ASSESSMENT OF TIMBER HARVEST IN ONDO STATE, NIGERIA BETWEEN 2013 AND 2019

ABSTRACT

The high rate of timber harvest from the forest without any replacement is hostile to the achievement of the objectives of sustainable forest management in Nigeria. The study was carried out to investigate the rate of timber harvest in Ondo state, Nigeria. Secondary data on logging activities from both forest reserves and free areas between 2013 and 2019 in three forestry administrative zones-Akure, and Ore, Okitipupa were collected from Ondo State Department of Forestry official records, files and annual reports. The analyses were carried out using Statistical Package for Social Science (SPSS). One-way Analysis of Variance (ANOVA) was used to test for significant differences in the number of stems and volume extracted between 2013 and 2019 in the study area. Our results revealed that 49,063 and 8409 stems were harvested from free areas and reserves respectively within this period. It was also revealed that 118323.0m^3 and 19022.1m^3 stem volume were also removed from free areas and forest reserve respectively. Generally, there were significant differences ($p>0.05$) in the number of stems and volume removed from free areas and forest reserves within these years. The study concluded that unregulated timber harvest is a threat to biodiversity conservation and recommended that conservative measures should be put in place to protect forest areas from deforestation and that more protected area should be established.

Keywords: Timber harvest, Sustainable Forest Management, Rainforest

INTRODUCTION

According to Adeduntan (2009), tropical rainforest has been the richest in abundance and diversity of plant and animal species but worldwide. However, the forest biodiversity is under threat as a result of anthropogenic human activities. Presently, despite the increase global unease and increase in awareness, tropical rain forests continue to disappear at an alarming rate. The forest resources base of Ondo State has reduced with above 200 hectares of the forests being removed annually through many anthropogenic activities such as accelerated urbanization, industrialization, fuelwood production, conversion of forest reserves to farmlands and other agricultural purpose as well as housing estate (Fuwape, 2001).

As one of the important components of the tropical forest, tree species diversity is fundamental to rainforest biodiversity (Olawoyin et al. 2020; Daramola et al. 2020). They are famed for their exceptional biological richness, but the future of this biodiversity is increasingly threatened by land-use and climate change. The current rate of deforestation in the southwest geo-political zone of Nigeria was put at 1.36% per annum when Nigerian forest was monitored with Nigeriasat-1 and other satellites (Salami, 2006). Current concerns about forest sustainability have also focused attention on the need to conserve the forest and other resources as agriculture and other land use intensifies (Adeyekun et al,.2022). The forestry sector is one of the main pivots on which the nation’s welfare was built. The forest is not only important for material goods but also as valuable ecological and cultural resources. The demand for wood raw materials by industries in recent times has outstripped the production capacity of the forest (Fuwape, 2001). Thus, uncontrolled exploitation of timber from the forest leads to decline of biological diversity. In Nigeria today, forest management is at crossroads because the guiding principles of managing the forest sustainably are no more with us. Challenges like illegal activities in the forest, declining manpower and capacity in Forestry Department, inadequate forest patrol, lack of returns from timber felling accruing to local people, outdated forestry laws and regulations and population pressure leading to increased clearing of forest land for cultivation of arable and tree crops are such that pose grave threat to sustainable forest management (SFM) in the country (Adetula, 2008).

More so, data on the rate of timber production and harvest in Nigeria are insufficient as a result of poor record keeping system and the negligent attitude of Nigerian civil servants. Where these data are available, they are not well studied and analyzed. As a result, it has been so difficult to compare the rate of forest harvesting with the regeneration potential of the natural forests. This would have formed the premise on which forestry planning and development should rest like in the developed nations that have committed substantial amount of fund to monitor growth and harvesting in their natural forests and plantations. Therefore, this study investigated the rate of timber harvest in Ondo state, Nigeria between 2013-2019.

METHODOLOGY

Description of the 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 consists of eighteen (18) Local Government Areas. Its land area is 15,500km$^{2.}$ Ondo State is one of the most forested states in Nigeria, with 16.4% of the total area demarcated as forest reserves (Omoluabi *et al*. 1990). The climate is a humid tropical climate with wet and dry seasons. The wet season runs from March to November each year, whereas the dry season is from December to February. In the rainy season, annual rainfall ranges from 1500 to 2500 mm, and in the dry season, it can be as low as 250 mm. During the rainy season, the average daily relative humidity is at 84 percent. The annual average temperature is around 27°C. Their major occupation is farming.

Method of data collection

Secondary data on logging activities from both forest reserves and free areas between 2013 and 2019 in three forestry administrative zones- Akure, and Ore, Okitipupa in the State were collected from Ondo State Department of Forestry official records, files and annual reports.

Method of data analysis

The analyses were carried out using Statistical Package for Social Science (SPSS). One-way analysis of variance (ANOVA) was used to test for significant differences in the number of stems and volume extracted between 2013 and 2019 in the study area.

RESULTS

Table 1 shows the number of stems harvested per annum from free area between 2013 and 2019 in Ondo state. The results showed that a total of 57472 stems were exploited from both free areas and forest reserves between 2013 and 2019. A total of 49,063 stems were harvested from free areas within this period. The number of individual tree species exploited from the free areas were higher than that of the forest reserve. The tree species with the highest number of stems harvested from free areas was identified as other spp.(tree species that cannot be identified as at the time the records were taken) with 7605 stems. This was followed by *Ricinodendron heudelotii* (Baill.) Pierre ex and *Pycnanthus angolensis* (Welw.) Warb represented by 2684 and 2457 stems respectively. Some of the tree species with low number of harvested stems from the free areas were *Cola nitida* (2), *Sterculia oblonga* (2), *Nuclea papau* (3) and *Acacia senegalensis* with 5 stems. In free area, the highest number of stems (11649) were harvested in 2018, followed by 11495 stems that were removed in 2013. Also, 3216 and 4262 stems were removed in 2015 and 2016 respectively while the lowest number of 3059 stems were removed in 2017. The result further showed that a total of 8409 stems were removed from forest reserves. Tree species with high number of harvested stems were *Pterygota macrocarpa* (1653), C*eiba pentendra* (914), *Sterculia rhinopetala* K. Schum (616) while tree species with the low number of harvested stems were *Amphimas pterocarpoides* Harms (4), *Weltist sterculia* (1), *Adenocarpus manni* (5). More stems (2556) were harvested in 2014 when compared to other years. The number of stems harvested in the year 2013, 2015, 2016, 2017, 2018 and 2019 were 358, 1150, 671, 365, 1315 and 1994 respectively.

Table 1: Number of stems harvested per annum from free areas and forest reserve between 2013 and 2019

Family	**Tree Species**	**2013**		**2014**		**2015**		**2016**		**2017**		**2018**		**2019**		**Total**	
		FA	**FR**	**FA**	**FR**	**FA**	**FR**	**FA**	**FR**	**FA**	**FR**	**FA**	**FR**	**FA**	**FR**	**FA**	**FR**
Fabaceae	*Acacia Senegaensis*	0	0	0	0	0	0	0	0	0	0	1	0	4	0	5	0
Fabaceae	*Adenocarpus manni*	0	0	0	0	0	0	0	0	0	0	4	0	10	0	14	0
Papilionoidae	*Afromosia elata Harms*	10	0	6	8	5	2	2	1	3	9	17	4	24	0	67	24
Caesalpinoidae	*Afzelia africana Sm.*	24	3	1	1	147	1	31	5	11		171	6	18	11	403	30
Mimosoidae	*Albizia spp. Durazz*	482	3	271	13	22	1	154		89	10	90	14	740	15	1848	59
Clusiceae	*Allanblackia floribunda. Oliv*	210	0	126	4	6		1	5		0	309	10			652	19
Apocynaceae	*Alstonia congensis de Wild.*	450	12	154	4	46	0	130		141	2	88	1	56		1065	31
Apocynaceae	*Alstonia boonie.*	159		95	20	179	3	29	5		6	578	8	311	31	1351	73
Caesalpinoidae	*Amphimas pterocarpoides Harms.*	337	0	205	0	64	2	57		29	0	193	2	191		1076	4
Moraceae	*Antiaris africana Engl*	105	2	28	21	27	25	99	9	38	3	227	5	290	10	814	77
Papilionoidae	*Baphia nitida*			28	6	7			1			56		21	5	112	12
Caesalpinoidae	*Berlinia confusa Hoyle*	158	2	7	2	49	2	28	0	17	2	123	2	14		396	12
Sapindaceae	*Blighia sapida K. Konig*	17	0	59	47	16	2	36	1	6	26	77	3	136	3	347	82
Bombacaceae	*Bombax buonopozense P. Beauv.*	74	3	28	0	3	6	5	10	13	1	21	83	2	2	146	108
Caesalpinoidae	*Brachystegia eurycoma Harms*	196	12	81	96	90	69	175	40	102	19	138	76	121	86	903	410
Burseraceae	*Canarium schweinfurthii*	97	0	52	30	22	13	22		13	19	20	1	48	13	274	76
Meliaceae	*Carapa procera DC.*	315	0	21	22	10	0	2		4	4	73	11	45		470	37
Bombacaceae	*Ceiba pentandra L. Gaertn.*	657	14	360	402	117	218	167	46	156	15	237	74	408	145	2102	928
Ulmaceae	*Celtis zenkeri Engl.*	75	6	169	33	35	11	70	4	20	1	230	18	272	34	871	113
Moraceae	*Chlorophora Exclosa*			6	37	22	1				11			6	1	34	50
Sapotaceae	*Chrysophyllum spp. L.*	50	0	52	14	98	23	6	9	3	4	186	9	100	129	495	188
Annonaceae	*Cleistopholis patens (Benth.) Engl. & Diels*	419	39	204	107	193	46	127	15	115	6	559	40	159		1776	292
Sterculiaceae	*Cola nitida*													2		2	0

Combretodentrum	*Combretodendrum A Chev*	41	0	12	8	28	9	12	2	12	15	71	2	19		195	36
Boraginaceae	*Cordia millenii Baker*	86	0	46	13	7	9	41	4	14	1	104	22	36	28	334	77
Caesalpinoidae	*Daniellia ogea (Harms) Rolfe ex Holland*	389	9	122	1	76		184	17	199		193	1	128	2	1291	39
Caesalpinioideae	*Dialium dinklagei*	115	0	70	12	6	1	18			6	91		83		383	19
Ebenaceae	*Diospyros spp.*				5		4		3			25	5			25	17
Caesalpinoidae	*Distemonanthus spp. Benth.*	22	0	1	2			7	3		1		44			30	50
	Elainadoxia spp	248	5	75	54	47	2	206	1	86	33	271	0	33	1	966	101
Meliaceae	*Entandrophragma cylindricum (Sprague)*	232	1	41	78	18		67	6	28	1	112	60	57	1	555	148
Caesalpinoidae	*Erythropholeum spp. A. Chev.*	130	9	168	3	59		131	24	77	15	187	74	249	84	1001	218
Rutaceae	*Fagara spp.*	316	1	54	2	144		27	0	24	1	355	3	67	7	987	15
Moraceae	*Ficus spp. Linn.*	118	6	237	28	105	14	104	15	41	6	317	24	441	34	1363	133
Apocynaceae	*Funtumia elastica (P. Preuss) Stapf*	22		24	11	14		41		41	4	188		146		476	15
	Garcina spp					1		1			0			48		50	0
	Gmelina arborea	27	81	4		6		13			0	13		15		78	162
	Guuboutia sapida					1	7				0		8	106		107	15
Simaroubaceae	*Hannoa klaineana Pierre ex Engl.*	298	2	138	4	45	4	53		21	3	112	3	90	2	757	20
Ulmaceae	*Holoptelia grandis (Hutch.) Mildbr.*	32	0	28	12	4	9	8	3	2	2	105	8	11	10	190	44
Irvingiaceae	*Irvingia spp. Hook.f.*	49	0	16		7	1	5	1	29	2	77	3	31	1	214	8
Meliaceae	*Khaya spp.*	142	3	70	6	30		56		21		119	2	50		488	14
Sterculiaceae	*Cola gigantea A. Chev.*	4	0		24			37		0		15	6	10	23	66	53
Anacardiaceae	*Lannea welwitschii (Hiein) Engl.*	164	3	82	15	115	11	41	3	32	0	88	8	83		605	43
Ochnaceae	*Lophira alata Banks ex C. F. Gaertn.*	33	13	26	4	35	2	153	1	71	0	122		21	1	461	34
	Lovoa trichilioides	34	1	14		8	1	9		3			12		17	68	32
	Magnifera indica	8		1				1		0		52	4	60		122	4
	Mahogany							4					11	19	6	23	17
Sterculiaceae	*Mansonia altissima A. Chev.*	14		13	2	97	4	10		3	1	187	0	104	15	428	22

Moraceae	*Melicia excelsa (Benth and Hook)*	300	4	142	20	98	8	104	12	42	4	270	0	221		1177	52
Rubiaceae	*Mitragyna stipulosa (DC.) Kuntze*	24		21	4	11	12	8	4	3	1	7	52	19		93	73
Urticaceae	*Nuclea papau*				3	1	51	1	7	1						3	61
Sterculiaceae	*Nesogordonia papaverifera (A. Chev.)*	50		28	1	18		17		17		61		21	1	212	2
Rubiaceae	*Nauclea diderrichii De Wild. & T. Durand*	140	25	54	96	19	3	68		44	38	26		25	1	376	188
	Other spp	1366	36	747	83	251	5	922	0	923	0	1472	103	1924	180	7605	443
	Parkia biglobosa			4			0							22		26	0
	Piptadeniastrum africana (Hook. f.)	148	1	72	7	123	0	102	1	70	1	390	3	68		973	14
Papilionoidae	*Pterocarpus spp. Jacq.*	107		24	41	140	0	15	5	4	11	905	1	162		1357	58
Sterculiaceae	*Pterygota macrocarpa K. Schum.*	517	7	248	423	68	228	77	274	48	28	316	219	415	474	1689	1660
Myristicaceae	*Pycnanthus angolensis (Welw.) Warb.*	807	16	329	19	169	4	162	21	190	6	425	12	375	7	2457	101
Euphorbiaceae	*Ricinodendron heudelotii (Baill.) Pierre ex*	777	17	326	248	146	49	164	39	149	9	821	76	301	153	2684	608
	Cedrus atlantica				7	0	0	0	0	0		0	0	0	35	0	42
Sterculiaceae	*Sterculia oblonga Mast*	2	0			0	0	0	0	0	14	0	0	0		2	14
Sterculiaceae	*Sterculia rhinopetala K. Schum*	118	12	85	189	25	100	42	18	7	11	70	68	111	215	458	625
	Swietenia macrophylla				2		1				1		2		3	0	9
Combretaceae	*Terminalia ivorensis A. Chev.*	138	3	86	12	85	126	54		30		222	75	211	137	826	356
Sterculiaceae	*Triplochiton scleroxylon K. Schum*	210	1	115	144	17		23	35	1	8	133	37	265	71	764	297
	Terminalia superba Engl. & Diels.	424	5	188	106	33	60	127	21	66	4	293		681		1812	201
	Tectona grandis							2				19		6		27	0
Verbenaceae	*Vitex rivularis Gürke*	8		14		1		2		0		17				42	0
	W/sterculia	1	1	2	0			2		0	0	0	0	0	0	5	2
	Total	**11495**	**358**	**5680**	**2556**	**3216**	**1150**	**4262**	**671**	**3059**	**365**	**11649**	**1315**	**9702**	**1994**	**49063**	**8409**

Table 2 shows the volume of stems harvested per annum from selected the free area between 2013 and 2019. The results showed that a total of 137345m^3 stem volume was removed from both free areas and forest reserves. It was also revealed that 118323.0m^3 and 19022.1m^3 stem volume were removed from both free areas and forest reserve respectively within this period. Obviously, free areas had the highest volume of stem harvested than forest reserve. *Ricinodedrum heudelotti* had the highest number of harvested volume from free areas with 16009.17m^3. This was followed by other species (tree species that cannot be identified as at the time the records were taken) with 11001.26 m^3 and N/papau with volume of 4891.3m^3. Some of the tree species with low volume of harvested stems in free areas were: *Adenocarpus manni*, *Cola nitida* and *Diospyrous spp* with 4.0 m^3, 3.9m^3 and 2.0m^3 respectively. The results further revealed that the lowest and highest harvested volume of 29676.7m^3 and 7738.9m^3 were recorded in 2013 and 2015 respectively. It was also observed that total volume of 19022.1m^3 were harvested from forest reserves within this period. *Pterygota macrocarpal* had the highest stem volume of 3854.3m^3. This was followed by *Ceiba pentandra L*. and *Brachystegia eurycoma* with volume of 2762.8m^3 and 1414.3m^3 respectively. Some of the tree species with low harvested stem volume were *W/sterculia*, *Berlinia confusa Hoyle* and *Dialium dinklagei* with 1.4 m^3, 4.2 m^3 and 4.5m^3 respectively. Generally, the lowest and highest stem volume of 5264.6 m^3 and 483.7 m^{3}were removed from the reserve in 2013 and 2015 respectively.

Table 2: Volume of stems harvested per annum from selected the free area between 2013 and 2019

Tree Species	2013		2014		2015		2016		2017		2018		2019		Total	
	FA	FR	FA	FR	FA	FR	FA	FR	FA	FR	FA	FR	FA	FR	FA	FR
Acacia spp	15.9		7.0						16.4		6.4		3.9		49.6	0.0
Adenocarpus manni								7.6			1.7		2.1		3.8	7.6
Afromosia elata Harms	373.6		1.7		11.5		8.8	5.3	4.5	10.4	19.5	1.7	9.7	12.6	429.3	29.9
Afzelia africana Sm.	918.5	1.8	1138.9	4.2	344.7	2.8	45.1		29.0	4.4	14.6	30.7	524.6	24.1	3015.5	68.0
Albizia spp. Durazz	748.0	6.3	750.5	6.2	49.1	5.1	196.0	14.6	747.8	13.0	1099.7	36.4	334.3		3925.6	81.7
Allanblackia floribunda. Oliv.	306.5		183.9		14.0		3.4				216.8	11.3	197.9		922.5	11.3
Alstonia boonie				41.4		4.5		9.7		8.7		58.7		7.8	0.0	130.7
Alstonia congensis de Wild.	959.7	22.2	346.7		107.9		126.4	16.8	295.7	14.3	185.2	6.2	309.7	11.2	2331.2	70.7
Alstonia spp.	445.4		322.8		340.2	69.4	51.0		238.4		278.1		178.3		1854.1	69.4
Amphimas pterocarpoides Harms.	540.3	0.0	528.7		151.6	2.1	107.2	8.0	248.4		411.0	3.5	287.1		2274.4	13.5
Antiaris africana Engl	190.4	3.9	74.8	38.1	59.9	24.1	121.8	24.5	358.4	10.4	188.4	23.6	171.3	8.7	1165.0	133.2
Baphia nitida	297.8			9.0	20.2			2.0	9.1		2.1	10.5	24.1		353.2	21.4
Berlinia confusa Hoyle	115.3	4.2	223.2		130.2		87.1		51.2	0.0	170.7	0.0	136.8		914.5	4.2
Blighia sapida K. Konig	388.3	0.0	407.3		40.4	4.3	23.0	2.2	138.5	6.4	72.1	9.2	49.1	0.0	1118.6	22.2
Bombax buonopozense P. Beauv.	176.3	7.0	77.6		6.7	2.2	50.2	3.6	22.8	4.5	67.9	11.0	45.5	0.0	447.1	28.3
Brachystegia eurycoma Harms	714.8	41.1	810.7	261.5	237.0	267.1	350.1	171.9	290.3	79.2	294.8	488.5	280.3	105.0	2977.9	1414.3
Canarium schweinfurthii	1394.8		65.2	3.8	52.4	6.9	16.5	0.0	67.3	2.0	60.9	33.7	42.5	7.3	1699.5	53.6
Carapa procera DC.	327.9	0.0	609.6		21.9		3.5		31.6		287.0		240.5	1.7	1522.0	1.7
Ceiba pentandra L. Gaertn.	1574.9	28.8	761.2	1230.7	281.1	816.2	326.9	199.4	549.7	81.1	568.3	347.6	506.5	59.1	4568.7	2762.8
Celtis zenkeri Engl.	214.7	8.9	27.5	48.8	97.6	48.0	74.8	50.3	289.3	9.9	152.3	80.4	130.7	14.4	986.9	260.6
Chlorophora Exclosa	39.1		13.6		58.8	28.6	5.9	0.0			13.2	1.8	48.1		178.6	30.4

Chrysophyllum spp. L.	324.6	0.0	346.4	26.7	196.4	32.1	18.0	15.0	22.1	7.0	182.6	226.5	140.0		1230.1	307.3
Cleistopholis patens (Benth.) Engl. & Diels	636.6	43.2	186.0	243.5	501.0	196.7	205.5	109.0	366.6	28.3	194.2	13.8	174.9	50.7	2264.7	685.0
Cola nitida	2.0												2.0		3.9	0.0
Combretodendrum A Chev	223.4	0.0	321.3	1.9	59.9	74.1	19.2	4.8	39.8	6.9	107.9	0.0	96.7	0.0	868.4	87.6
Cordia millenii Baker	451.1	0.0	141.5	23.4	16.9	8.2	43.3	6.6	77.7	6.1	124.2	69.7	91.4	10.6	946.0	124.6
Daniellia ogea (Harms) Rolfe ex Holland	959.1	15.0	829.0	1.7	179.7	6.8	234.4	51.0	478.5	22.7	512.3	20.2	486.3	3.9	3679.2	121.2
Dialium dinklagei	87.3	0.0	76.4	4.5	14.4		32.1		198.4		117.6		2.2		528.4	4.5
Diospyros spp.				10.5		8.5		4.8			2.0	7.0			2.0	30.8
Distemonanthus spp. Benth.	81.2		27.9			17.4	23.5		0.0		6.4		4.3		143.2	17.4
Elainadoxia Spp	847.7	10.6	139.9	2.2	115.1		276.4	21.4	278.6	15.9	332.1	106.0	630.8	22.2	2620.5	178.4
Entandrophragma cylindricum (Sprague)	307.4	1.4	384.1	166.7	49.2		62.6	13.1	224.8	4.4	284.1	5.4	289.7	3.0	1601.9	194.0
Erythropholeum spp. A. Chev.	839.8	16.2	119.6		138.7	2.2	269.7	177.6	235.3	93.9	262.4	228.8	227.5	71.8	2093.1	590.4
Zanthoxylum zanthoxyloides	186.9	1.8	531.9	3.3	368.7		60.7	1.5	343.0	1.7	416.9	14.6	334.2	2.2	2242.2	25.1
Ficus spp. Linn.	222.9	11.1	97.4	59.2	280.6	49.6	124.1	28.4	152.5	12.9	229.3	63.3	225.1	22.1	1332.0	246.5
Funtumia elastica (P. Preuss) Stapf	47.6		38.5		24.7		72.9		89.6		23.2		116.2		412.7	0.0
Garcina spp	4.0		705.2		1.3		3.1				9.2		2.1		725.0	0.0
Gmelina arborea	31.9	36.5	120.9		12.4		9.7		1.8		0.6		18.3		195.5	36.5
Guuboutia sapida	237.3		364.9		1.7	12.4					81.5		61.8		747.2	12.4
Hannoa klaineana Pierre ex Engl.	536.4	3.7	401.9	8.0	102.9	72.1	76.5	21.3	135.3	7.5	117.5	22.4	111.9		1482.3	135.1
Holoptelia grandis (Hutch.) Mildbr.	83.3	0.0	29.5	15.1	9.8	16.9	38.6	4.8	23.2	0.0	116.4	25.1	59.9	6.2	360.7	68.0
Irvingia spp. Hook.f.	311.7	0.0	545.2		14.6		9.5	2.0	59.0	5.0	119.9	11.5	56.2		1116.1	18.5
Khaya spp.	417.3	4.3	298.0	2.2	71.1	2.0	97.8	4.8	101.6	0.0	93.2	6.0	103.2		1182.2	19.4
Cola gigantea A. Chev.	134.2	0.0	93.6				21.1		0.0	0.0	70.7	31.9	100.4		420.0	31.9
Lannea welwitschii (Hiein) Engl.	275.1	5.1	194.2	34.6	234.5	59.7	109.4	16.4	113.3	4.0	62.7	12.2	74.3	3.6	1063.4	135.5
Lophira alata Banks ex C. F. Gaertn.	93.8	27.7	29.1	8.4	75.0	5.5	93.2	61.5	223.7	4.1	281.7	9.8	344.2		1140.7	117.0

Lovoa trichilioides	69.2	1.4	33.9		16.8	18.2	7.5		7.1	0.0	4.8	21.4	58.3	11.8	197.6	52.8
Magnifera indica	6.0		4.5				1.8		7.3		5.8		48.9	1.7	74.3	1.7
Swietenia mahagoni	216.8		14.6								32.2	3.9	162.1	13.2	425.7	17.0
Mansonia altissima A. Chev.	423.8	0.0	558.7	2.4	239.6	6.3	10.9		9.2	4.9	308.7	23.0	17.9		1568.9	36.6
Melicia excelsa (Benth and Hook)	272.9	7.0	87.4	45.9	190.8	16.6	155.5	26.5	326.4	5.0	292.6	31.4	201.9		1527.6	132.3
Mitragyna stipulosa (DC.) Kuntze	76.6	0.0	91.1		35.7	1.8	21.9	5.1	40.9	0.0	32.9	0.0	2.5		301.6	6.9
Musanga cecropioides R.Br.			20.9									0.0			20.9	0.0
Nuclea papau	1025.6		671.9		3.4	356.7	3.4		3.4		1660.1		1523.7		4891.3	356.7
Nesogordonia papaverifera (A. Chev.)	69.4	0.0	48.6	2.0	40.8	2.2	15.0		59.8	4.0	33.0	8.9	36.9	1.5	303.5	18.6
Nauclea diderrichii De Wild. & T. Durand	212.0	24.7	90.4		40.0	8.2	66.1	4.0	96.0	2.1	64.4	4.8	123.3		692.1	43.7
Other spp	1957.3	43.5	521.1	159.1	651.7		1343.0	143.0	2774.5	80.8	1951.8	480.1	1802.0	149.5	11001.3	1055.9
Parkia biglobosa	70.0		77.2							0.0	22.0		49.1		218.3	0.0
Piptadeniastrum africana (Hook. f.)	518.7	1.6	365.4	2.8	339.6		236.7	9.1	199.0	0.0	225.4	8.0	417.2	0.0	2302.0	21.5
Pterocarpus spp. Jacq.	993.2	0.0	757.2	19.0	390.5		12.2	166.8	45.4	46.2	412.3	5.3	97.4	0.0	2708.3	237.3
Pterygota macrocarpa K. Schum.	447.6	13.7	442.9	821.4	169.7	1284.8	115.3	75.7	279.5	28.1	263.1	1353.7	576.9	167.7	2294.9	3745.1
Pycnanthus angolensis (Welw.) Warb.	2878.5	21.2	1230.8		417.1	17.1	247.9		530.7	28.5	702.6	31.1	383.2	0.0	6390.8	97.9
Ricinodendron heudelotii (Baill.) Pierre ex	1078.7	34.9	473.0	328.7	341.5	233.5	12915.2	137.1	577.5	28.5	354.8	289.6	268.6	90.6	16009.2	1143.0
Cedrus atlantica				13.4								72.0			0.0	85.4
Sterculia oblonga Mast	89.1		76.9								43.1		61.7		270.8	0.0
Sterculia rhinopetala K. Schum	133.8	17.6	57.9	353.6	54.0	412.0	62.4	100.5	39.6	23.9	51.6	364.1	78.5	41.7	477.9	1313.2
Terminalia ivorensis A. Chev.	659.9	5.5	626.6		208.2	900.7	47.3	1.8	133.5	1.4	389.7	6.3	256.2		2321.4	915.7
Triplochiton scleroxylon K. Schum	503.1	1.4	350.6	254.9	40.4	0.0	46.1	68.7	161.7	18.0	508.6	268.4	76.3	48.9	1686.6	660.2
Terminalia superba Engl. & Diels.	814.5	8.9	809.1	217.2	65.6	161.1	160.5	69.4	460.5	29.1	235.6	157.7	258.1	32.8	2803.9	676.2

Tectona grandis	73.2		67.2				3.8		58.2		54.3		400.9		657.6	0.0
Vitex rivularis Gürke											20.4		4.3		24.7	0.0
W/sterculia	2.1	1.4	4.3				6.7								13.1	1.4
Total	**29676.7**	**483.7**	**19855.4**	**4476.0**	**7738.9**	**5264.6**	**18969.1**	**1867.0**	**12364.2**	**764.8**	**15520.8**	**5158.5**	**13901.0**	**1007.5**	**118026.4**	**19022.2**

Table 3 shows the number and volume of trees exploited in both free areas and forest reserves on Monthly Basis. A total of 49,062 and 8409.07 stems were harvested from free areas and forest reserves respectively. It was also recorded that a total stem volume of 118026.4 and 19022.2m^3 were removed from both free areas and forest reserves. Highest number of stems were removed in the month of January and April with 7306 and 4879 stems from free areas and forest reserve respectively. It was also observed that highest stem volume of 20278.5 and 2490.0m^3 were removed in the month of April and February from both free area and reserves. The lowest number of stems were found to be harvested during the month of June and December with 2908 and 560.82 from free areas and reserves. Lowest stem volume was removed from free areas and forest reserves in the month of July and October with 7159.3m^3 and 850m^3 respectively. In the month of September, between 2013 and 2019, number of stems removed were 2813 and 708, volume harvested were 7233.1 and 2168.2m^{3}from free areas and forest reserves respectively.

Table 3: Number and volume of trees exploited on monthly basis from free areas and forest reserves.

	No of stems		**Volume(m^3)**	
Months	**Free Area**	**Forest Reserve**	**Free Area**	**Forest Reserve**
Jan	7306	741.23	10174.4	2025.2
Feb	5875	622	10546.9	2490.0
March	4514	812.8	11407.4	1975.3
April	4879	989.1	20278.5	2037.5
May	3277	909.7	9827.8	2008.2
June	2908	617.8	8462.1	1367.8
July	3193	569.3	7159.3	1433.5
Aug	3571	692	8125.7	1678.1
Sept	2813	708.1	7233.1	2168.2
Oct	3312	560.82	7778.1	850.0
November	3766.68	747.9	8995.0	7713.7
Dec	3648	438.32	8038.0	1143.3
Total	**49062.68**	**8409.07**	**118026.4**	**19022.2**

Table 4 is on the summary of number of stems, species, family and volume of trees exploited between 2013 and 2019. A total of 11495, 5680, 3216, 4262, 3059, 11649, 9702 and 49063 stems were harvested from free areas in 2013, 2014, 2015, 2016, 2017, 2018 and 2019 respectively. Also, total volume removed were 29676.7, 19855.4, 7738.9, 18969.1, 12364.2, 15520.8, 13901.0 and 118026.4 in 2013, 2014, 2015, 2016, 2017, 2018 and 2019 respectively. It was also recorded 67 tree species each distributed among 27 and 24 families were felled in 2018 and 2019 respectively from the free areas. Total number of stems removed annually from forest reserves were as follow 358; 2013, 2556; 2014, 1150; 2015, 671; 2016, 365; 2017, 1315 ;2018, 1994 ;2019. Volume removed were 483.7, 4476.0, 5264.6, 1867.0, 764.4, 5158.5, and 1007.5m^3 in 2013, 2014, 2015, 2016, 2017, 2018 and 2019 respectively. When pooled, a total of 70 and 63 tree species distributed among 29 and 26 families were recorded in both free areas and reserves used in this study.

Table 4: Summary of number of stems, species, family and volume of trees exploited between 2013 and 2019

Year		**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
Free area	**No of stems**	11495	5680	3216	4262	3059	11649	9702	49063
	Volume (m^3)	29676.7	19855.4	7738.9	18969.1	12364.2	15520.8	13901.0	118026.4
	No of spp.	66	65	56	59	55	67	67	70
	No of family	25	23	21	22	21	27	24	29
Forest reserve	**No of stems**	358	2556	1150	671	365	1315	1994	8409
	Volume (m^3)	483.7	4476.0	5264.6	1867.0	764.4	5158.5	1007.5	19022.2
	No of spp.	34	37	41	42	39	51	30	63
	No of family	19	23	24	23	20	25	22	26

Table 5 is on comparison of the number of species, families and stems and volume of timber exploited (±S.E) in the free areas and forest reserves. Generally, there were significant differences($p>0.05$) in the number of stems harvested and volume removed between 2013-2019 from free areas and forest reserves. However, no significant difference($p<0.05$) was observed between the number of stems removed in 2015 and 2017 from free areas. There was no significant difference in the families of trees removed between 2013-2019 from free area and forest reserve.

Table 5: Comparison of the number of species, families and stems and volume of timber exploited (±S.E) in the free areas and forest reserves

	Year	**2013** Mean± SE	**2014** Mean± SE	**2015** Mean± SE	**2016** Mean± SE	**2017** Mean± SE	**2018** Mean± SE	**2019** Mean± SE
Free Area	**No of stems**	174.17±29.8[a]	87.38±4.05[c]	57.43±2.58[e]	72.24±3.01[d]	55.62±2.56[e]	173.87±26.1[a]	144.81±15.5[b]
	Volume (m^3)	449.65±67.3[a]	305.47±43.9[b]	138.19±13.3[e]	321.51±35.1[b]	224.80±20.8[c]	231.65±21.6[c]	207.48±17.1[d]
	No of spp.	66.00±3.61[a]	65.00±3.01[a]	56.00±2.56[b]	59.00±2.33[ab]	55.00±2.55[b]	67.00±3.81[a]	67.00±3.81[a]
	No of family	25.00±1.49[a]	23.00±1.31[a]	21.00±1.21[a]	22.00±1.25[a]	21.00±1.22[a]	27.00±1.64[a]	24.00±1.35[a]
Forest Reserve	**No of stems**	5.42±0.38[e]	39.32±1.88[a]	20.54±1.20[c]	11.37±0.75[d]	6.64±1.56[e]	19.63±1.23[c]	29.76±1.78[b]
	Volume (m^3)	7.33±0.67[f]	68.86±2.87[c]	94.01±4.03[a]	31.64±1.34[d]	13.90±1.11[e]	76.99±3.21[b]	15.04±1.09[e]
	No of spp.	34.00±1.33[b]	37.00±1.38[b]	41.00±2.01[a]	42.00±1.99[a]	39.00±2.54[ab]	51.00±2.5[a]	30.00±1.79[bc]
	No of family	19.00±1.11[ab]	23.00±1.25[a]	24.00±1.251.48[a]	23.00±1.48[a]	20.00±1.99[a]	25.00±1.33[a]	22.00±1.24[a]

DISCUSSION

The number of tree species in the tropical rain forest has been reported to be far greater in terms of species, genetic material and ecological processes of all ecosystems than what is in any other single forest community (Adekunle, 2006). Most tropical forest ecosystems are rich in floristic composition, this results in a variety of life forms and preservation of global biodiversity (Shi & Singh, 2002). Forest habitats play a central role in the functioning of the biosphere, as they are the origin of many cultivated plants and animals (EU 2008). Most of the tree species encountered in this study are tropical timber hardwood species that dominate the tropical rainforest ecosystem. They are economic trees that are capable of changing the economic fortune of any nation.

Timber harvest data are very essential for sustainable management of forest and its resources (Adekunle et al.,2010). Forest exploitation in Nigeria are poorly executed without following sustainable resources management plan. So, it is very deleterious to the environment and biological diversity conservation (Fuwape 2001). The increasing rate of timber harvest from the free areas and reserves as revealed in this study is hostile to the achievement of the objectives of sustainable forest management in Nigeria. Generally, the main problems of sustainable forest management in Nigeria include high rate of indiscriminate logging, over allocation of reserves to contractors, reckless felling of logs in the free areas and the allocated plots, weak control of felling in the free forest areas, weak forest policies, political interference and government's high level of interest in converting forest resources to revenue.

High demand for timber products has resulted in destruction of quantity and quality of faultless forest (Onyekwelu et al.,2007). Timber harvest appears to be the overriding force driving plant invasion, and plant invasion is a major predictor of reduced native species diversity (Brown & Gurevitch, 2004). The result obtained from this study revealed that significantly high number of stems and tree volume were harvested in free area than the forest reserves between 2013 and 2019. This was as a result of limited control of the government on logging activities in the free areas. The findings of this study corroborate the results of Akindele and Fuwape (1998), who reported that the lower proportion of timber harvested from the forest reserves could be attributed to the control on logging timber resources within the forest reserves and also as a result of conservation noting that the forest have not been exploited within a living memory. More so, the logging policy laid down by the state that prohibited the felling down of tree with small diameter size has also contributed to this few number and volume.

The volume of stem removed from free areas is greater than those removed from forest reserves between 2013 and 2019. This was attributed to the fact that there were no stringent conditions attached to logging in the free areas as in the reserves where all activities within are controlled by the State Department of Forestry. Similar result was observed by Adekunle et. al. (2010) who reported that more tree volume was exploited in the free areas than reserves. The results revealed that valuable economic tree species with specific qualities were harvested in both free forest area and forest reserves. Significant difference in the number of stems exploited for each of the species is an indication that timber contractors prefer tree species that are durable than the less durable (Akindele and Fuwape, 1998). This result further revealed that most of the hardwood species with quality aesthetic values have been over exploited in the forest to the extent that they are no longer available. Hence timber contractors now resulted in harvesting low quality species that have been abandoned over the years. Tree species such as *Ricinodendron heudelotii* (Baill.) Pierre ex (2599 stems), *Pycnanthus angolensis* (Welw.) Warb. (2397stems), *Alstonia congensis* de Wild. (2282 stems), *Albizia spp*. Durazz (2045 stems). *Ceiba pentandra* L. Gaertn. (1878 stems), *Cleistopholis patens* (Benth.) Engl. & Diels (1605 stems), *Daniellia ogea* (Harms) Rolfe ex Holland (1570 stems) etc. were mostly exploited in this study. Today, important tree species *Melicia excelsa*, *Mansonia altissima*, *Terminalia superba*, *Nuclea diderrichi*, *Khaya spp*. etc. are not only rare, but they are seriously threatened with extinction. Oyagade (1997), also reported that due to the worsening shortages of the primary species like Iroko, Mahogany, etc. lesser utilized species such as Celtis spp., *Ceiba pentandra*, *Brachystegia spp.*, etc. are now becoming available in the market. This was responsible for why the felling of some the listed tree species was banned from harvesting in some States of Nigeria (FORMECU 1999).

Pressure on the available forest resources is not only limited to the high level of demand for wood but also caused by other deforestation activities such as agriculture, urbanization, encroachment, industrialization, mining activities etc. and this is more than the regenerative capacity of the forest, which has resulted to loss of biodiversity. Olajide et al. (2008) reported that what is removed in the forest is far beyond the natural capacity of the forest to recuperate in order to continue its normal functions.

Our results also showed that the number of stems, species and volume of trees harvested during dry season (November- March) is higher than during the raining season (April-October). This agrees with what was reported by Adekunle et al. (2010) that timber loggers take advantage of exploiting more trees due to favorable weather when roads are passable. Also, difficulty in having access to the forest during rainy season, due to erosion, flood, and seasonal streams that destroy roads, reduces the rate of exploitation during raining season.

Oyebo (2006) predicted that there is the possibility of an annual deficit of about 80 million to 100 million m^3 in the supply and demand for wood from the year of 2005 to 2020. The negative economic, ecological and environmental impacts of logging are very grave. Continuous harvesting without adequate regeneration strategies will invariably results into loss of biodiversity, which are extremely difficult and expensive to rehabilitate. This calls for revisiting and implementing the basic principles of sustainable forest management (SFM) which is the only way forward to save Nigerian forest from degradation

CONCLUSION AND RECOMMENDATIONS

Forest ecosystem play important roles in climate change mitigation, carbon sequestration and biodiversity conservation. Thus, unregulated timber harvest is a threat to biodiversity conservation. Our study revealed that timber harvest is on the increase and uncontrolled due to the fact that Ondo state government tagged revenue generation to exploitation of timber in all our forest reserves without putting in place the necessary sustainable forest management practices. As a result of this, forest diversity and the other resources are greatly eroded. This study recommends that conservative measures should be put in place to protect forest areas from deforestation and that more protected area should be established. Forest reserve in the various part of the state must be managed sustainably for it to provide its goods and services in perpetuity. The number of trees removed must be replaced with more trees in accordance with the acronym ‘’Cut a tree, replace with two''. However, degraded forest that have potential for self-regeneration should be left alone to recover from its present status. Government should provide the appropriate resources needed by the forest policy implementors to review and update obsolete laws. There should also be strict adherence to forestry laws at the same time ensuring proper monitoring and management of the existing forest from further degradation or deforestation activities.

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