Journal of Research in Forestry, Wildlife & Environment Vol. 13(4) September, 2021
E-mail: jrfwe2019@gmail.com; jfewr@yahoo.com
http://www.ajol.info/index.php/jrfwe
jfewr ©2020 - jfewr Publications
ISBN: 2141 – 1778
Eludoyin et al., 2021

IMPACT OF LOGGING ON NON-TIMBER FOREST PRODUCTS IN A RAINFOREST ECOSYSTEM OF CROSS RIVER STATE, NIGERIA

Eludoyin O.S. Dappa D. I. and Kokei P.N.

Department of Geography and Environmental Management, University of Port Harcourt, Port Harcourt, Nigeria
Corresponding Email: *olatunde.eludoyin@uniport.edu.ng*

ABSTRACT

The study investigated the impact of logging on non-timber forest products (NTFP's) in Agoi-Ekpo Forest of Cross River State, Nigeria. Three 20m x 20m quadrats were laid randomly in the sampled plots of different logging intensities (intensively logged (IL), fairly logged (FL) and unlogged (U)) whereby the NTFPs were identified. The data collected were used to compute the number of individual species (NIS), species diversity (SD), richness (R), density (D) and evenness (E). Descriptive statistics were used to describe the result while inferential statistics such as analysis of variance and Pearson's correlation statistics were used to test the hypotheses at 0.05 significant levels. Results showed that a total number of 2742 of individual species of NTFPs with 85 species were recorded. Sacrophrium brachystachyum recorded the highest number of species (519). Of the total number of individual species of NTFPs, IL plot had 12.4%, FL 20.12% while U had 67.5%. The D was highest in the U plot (1.25 species/m^2) while the least was observed in the IL plot (0.85 species/m^2). The U plot recorded the highest SD (0.9987) and R (234.73) while the least SD (0.9785) and R (43.89) was recorded in IL. Significant variations existed in R (F=4.130; p=0.017), D (F=4.897; p=0.008) and NIS (F= 4.936; p=0.008) among the plots. Furthermore, NIS was significantly correlated with D (r=0.653; p<0.05) and R (r=0.997; p<0.05). The study recommended among others that immediate restoration and rehabilitation of the degraded (IL) areas of the forest should be done through rapid regeneration programmes like afforestation.

Keywords: Logging, Rainforest, Species density, Species diversity, Species richness, Agoi-Ekpo Forest

Correct Citation of this Publication
Eludoyin O.S. Dappa D. I. and Kokei P.N. (2021). Impact of Logging on Non-Timber Forest Products in A Rainforest Ecosystem of Cross River State, Nigeria. *Journal of Research in Forestry, Wildlife & Environment* Vol. 13(4): 66 - 76

INTRODUCTION

The world has in recent times witnessed unprecedented environmental crises as evidenced in the rapid growth of natural and anthropogenic changes in the environment. Man being the major culprit of these changes has either aggravated the natural changes or lead entirely to new dimensions of environmental change. There is ample evidence to show that uncontrolled human activity is putting significant stress on the earth's life support systems thereby creating serious environmental problems. One of such environmental problem of global concern is the destruction of the tropical rainforest which is often referred to as "deforestation" (Bisong, 1996).

Logging is a major culprit of deforestation in the tropics. Despite the relatively small area rainforests occupy on the globe (about 6% of the total earth's land surface), they perform several socio-economic and ecological functions and contains some of the most valuable resources needed by man for survival and development (Primack et al., 2013). Socio-economically, local populations harvest timber and non-timber forest products for a number of purposes including but not limited to: household substances, building materials, materials for local craft and industry, clothing, fiber, herbs and medicines, hunting accessories, food (vegetables, nuts, oils, flavorings sweeteners, fruits) among others (Seragaldin, 2001; Rist, 2012). Ecologically, forests regulate both micro and macro climates, protects ground surface (soil) from erosion, protects water – sheds, among others. Forests also provide habitat to at least 50% of the entire vertebrates, 60% known plant species and about 90% of the world's total species. The higher estimate is based on the assumption that a large share of the to-be-discovered species will be tropical. In other words, rainforests are the world's gene-pull reservoir. Thus, Kamp et al (2004) indicated that the role of non-timber forest products is very important to the longer – time conservation of the forest resources and genetic diversity. The concern for non-timber forest resources as regard *in situ* conservation of genetic resources can be considered because of their contribution to the conservation and management of forest resources and their intrinsic values as part of the genetic diversity of the ecosystems (FAO, 2014). It is difficult to estimate the contribution of non-timber forest products to national or regional economies as there is a combined value of the hundreds of products that make up the non-timber forest products industry.

Throughout most of history, rainforests were considered to be dangerous, remote, inaccessible, unpleasant places and as result they were little affected. However, rainforest have been exploited and devastated at an accelerating pace in the present century. Consequently, this rich ecosystem is under threat of mass elimination of species and genetic resources (McKnight, 1992; Bisong, 1994). Indiscriminate commercial logging for export and internal consumption is a widespread and profitable business in tropical rainforest regions. This is often carried out either illegally or legally by individuals and companies who are granted concessionary rights by the government over vast hectares of forest for selective extraction of valuable tress. These usually have direct and profound effects on the forest structure and habitat composition, and as a consequence, significantly impact the abundance and distribution of tropical wildlife associated to them. Selective logging of mature or superior trees generally causes genetic depletion, consequent loss of potential food sources and disease control, reduction in the stability of forest ecosystem and a loss of resilience against catastrophes.

The removal of seed trees also reduces the potential of the forest to regenerate after logging. The disappearance of species or the alteration of species compositions in forest ecosystems may causes irreversible losses. Laird (1999), Mfon and Bisong (2011) associated logging operation to have direct effect on both present and future harvest of timber and non-timber forest products (NTFPs) as well as reduced species and forest structural diversity. This is primarily because rainforest logging operations are particularly subject to "green washing" where firms' claims to be committed to sustainable harvesting techniques but in practice fail to implement the most basic safeguards. Globally, 865 million acres of tropical moist forest are designated as "production forests" - forests whose tress are commercially harvested. But forests that are certified as being sustainably managed and that incorporate reduced-impact logging comprises less than 5% of these lands. Illegal and commercial logging occurs all over the world but mainly in Africa and Asia where sustainable forest management and respective forest certification schemes are almost absent. This position is particularly alarming for Nigeria which losses 5.2% of forest annually and 90% of the original nature forest is already lost to logging and other causes of deforestation. Cross River State holds a unique share (about 50%) of the remaining forest and biodiversity resources in Nigeria.

The socio-economic and ecological value when considered in aggregate makes managing non-timber forest products an important component of sustainable forest management and conservation of biological diversity. One of the keys to providing meaningful forecasts of the future of forests is to understand the past and recognize factors that have shaped patterns of land use. The analysis of current status and trends will possibly lead to the identification of themes that are likely to be important in determining the future of forest resource utilization. In view of the above backdrop, it is therefore imperative to examine the impact of logging operations on no-timber forest products in Agoi-Ekpo forest, which is an integral part of Nigeria's threatened rainforest.

MATERIALS AND METHODS

Study Area

The study area was Agoi-Ekpo forest, Yakurr Local Government Area of Cross River State of Nigeria. It is approximately between latitudes 5° 45' -5° 47' N, and longitude 8°16'-8°18'E. It covers an area of about 117.95km^2(Figure 1). Agoi-Ekpo is bounded to the North by Adun in Obubra Local Government Area of Cross River State, to the south by the Ekuri and Ejagham speaking people of Akamkpa Local Government Area, to the east by the tropical rainforest, and to the west by Mkpani. The study area falls within the tropical humid climate of southern Nigeria. Rainfall is mostly conventional and has two peaks. It ranges between 250mm to 500mm from November to April. Between May and October, rainfall increases above 2500mm. Annual rainfall ranges between 2500mm-3000mm (Iwara et al., 2014). The mean temperature is often high, about 27°C (80°F) with little variations, while the diurnal temperature ranges from 2°C-8°C, with a low annual range. Humidity is relatively high (over 80% with high seasonal and daily variations of about 55%). The area falls within the lowlands and scarp lands of south eastern Nigeria called the Cross River Plain. The relief is gentle, except in few places where granite rises above the general level of the surface. However, Tekowa Forest Management Committee (2001) recognized four distinct land units in Agoi-Ekpo to include: small hills (30%); the gentle undulating lands (40%); the swamplands (20%); and valley-like depressions (10%). The lowland rises to a height of 100m above sea level, while the hills stand 300m. The study area is drained with River Lokpoi, Okwo and Ukpan are the major sources of fresh water and they all drain into the Cross River.

The unique combination of fertile soil rainfall, humidity and temperature interplay to support evergreen vegetation type called the Tropical Rain Forest. The average trees heights range between 50-70m. This ecological zone is the home of highly valuable timber (hard wood) and non-timber forest products on which the rural and regional economies depend. The luxuriant forest vegetation is about 44.38km^2 in Agoi-Ekpo Forest Reserve, and 315.72km^2 in Ukpon Forest Reserve. About 60% of the vegetation is still tick (virgin forest) 10% is secondary forest, while the remaining 30% is mixed with farm lands.

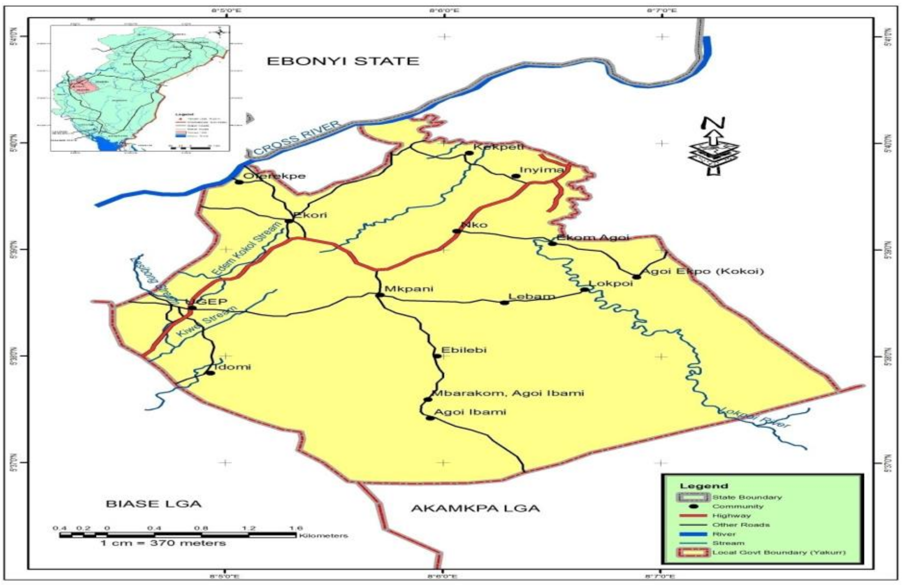

Figure 1: Yakurr LGA showing Agoi-Ekpoi Forest Reserve

The sampled plots based on the number of stumps, seedlings and matured trees found (Mfon and Bisong, 2011) were basically classified into three categories namely intensively logged (not more than 10 trees of about 25cm DBH at an average of about 20m, between 0-20 seedlings, and more than 11 stumps found at an average of about 20 m); fairly logged (between 11-20 trees of 25cm DBH, 21-60 seedlings and between 1-10 stumps); unlogged (21 trees and above; 60

seedlings and above; and 0 stumps at an average of about 20 m).

In each of intensively logged, fairly logged and unlogged plots, 3 quadrats of 20m x 20m were laid randomly whereby the NTFPs species were collected. The NTFPs species were identified with the assistance of a Taxonomist from the Department of Forestry, University of Calabar, Nigeria. The study was carried out between August and November, 2017. The data on the identification were used to compute species composition of NTFP by counting the number of species available in each sampled plot. Furthermore, species density, diversity, richness and evenness of NTFPs were computed. Species density was computed by dividing the total number of individuals of species in all plots/Total area of plots in hectares. Species diversity was computed using the Simpson's diversity index (Simpson, 1949). The index ranges from 0 to 1 where higher score (close to 1) indicate high diversity, low scores (close to 1) indicate low diversity while 0 indicates no diversity and 1 represents infinite diversity (Chima and Omokua, 2011). Species richness was computed using Margalef's index (Margalef, 1945).
The study made use of both descriptive and inferential statistics. The descriptive involved the use of mean, percentages, standard deviation, graphs, and charts. Inferential statistics involved the use statistical analysis to test the formulated hypotheses. Analysis of variance was used to determine the significant difference in the individual number of species of NTFPs, species diversity, richness and density of NTFP among the intensively logged, fairly logged and unlogged plots. Pearson's Product Moment Correlation Statistics was used test significant relationship between the number of individual species and species richness and diversity of the NTFPs.

RESULTS

Species Composition and Number of Individuals Species of NTFPs

Species composition and number of individual species of NTFPs is presented in Table 1. The analysis revealed that a total 2742 individual species of NTFPs was recorded. The total number of species recorded was 85 with *Sacrophrium brachystachyum* having the highest (519 species), *Ariomomum banburyi* (393), and *Ariomomum melegueta* (316 species) while *Bambusa vulgaris* had 269 species. Of the total number of individual species of NTFPs, intensively logged plot had 12.4%, fairly logged plot had 20.12% while unlogged plot had 67.5%. The analysis further revealed that individual species of NTFPs was significantly varied among the sampled plots ($F=4.936$; $p<0.05$).

The general analysis of the families of NTFPs in Table 2 showed that a total of 36 families of NTFPs was recorded with Fabaceae recording the highest (15.3%), followed by Rubiaceae and Euphobiaceae having 8.2% while Annonaceae was 5.9%. However, considering the families across the sampled plots in Table 3, the analysis revealed that Poacea was highest in the intensively logged plot (168) and unlogged plot (442) while Marantaceae was highest in fairly logged plot.

Furthermore, the analysis of the life form of NTFPs in the study area showed that tree had 74.1% while shrubs had 15.3% (Table 4). The analysis of life forms across the sampled plots showed that shrubs dominated by having 39.9% in the intensively logged plot, 65.1% in the fairly logged plot while it was 50.1% in the unlogged plot (Table 4). Grasses were highest in the intensively logged plot (49.0%) (Table 4). It was also revealed that tree, shrub and creepers/climbers were arranged in the order of intensively logged plot<fairly logged plot<unlogged plot.

Table 1: Species composition and number of individuals per species

S/No	Scientific Names of Species	Family	Logging Intensities			Total
			Intensively Logged	Fairly Logged	Unlogged	
1	*Acasia seyal*	Fabaceae	-	-	1	1
2	*Afzelia africana*	Fabaceae	1	3	6	10
3	*Afzelia bipindensis*	Fabaceae	-	-	2	2
4	*Albizia adianthifolia*	Fabaceae	-	1	1	2
5	*Alchornea cordifolia*	Euphorbiaceae	6	5	27	38
6	Alstonia boonei	Apocynaceae	7	26	20	53
7	*Anthocleista vogelii*	Loganiaceae	-	2	1	3
8	*Anthostema aubryanum*	Euphorbiaceae	-	1	-	1
9	*Ariomomum banburyi*	Liliaceae	-	101	292	393
10	*Ariomomum melegueta*	Zingiberaceae	71	90	155	316
11	*Astonia booneii*	Apocynaceae		1	2	3
12	*Baillonela toxisperma*	Sapotaceae	-	-	1	1
13	*Baphira nitida*	Fabaceae	-	2	4	6
14	*Barteria fistulosa*	Passifloraceae	-	-	2	2
15	*Bombax buouopozense*	Malvaceae		1	4	5
16	*Bombusa vulgaris*	Poaceae	74	-	195	269
17	*Brachystegia eurycoma*	Caesalpinioideae	2	1	5	8
18	*Canarium schweinfurthii*	Poaceae	1	-	-	1
19	*Carpolobia lutea*	Polyalaceae	-	1	5	6
20	*Ceiba pentandra*	Bombacaceae	-	-	2	2
21	Celtis philippensis	Urticaceae	1	2	2	5
22	*Chrysophyllum giganteum*	Sapotaceae	-	-	1	1
23	*Coffea eketensis*	Rubiaceae	5	2	10	17
24	*Cola pachycarpa*	Malvaceae	-	1	1	2
25	*Costus afer*	Costaceae	44			44
26	*Coula edulis*	Olacaceae	-	1	2	3
27	*Cylicodiscus gabunensis*	Mimosaceae	-	-	2	2
28	*Diospyros conocarpa*	Ebenaceae	4	7	13	24
29	*Diospyros piscatoria*	Ebenaceae	-	-	1	1
30	*Distemonanthus benthamianus*	Fabaceae	2	-	3	5
31	*Draceana arborea*	Asparagaceae	-	-	2	2
32	*Draceana manni*	Asparagaceae	-	-	1	2
33	*Dryptes floribundo*	Euphorbiaceae	-	-	1	1
34	*Enati chlorantha*	Annonaceae	-	1	4	5
35	*Entandrophragma cylindricum*	Meliaceae	-	-	4	4
36	*Eramospatha macrocarpa*	Arecaceae	-	28	113	141
37	*Erythrina senegalensis*	Fabaceae	1	1	5	7
38	*Euphorbia hirta*	Euphorbiaceae	1	-	2	3
39	*Ficus ottonifolia*	Moraceae	-	-	5	5
40	*Garcinia cola*	Clusiaceae	-	2	4	6
41	*Glyphaea brevis*	Tiliaceae		1	5	6
42	*Gnetum africanum*	Gnetaceae	7	13	84	104
43	*Guarea cedrata*	Meliaceae	-		1	1
44	*Hensia crinita*	Rubiaceae	-	3	5	8
45	*Hylodendron gabunense*	Caesal pinoideae	1	-	3	4
46	*Khaya ivorensis*	Moraceae	-	-	2	2
47	*Lacosperma secondiflora*	Arecaceae	-	-	171	171
48	*Lasianthera africanum*	Icacinaceae	6	4	8	18
49	*Lophira alata*	Ochanaceae	-	-	2	2
50	*Lovea trichiloides*	Meliaceae	-	-	4	4
51	*Mammea africana*	Calophyllaceae	-	-	2	2
52	Masularia acuminata	Rubiaceae	-	10	21	31
53	*Milicia excelsa*	Moraceae	-	1	1	2
54	*Momodra myristica*	Annonaceae	-	1	1	2
55	*Momordica spp*	Curcurbitaceae	-	2	5	7
56	*Monodra brevipes*	Annonaceae	-	1	2	3
57	*Morinda lucida*	Rubiaceae	-	1	1	2
58	*Musanga* cecropioides	Rubiaceae	-	3	-	3
59	*Nauclea latifolia*	Rubiaceae	-	-	1	1
60	*Oxstigma mannii*	Fabaceae	-	-	3	3
61	*Oxyganthus racemosus*	Rubiaceae	-	2	-	2
62	*Oxystenthera abyssynica*	Poaceae	93	79	-	172
63	*Parkia bicolor*	Fabaceae	-	1	3	4

64	*Petaclethra macrophylla*	Fabaceae	-	1	2	3
65	*Piper guineensis*	Piperaceae	11	5	26	42
66	*Piptandenstrum africanum*	Fabaceae	-	-	1	1
67	*Poga oleosa*	Rhizophoraceae	-	2	4	6
68	*Pteocarpus osun*	Fabaceae	-	-	2	2
69	*Pterygota macrocarpa*	Malvaceae	1	2	1	4
70	*Pycanthus angolensis*	Myristicaceae	-	-	4	4
71	*Rauvolfia vomitoria*	Apocynaceae	1	-	-	1
72	*Ricinodendrom heudelotii*	Euphorbiaceae	-	-	2	2
73	*Sarcophrynium brachystachyum*	Marantaceae	-	132	387	519
74	*Straphantus gratus*	Apocynaceae	-	-	169	169
75	*Terminalia superba*	Combretaceae	1	1	5	7
76	*Terminaliaivotensis*	Combretaceae	-	-	2	2
77	*Tetrapleura tetraptera*	Fabaceae	-	-	3	3
78	*Tieghemella heckelii*	Sapotaceae	-	-	1	1
79	*Treculia africana*	Moraceae	-	-	2	2
80	*Treculia spp*	Moraceae	-	-	2	2
81	*Triplochiton sleroxylon*	Meliaceae	-	1	3	4
82	*Uapaca heudelotii*	Euphobiaceae	-	2	2	4
83	*Uapaca spp*	Euphorbiaceae	-	2	3	5
84	*Xylophia aethiopica*	Annonaceae	-	-	1	1
85	*Xylophia rubescens*	Annonaceae	-	-	3	3
TOTAL			**341 (12.4%)**	**550(20.1%)**	**1851(67.5%)**	**2742**

$F_{cal} = 4.936; p=0.008$

Table 2: Summary of Families of NTFPs

Families	Frequency	Percentage (%)
Annonaceae	5	5.9
Apocynaceae	4	4.7
Arecaceae	2	2.4
Asparagaceae	2	2.4
Bombacaceae	1	1.2
Caesal pinoideae	2	2.4
Calophyllaceae	1	1.2
Clusiaceae	1	1.2
Combretaceae	2	2.4
Costaceae	1	1.2
Curcurbitaceae	1	1.2
Ebenaceae	2	2.4
Euphobiaceae	7	8.2
Fabaceae	13	15.3
Loganiaceae	1	1.2
Gnetaceae	1	1.2
Icacinaceae	1	1.2
Liliaceae	1	1.2
Malvaceae	3	3.5
Marantaceae	1	1.2
Meliaceae	4	4.7
Mimosaceae	1	1.2
Moraceae	5	5.9
Myristicaceae	1	1.2
Ochanaceae	1	1.2
Olacaceae	1	1.2
Passifloraceae	1	1.2
Piperaceae	1	1.2
Poaceae	3	3.5
Polyalaceae	1	1.2
Rhizophoraceae	1	1.2
Rubiaceae	7	8.2
Sapotaceae	3	3.5
Tiliaceae	1	1.2
Uticaceae	1	1.2
Zingiberaceae	1	1.2
Total	**85**	**100.0**

Table 3: Families of Individual Species of NTFPs across the sampled plots

S/No	Family	Intensively Logged	Fairly Logged	Unlogged	Total	Percentage (%)
1	Annonaceae	0	3	11	14	0.5
2	Apocynaceae	8	27	191	226	8.2
3	Arecaceae	0	28	284	312	11.4
4	Asparagaceae	0	0	3	3	0.1
5	Bombacaceae	0	0	2	2	0.1
6	Caesalpinoideae	3	1	8	12	0.4
7	Calophyllaceae	0	0	2	2	0.1
8	Clusiaceae	0	2	4	6	0.2
9	Combretaceae	1	1	7	9	0.3
10	Costaceae	44	0	0	44	1.6
11	Curcurbitaceae	0	2	5	7	0.3
12	Ebenaceae	4	7	14	25	0.9
13	Euphobiaceae	7	10	37	58	2.1
14	Fabaceae	4	9	36	49	1.8
15	Loganiaceae	7	13	84	104	3.8
16	Gnetaceae	6	4	8	18	0.7
17	Icacinaceae	0	101	292	393	14.3
18	Liliaceae	0	2	1	3	0.1
19	Malvaceae	1	4	6	11	0.4
20	Marantaceae	0	132	387	519	18.9
21	Meliaceae	0	1	12	13	0.5
22	Mimosaceae	0	0	2	2	0.1
23	Moraceae	0	1	12	13	0.5
24	Myristicaceae	0	0	4	4	0.1
25	Ochanaceae	0	0	2	2	0.1
26	Olacaceae	0	1	2	3	0.1
27	Passifloraceae	0	0	2	2	0.2
28	Piperaceae	11	5	26	42	1.5
29	Poaceae	168	79	195	442	16.1
30	Polyalaceae	0	1	5	6	0.2
31	Rhizophoraceae	0	2	4	6	0.2
32	Rubiaceae	5	21	38	64	2.3
33	Sapotaceae	0	0	3	3	0.1
34	Tiliaceae	0	1	5	6	0.2
35	Uticaceae	1	2	2	5	0.2
36	Zingiberaceae	71	90	155	316	11.5
Total		341	550	1851	2742	100

Table 4: Summary of Life Forms of NTFPs in the Study Area

Life Forms	Frequency	Percentage (%)
Tree	63	74.1
Shrub	13	15.3
Grasses	2	2.4
Creepers/Climbers	7	8.2
Total	**85**	**100.0**

Table 5: Life Forms of NTFPs in the Sampled Plots

Life Form	Intensively Logged	%	Fairly Logged	Unlogged	%	Total	%
Trees	13	3.8	39	140	7.6	192	7.0
Shrubs	136	39.9	358	928	50.1	1422	51.9
Grasses	167	49.0	79	195	10.5	441	16.1
Creepers/Climbers	25	7.3	74	588	31.8	687	25.1
Total	341	100.0	550	1851	100	2742	100

Species Density, Species Diversity and Richness of NTFPS

The species density of NTFPs was 0.85 species per squared meters in intensively logged plot while it was 1.25 species per squared meters in fairly logged plot and 4.63 species per square meter in unlogged plot (Table 6). This analysis thus shows that the species density was highest in the unlogged plot while the least was observed in the intensively logged plot. However, the species diversity of all the plots was high generally. However, the species diversity was highest in the unlogged plot with 0.9987 and the least was found in the intensive logged plot with 0.9785. Considering the species richness of NTFPs in the study area, intensively logged plot had 43.89, fairly logged had 73.69 while unlogged had 234.73; suggesting that species richness of NTFPs was highest in the unlogged plot. Findings also revealed that significant variation existed in species richness (F=4.130; p<0.05), density (F=4.897; p<0.05) among the intensively logged, fairly logged and unlogged sampled plots.

Number of individual species was significantly and positively correlated with species diversity (r=0.653; p<0.05); and richness (r=0.997; p<0.05). The coefficient of determination explains that number of individual species of NTFPs determined only 39.94% (Figure 2) and 99.36% of the species richness (Figure 3).

Table 6: Species density, diversity and richness of NTFPs

Plots	Species Density (m^2)	Species Diversity	Species Richness
Intensively Logged	0.85	0.9785	43.89
Fairly Logged	1.25	0.9831	73.69
Unlogged	4.63	0.9987	234.73
F_{cal}	4.987	0.224	4.130
P Value	0.008	0.800	0.17

Table 7: Pearson's Correlation Statistics

Variable	Analysis	Diversity	Richness	Density
Individual	Pearson Correlation	0.653*	0.997*	1.000*
Species	Sig. (2-tailed)	.000	.000	.000
	N	254	254	254

**. Correlation is significant at the 0.05 level (2-tailed).*

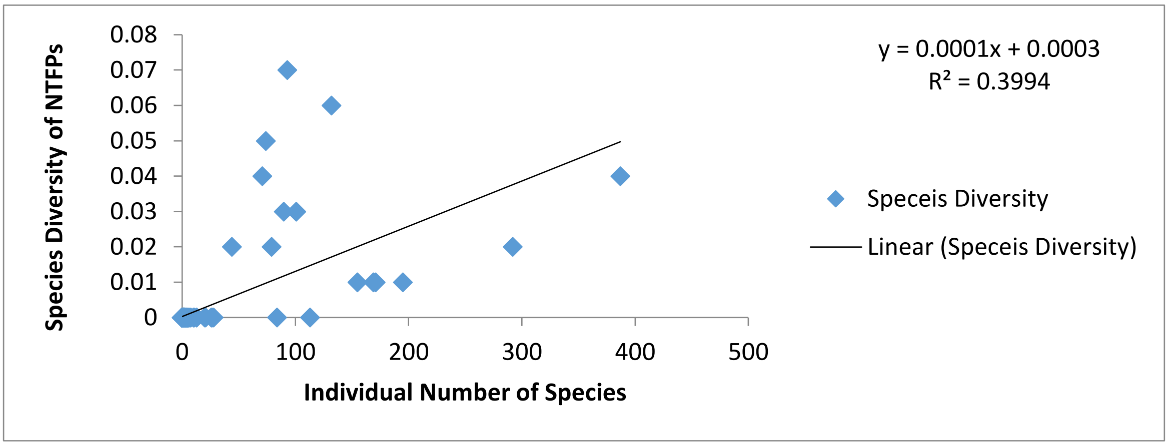

Figure 2: Scatter Diagram between Species Diversity and Individual Species of NTFPs

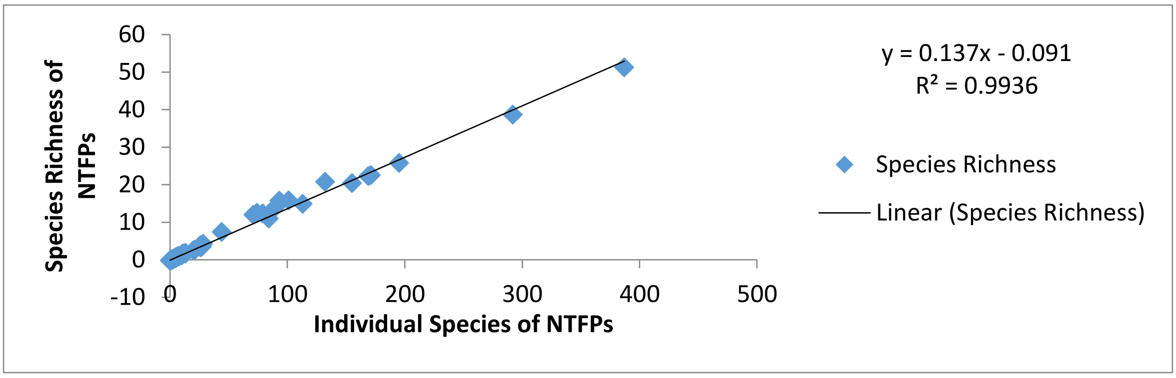

Figure 3: Scatter Diagram between Species Richness and Individual Species of NTFPs

DISCUSSION

Protracted logging has negatively impacted the population and distribution of the different NTFP's. The species composition of the entire study area was relatively high but the highest was found in the unlogged plot (1851 species) and this is followed by the fairly logged plot having 550. Thus, the number of individual species of NTFPs was significantly higher in the unlogged plot. This can be attributed to the effect of logging in the study area which has devastated the existence of flora in their natural habitat. Uhl and Viera (2003) found that in order to log 52m^3/ha or 8 trees in the Amazon forest of Brazil, logging operations destroy about 26% of other tree stands thereby posing a serious threat to the growth of non-timber forest products. Sist et al (2001) stated that whereas felling injures neighboring trees, especially crowns, skidding tends to increase mortality in the very short term. Subsequently, Sist et al (2003) asserted that skidding was responsible for twice the number of tree death as felling.

The species diversity was high generally whereby all plots had above 0.9 but highest in the unlogged plot. This can be attributed to the equatorial type of climate experienced in the study area. However, the species richness was least in the intensively logged plot (43.89) and highest in unlogged (234.73). This is similar to the study of Imai et al (2012). There was significant relationship between the number of individual species and species diversity and richness. This is also found in the work of Imai et al (2012) which showed the relationship between species richness and logging intensity. The relationship showed that logging can efficiently affect the growth and survival of NTFPs species which form part of the ecosystem balance in the study area. This could be dangerous to the sustainability of the wildlife animals and affects the nutrient cycles of the soil. The evidence in the reduction of the NTFPs was the presence of more grasses in the intensively logged plot.

Conclusion and Recommendations

The study has confirmed that logging practices has reduced the number of individual species, richness, density and diversity of NTFPs in the study area. The study therefore recommended that immediate restoration and rehabilitation of the degraded (intensively logged) areas of the forest through rapid regeneration programmes (like afforestation with exotic trees) should commence as soon as possible by government and non-governmental organizations; with optimum involvement of stakeholders in the forestry sector. Periodic inventory should be encouraged to aid regular monitoring, modeling and planning of less impact forest harvest. Finally, public enlightenment campaigns on the need for forest resources conservation should be carried out at regular intervals by stakeholders to call for change in people's attitudes and practices through the adaptation of an ethic for sustainable living.

REFERENCES

Arms K (2005). Environmental Science. Philadephia: Saunders College.

Bisong F (1996). "Environmental Crises and Agenda for Change". *West African Journal of Research and Development in Education*, 3 (1): 126 -30.

Bisong F (2001a). Human Ecology and Natural Resource Management: Principles, Concepts and Applications: port Harcourt. Double diamond.

Bisong F (2001b). "Natural Resources System for sustainable Rural Development" in Natural Resource use and Conservation. Bisong, F. (edt). Calabar. BAAJ International Company.

Connel J (2000). "Diversity in Tropical Rainforest and coral reefs". *Science*, 1999: 1302 – 1310.

Eckholm E (2007). Down to Earth: Environment and Human Needs New York: Norton company.

Enger D, Smith B (2010). Environmental Science: A Study of Interrelationship 12th edt. Boston: Megraw Hill.

Faniran A, Ojo O (2002). Man's physical Environment London: Heinemann Educational Books.

Food and Agricultural Organization (2011). Intensive Multiple – use Forest Management in Kerala, Forestry paper N0. 53. Rome: Food and Agricultural Organization.

Gelman A (2005) Analysis of variance. Available at http://www.stat.columbia.edu/~gelman/research/unpublished/econanova.pdf Accessed on 14/07/2017

Gentry A, Lopes P (2008). "Deforestation and Increased flowing of the upper Amazon". *Science*, 132-136.

Global Biodiversity Strategy (1992) Guidelines for the action to Save, Study and use Earth's Wealth sustainably and Equitably WRLLUCN, and UNEP.

Goudie A (2003) The Human Impact: Man's Role in Environmental Change. Oxford: Basil Blackwell Publishers Ltd.

Hill A (2000). "Ecosystem Stability in Relation to Stresses caused by Human Activities". Canadian Geographer 19: *Resources*, 19(1): 2-19.

Holmes P et al (2010). Financial and Ecological Indicators of Reduced Impact Logging Performance in Eastern Amazon. *Forest Ecology and Management*, 163: 93-110.

Horsfall M. and Spiff, D. (2013). Principles of Environmental Pollution, Toxicology and Waste Management. Port Harcourt. Onyoma Research Publications.

Imai N, Seino, T., Aiba, S., Takyu M., Titin J. and Kitayama K. (2012) Effects of selective logging on tree species diversity and composition of Bornean tropical rain forests at different spatial scales, *Plant Ecology*, (2012) 213: 1413.

International Tropical Timber Organization (2006). . Status of Tropical Forest Management. ITTO Technical Series No. 24, Yokohama.

Iwara A.I., Offiong R.A.M., Njar G.N. and Ogundele F.O. (2014). An Assessment of Herbaceous Species Diversity, Density and Cover in Agoi Ekpo, Cross River State Nigeria. *International Journal of Biological Sciences*, 1(1): 21-29

Kemp, R. and Wadsworth, F. (1993). Conservation of Genetic Resources in Tropical Rainforest Management: Principles and Concepts. Cultural Organization Forestry paper 107.

Laird, S. (1999). "The Management of Forest Products in Central Africa" in Sunderland, T. et al (eds) Non-wood Forest Products of Central Africa: Current Research Issues and Prospects for Conservation and Development. Rome: Food and Agricultural Organization.

Lentini, M., Zweede J.C. and Holmes T.P. (2009). Case Studies in Measuring and Assessing Forest Degradation: Measuring Ecological impacts from Logging in Natural Forests of the Eastern Amazonia as a tool to Assess Forest Degradation: Forest Resources Assessment Working paper Rome: Food and Agricultural Organization, 1-15.

Mcknight, T. (1992). Essentials of Physical Geography. New Jersey: Prince Hall Inc.

Mfon, P. and Bisong, F. (2011). Impact of Logging on Non- Timber forest products in the Rainforest of South Eastern Nigeria. In *Mediterranean Journal of Social Sciences*. 2 (3):125.

Miles, S. (2008). "Eco-development" in MAB Technical Notes: 14 Approaches to the Environmental Implications of Contemporary Urbanization. As quoted by Bisong, F. (2001b).

Miller, G. (2006). Living in the Environment: An Introduction to Environmental

Science. Califonia: Wadswoth Publishing company. 4th edt p. 183.

Primack R.B, and Morrison R.A. (2013): Extinction, Causes of, In Levin S.A. (Eds), Encyclopedia of Biodiversity (Second Edition), Academic Press, 401-412, ISBN 9780123847201, https://doi.org/10.1016/B978-0-12-384719-5.00050-2.

Rist, l. (2012). The Impact of Selective Logging on Non-Timber Forest Products of Livelihood Importance. Elservien B. V.

Seragaldin, I. (2001). Saving the Rainforests. The World Bank.

Tekowa Forest Management Committee (2001). Report on Tekowa (Agoi – Ekpo) Community Land Use Plan. CRSCFP and Cross River State Forest Community.

Uche, C. and Viera, I. (1989). Ecological Impact of Selective Logging in the Brazilian Amazon. A Case Study from Paragominas Region of the State of Para. *Biotropical*, 21(2) 98 – 106.

Welford, R. (1996). "Environmental Issues and Corporate Environmental Management" in Welford, R. (edt) Corporate Environmental Management. London: Earthscan Publications Limited.

World development report (2010). Development and the Environment. Washington DC. The World Bank/Oxford University press.

Wuerthner G. (2014): Is Sustainable Forestry Sustainable? Is Sustainable Forestry Sustainable? I*n* Wildlife News , http://www.thewildlifenews.com/category/wildlife-news-2/ Accessed on 25/09/2019.