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ASSESSMENT OF RATE OF TIMBER EXPLOITATION IN SELECTED FREE FOREST AREAS IN ONDO STATE, NIGERIA

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ABSTRACT

This study assessed the rate of timber exploitation in free forest areas in Ondo State, Nigeria. Secondary data on the number of logs and volumes of legally felled trees in Akure, Ore, and Okitipupa (administrative zones) was obtained from the Ondo State Department of Forestry. Results showed that a total of 49,063 logs with a volume of 118,026.4 m^3 were exploited from all the study sites. Tree species with a low number of harvested logs were Sterculia oblonga Mast (2 logs), Cola nitida (2 logs), Nauclea orientalis (L.) (3 logs), Acacia Senegalensis (5 logs), and Diospyros spp. (25 logs). Other species (tree species with unknown scientific names as of the time of harvest) had the highest number of harvested logs with 7,605 logs. Tree species with harvested volumes >1000 m^3 were Entadrophragma angolense, Entandrophragma cylindricum (Sprague), Erythropholeum spp., and Fagara zanthoxyloides with 2,620.5, 1,601.9, 2,093.1 and 2,242 m^3 respectively. Generally, the lowest and highest number of logs (2,813 and 7,306) were removed in September and January. There was no significant difference ($p > 0.05$) in the volume of trees harvested in January and February. However, the volume of logs harvested in March, April, July, and October was significantly different ($p < 0.05$) from each other. Almost all indigenous tree species of high economic values are present in this study. However, these tree species are becoming threatened and are on the brink of extinction. Conservative measures should therefore be set up for these tree species to ensure their availability.

Keywords: Timber exploitation, biodiversity, conservation, sustainability

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INTRODUCTION

The impending situation of over-exploitation of timber for wood and other uses especially in developing countries has caused a great stir in the growth and development of the country over the past centuries (Salami, 2006). Nigeria, once evergreen land had a total of 1,160 Forest Reserves which encompasses a land area of about 1075 km². Relatedly, the forest reserves are only known on paper (Salami, 2006). Other woodlands that are not reserved and have a total land area of 914 km² are referred to as free or unprotected areas (Adetula, 2008). In time past, timber harvest has been a major source of income for communities in Nigeria, which has also contributed to the growth, stability, and livelihood of the economy in areas like the establishment of sawmills, housing materials road construction, among others (Idumah and Awe, 2017), although it may also be disadvantageous by contributing to deforestation.

Forest management in Nigeria has not been well practiced because the underlying principles of sustainably managing the forest is no longer put to use. The major forest vegetation in Nigeria comprises the Sahel, Sudan and Guinea savanna, freshwater and mangrove swamp forests and lowland rainforest (FAO, 2015). Of all the forest zones, the rainforest zone with the largest number of trees and land area due to its availability of growth essentials and nutrients for trees have a land cover of 13.6%, while the savanna zone and derived savanna zones have a land cover of 78.7% and 7.7% respectively (FAO, 2015). Some of the indigenous species found in the rainforest are: *Khaya senegalensis* (Desr.) A. Juss (African mahogany), *Ceiba pentandra* L. Gaertn (Kapok tree), *Terminalia superba* (white afara), *Milicia excela* Welw. C.C. Berg (Iroko), to mention a few (Olajuyigbe and Adaja, 2014). The lowland rainforest region which is the major source of hardwood timber products has caused depletion to less than 3.94 million hectares with continuous declination. Forest exploitation and destruction continue to become a norm, especially in unprotected areas causing a smaller number of trees and other Non-Timber Forest Products (NTFPs). According to Olajuyigbe (2018), the northern fringes of the rainforest have been degraded into secondary forests as a result of shifting cultivation, consistent bush burning, and increased population density, altering the rainforest ecosystem into derived savanna. This resulting in illegal logging, exploitation of coastal regions, industrialization, and urbanization. Also, data availability to know the rate of timber exploitation in Nigeria has not been well studied and analyzed. These situations need to be paid proper attention in order to restore the forest areas for sustainable forest management (Adekunle *et al*., 2013). The rate of timber exploitation in Ondo State could not be well compared, and there is a need to understand this in order to provide sustainable solutions. This study therefore assesses the rate of timber harvest in some free forest areas in Ondo state, Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out in Ondo State located in the Southwestern part of Nigeria. The area lies between latitude $5^0 45^1$E and $7^0 52^1$W and longitude $4^0 20^1$N and $6^0 5^1$S. The State is one of the most forested states in southwestern, Nigeria. The climatic condition of the area is that of a tropical climate with distinct two seasons which are the dry and rainy seasons. Rainy season starts from March - November while dry season runs from December - February. Annual rainfall ranges from 1500 to 2500 mm especially during rainy season, and can be as low as 250 mm in the dry season. During the rainy season, the average daily relative humidity is at 84 percent. The annual average temperature is around 27°C. The major occupation of people in this area is majorly farming.

Method of data collection

Secondary data was used in this study. Available records on the number of logs and volume of legally felled trees from free forest areas in the administrative areas of the state (Akure, Ore and Okitipupa) within the period between 2013 and 2019 were obtained from the Ondo State Department of Forestry. These areas were selected because they have available records of logging activities within the years in consideration. Though, logging data for some months was not precise, since the track record of what is logged in the forest is not properly kept. However, the available data were pooled together to provide information for this study.

Method of data analysis

Statistical Package for Social Science (SPSS) was used for data analyses. One-way Analysis of Variance (ANOVA) was used to test for significant difference in the number of logs and volume removed on a monthly and yearly basis. Where there is a significant difference, Least Significant Difference (LSD) was used to determine the best treatment through mean separation.

RESULTS

As shown in Table 1, a total of 49,063 logs were exploited from all the study sites between 2013 and 2019. Total number of logs removed were 11495, 5680, 3216, 4262, 3059, 11649, and 9702 in 2013, 2014, 2015, 2016, 2017, 2018 and 2019 respectively. In 2013, *Sterculia africana* Lour. had the lowest number of logs removed with one (1) log, and other species had the highest with 1366 logs. Tree species with a low number of logs harvested in 2014 were *Afzelia africana* Sm., *Distemonanthus spp*. and *Magnifera indica* with a single log each. Some of the tree species with low numbers of logs harvested in 2015 were *Garcina spp*. (1 log), *Gmelina arborea* Roxb. (6 logs), *Guibourtia arnoldiana* De Wild. & T. Durand (1 log), and *Afromosia elata* Harms (5 logs). In 2016, *Allanblackia floribunda* Oliv, *Garcina spp*, *Magnifera indica*, *Nauclea orientalis* (L.) had the lowest number of harvested logs with 1 log each. Some of the tree species with no logs harvested in 2017 were *Acacia Senegalensis* (L.) Wild, *Adenocarpus mannii* Hook.f., *Baphia nitida* Lodd, *Chlorophora exclosa*, etc. In 2018 and 2019, *Acacia senegalensis* (L.) Wild had the lowest number of logs harvested, with 1 to 4 logs in each year. Tree species with a low number of logs removed between 2013-2019 were *Sterculia oblonga* Mast (2 logs), *Cola nitida* (2 logs), *Nauclea orientalis* (L.) (3 logs), *Acacia Senegalensis* (5 logs), *Diospyros spp*. (25 logs), *Distemonanthus spp*. Benth (30 logs), etc. Across the years, other species (tree species with unknown scientific names as of the time of harvest) had the highest number of logs removed (1366 in 2013, 747 in 2014, 251 in 2015, 922 in 2016, 923 in 2017, 1472 in 2018, and 1924 in 2019). Some of the tree species with harvested logs (>1000) were *Alstonia congensis* de Wild (1065 logs), *Alstonia boonie* (1351 logs), *Daniellia ogea* (Harms) Rolfe ex Holland (1291 logs), *Erythropholeum spp.* A. Chev. (1001 logs), *Cleistopholis patens* (Benth.) Engl. & Diels (1776 logs), *Ficus spp*. (1363 logs), *Pycnanthus angolensis* (Welw.) Warb. (2457 logs), etc. *Acacia Senegalensis* (L.) Wild and *Adenocarpus mannii* Hook.f had not a single log harvested between 2013 - 2017. However, a total of 5 and 14 logs were reported to be removed for the two species when all the years were pooled together. A total of 2102 and 871 logs of *Ceiba pentandra* L. Gaertn and *Celtis zenkeri* Engl. were also removed within the years in consideration.

Table 1: Number of logs **harvested per annum from free areas between 2013 and 2019**

Family	Tree Species	2013	2014	2015	2016	2017	2018	2019	Total
Fabaceae	*Acacia Senegalensis* (L.) Wild	0	0	0	0	0	1	4	5
Fabaceae	*Adenocarpus mannii* Hook.f	0	0	0	0	0	4	10	14
Papilionoideae	*Afromosia elata Harms*	10	6	5	2	3	17	24	67
Caesalpinoideae	*Afzelia africana Sm.*	24	1	147	31	11	171	18	403
Mimosoideae	*Albizia spp. Durazz*	482	271	22	154	89	90	740	1848
Clusiceae	*Allanblackia floribunda. Oliv*	210	126	6	1	0	309	0	652
Apocynaceae	*Alstonia congensis de Wild.*	450	154	46	130	141	88	56	1065
Apocynaceae	*Alstonia boonie.* de Wild	159	95	179	29	0	578	311	1351
Caesalpinoideae	*Amphimas pterocarpoides Harms.*	337	205	64	57	29	193	191	1076
Moraceae	*Antiaris africana Engl*	105	28	27	99	38	227	290	814
Papilionoideae	*Baphia nitida* Lodd	0	28	7	0	0	56	21	112
Caesalpinoideae	*Berlinia confusa Hoyle*	158	7	49	28	17	123	14	396
Sapindaceae	*Blighia sapida K. Konig*	17	59	16	36	6	77	136	347
Bombacaceae	*Bombax buonopozense P. Beauv.*	74	28	3	5	13	21	2	146
Caesalpinoideae	*Brachystegia eurycoma Harms*	196	81	90	175	102	138	121	903
Burseraceae	*Canarium schweinfurthii Engl.*	97	52	22	22	13	20	48	274
Meliaceae	*Carapa procera DC.*	315	21	10	2	4	73	45	470
Bombacaceae	*Ceiba pentandra L. Gaertn.*	657	360	117	167	156	237	408	2102
Ulmaceae	*Celtis zenkeri Engl.*	75	169	35	70	20	230	272	871
Moraceae	*Chlorophora Exclosa*	0	6	22	0	0	0	6	34
Sapotaceae	*Chrysophyllum spp.*	50	52	98	6	3	186	100	495
Annonaceae	*Cleistopholis patens (Benth.) Engl. & Diels*	419	204	193	127	115	559	159	1776
Sterculiaceae	*Cola nitida* Schott et Endl	0	0	0	0	0	0	2	2
Combretodentrum	*Combretodendrum A Chev*	41	12	28	12	12	71	19	195
Boraginaceae	*Cordia millenii Baker*	86	46	7	41	14	104	36	334
Caesalpinoideae	*Daniellia ogea (Harms) Rolfe ex Holland*	389	122	76	184	199	193	128	1291
Caesalpinioideae	*Dialium dinklagei* Harms	115	70	6	18	0	91	83	383
Ebenaceae	*Diospyros spp.*	0	0	0	0	0	25	0	25
Caesalpinoideae	*Distemonanthus spp.*	22	1	0	7	0	0	0	30
Meliaceae	*Entadrophragma angolense* (Welw.) C DC.	248	75	47	206	86	271	33	966
Meliaceae	*Entandrophragma cylindricum (Sprague)*	232	41	18	67	28	112	57	555
Caesalpinoideae	*Erythropholeum spp.*	130	168	59	131	77	187	249	1001
Rutaceae	*Fagara zanthoxyloides* Lam	316	54	144	27	24	355	67	987
Moraceae	*Ficus spp.*	118	237	105	104	41	317	441	1363
Apocynaceae	*Funtumia elastica (P. Preuss) Stapf*	22	24	14	41	41	188	146	476
Guttiferae	*Garcina spp*	0	0	1	1	0	0	48	50
Verbenaceae	*Gmelina arborea* Roxb	27	4	6	13	0	13	15	78
Fabaceae	*Guibourtia arnoldiana* (De Wild. & T.Durand)	0	0	1	0	0	0	106	107
Simaroubaceae	*Hannoa klaineana Pierre ex Engl.*	298	138	45	53	21	112	90	757
Ulmaceae	*Holoptelia grandis (Hutch.) Mildbr.*	32	28	4	8	2	105	11	190
Irvingiaceae	*Irvingia gabonensis Baill.*	49	16	7	5	29	77	31	214
Meliaceae	*Khaya spp.*	142	70	30	56	21	119	50	488
Sterculiaceae	*Cola gigantea A. Chev.*	4	0	0	37	0	15	10	66
Anacardiaceae	*Lannea welwitschii (Hiein) Engl.*	164	82	115	41	32	88	83	605
Ochnaceae	*Lophira alata Banks ex C. F. Gaertn.*	33	26	35	153	71	122	21	461
Meliaceae	*Lovoa trichilioides* Harms	34	14	8	9	3	0	0	68
Anacardiaceae	*Magnifera indica*	8	1	0	1	0	52	60	122
Meliaceae	*Swietenia macrophyll**a** King*	0	0	0	4	0	0	19	23
Malvaceae	*Mansonia altissima A. Chev.*	14	13	97	10	3	187	104	428

Table 1: Cont.

Family	Tree Species	2013	2014	2015	2016	2017	2018	2019	Total
Moraceae	*Melicia excelsa (Benth and Hook)*	300	142	98	104	42	270	221	1177
Rubiaceae	*Mitragyna stipulosa (DC.) Kuntze*	*24*	21	11	8	3	7	19	93
Rubiaceae	*Nauclea orientalis* (L.)	0	0	1	1	1	0	0	3
Sterculiaceae	*Nesogordonia papaverifera (A. Chev.)*	50	28	18	17	17	61	21	212
Rubiaceae	*Nauclea diderrichii De Wild. & T. Durand*	140	54	19	68	44	26	25	376
	Other spp	1366	747	251	922	923	1472	1924	7605
Fabaceae	*Parkia biglobosa (Jacq.) R. Br. ex G. Don*	0	4	0	0	0	0	22	26
Fabaceae	*Piptadeniastrum africana (Hook. f.)*	148	72	123	102	70	390	68	973
Fabaceae	*Pterocarpus spp.*	107	24	140	15	4	905	162	1357
Sterculiaceae	*Pterygota macrocarpa K. Schum.*	517	248	68	77	48	316	415	1689
Myristicaceae	*Pycnanthus angolensis (Welw.) Warb.*	807	329	169	162	190	425	375	2457
Euphorbiaceae	*Ricinodendron heudelotii (Baill.) Pierre ex*	777	326	146	164	149	821	301	2684
Sterculiaceae	*Sterculia oblonga Mast*	2	0	0	0	0	0	0	2
Sterculiaceae	*Sterculia rhinopetala K. Schum*	118	85	25	42	7	70	111	458
Combretaceae	*Terminalia ivorensis A. Chev.*	138	86	85	54	30	222	211	826
Sterculiaceae	*Triplochiton scleroxylon K. Schum*	210	115	17	23	1	133	265	764
Combretaceae	*Terminalia superba Engl. & Diels.*	424	188	33	127	66	293	681	1812
Lamiaceae	*Tectona grandis* L.f	0	0	0	2	0	19	6	27
Verbenaceae	*Vitex rivularis Gürke*	8	14	1	2	0	17	0	42
Sterculiaceae	*Sterculia africana* Lour.	1	2	0	2	0	0	0	5
	Total	**11,495**	**5,680**	**3,216**	**4,262**	**3,059**	**11,649**	**9,702**	**49,063**

As shown in Table 2, a total volume of 118,026.4 m^3 was removed within the period between 2013 and 2019. Log volumes removed were 29676.7, 19855.4, 7738.9, 18969.1, 12364.2, 15520.8, and 13901m^3 in 2013, 2014, 2015, 3016, 2017, 2018, and 2019 respectively. In 2013, *Cola nitida* Schott et Endl had the lowest volume removed with 2m^3 and *Pycnanthus angolensis* (Welw.) Warb. had the highest with 2878.5m^3. No single logs of *Adenocarpus manni* Hook.f., *Baphia nitida* Lodd, *Cola nitida* Schott et Endl, *Diospyros spp*., and *Vitex rivularis* Gürke was harvested in 2014. *Afromosia elata* Harms with 1.7m^3 had the lowest harvested log volume in 2014, and *Pycnanthus angolensis* (Welw.) Warb. had the highest of 1230.8m^3. *Garcina spp*. had the lowest log volume removed in 2015 with 1.3m^3 and other species with 651.7m^3 had the highest. *Acacia senegalensis* (L.) Wild and *Adenocarpus manni* (Hook.f.) had no logs removed in 2015 and 2016. However, the total log harvested from 2013–2019 was 49.6m and 3.8m^3 for these two species. Volumes removed in 2018 were 1099.7, 216.8, 185.2 and 278.1 for *Albizia spp*., *Allanblackia floribunda*. Oliv., *Alstonia congensis* de Wild., and *Alstonia boonei* de Wild respectively. Harvested log volume in 2019 ranged from 2.1m^3 for *Garcina spp* and *Adenocarpus manni* (Hook f.) to 1802m^3 for other species. *Entadrophragma angolense* (2620.5m^3), *Entandrophragma cylindricum* (1601.9m^3), *Erythropholeum spp*. (2093.1 m^3), and *Fagara zanthoxyloides* (2242 m^3) were some of the tree species with harvested log volumes >1000m^3.

Table 2: Volume of logs (m^3) harvested per annum from free areas between 2013 and 2019

Tree Species	2013	2014	2015	2016	2017	2018	2019	Total
Acacia senegalensis (L.) Wild	15.9	7	0	0	16.4	6.4	3.9	49.6
Adenocarpus manni (Hook.f.)	0	0	0	0	0	1.7	2.1	3.8
Afromosia elata Harms	373.6	1.7	11.5	8.8	4.5	19.5	9.7	429.3
Afzelia africana Sm.	918.5	1138.9	344.7	45.1	29	14.6	524.6	3015.5
Albizia spp.	748	750.5	49.1	196	747.8	1099.7	334.3	3925.6
Allanblackia floribunda. Oliv.	306.5	183.9	14	3.4	0	216.8	197.9	922.5
Alstonia congensis de Wild.	959.7	346.7	107.9	126.4	295.7	185.2	309.7	2331.2
Alstonia boonei de Wild	445.4	322.8	340.2	51	238.4	278.1	178.3	1854.1
Amphimas pterocarpoides Harms.	540.3	528.7	151.6	107.2	248.4	411	287.1	2274.4
Antiaris africana Engl	190.4	74.8	59.9	121.8	358.4	188.4	171.3	1165
Baphia nitida Lodd	297.8	0	20.2	0	9.1	2.1	24.1	353.2
Berlinia confusa Hoyle	115.3	223.2	130.2	87.1	51.2	170.7	136.8	914.5
Blighia sapida K. Konig	388.3	407.3	40.4	23	138.5	72.1	49.1	1118.6
Bombax buonopozense P. Beauv.	176.3	77.6	6.7	50.2	22.8	67.9	45.5	447.1
Brachystegia eurycoma Harms	714.8	810.7	237	350.1	290.3	294.8	280.3	2977.9
Canarium schweinfurthii	1394.8	65.2	52.4	16.5	67.3	60.9	42.5	1699.5
Carapa procera DC.	327.9	609.6	21.9	3.5	31.6	287	240.5	1522
Ceiba pentandra L. Gaertn.	1574.9	761.2	281.1	326.9	549.7	568.3	506.5	4568.7
Celtis zenkeri Engl.	214.7	27.5	97.6	74.8	289.3	152.3	130.7	986.9
Chlorophora Exclosa	39.1	13.6	58.8	5.9	0	13.2	48.1	178.6
Chrysophyllum spp.	324.6	346.4	196.4	18	22.1	182.6	140	1230.1
Cleistopholis patens (Benth.) Engl. & Diels	636.6	186	501	205.5	366.6	194.2	174.9	2264.7
Cola nitida Schott et Endl	2	0	0	0	0	0	0	3.9
Combretodendrum A Chev	223.4	321.3	59.9	19.2	39.8	107.9	96.7	868.4
Cordia millenii Baker	451.1	141.5	16.9	43.3	77.7	124.2	91.4	946
Daniellia ogea (Harms) Rolfe ex Holland	959.1	829	179.7	234.4	478.5	512.3	486.3	3679.2
Dialium dinklagei Harms	87.3	76.4	14.4	32.1	198.4	117.6	2.2	528.4
Diospyros spp.	0	0	0	0	0	2	0	2
Distemonanthus spp.	81.2	27.9	0	23.5	0	6.4	4.3	143.2
Entadrophragma angolense (Welw.) C DC	847.7	139.9	115.1	276.4	278.6	332.1	630.8	2620.5
Entandrophragma cylindricum (Sprague)	307.4	384.1	49.2	62.6	224.8	284.1	289.7	1601.9
Erythropholeum spp.	839.8	119.6	138.7	269.7	235.3	262.4	227.5	2093.1
Fagara zanthoxyloides Lam	186.9	531.9	368.7	60.7	343	416.9	334.2	2242.2
Ficus spp.	222.9	97.4	280.6	124.1	152.5	229.3	225.1	1332
Funtumia elastica (P. Preuss) Stapf	47.6	38.5	24.7	72.9	89.6	23.2	116.2	412.7
Garcina spp	4	705.2	1.3	3.1	0	9.2	2.1	725
Gmelina arborea Roxb	31.9	120.9	12.4	9.7	1.8	0.6	18.3	195.5
Guibourtia arnoldiana (De Wild. & T.Durand)	237.3	364.9	1.7	0	0	81.5	61.8	747.2
Hannoa klaineana Pierre ex Engl.	536.4	401.9	102.9	76.5	135.3	117.5	111.9	1482.3
Holoptelia grandis (Hutch.) Mildbr.	83.3	29.5	9.8	38.6	23.2	116.4	59.9	360.7
Irvingia gabonensis Baill.	311.7	545.2	14.6	9.5	59	119.9	56.2	1116.1
Khaya spp.	417.3	298	71.1	97.8	101.6	93.2	103.2	1182.2
Cola gigantea A. Chev.	134.2	93.6	0	21.1	0	70.7	100.4	420
*Lannea welwitschii (*Hiein*)* Engl.	275.1	194.2	234.5	109.4	113.3	62.7	74.3	1063.4
Lophira alata Banks ex C. F. Gaertn.	93.8	29.1	75	93.2	223.7	281.7	344.2	1140.7
Lovoa trichilioides Harms	69.2	33.9	16.8	7.5	7.1	4.8	58.3	197.6
Magnifera indica	6	4.5	0	1.8	7.3	5.8	48.9	74.3
Swietenia macrophylla King	216.8	14.6	0	0	0	32.2	162.1	425.7
Mansonia altissima A. Chev.	423.8	558.7	239.6	10.9	9.2	308.7	17.9	1568.9
Melicia excelsa (Benth and Hook)	272.9	87.4	190.8	155.5	326.4	292.6	201.9	1527.6
*Mitragyna stipulosa (*DC.) Kuntze	76.6	91.1	35.7	21.9	40.9	32.9	2.5	301.6
Musanga cecropioides R.Br.	0	20.9	0	0	0	0	0	20.9
Nauclea orientalis (L.)	1025.6	671.9	3.4	3.4	3.4	1660.1	1523.7	4891.3
Nesogordonia papaverifera (A. Chev.)	69.4	48.6	40.8	15	59.8	33	36.9	303.5
Nauclea diderrichii De Wild. & T. Durand	212	90.4	40	66.1	96	64.4	123.3	692.1
Other spp	1957.3	521.1	651.7	1343	2774.5	1951.8	1802	11001.3
Parkia biglobosa (Jacq.) R. Br. ex G. Don	70	77.2	0	0	0	22	49.1	218.3

Tree Species	2013	2014	2015	2016	2017	2018	2019	Total
Piptadeniastrum africana (Hook. f.)	518.7	365.4	339.6	236.7	199	225.4	417.2	2302
Pterocarpus spp.	993.2	757.2	390.5	12.2	45.4	412.3	97.4	2708.3
Pterygota macrocarpa K. Schum.	447.6	442.9	169.7	115.3	279.5	263.1	576.9	2294.9
Pycnanthus angolensis (Welw.) Warb.	2878.5	1230.8	417.1	247.9	530.7	702.6	383.2	6390.8
Ricinodendron heudelotii (Baill.) Pierre ex	1078.7	473	341.5	12915.2	577.5	354.8	268.6	16009.2
Sterculia oblonga Mast	89.1	76.9	0	0	0	43.1	61.7	270.8
Sterculia rhinopetala K. Schum	133.8	57.9	54	62.4	39.6	51.6	78.5	477.9
Terminalia ivorensis A. Chev.	659.9	626.6	208.2	47.3	133.5	389.7	256.2	2321.4
Triplochiton scleroxylon K. Schum	503.1	350.6	40.4	46.1	161.7	508.6	76.3	1686.6
Terminalia superba Engl. & Diels.	814.5	809.1	65.6	160.5	460.5	235.6	258.1	2803.9
Tectona grandis L.f	73.2	67.2	0	3.8	58.2	54.3	400.9	657.6
Vitex rivularis Gürke	0	0	0	0	0	20.4	4.3	24.7
Sterculia Africana Lour	2.1	4.3	0	6.7	0	0	0	13.1
Total	**29676.7**	**19855.4**	**7738.9**	**18969.1**	**12364.2**	**15520.8**	**13901**	**118026.4**

The result of the Analysis of Variance (ANOVA) for the number of logs/volumes removed monthly from the study areas between 2013 and 2019 is shown in Table 3. The number of logs exploited in January was significantly different ($p < 0.05$) from those harvested from February to December. There was no significant difference ($p > 0.05$) in the number of logs harvested in March (132.76) and that in April (139.4). Similarly, there was no significant difference ($p > 0.05$) in the number of logs harvested in May (109.23), June (111.85), July (114.04), August (115.19), November (107.62), and December (107.29). It was observed from their means that no significant difference ($p > 0.05$) was found in the volume of trees harvested in January and February. However, the volume of logs harvested in March, April, July, and October was significantly different ($p<0.05$) from each other.

Table 3: Analysis of Variance (ANOVA) for number of logs /volumes harvested from 2013 – 2019 on monthly basis

Months	No. of logs	Volume (m^3)
January	202.94^{a}	282.62^{c}
February	167.86^{b}	301.34^{c}
March	132.76^{c}	335.51^{b}
April	139.4^{c}	579.39^{a}
May	109.23^{d}	327.59^{b}
June	111.85^{d}	325.47^{b}
July	114.04^{d}	255.69^{d}
August	115.19^{d}	262.12^{d}
September	97^{de}	249.42^{de}
October	97.41^{de}	228.77^{e}
November	107.62^{d}	257^{d}
December	107.29^{d}	236.41^{e}

Means with the same alphabet vertically are not significantly different from each other (LSD<0.05)

The number of logs and volumes removed monthly between 2013 and 2019 is shown in Figure 1. It was observed that a high number of logs and volumes (m^3) were exploited in the months when there was little or no rain compared to the months of rainy season. Generally, the lowest and highest number of logs (2813 and 7306) were exploited in September and January. Similarly, volume of log removed were 7159.3 m^3 (lowest) and 20,278.55m^3 (highest) in July and April.

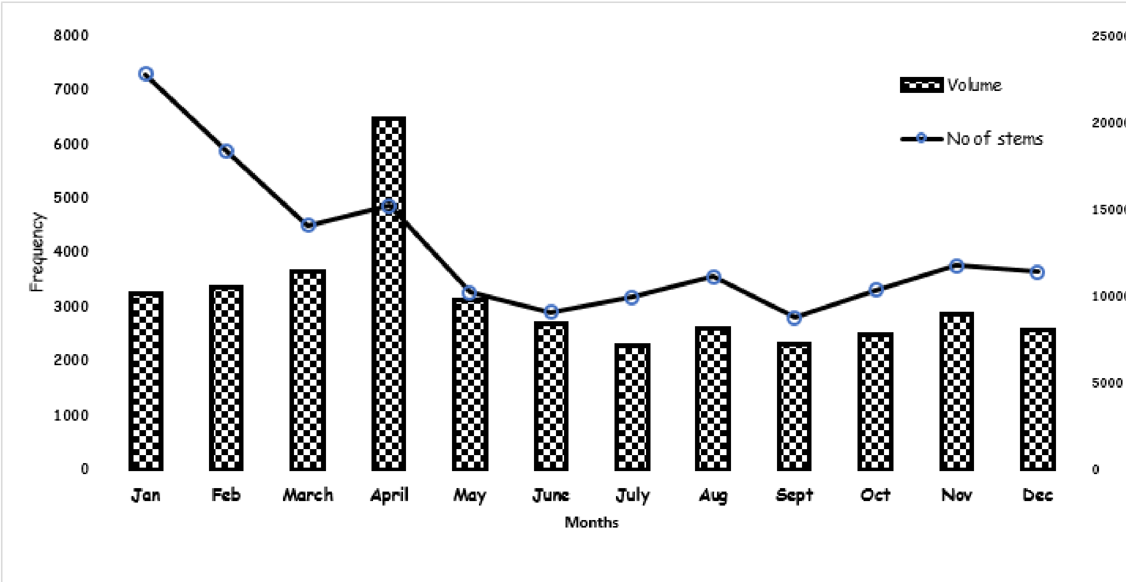

Figure 1: Number of logs **and volumes exploited monthly from all the selected free areas between 2013-2019**

As shown in Figures 2 and 3, 49,063 logs were exploited between 2013 and 2019, whereas the total volume removed was 118,026.4 m^3. Total of 70 species belonging to 29 families were removed within this period. The highest number of logs was removed in 2018 with 11,649 logs, followed by 11495 logs exploited in 2013 and the lowest number of 3059 logs was removed in 2017. It was also observed that year 2013 had the highest volume removed with 29676.7 m^3, followed by 19855.4 m^3 in 2014 and the lowest of 7738.9 m^3 in 2015. More so, the highest number of species was exploited in 2018 and 2019 with 67 spp. each, followed by 2013 with 66 spp. and the lowest of 56 spp. was removed in 2015. The number of logs removed in 2013 and 2018 was not significantly different ($p > 0.05$) from each other but was significantly different ($p < 0.05$) from those removed in 2017 and 2019. The number of tree species exploited in 2013, 2014, 2018, and 2019 was not significantly different from one another. However, they were significantly different from those exploited in 2017.

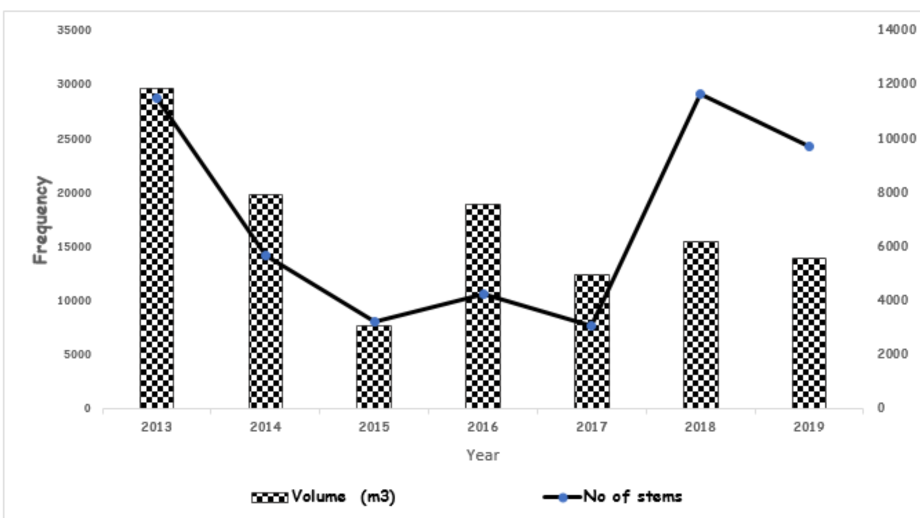

Figure 2: Number of logs and volumes harvested from 2013 -2019

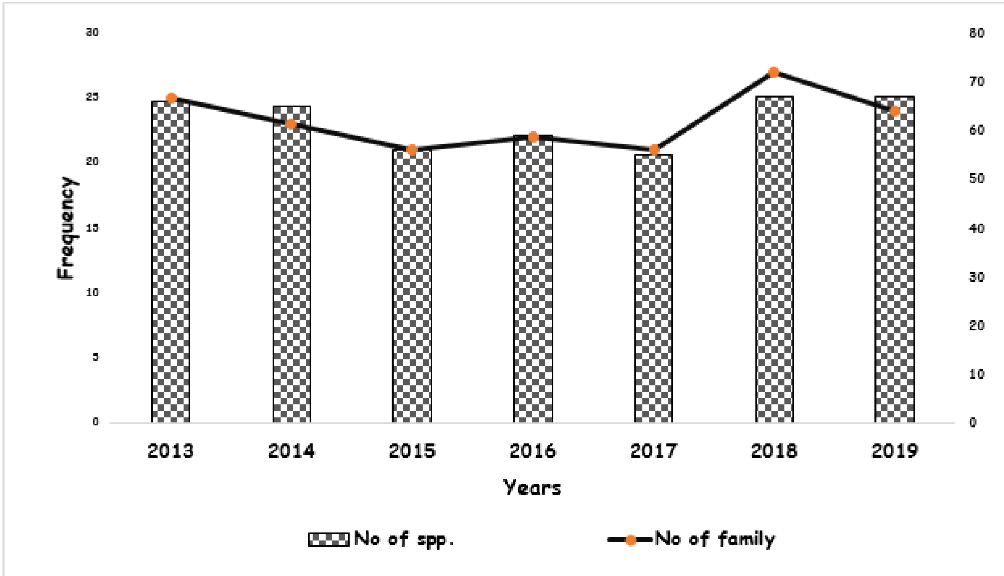

Figure 3: Number of species and family harvested from 2013 -2019

DISCUSSION

Tree species diversity is one of the important characteristics of tropical forest ecosystems, and it is fundamental to forest biodiversity conservation (Olawoyin et al. 2020). Most of the tree species exploited in this study as shown in table 1&2 are indigenous tropical hardwood tree species that can improve the socio-economic status of indigenous people and can also contribute significantly to the economy of any country (Adekunle, 2006). Total of 49,063 logs with a volume of 118026.4m^3 were exploited in this study. All of the threatened and endangered species identified by FORMECU (1999) were identified in our study. These were *Terminalia superba, Triplochiton scleroxylon, Afzelia africana, Sterculia rhinopetala, Mansonia altissima, Cordia millenii, Melicia excelsa, Nesogordonia papaverifera, Antiaris africana, Dialium spp, Pterygota macrocarpa, Khaya spp, Alstonia boonei* and *Brachystegia eurycoma*. Other species with 7605 logs had the highest number of logs exploited. Tree species of high economic and aesthetic value such *Melicia excelsa*, *Mansonia altissima*, *Terminalia superba, Nuclea diderrichii, Khaya spp*. etc. have been over-exploited to the extent that they are faced with extinction (Fuwape, 2001). Loggers have now resulted in harvesting lesser-known trees species and this is evident in this study as some of the tree species with a high number of harvested logs are less durable tree species e.g., *Ricinodendron heudelotii* (Baill.) Pierre ex (2684 logs). Other trees with high number of harvested logs (>1000) were *Alstonia congensis de Wild* (1065 logs), *Alstonia boonie* (1351 logs), *Daniellia ogea (Harms) Rolfe ex Holland* (1291 logs), *Erythropholeum spp. A. Chev*. (1001 logs), *Cleistopholis patens (Benth.) Engl. &* Diels (1776 logs), *Ficus spp.* Linn. (1363 logs), *Pycnanthus angolensis* (Welw.) Warb. (2457 logs), etc. Tree species with a low number of logs removed were *Sterculia oblonga Mast* (2 logs) *Cola nitida* (2 logs), *Nauclea orientalis* (L.) (3 logs), *Acacia Senegalensis* (5 logs), *Diospyros spp* (25 logs). *Distemonanthus spp. Benth* (30 logs). etc.

The difference in the number of harvested logs exploited from this study is an indication that loggers have a preference for particular tree species. A few years ago, some important tree species were banned and listed on the International Union for Conservation of Nature (IUCN) red List because they were endangered and on verge of extinction as a result of over-exploitation (Adekunle et al., 2014). Some of the banned tree species encountered in our study were *Diospyros spp.* and *Milicia excelsa*. These species are mostly sought after by timber contractors due to their durability and high economic value. Tree species with harvested log volume >1000m^3 were *Entadrophragma angolense*, *Entandrophragma cylindricum*, *Erythropholeum spp*., and *Fagara zanthoxyloides* with 2620.5 m³, 1601.9 m³, 2093.1 m³, and 2242 m³ respectively (Table 2). The significant difference in the number of logs harvested from month to month emphasizes the effects of climatic factors on logging operations in tropical rainforest ecosystems. The highest number of logs and volumes removed in the months with little or no rain, January and April (7,306 and 20,278.55 m^3), could be attributed to the less severe nature of soil damage caused by logging operations during this period, making the road to the forest workable for loggers. This agrees with Adekunle et al., (2014) who reported in their study that timber contractors take advantage of exploiting more trees due to favorable weather when roads are passable. Also, difficulty in having access to the forest during the rainy season due to erosion, floods, and seasonal streams could be one of the reasons why a low number of logs and volumes were removed during the months of the rainy season. According to Powertrac (2018), logging equipment is built to operate in almost all conditions. However, the presence of heavy rains can reduce its functionality and the visibility of operators and turn the ground into mud. Slippery roads can cause trucks and other machines to drift uncontrollably.

Despite the far-reaching benefits derived from the forest ecosystem, the deforestation rate in Nigeria is very high, and this is because Nigerian forests are not sustainably managed (Akinbowale et al., 2020). It was estimated that about 350,000–400,000 ha of forest is destroyed yearly, and if this rate continues, Nigerian forests would be gone in the next thirty years (FAO, 2011). Pressure on the available forest resources is not only limited to the high level of demand for wood but is also caused by other deforestation activities such as agriculture, urbanization, encroachment, industrialization, mining activities, etc. The highest number of logs (11.495) were harvested in 2013, and this is because the forest ecosystem was regenerating well with less disturbance resulting from human activities. It was observed that as the year increases, there was a sharp reduction in the number of logs harvested, except in 2018 when there was a huge surge in the number of logs harvested. The sharp increase in the number of logs exploited in 2018 could be attributed to the control of logging timber resources in both forest reserves and free areas in the state in 2017. This was done because what has been taken from the forest is greater than the productive capacity of the forest, thus causing a huge decline in the biodiversity status of the forest ecosystem. As a result of this, more stems were available for allocation in 2018, and the number of families exploited from these sites was significantly higher in this year than the other years in consideration.

CONCLUSION AND RECOMMENDATIONS

Our results revealed that almost all native tree species were harvested for their wood. Timber harvesting was intense during the dry season, when there was little or no rain, as opposed to the rainy season, and this was ascribed to the good weather, since roads are passable during the dry season. High aesthetic and economic value trees are under a lot of pressure, and as a result, some tree species are in danger of extinction. Therefore, conservative measures must be set up for these tree species to ensure their availability. Forestry Department should also be provided with sufficient funding to enable efficient monitoring and patrol of forest free areas.

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