*	2	0	1	0	1	1	0	0	0	0	0	0	1	1	0	0
74.	*Terminalia superba*	2	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
75	*Uapaca togogensis*	6	1	2	0	5	3	0	0	1	0	0	0	0	0	0	0
76.	*Xylopia quintasii*	7	3	0	0	2	0	1	0	3	0	0	1	1	0	1	0
77.	*Xylopia rubescens*	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
CLIMBERS																	
78.	*Gnetum africana*	22	1	1	0	17	3	2	1	10	2	1	1	4	0	1	1
79.	*Piper guineenses*	4	1	0	1	2	0	1	0	1	0	0	1	2	0	1	1
80.	*Eremospatha macrocarpa*	125	10	0	0	88	16	4	2	51	3	3	4	20	5	0	1
81.	*Gondronema latifolium*	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
82.	*Laccosperma secondiflora*	62	13	6	3	12	2	0	2	18	2	2	2	10	5	1	0
83.	*Momordica augustisepala*	11	1	0	0	6	1	1	1	4	0	2	0	2	1	0	0
SHRUBS																	
84	*Afromomum melegueta*	12	2	1	0	6	2	0	1	6	1	2	1	2	0	0	1
85.	*Lasianthera africanum*	24	9	1	1	11	2	1	2	8	2	0	2	2	0	1	0
86.	*Aframomum hanburyi*	1401	31	10	2	811	61	14	32	310	52	50	20	80	23	14	7
87.	*Marantaceae species*	1201	42	5	13	468	24	35	32	182	12	6	9	34	19	3	9
88.	*Heinsia crinata*	3	0	1	0	3	1	0	1	1	0	1	0	0	0	0	0
89	*Carpolobia lutea*	7	1	1	2	3	0	1	1	3	0	0	2	1	0	0	1
90	*Costus afer*	2	0	0	0	3	0	1	0	2	0	1	0	1	0	0	0

Source: *Researcher's Field Data*

Table 4. *Statistical Means of Differences in Quality and Quantity Non-Timber Forest Products in Sample Plots with Different Logging Intensities.*

	Qty of NTFPs	Forest Type Logging Intensity	Mean	N	Std. Deviation	% of Total Sum	% of Total N	Sum
A	Good	Unlogged Lightly Logged Moderately Logged Intensively Logged Total	31.4000 13.6889 4.7111 0.7889 **12.6472**	90 90 90 90 **360**	185.8218 83,.8382 24.4542 4.08820 **102.9314**	52.1 22.7 78 1.3 **83.9**	6.3 6.3 6.3 6.3 **25.0**	2826.00 1232.00 424.00 71.00 **4553.00**

B.	Minimal	Unlogged Lightly Logged Moderately Logged Intensively Logged Total	1.6222 1.6556 0.8556 0.6778 **1.2028**	90 90 90 90 **360**	5.7055 7.0267 5.4886 3.1970 **5.5234**	2.7 2.7 1.4 1,1 **8.0**	6.3 6.3 6.3 6.3 **25.0**	146.00 149.00 77.00 61.00 **433.00**
C.	Moderate	Unlogged Lightly Logged Moderately Logged Intensively Logged Total	0.5000 0.9222 0.8667 0.4222 **0.6778**	90 90 90 90 **360**	1.3678 3.9696 5.2707 1.5505 **3.4498**	0.8 1.5 1.4 0.6 **4.5**	6.3 6.3 6.3 6.3 **25.0**	45.00 83.00 78.00 38.00 **244.00**
D.	*Severe*	Unlogged Lightly Logged Moderately Logged Intensively Logged Total	0.4000 0.9667 0.5111 0.3333 0.5528	90 90 90 90 360	1.4518 4.7344 2.1788 1.2270 2.7732	0.7 1.6 0.8 0.6 3.7	6.3 6.3 6.3 6.3 25.0	36.00 87.00 46.00 30.00 199.00
E.	Total	Unlogged Lightly Logged Moderately Logged Intensively Logged **Total**	8.4806 4.3083 1.7361 0.5556 **3.7701**	90 90 90 90 **360**	93.5166 42.3524 12.9137 2.7692 **51.7884**	56.2 28.6 11.5 3.7 **100**	25.0 25.0 25.0 25.0 **100.0**	3053.00 1551.00 625.00 200.00 **5429.00**

Source: *Researcher's Field Data*

In the same table 1(B), we also observed almost a totally similar trend except that the highest mean value is observed in the lightly logged tropical rainforest sample plot since species graded as *"Minimal"* were considered here (1.6556) while the next higher mean value is recorded in the Unlogged plots (1.6222), a difference of 0.0334, which is notably insignificant. The diminishing mean values for moderately and intensively logged sampled plots are 0.8556 and 0.6778 respectively.

These indicate that qualitatively and quantitatively more species graded as "*Minimal*" were enumerated in lightly logged plots. The relatively high level of bruised individuals in the Unlogged plot may have been caused by natural processes of tree ageing and falling, thunderstorm damage, animal actions and so on; but when compared to the 31. 400 mean value of "Good species in table 4(A), the relatively high level of bruised species in the unlogged sample plot may be considered as insignificant. Both the percentage of total sum and sum totals for table 1(A) confirm all earlier observations.

In table 4 (C & D), lightly logged plot recorded the highest statistical means for species graded "*Moderate*" (0.9222) and "*Severe"* (0.9667). This may be due to the fact that although the quantity of timber species extracted qualifies the plot as lightly logged, the methods and equipments adopted in logging operations may have caused more severe damage relative to other sampled plots. Table 4 (E) presents the totals for all the sample plots. This reveals very distinct disparities in the distribution of species when quantity is considered. The highest mean value reflecting highest population is recorded in the Unlogged plot (8.4806), the next higher value in the lightly logged plot (4.3383), moderately logged plot (1.7361) and the lowest statistical mean value in the intensively logged tropical rain forest sample plot.

Based on the observed highly significant disparity in the distribution of species with different quality values as shown especially in table 4 (A-D) and different quantity as especially shown in table 4 (E), the null hypothesis "That logging intensity has made no significant contribution to the stocking rate and quantity of non timber forest products in Iwuru is rejected and the alternative hypothesis "that logging intensity has made significant contributions to the stocking rate and quantity of non-timber forest products in Iwuru is accepted.

6. Conclusion and Recommendations

The findings from this research have revealed that logging intensity significantly influences forest flora diversity and that the higher the logging intensity, the greater the damage to the forest flora population. Consequently, these could have dire effect on the general forest ecosystem and severe implications on the availability of socio-economic, industrial and medical (health) dependent natural resources obtainable from this highly precious type of vegetation.

To ameliorate or totally eradicate these possible problems, the following recommendations have been made. These, if adopted, where relevant, would contribute immensely to the present strategies of governments, local and international, non-governmental agencies (NGOs) and other stakeholders in the conservation and management of the tropical rain forests of Cross River State and inevitably other similar regions in Nigeria, or else where in the world.

The concessional programme for allocation of tropical rainforests for logging should include the monitoring and actual co-ordination of the logging activities. Stock survey should be carried out while trees to be logged should be carefully selected and marked out by officials of the Forestry Commission. Severe penalties should be meted out to lawbreakers. Forest areas with rare endemic species should not be logged while sloppy areas, which are highly prone to erosion, should be excluded from logging.

There should be a compulsory system of replacement of at least three seedlings for every one tree logged. Emphasis should be given to indigenous species over exotic ones. No logging should be carried out close to stream and other perennial water sources. Participatory management strategies incorporating the multiple views and opinions of the various tiers of governments, communities, local and international non-government agencies (NGOs) should be encouraged.

The possible consequence of logging activities on NTFPs and wildlife populations on which rural populations depend largely should be a priority in the list of factors considered for granting logging concessions. Most productive NTFPs collection areas should be protected from logging operators. More environmental friendly logging strategies should be identified through increased research and encouraged. Minimum and maximum logging intensities for all logging concession areas should be stipulated and highly destructive machines and vehicles discouraged from the area.

The construction of logging roads and log retrieval trails should be planned before logging operations commence. This should be based on mapping strategies, which reduces the opening of the forest to other users (such as farmers, hunters and house developers) and at the same time reduces forest destruction.

The importance of forest disturbance and canopy openings to regeneration of certain commercially favored timber species and NTFPs should be identified and such moderate processes should not be totally discouraged. There should be-pre-logging environmental impact assessments, which culminates in the submission of environmental impact assessment reports on which logging operations can be adjustably executed.

An increasingly high proportion of the income from felled trees and NTFPs should go to the rural communities or individuals as the case may be. This would encourage natural resource conservation since the rural people so deprived of possibly using the forest areas for farming can still earn highly valuable income.

Logging companies and even powered chain-saw logging operators should be mandated to be involved in rural infrastructural development, employment of the members of the host communities and support of other socio-economic activities of such host rural settlements.

Adequate funds should be provided by government, individuals and Non-governmental Organizations (NGOs) with the view to raising nurseries and plantations. Also, more forestry personnel should be employed, trained and motivated in order to police the forest and reduce the indiscriminate felling of trees.

Research should be carried out by foresters to develop fast growing trees as well as those resistant to fire and pathogenic attack. Developed countries that produce a lot of green house gases should sponsor re-afforestation programmes in third world countries whole-heartedly. Cross River State, which has a high percentage of biodiversity, should be well considered.

Serious awareness campaign should be created Government and environmentalists on the important role played by the forest as the current national tree planting campaign are a mere ritual as well as radio and television propaganda. The negative impact of deforestation through logging should be made known to the masses.

A cheap and readily substitute for fuel wood should be sought immediately. Already there are kerosene and gas, which unfortunately are neither cheap nor readily available thereby, rendering trees vulnerable to destruction in Cross River State.

Environmental Laws should be revised and fully implemented to carry severe jail terms and fines. At present, very few if any defaulter had ever been prosecuted under those laws.

Efforts should be made towards the domestication of some wild animals, economic timber trees and non-timber forest producing plants. Intensive agriculture where tree leaves and animal droppings are used to fertilize the soil and several species of crops are planted on the same plot should be encouraged. This will reduce the technique of shifting cultivation and multiple use of the land will be enhanced leading to forest conservation.

Bush burning should be discouraged and where it is unavoidable, then fire tracing should be employed to prevent the fire from spreading beyond the proposed area.

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