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Effects of Logging Activities on the Floristics and Structure of the Vegetation in Isokan Area of Southwestern Nigeria

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Abstract: A study was carried out to identify species of forest trees that are preferentially extracted for timber by assessing their disappearance from the forest reserve, its effects on the floristics and structure of the vegetation and their presence at the sawmills in Isokan Local Government area of southwestern Nigeria. Three 25×25 m sample plots in Ago-Owu forest reserve and six sawmills in Isokan Local Government area, Nigeria were selected. Results showed that the densities of non-timber species per hectare were higher than densities of the timber species in all the three study forest plots. The floristic composition of the study forest plots and the study sawmills fields logs revealed the most commonly logged timber species. The study also revealed that logging activities have resulted in the loss of important timber tree species in the study forest. Hence, most of the least available forest timber tree species in the forest plots are the most available in the sawmills.

Key words: Vegetation structure, logging, forest reserve, sawmills, southwestern Nigeria

INTRODUCTION

Most of the world's tropical rainforests are likely to be affected by commercial logging or other disturbance within the next few years (Johns and Skorupa, 1987). Therefore, it is important to understand what effects disturbance has upon rain forest flora and fauna. Selective logging typically results in the destruction of about 50% of all trees present before logging activities. Vegetation destruction and degradation have continued to attract the attention of researchers probably because of the far reaching environmental implications. Adesina (1989), Salami (1995), Ekanade *et al*. (1996) and Oke and Isichei (1997) among others have carried out studies on floristic composition of disturbed forest community. Through various forms of exploitation and interference with native vegetation, the natural forms and characteristics of floristic composition in many forested areas have become remarkably altered.

Anthropogenic activities especially logging have continued to modify and destroy the natural state of vegetation and consequently the ecological systems across the globe (Myers 1989; FAO, 1992; Jang *et al*., 1996). These uncontrolled modification, disturbances and destruction of the natural vegetation have resulted in severe ecological degradation (Odum, 1971; 1985; Rapport and Regier, 1995). The current rate of deforestation due to logging and other forms of human activities in Nigeria has been put to about 40,000 ha per annum (Akachuku, 1997). Timber extraction poses a serious treat to tropical forests and is responsible for a quarter of the annual loss of primary rainforest around the world (Park, 1995). Commercial timber extraction studies have been undertaken to investigate how logging is affecting forest structure and composition (Wilkie *et al*., 1992).

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Tyler (1990) observed that some intensively logged forests are so badly depleted that tropical timber supplies are running out with serious economic and ecological consequences. Effects of logging include the damages to nearby trees, the trees as they fall down destroy everything else in their path and create much large gaps than intended. Also felling and extraction of large trees may produce so much damage to the surrounding vegetation that regrowth may be too slow for further profitable exploitations (Burgess, 1971; De-Graaf, 1986; Park, 1995).

The aims of this present study were to identify different species of forest trees that are preferentially extracted for timbers by assessing their disappearance from the forest and their presence at the sawmills in Isokan Local Government Area of Southwestern Nigeria.

MATERIALS AND METHODS

The study was carried out in Isokan Local Government Area of Southwestern Nigeria between latitude 7°12' N and 7°21' N and longitude 4°11' E and 4°15' E. On the basis of an initial field reconnaissance survey of the area, three representative plots of 25×25 m each designated as plots, A, B and C were selected in Ago-Owu forest reserve area. Also six sawmills were selected in the same Local Government Area.

The study area is underlain by metamorphic rocks of the Precambrian Basement Complex. These rocks show great variation in structure, mineral composition and grain size (Smyth and Montgomery, 1962). The soils of the area are moderately to strongly leached and have low to medium humus content, weakly and to neutral surface layers and moderately to strongly acid sub-soils (Smyth and Montgomery, 1962). The climate of the area is humid tropical, with distinct dry and wet season. The wet season starts from around mid March to late October and rainfall pattern is bimodal with peak periods in July and September.

Tree density was estimated in each of the tree plots by complete enumeration. Every woody plants (trees and shrubs) ≥ 1 m within each plot was tagged with a number, counted and identified to species level. Indices of diversity and similarity were calculated based on the enumerations to know the species diversity in each plot and the similarity of the plots.

The girths of the woody plants were measured at breast height (GBH) for species = 3 m high and mid-point for those less than 3 m tall. The girth measurements were used to calculate the basal area for each plant and for each species.

Six sawmills were randomly selected for the study and were designated as 1, 2, 3, 4, 5 and 6. In each of the sawmills all timber logs for milling were listed and identified to species level, the girths were measured with measuring tape for subsequent determination of basal area. This was done during the rainy season and during the dry season.

RESULTS

Floristics Composition of the Plots

Species nomenclature is in accordance with Hutchinson and Dalziel's flora of West Tropical Africa (1954-1972).

There were forty-three species in Plot A, forty-three species in Plot B and forty-one species in plot C. Some timber species are common to all the plots in varying frequencies. Such species include *Aningeria robusta*, *Celtis zenkeri*, *Entandrophragma angolense*, *Mansonia altissima*, *Pycnanthus angolensis*, *Ricinodendron heudelotii*, *Sterculia rhinopetala* and *Triplochiton scleroxylon.* Some non-timber species are also common to all the plots in varying frequencies. Such species include *Cola millenii*, *Drypetes gilgiana*, *Drypteres aframensis*, *Funtumia elastica*, *Octolobus angustatus* and *Strombosia pustulata.*

Sorenson Index of Similarity (IS) between the plots shows that plots B and C to be most Similar (IS 61.9%). The least Similarity (IS 52.38%) was found between Plots A and B while Intermediate Similarity (IS 53.66%) was found between Plots A and C (Table 1).

The Shannon-Wiener species diversity index was found to be high in Plot B (H' = 1.424) and low in Plot C (H' = 1.289) and intermediate in Plot A (H' = 1.404) (Table 1).

The density and basal area of the woody species are shown in Table 2 and 3, respectively. In Plot A, *Strombosia pustulata* (non-timber) had the highest density of 304 plants ha^{-1} while *Albizia zygia*, *Daniella ogea*, *Entandrophragma angolense*, *Holoptelea grandis, Lannea welwitschii*, *Pycnanthus angolensis*, *Ricinodendron heudelotii* and *Cordia millenii* (timber and non-timber) had the lowest density of 16 plants ha^{-1} and other species had intermediate values. In Plot B, *Strombosia pustulata* (non-timber) had the highest density of 368 plants ha^{-1} while *Antiaris africana*, *Cylicodiscus gaboonensis, Entandrophragma angolense*, *Guarea cedrata*, *Holoptelea grandis*, *Ricinodendron*

Table 1: Vegetation characteristics of the three study plots in Ago-Owu Forest Reserve area of Southwestern Nigeria

Plots	Mean basal area of Woody Species (m^2 ha^{-1})	Sorenson Index of Similarity (IS)	No. of woody species	Density of woody species (No. ha^{-1})	Density of woody timber species (No. ha^{-1})	Density of non-timber species (No. ha^{-1})	No. of timber species	No. of non - timber species	Shannon Weiner species diversity index (H')
A	12.57	B = 52.38 C = 53.66	43	2304	1056	1248	17	26	1.404
B	13.26	A = 52.38 C = 61.91	43	2368	656	1712	16	27	1.424
C	13.38	A = 53.66 B = 61.91	41	3232	592	2640	12	29	1.289

Table 2: Density of Woody species (per hectare) in three study plots at Ago-Owu Forest Reserve area of Southwestern Nigeria

No.	Species	Family	Timber	Non-timber	Plot A	Plot B	Plot C
1	*Albizia zygia* (D.C) J.F. Macbr. FWTA	Mimosoideae	Timber		16	-	-
2	*Alstonia boonei* De. Wild. FWTA	Apocynaceae	Timber		-	32	16
3	*Amphimas pterocarpoides* Harms FWTA	Papilionaceae	Timber		32	-	-
4	*Anacardiaceae* spp. Linn FWTA	Anacardiaceae		Non-timber	-	16	-
5	*Aningeria robusta* (A. Chev.) Aubrev and Pellegr	Sapoteceae	Timber		64	144	32
6	*Angylocalyx oligophyllus* Bak. F.	Papilionaceae		Non-timber	-	32	-
7	*Anthronotha macrophylla* P. Beauv FWTA	Caesalpinioideae		Non-timber	-	16	-
8	*Antiaris africana* Lesch	Moraceae	Timber		-	32	-
9	*Baphia nitida* Lodd-FWTA	Papilionaceae		Non-timber	-	16	16
10	*Beilschmiedia gaboonensis* (Meisn) Benth and Hook F. FWTA	Lauraceae		Non-timber	16	16	-
11	*Blighia sapida* Konig FWTA	Sapindaceae		Non-timber	16	-	-
12	*Buchholzia coriacea* Engl	Capparaceae		Non-timber	16	16	-
13	*Cola gigantea* A. Chev. FWTA	Sterculiaceae		Non-timber	16	-	16
14	*Cola millenii* K. Shum.	Sterculiaceae		Non-timber	48	16	16
15	*Celtis zenkeri* Engl FWTA	Ulmaceae	Timber		160	48	80
16	*Cordia millenii* Bak	Boraginaceae	Timber		16	-	16
17	*Cordia platythrsa* Bak	Boraginaceae		Non-timber	16	-	-
18	*Chrysophyllum albidum* G. Don FWTA	Sapotaceae		Non-timber	-	16	16
19	*Chytranthus macrobotrys* (Gilg.) Exell and Mendonca FWTA	Sapindaceae		Non-timber	-	16	-
20	*Cylicodiscus gabunensis* Harms	Mimosoideae	Timber		-	16	-
21	*Daniellia ogea* (Harms) Rolfe	Caesalpinioideae	Timber		16	-	-
22	*Diospyros abyssinica* Hiern F. White FWTA	Ebanaceae		Non-timber	16	16	-
23	*Diospyros crassiflora* Hiern FWTA	Ebanaceae		Non-timber	-	-	32
24	*Diospyros monbuttensis* Gruke FWTA	Ebanaceae		Non-timber	16	-	64
25	*Diospyros suaveolens* Gurke FWTA	Ebanaceae		Non-timber	-	16	16
26	*Discoglypremna caloneura* (Pax) Prain FWTA	Euphorbiaceae	Timber		128	240	128

Table 2: Continued

No.	Species	Family	Timber	Non-timber	Plot A	Plot B	Plot C
27	*Drypetes aframensis* Hutch. FWTA	Euphorbiaceae		Non-timber	160	64	336
28	*Drypetes gilgiana* (Pax) Pax and K. Hoffin FWTA	Euphorbiaceae		Non-timber	48	16	48
29	*Drypetes paxii* Hutch FWTA	Euphorbiaceae		Non-timber	-	-	-
30	*Elaeis guineensis* Jacq FWTA	Palmae		Non-timber	-	-	32
31	*Enanthia chloranthan* Oliv-FWTA	Annonaceae		Non-timber	-	16	32
32	*Entandrophragma angolense* (Welw). CDC	Meliaceae	Timber		16	16	16
33	*Ficus exasperata* Vahl-FWTA	Moraceae		Non-timber	32	-	-
34	*Ficus* spp. Vahl-FWTA	Moraceae		Non-timber	48	-	16
35	*Funtumia elastica* (Preuss) Stapf FWTA	Apocynaceae		Non-timber	160	192	336
36	*Guarea cedrata* (A. Chev.) Pelleger	Meliaceae	Timber		64	16	-
37	*Hannoa klaineana* Pierre and Engl	Simaronbaceae		Non-timber	-	-	16
38	*Holoptelea grandis* (Hutch.) Mildbr.	Ulmaceae	Timber		16	16	-
39	*Hunteria umbellate* (K. Schum) Hallier F.	Apocynaceae		Non-timber	-	-	304
40	*Lannea welwitschii* (Hiern) Engl. FWTA	Anacardiaceae	Timber		16	16	-
41	*Lecaniodiscus cupanoides* Planch ex Benth FWTA	Sapindaceae		Non-timber	32	32	-
42	*Macaranga barteri* Muell. Ang. FWTA	Euphorbiaceae		Non-timber	16	16	-
43	*Mansonia altissima* (A. Chev.) A. Chev-FWTA	Sterculiaceae	Timber		96	96	64
44	*Margaritaria discoidea* (Baill) Webster in J. Ar. Anb.	Euphorbiaceae	Timber		64	64	-
45	*Millettia thoningi* (Schum and Thonn) Bak FWTA	Papilionoideae		Non-timber	-	-	-
46	*Microdesmis puberula* Hok. F. ex Planch FWTA	Pandaceae		Non-timber	-	-	-
47	*Monodora tenuifolia* Benth-FWTA	Monimiaceae		Non-timber	32	32	-
48	*Myrianthus arboreus* P. Beauv.	Moraceae		Non-timber	16	16	32
49	*Nesigordonia papaverifera* (A. Chev.) R. Capuron FWTA	Sterculiaceae	Timber		-	32	16
50	*Octolobus angustatu* Welw. Ex. Benth and Hook. F.	Sterculiaceae		Non-timber	32	80	80
51	*Piptadeniastrum africanum* (Hook. F.) Brenan	Mimosoideae	Timber		-	-	16
52	*Polyeuthia suavedens* Engl. and Diels FWTA	Annonaceae		Non-timber	-	-	48
53	*Pycanthus angolensis* (Welw.) Warb FWTA	Myristicaceae	Timber		16	32	64
54	*Radlkofera calodendron* Gilg-FL. Cam	Sapindaceae		Non-timber	-	-	16
55	*Ricinodendron heudelotii* (Baill). Heckel Subsp.	Euphorbiaceae	Timber		16	16	80
56	*Rinorea dentate* (P. Beauv) Kuntze FWTA	Violaceae		Non-timber	32	16	-
57	*Rothmannia whitfieldi* (Lindl) Dandy	Rubiaceae		Non-timber	-	16	-
58	*Rubiaceae* spp. (K. Schum)	Rubiaceae		Non-timber	-	-	16
59	*Scottelia coriaceae* A. Chev. Exhutch and Dalz FWTA	Flacourtiaceae	Timber		32	-	-
60	*Sterculia rhinopetala* K. Schum FWTA	Sterculiaceae	Timber		256	144	112
61	*Sterculia tragacantha* Lindl FWTA	Sterculiaceae	Timber		-	16	-
62	*Strombosia pustulata* Oliv. FWTA	Olacaceae		Non-timber	304	368	704
63	*Teclea afzeli* Engl.	Rutaceae		Non-timber	112	176	112
64	*Terminalia superba* Engl. and Diels FWTA	Combretaceae	Timber		-	16	16
65	*Trema orientalis* (Linn) Blume Polhillinkew Bull	Ulmaceae		Non-timber	16	-	-
66	*Trichilia monadelpha* (Thonn.) J.J. De Wilde	Meliaceae		Non-timber	-	-	16
67	*Trichilia prieurriana* A. Juss	Meliaceae		Non-timber	16	32	16
68	*Trilepisium madagascariense* Dc. Fl. Caom	Moraceae		Non-timber	16	-	-
69	*Triplochiton scleroxylon* K. Schum FWTA	Sterculiaceae		Non-timber	32	32	16
70	*Xylopia acutiflora* (Dunal) A. Rich FWTA	Annonaceae		Non-timber	-	-	16
71	*Zanthoxylum Zanthoxyloides* (Law) zepernick and Timler in Wildenewia	Rutaceae		Non-timber	16	-	160
				Total	2304	2368	3232

All authorities of botanical names are according to Nigerian Trees Keay, R.W.I., C.F.A. Onochie and D.P. Stanfield (1989)

Table 3: Mean basal area of tree species ±95% confidence interval in three study plots in Ago-Owu Forest Reserve of Southwestern Nigeria

		Basal area (m^2 ha^{-1})		
No.	Species	Plot A	Plot B	Plot C
1	*Albizia zygia*	0.10±0.00	-	-
2	*Alstonia boonei*	-	0.66±0.73	0.51±0.00
3	*Alstonia boonei*	0.10±0.97	-	
4	*Anacardiaceae*	-	0.06±0.00	
5	*Aningeria robusta*	0.03±0.02	0.05±0.05	0.08±0.08
6	*Angylocalyx oligophyllus*	-	0.01±0.00	
7	*Anthronotha macrophylla*	-	0.12±0.00	
8	*Antiaris africana*	-	0.46±0.00	
9	*Baphia nitida*	-	0.02±0.02	0.02±0.00
10	*Beilschmiedia gaboonensis*	0.12±0.00	0.12±0.00	-
11	*Blighia sapida*	0.08±0.00	-	-
12	*Buchholzia coriacea*	0.06±0.00	0.21±0.00	-
13	*Cola gigantea*	-	-	0.13±0.00
14	*Cola millenii*	0.08±0.06	0.12±0.00	0.02±0.00
15	*Celtis zenkeri*	0.24±0.32	0.13±0.05	0.39±0.63
16	*Cordia millenii*	0.14±0.00	-	0.21±0.00
17	*Cordia platythrsa*	1.10±0.00	-	-
18	*Chrysophyllum albidum*	-	0.00±0.00	0.01±0.00
19	*Chytranthus macrobotrys*	-	0.09±0.00	-
20	*Cylicodiscus gabunensis*	-	0.08±0.00	-
21	*Daniellia ogea*	0.00±0.00	-	-
22	*Diospyros abyssinica*	0.03±0.00	0.01±0.00	-
23	*Diospyros crassiflora*	-	-	0.06±0.00
24	*Diospyros monbuttensis*	0.02±0.00	-	-
25	*Diospyros suaveolens*	-	0.00±0.00	0.00±0.00
26	*Discoglypremna caloneura*	0.10±0.06	-	0.43±0.74
27	*Drypetes aframensis*	0.10±0.22	0.04±0.06	0.06±0.10
28	*Drypetes gilgiana*	0.03±0.03	0.01±0.00	0.06±0.11
29	*Drypetes paxii*	-	0.02±0.00	0.53±0.76
30	*Elaeis guineensis*	-	-	1.33±1.30
31	*Enanthia chloranthan*	-	0.02±0.00	0.05±0.01
32	*Entandrophragma angolense*	0.49±0.00	3.30±0.00	0.72±0.00
33	*Ficus exasperate*	0.96±0.64	-	-
34	*Ficus*	0.30±0.42	-	0.07±0.00
35	*Funtumia elastica*	0.10±0.15	0.10±0.14	0.07±0.13
36	*Guarea cedrata*	0.21±0.15	0.15±0.00	-
37	*Hannoa klaineana*	-	-	1.99±0.00
38	*Holoptelea grandis*	0.17±0.00	0.22±0.00	-
39	*Hunteria umbellate*	-	0.07±0.08	0.06±0.10
40	*Lannea welwitschii*	0.00±0.00	-	-
41	*Lecaniodiscus cupanoides*	0.13±0.00	0.08±0.00	-
42	*Macaranga barteri*	0.63±0.00	-	-
43	*Mansonia altissima*	0.06±0.08	0.06±0.004	0.01±0.01
44	*Margaritaria discoidea*	0.04±0.76	-	-
45	*Millettia thoningi*	-	0.72±0.00	-
46	*Microdesmis puberula*	-	0.49±0.00	-
47	*Monodora tenuifolia*	0.70±0.35	-	-
48	*Myrianthus arboreus*	0.03±0.00	1.03±0.00	0.06±0.07
49	*Nesigordonia papaverifera*	-	0.02±0.01	1.61±0.00
50	*Octolobus angustatu*	0.02±0.06	0.02±0.03	0.04±0.04
51	*Piptadeniastrum africanum*	-	-	0.01±0.00
52	*Polyeuthia suavedens*	-	-	0.03±0.03
53	*Pycanthus angolensis*	0.10±0.00	0.35±0.32	0.01±0.13
54	*Radlkofera calodendron*	-	-	0.01±0.00
55	*Ricinodendron heudelotii*	0.21±0.00	2.22±0.00	2.38±0.93
56	*Rinorea dentate*	0.00±0.00	0.10±0.00	-
57	*Rothmannia whitfieldi*	-	0.03±0.00	-
58	*Rubiaceae*	-	-	0.96±0.00
59	*Scottelia coriaceae*	1.85±0.00	-	-

Table 3: Continued

No.	Species	Basal area (m^2 ha^{-1}) Plot A	Plot B	Plot C
60	*Sterculia rhinopetala*	0.16±0.26	0.12±0.08	0.17±0.34
61	*Sterculia tragacantha*	-	0.54±0.00	-
62	*Strombosia pustulata*	0.13±0.18	0.06±0.08	0.14±0.28
63	*Teclea afzeli*	0.12±0.18	0.09±0.14	0.06±0.05
64	*Terminalia superba*	-	1.03±0.00	0.09±0.00
65	*Trema orientalis*	0.00±0.00	-	-
66	*Trichilia monadelpha*	-	-	0.01±0.00
67	*Trichilia prieurriana*	0.07±0.00	0.15±0.18	0.02±0.00
68	*Trilepisium madagascariense*	0.12±0.00	-	-
69	*Triplochiton scleroxylon*	0.32±0.16	0.09±0.13	0.72±0.00
70	*Xylopia acutiflora*	-	-	0.02±0.00
71	*Zanthoxylum zanthoxyloides*	3.49 ±0.00	-	0.29±0.00
	Total mean basal area	12.57	13.26	13.38

heudelotii, *Sterculia tragacantha* and *Terminalia superba* (timber and non-timber) had the lowest density of 16 plants ha^{-1} and other species had intermediate values.

In Plot C *Strombosia pustulata* (non-timber) had the highest density of 704 plants ha^{-1} while *Alstonia boonei*, *Cordia millenii*, *Entandrophragma angolense*, *Nesogordonia papaverifera*, *Piptadeniastrum africanum*, *Terminalia superba* and *Triplochiton scleroxylon* (timber and non-timber) had the lowest density of 16 plants ha^{-1} and other species had intermediate values. Plot C with the lowest number of species (41), had the lowest number of timber species (12), also had the lowest value of species diversity index (H' = 1.289) but had the highest plant density ha^{-1} (Table 1).

Consideration of the basal area contribution of each species to the overall basal area of the plots showed that in Plot A Zanthoxylum zanthonxyloides (non-timber) contributed the largest mean basal area of 3.49±0.001 m^2 ha^{-1} (2.77% of the total basal area) while *Daniella ogea* (timber) had the smallest mean basal area of 0.001±0.001 m^2 ha^{-1} while other species had intermediate values. In Plot B, *Entadrophragma angolense* (timber) contributed the largest mean basal area of 3.30± 0.001 m^2 ha^{-1} (24.91% of the total basal area while *Chrysophullum albidium* and *Diospyros suavedens* contributed the smallest mean basal area of 0.002±0.001 m^2 ha^{-1} each other species had intermediate values. In Plot C, *Ricinodendron heudelotii* (timber species) contributed 2.38 ±0.93 m^2 ha^{-1} (17.79% of the total basal area) and the smallest mean basal area of 0.01±0.001 m^2 ha^{-1} was contributed by *Chrysophyllum albidum* (non-timber) (Table 3).

A look at the girth size class distribution of all the timber species showed that highest number of the timber species of 1200 plants ha^{-1} in all the three plots falls in small girth class of 21-40 cm while the timber species of only 144 plants ha^{-1} falls in the girth size class of >100 cm (Table 4).

Timber Species Composition and Abundance on the Sawmills Fields

The timber logs found on sawmills fields were the biggest trees of remarkable sizes. The result indicates that in the dry season sawmill 4 had the highest number of timber logs of 892 while sawmill 5 had the lowest number of timber logs of 233, while in the rainy season sawmill 6 had the highest timber logs of 774 and sawmill 2 had the lowest timber of logs of 51 (Table 5).

The timber logs found on sawmills fields were the biggest trees of remarkable sizes. *Ceiba pentandra*, had the largest girth size of 3.389 m^2 during the rainy season while *Mansonia altissima* had the smallest girth size of 1.04 m^2. Other timber logs species had intermediate values for rainy season. *Triplochiton scleroxylon* had the largest girth size of 3.31 m^2 during the dry season while *Terminalia superba* had the smallest girth size of 0.03 m^2 during the dry season. Other timber logs had intermediate values.

The number of timber logs species vary in various frequencies in all the study six sawmills but *Terminalia superba* was found in all the study six sawmills. A total of 21 different timber species

Table 4: Girth size class distribution of timber species in the three study plots in Ago-Owu Forest Reserve per ha^{-1}

No.	Species	Family	1-20 cm	21-40	41-60	61-80	81-100	>100
1	*Albizia zygia*	Mimosoideae		16				
2	*Alstonia boonei*	Apocynaceae		16	16	16		
3	*Aningeria robusta*	Sapoteceae	176	64				
4	*Antiaris africana*	Moraceae		16				
5	*Celtis zenkeri*	Ulmaceae		208	80			
6	*Cordia millenii*	Boraginaceae		32				
7	*Cylicodiscus gabunensis*	Mimosoideae		16				
8	*Daniellia ogea*	Caesalpinioideae	16					
9	*Discoglypremna caloneura*	Euphorbiaceae	128		64			
10	*Entandrophragma angolense*	Meliaceae				32		16
11	*Guarea cedrata*	Meliaceae		80	32			
12	*Holoptelea grandis*	Ulmaceae		32				
13	*Lannea welwitschii*	Anacardiaceae	16	64				
14	*Mansonia altissima*	Sterculiaceae	160					
15	*Margaritaria discoidea*	Euphorbiaceae				64		
16	*Nesigordonia papaverifera*	Sterculiaceae	32					16
17	*Piptadeniastrum africanum*	Mimosoideae	16					
18	*Pycanthus angolensis*	Myristicaceae		80				
19	*Ricinodendron heudelotii*	Euphorbiaceae		16				80
20	*Scottelia coriaceae*	Flacourtiaceae						32
21	*Sterculia rhinopetala*	Sterculiaceae		512				
22	*Sterculia tragacautha*	Sterculiaceae				16		
23	*Terminalia superba*	Combretaceae		16				
24	*Triplochiton scleroxylon*	Sterculiaceae		32	32	16	16	
	Total		544	1200	208	144	32	144

Table 5: Timber log species composition and abundance at the six sawmills study in Isokan Local Government Area of Osun State

			Dry season							
			No. of Sawmills							
			1	2	3	4	5	6		
No.	Name of Timber	Family	No. of Logs						Σ	X
1	*Albizia zygia*	Mimossoideae	34	-	23	48	-	-	105	35
2	*Alstonia congensis*	Apocynaceae	21	39	-	48	-	-	108	36
3	*Afzelia africana*	Caesalpinoideae	-	-	-	-	16	17	33	16.5
4	*Blighia sapida*	Sapindaceae	45	27	-	36	16	16	143	28.6
5	*Brachyestegia eurycoma*	Caesalpinoideae	-	-	-	47	-	-	47	47
6	*Ceiba pentandra*	Bombaceae	29	46	-	26	23	-	124	31
7	*Celtis wightii*	Ulmaceae	49	25	-	65	-	-	139	46.3
8	*Milicia excelsa*	Meliaceae	-	-	23	26	24	49	122	30.5
9	*Chrysophyllum* spp.	Sapindaceae	-	-	-	-	-	13	13	13
10	*Cordia millenii*	Broaginaceae	76	-	-	115	18	24	233	58.3
11	*Khaya ivorensis*	Meliaceae	-	34	23	92	13	32	194	38.8
12	*Lannea acidissima*	Anacardiaceae	20	26	22	62	-	-	130	32.5
13	*Mansonia altissima*	Sterculiaceae	-	-	64	40	-	-	104	52
14	*Nauclea diderrichii*	Rubiaceae	92	-	92	23	44	44	295	59
15	*Nesogordonia papaverifera*	Sterculiaceae	-	-	23	43	12	21	99	24.75
16	*Piptadeniastrum africanum*	Mimosoideae	-	-	-	-	-	8	8	8
17	*Pterygota macrocarpa*	Sterculiaceae	23	37	23	48	-	-	131	32.75
18	*Sterculia rhinopetala*	Sterculiaceae	22	60	23	26	7	31	169	28.2
19	*Terminalia ivorensis*	Combretaceae	26	-	-	52	-	-	78	39
20	*Terminalia superba*	Combretaceae	65	30	-	23	23	52	193	38.6
21	*Triplochiton scleroxylon*	Sterculiaceae	-	-	131	72	37	72	312	78

Table 5: Continued

			Rainy season							
			Sawmills							
			1	2	3	4	5	6		
No.	Name of Timber	Family	No. of Logs						Σ	X
1	*Albizia zygia*	Mimossoideae	9	-	8	-	-	-	17	8.5
2	*Alstonia congensis*	Apocynaceae	9	7	-	13	-	-	29	9.7
3	*Afzelia africana*	Caesalpinoideae	-	-	-	-	23	27	50	25
4	*Blighia sapida*	Sapindaceae	4	12	-	-	-	46	62	20.7
5	*Brachyestegia eurycoma*	Caesalpinoideae	-	-	8	14	-	-	22	11
6	*Ceiba pentandra*	Bombaceae	8	4	-	3	66	54	135	27
7	*Celtis wightii*	Ulmaceae	8	3	6	10	-	-	27	6.75
8	*Milicia excelsa*	Meliaceae	-	-	10	7	66	64	147	36.75
9	*Chrysophyllum* spp	Sapindaceae	-	-	-	-	11	8	19	9.5
10	*Cordia millenii*	Broaginaceae	9	-	-	-	39	129	177	59
11	*Khaya ivorensis*	Meliaceae	5	-	4	6	23	63	101	20.2
12	*Lannea acidissima*	Anacardiaceae	16	4	8	7	-	-	35	8.75
13	*Mansonia altissima*	Sterculiaceae	-	-	15	18	-	-	33	16.5
14	*Nauclea diderrichii*	Rubiaceae	6	-	-	11	65	64	146	36.5
15	*Nesogordonia papaverifera*	Sterculiaceae	-	4	-	7	23	50	84	21
16	*Piptadeniastrum africanum*	Mimosoideae	-	-	-	-	-	-	-	-
17	*Pterygota macrocarpa*	Sterculiaceae	16	8	-	-	-	-	24	12
18	*Sterculia rhinopetala*	Sterculiaceae	-	4	-	13	23	69	109	27.25
19	*Terminalia ivorensis*	Combretaceae	8	-	-	4	-	-	12	6
20	*Terminalia superba*	Combretaceae	12	5	6	8	44	66	141	23.5
21	*Triplochiton scleroxylon*	Sterculiaceae	-	-	15	10	69	134	228	57

1. Daolec sawmill, 2. Titilope sawmill, Sawmill 3. Orelope sawmill, 4. Mosel Royal sawmill, 5. Wabilah Taofeek sawmill, 6. Ore-Ofe Jesu sawmill

comprising of hard and soft wood were encountered in all the six sawmills and 13 families were represented. *Triplochiton scleroxylon* had the highest mean log number of 78 which was encountered in four sawmills while *Piptadeniastrum africanum* had the lowest mean log number of eight which was encountered in only one sawmill in the dry season. *Triplochiton scleroxylon* had the highest mean log number of 57 in the rainy season while *Terminalia ivorensis* had the lowest mean log number of 6. The results of the timber logs number in all the six sawmills were subjected to one way analysis of variance and it was found that the number of timber logs found during the dry season was significantly higher ($p<0.05$) than those found in rainy season in all the six sawmills.

The total number of timber species encountered in the sawmills were higher than those encountered in the study forest plots. Twelve timber species namely: *Albizia zygia*, *Alstonia boonei*, *Blighia sapida*, *Celtis zenkeri*, *Cordia millenii*, *Lannea welwitcchii*, *Mansonia altissima*, *Nesogordonia papaveritera*, *Piptadeniastrum africanum*, *Pycnanthus angolensis*, *Sterculia rhinopetala* and *Terminalia superba* were found both in the study forest plots and the sawmills. The timber logs found in the sawmills had the higher girth size and basal areas that those found in the study forest plots. *Aningeria robusta*, *Antiaris africana*, *Cylicodiscus calnoneura*, *Entandrophragma angolense*, *Guarea cedrata*, *Holoptelea grandis*, *Margaritaria discoidea*, *Ricinodendron heudelotii*, *Scottelia coriacea*, *Sterculia tragacantha* and *Triplochiton scleroxylon* were found in the study plots sawmill fields but not found in the sawmills.

DISCUSSION

The tree density values obtained in each plot compare relatively to the values of tree densities obtained in the previous secondary forest studied in Ile-Ife area of southwester Nigeria (Oke and

Isichei, 1997). The density of non-timber species ha^{-1} was higher than densities of the timber species in all the tree plots.

The dominant tree species were *Stombosia pustulata*, *Funtumia elastica* and *Drypetes gilgiana*, all non-timber, reflect evidence of previous land use and disturbance of forest region which can be attributed to clearing, lumbering and other forms of forest destruction and this is in agreement with the findings of Hall (1977); Oke and Isichei (1997). *Sterculia rhinopetala* and *Aningeria robusta* were the dominant timber species while the mostly depleted timber species include *Daniellia ogea, Entandrophragma angolense, Holoptelea grandis, Ricinodendron heudelotii, Cordia milleni, Antiaris africana, Guarea cedrata, Sterculia tragacentha, Terminalia superba, Nesogordonia papaverifera* and *Triplochiton scleroxylon* and they were poorly represented in all the plots due to excessive removal of mother trees, these compared favourably with the forest resources study (1999) who found most of the species to be endangered due to habitat loss as well as agricultural encroachment and logging activities. When the most preferred species have been removed, the less preferred trees such as *Strombosia pustulata, Funtumia elastica, Drypetes gilgiana, Drypetes aframensis, Zanthoxylon zanthoxyloides* were left to reproduce and this is in agreement with the findings of Dike (1992).

The distribution of the girth size class has shown that Plots A and B were characterized by small and young tree species whose girths were mostly 0-20 and 21-40 cm girth size classes. The implication of this is that most of the trees are secondary regrowth species after the original vegetation had been destroyed by logging activities. It is also an indication that the forest plots are degraded and they are in their successional stages, this findings is in agreement with Hall and Okali (1979) and Swaine *et al.* (1987) whose reports revealed increase in number of stems in lower girth size classes in Nigeria disturbed forests.

Moreover, the basal area of the timber species (0.0032---2.219 m^2) further gives evidence to the feature that the plots were characterized by regrowth from disturbance. The Sorensen index of similarity however revealed that the three plots were not significantly different from one another which is an indication that all the plots were degraded or disturbed to a similar extent. This is also an indication that the original vegetation of the study plots have been degraded by logging activities. The present vegetation is a regrowth forest as evident by the general small basal area of most species, small girth size and dominated by non-timber species.

The result of the comparison between forest species and the sawmills species revealed that some species were not common to both areas. On the average, the commonest timber logs include *Nauclea diderrichii*, *Blighia sapida*, *Triplochiton scleroxylon* and *Cordia millenii* in the dry season while the most logged forest timber in the rainy season include *Lannea acidissima, Pterygota macrocarpa, Sterculia rhinopetala, Mansonia altissima* and *Triplochiton scleroxylon. Terminalia superba* is the only species that was mostly available or common despite the seasonal variation in all the investigated sawmills. *Terminalia superba* has been identified as one of the endangered tree species mainly by habitat loss due to logging (Forest Resources Study, 1999).

A comparative analysis of the properties of the logs from the sawmills fields revealed larger girth size (1.04---3.38 m), higher basal area of timber species (0.09---18.11 m) and a denser timber species density (112---2.096 m) than those found in the forest. This is an indication that many bigger timber species have been harvested from the forest leaving behind the smaller ones.

The general trend in the species composition of the forest revealed that there was a drastic reduction in the abundance of the timber species in the reserve forest where logging has taken place when compared with the undisturbed forest composition of data of Adeyoju (1975). The abundance of sawmills timber logs is also more during the dry season than rainy season owning to extraneous factors such as the problem of accessibility. The roads linking the reserve forests to the main roads are not motorable during the rainy season as a result of which only logs of the peripheral areas of the

forests could be reached for felling and transportation to the sawmills. During the dry season the roads become more motorable and almost all the parts of the forest could be more easily reached hence the abundance of more timber species at the sawmills during the dry season than rainy season.

Jones and Darkenwald (1954) reported that lumbering in the tropical rainforest are handicapped by the scattered fashions of trees in the forest, with only a few of each species per hectare and tangles underbush block the way into the forest during the rainy season and this could be an hinderance to forest species exploitation during the rainy season. Comparison of the timber species in the forest and the sawmills fields revealed absence of some timber species in the forest plots studied while they were present in the sawmills fields. This could be that such timber species were probably harvested outside the marked plots for this study in the reserve. Further comparison with the Red Data of FAO (1986) revealed that absence of some timber species in the forest as well as on the sawmills fields confirms their rarity and endangered states. The distribution and abundance of timber species have revealed loss through logging and agricultural activities. Hence, most of the least available forest timber species are the most available in the sawmill fields.

CONCLUSIONS

This study assessed the effects of logging activities in selected forest plots in Ago-Owu forest reserve, Osun State, Nigeria. The result of Sorenson similarity of index in the study plots reflected that all the three selected plots were similar in the properties in relation to timber and non-timber species. The three plots were detected to contain a high number of regrowth forest species and are obviously at the successional stage, low timber density are the common features. The three plots also revealed to be dominated by secondary regrowth species of the forest such as *Funtumia elastica, Drypetes* spp and *Strombosia pustulata* (non-timbers) and young timbers such as *Sterculia rhinopetala* and *Aningeria robusta* which have been showed by (Hall 1977; Oke and Isichei, 1997) to be associated to areas which have huge exposure to clearing by fire, lumbering and other forms of disturbance of forest.

Moreover, the distribution and abundance of timber species have revealed loss through logging and agricultural activities. Hence, most of the least available forest timbers species are the most available in the sawmills e.g., *Cordia millenii, Triplochiton scleroxylon, Sterculia rhinopetala* and *Terminalia superba* which have either been declared as endangered by Forest Resources Study (1999) or whose exploitation has been banned. There was also obvious evidence that most of the economic timber trees could have been logged from other closed forest reserve, free areas, or farm lands as it becomes increasingly obvious that the studied plots could no longer provide the economic demands.

REFERENCES

Adesina, F.A., 1989. Plant species characteristics and vegetation dynamics in the tropics. Int. J. Environ. Stud., 33: 67-68.

Adeyoju, S.K., 1975. Forestry and National Economy of Nigeria. University of Ibadan Press.

Akachuku, A.E., 1997. Strategies for Sustainable Environmental Conservation Through Resources Development. In: Annual Proceeding of Forest Association of Nigeria, Sanwo, K. (Ed.), pp: 258-269.

Burgress, P.F., 1971. The effect of logging on hill dipterocarp forests. Malayan Cult. J., 24: 231-237.

De-graaf, N.R., 1986. A silvicultural system for Natural regeneration of tropical rainforest in Suriname, Ph.D. Thesis (Unpub.), Agricultural University, Wageningen, pp: 250.

Dike, M.C., 1992. Tree Regeneration Recruitment and Mortality in Nigeria Tropical Moist Forests Ph.D. Thesis (Unpub.) University of Ibadan, Ibadan.

Ekanade, O., A.T. Salami and M. Aborode, 1996. Floristic changes in the tropical rain forest of southwestern. Nigeria-Malayan J. Trop. Geogr., pp: 27.

Food and Agricultural Orgnisation, 1992. Third Interim report on state of Tropical Forests-FAO Rome, Italy.

Forest Resources Study, 1999. National Report. Vol. 1, Prepared for Formegu Federal Department of Forestry, Nigeria.

Hall, J.B., 1977. Forest types in Nigeria analysis of pre-exploitation forest enumeration data. J. Ecol., 65: 187-199.

Hall, J.B. and D.U.U. Okali, 1979. A structural analysis of woody fallow vegetation near Ibadan, Nigeria. J. Ecol., 67: 321-346.

Hutchinson, J. and J.M. Dalziel, 1954-1972. Flora of West Tropical Africa, Revised by Keay, R.W.J. and F.N. Happer (Eds.), Crown Agents for Overseas Government, London.

Jang, C.I., Y. Nishigami and Y. Yanagisawa, 1996. Assessment of global forest change between 1986 and 1993 using satellite-derived terrestrial net primary productivity. Environ. Conserv., 23: 315-321.

Johns, A.D. and J.P. Skorupa, 1987. Responses of rain forest primates to habitat disturbances: A review. Intl. J. Primatol., 8: 157-191.

Jones, C.F. and G.G. Darkenwold, 1954. Economic Geography. The Macmillan Company, New York, pp: 68.

Odum, E.P., 1971. Fundamental of Ecology, W.A. Saunder Company, London.

Odum, E.P., 1985. Trends expected in stressed ecosystems. Bioscience, 35: 419-422.

Oke, S.O. and A.O. Isichei, 1997. Floristics and structure of the Fallow Vegetation in Ile-Ife area of Southwestern Nigeria. Nig. J. Bot., 10: 37-50.

Myers, N., 1989. Deforestation rates in Tropical forests and their climate implications trend of the Gerth London.

Park, C.C., 1995. Tropical Rainforest. London and New York.

Rapport, D.J. and H.A. Regier, 1995. Disturbance and Stress Effects on Ecological Systems. In: Complex Ecology. Pattern, B.C. and S.E. Jorgensen (Eds.), Prentice Hall. Eaglewood Cliff, New York, pp: 397-414.

Salami, A.T., 1995. Human colonization and vegetation dynamics in the rain forest belt of southwestern Nigeria comparative analysis Ife Psychologia. An Int. J., 3: 217-233.

Smyth, A.J. and E.R. Montgomery, 1962. Soil and Land use in Central Western Nigeria. Government Printers Ibadan.

Swaine, M.D., J.B. Hall and C.J. Alexander, 1987. Tree population dynamics at Kade, Ghana (1968-1982). J. Trop. Ecol., 3: 331-345.

Tyler, C., 1990. The sense of sustainability. Geographical Magazine (February), pp: 8-13.

Wilkie, D.S., J.G. Sidle and G.C. Boundzanga, 1992. Mechanized logging, market hunting and a bank loan in Congo. Conserv. Biol., 6: 570-580.