

Threat Status of Commercially Exploited Trees in the Nigerian Rainforest

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Abstract

Unregulated commercial-scale exploitation of trees is an indication of the extent of threat to various tree species. The study examined the threat status of commercially exploited trees in the forest estates of South eastern Nigeria. Specifically, it identified tree species under threat, and categorized them into threat classes, as well as determined the rate at which exploited trees were slipping into extinction. The study utilized the IUCN's threat categorization criteria, in determining the threat status of commercially exploited trees. This study combined both secondary and primary data sources generated through Forest Inventory records, Tree Felled Analysis records and Participatory Survey. Data such as population size and density of species, level of exploitation and threat sensitive social and ecological parameters were obtained and applied against the IUCN criteria. Twenty-eight (28) tree species representing Thirty-two percent (32%) of eighty-six (86) commercially exploited trees were identified as threatened, ranging from the Vulnerable to the Critically Endangered categories. The theory of small and declining population paradigms were found to be of relevance in explaining the processes. Nine tree species such as *Triplochiton* spp., *Baillonella toxisperma*, *Pogaoleosa*, *Anopyxis* spp. among others were considered to require urgent conservation attention. Recommendations are proposed to halt the process of decline in the biodiversity of exploited trees.

Keywords

Threat status, Commercial, IUCN, Exploited Trees, Endangered, Vulnerable, Threatened Species, Extinction

1. Introduction

The speed of loss of natural habitats at global and local levels makes it necessary to acquire information on

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which species exist and where they are (Glowka et al., 1994; Thogmartin, 2010). As the number of threatened species increases globally due to wide scale decimation of habitats and ecosystems (Whittaker et al., 2005; Nelson et al., 2010; 5 Eggers et al., 2010; Martorell et al., 2009), the identification and monitoring of species under threat in order to make effective conservation plan becomes critical (Stork et al., 1995; Joseph et al., 2009; Gavin et al., 2010; Underwood et al., 2010).

Plant species in many parts of the world are in danger of extinction. Particularly, target species face harvesting pressure and yet little is known about the threat status of such species to document them on an individual basis (Given, 1994; Joseph et al., 2009). Forests in tropical environments are unstable and hardly maintain fixed climax species composition over long periods. They are victims of modifications by a variety of factors including human influences that result in long lasting disturbances (Bisong, 2004; Bisong et al., 2003; Nicholson et al., 2009; Lawrence et al., 2010; Wade et al., 2010). Forest resource exploitation has progressed in Cross River State in the Niger Delta Region of Nigeria without any specific thought given to the periodic monitoring and evaluation of exploited species, to determine their threats levels.

Analyses of enumeration data of pre-exploitation trees in the forest of Cross River State documented in 1930 (Hall et al., 1977) suggests that 31% of the species at that time are no longer listed among the exploited species in the region because they have become very rare due to over harvesting (Bisong, 1999; Bisong, 2003). The above underscores the need to identify and monitor tree species under threat from over-exploitation in the region as a basis for developing a conservation and management plan.

The Red Data Books (RDBs) compiled by IUCN are a global database of threatened species intended to serve as basis of setting conservation priorities. RDB is based on a quantitative threshold used to categorize species at various levels of threat status. This has been criticized as being too quantitative, with the numerical rankings too specific for the vast number of rare and potentially threatened species (Miller et al., 1995b). In addition, the cost of quantitatively determining species status could constrain most developing countries' ability to protect their wild flora and fauna. Many species are therefore in fact considered threatened but are unlisted because little information exists concerning them (Miller et al., 1995a; Lawrence & Marshall, 1997). The more critical pattern for local level threat analysis is that the IUCN's criteria may only be appropriately applied for whole taxa at global scales and is unsuitable at national and local levels (Rylands et al., 1995). The need for flexible approaches in determining regional and local estimates of species threat status for national and sub-national territories has therefore become obvious, particularly for prime forest conservation areas. Adapting this criterion to suit regional or county level analysis of threat is also important.

This study integrates a suite of techniques combined with local inventory data and Tree Felled Analysis (TFA) report to determine the threat status of commercially exploited trees in the forest estates of Cross River State. The application of TFA report makes possible the utilization of aspects of IUCN's criteria combined with existing inventory data, aided by computer algorithms to determine threat status for commercially exploited trees of south eastern Nigeria.

1.1. Objective of Study

The study therefore examines the threat levels of commercially exploited tree species in the Forest Estates of Cross River State, South-Eastern Nigeria.

The specific objective of this study is to:

- 1) To identify tree species under threat and categorize according to key factors of threat.
- 2) To determine the rate at which currently exploited tree species are slipping into extinction and the time it takes for the stock of exploited trees to fall within threat categories.

1.2. Regional Setting

Cross River State in the Niger Delta region and South-South Geopolitical zone of Nigeria is a region with the greatest biodiversity concentration in the country. Although occupying just 2.4% of the of the country's total land surface of 923,850 km², its national forest covers 924,957 ha (Forest Resources Study, 1999), and represents a sizeable 31% of the total remaining Tropical Moist Forest in Nigeria (FDD 1994). The area lies between latitude 4°25'E and 7°00'E and longitude 7°45'N and 9°20'N. The area is considerably diverse with 205 species are endemic to the region, making it one of Africa's biodiversity "hot spots". The region is home to West Africa's only population of western lowland gorillas. Forest Cover Statistics derived from recent satellite images

for the region show a high rate of forest cover loss. The total deforested area increased by 22.5% for areas outside the Cross River National Park, between 1991 and 2001, while degraded and fragmented forest increased by an astronomic 522% (Flasse et al., 2002; Dunn et al., 1994). Much of the cause of forest degradation was of timber exploitation by individuals and concessionaires. Presently, about eighty-six timber species are documented as exploitable species in the region, and much of these without any specific regeneration and conservation plan.

2. The IUCN's Criteria

This assigns threat categories hinged on five main criteria, determined by different quantitative thresholds for each category. The criteria include: Population and habitat decline, Habitat area, Population fragmentation or isolation, Population size, and Population viability analysis (PVA). Aspects of the IUCN's Criteria as applicable to the study are provided in the methodology.

While it is acknowledged that calculating extinction risk from the IUCN criteria yields more accurate predications due to its reliance on data based on species number, insufficient information for most taxa is considered a major limitation in applying the approach to regional estimates of extinction rate. (Flasse et al., 2002) asserts that IUCN criteria originally designed to evaluate risk of species extinction at global scales had often produced incorrect assessment when applied to regional subpopulations. The adduced reasons are that sub global population, that is, a continent, country or sub national territory in naturally sub divided biological populations into smaller and restricted sub populations. Since smaller populations have higher extinction risks than larger ones, artificially delineated sub populations may be assessed to have higher risk of extinction than normally would. Regional guidelines have been developed by IUCN to obviate these problems by factoring into the extinction calculus the effect that sub populations outside a region has on the likelihood of extinction in the region being assessed. The guidelines provide for a two phased process and entails: 1) application of IUCN criteria to regional populations as if they are completely isolated, and tentative category assigned; 2) factoring in the effect of populations in neighbouring regions and tentative categories upgraded or downgraded as appropriate (IUCN, 2003). (Given, 1994) however, suggests that threat categories can be applied to entities with reference to any predefined area as large or small as one may desire. A plant may therefore be classed in different threat categories with respect to any area under consideration, such that a species, considered extinct in one place may be endangered in another country and rare in another. The framework provided by IUCN for threat assessment remains the most reliable and robust despite criticism.

3. Method

3.1. Criteria for Determining Threat Status

Methodology for determining threat status of a taxon was derived from both the IUCN's criteria version 2.3. By applying the IUCN's criteria, species were first listed as Critically Endangered (CR), Endangered (EN), or Vulnerable (VU). The Study utilized IUCN's Criteria—A, C and D for assigning species into threat categories based largely on population reduction considerations.

Criteria A: Species are Critically Endangered if 80% reduction in population is observed, inferred or suspected to occur over the last 10 years (A1); or if a reduction of 80%, is projected or suspected within the next 10 years (A2). They are considered Endangered if 50% reduction in population is observed inferred or suspected to occur in past 10 years (A1) or if a reduction of 50% is projected within the next 10 years (A2). Species are classified as Vulnerable if 20% reductions have occurred over the last 10 years (A1), or 20% reduction is projected or suspected to be within the next 10 years (A2). **Table 1** outlines the threat levels based on Criteria A.

Criteria C: Species are Critically Endangered if the population is estimated to number less than 250 mature individuals, plus a continuing decline of at least 25% within three years. Populations are Endangered if they number fewer than 2500 mature individuals, plus showing continuing decline of at least 20% within 5 years (or two generations). Populations are vulnerable if estimated to number less than 10,000 mature individuals, plus an estimated continuing decline of at least 10 years.

Criteria D: Species are Critically Endangered where the population is estimated to number less than 50 mature individuals. Endangered where population is restricted to less than 250 mature individuals, and Vulnerable where population is restricted to less than 1000 mature individuals.

Each commercially exploited tree species was evaluated against the above-mentioned Criteria (A (1 & 2), C &

Table 1. Criteria for determining species threat status.

S/n	Threat Category	Description	Criteria
1	Critically Endangered (CR)	80% reduction in population observed inferred or suspected to occur over last 10 years	A1
		80% reduction in species population projected to occur within next 10 years	A2
2	Endangered (EN)	50% reduction in population observed inferred or suspected to occur over last 10 years	A1
		50% reduction in species population projected to occur within next 10 years	A2
3	Vulnerable (VU)	20% reduction in population observed inferred or suspected to occur over last 10 years	A1
		20% reduction in species population projected to occur with next 10 years	A2

D) and their Threat category assigned when any of the listed criteria was met, with an indication of the specific criterion. “All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for vulnerable. They are all regarded as threatened”.

The population size of a species is used in reference to the number of mature individuals only, while in turn refers to the numbers known, estimated or inferred to be capable of reproduction. In the context of this study, mature trees are those with a diameter at breast high (DBH) > 90 cm. Population reductions are expressed as the percentage decline in the number of mature individuals within the amount (%) stated time frame, while continuing decline is a recent, current or projected future decline from unknown cause or causes not adequately controlled, and liable to continue except when mitigation measures are adopted (Miller et al., 1995a; Barbault et al., 1995; Chittaro et al., 2010; Deb et al., 2011; Frankel et al., 1998).

3.2. Data Source/Collection Methods

The data set used to evaluate the species against the IUCN’s criteria are the actual/projected levels of tree species exploitation, the population size and density of the species (relating to their abundance), the habitat defining species range, and the level of change in species stocking. Population size estimates of species were derived from the density per hectare of mature tree stands multiplied by the size of total habitat area derived from forest inventory data of Cross River State (Dunn et al. 1994).

The actual level of species exploitation was derived from the Tree Felled Analysis data, which reports monthly the number and volume (m^3) of timber trees felled by species type across the ecological zones in the study region from 1990 to 2004. Apart from showing change in the magnitude to which species are being exploited, it helps forecast future exploitation, which consequently highlights the rate at which the stock of exploited trees is tending towards extinction. Variables such as geographic range, population size, density, exploitation pressure and reproductive success were derived from the Inventory and Tree Felled Analysis data. Reproductive success of the tree species was estimated from density per hectare of juvenile trees (10 cm - 29 cm dbh) (Dunn et al. 1994).

3.3. Sampling

The Inventory data was restricted to trees larger than 10 cm diameter on systematically laid down 2 ha Temporary Sample Plot (PSP) at the corner of every block of 20 km^2 . A total of 130 plots were sampled, 118 plots in the high forest, and 12 plots in the swamp forest (Forest Resources Study, 1999). Tree Felled Analysis data reports include felled trees by species type, number, and volume (m^3) from 23 forest charges and sub-charges across all major ecozones and covering all forestry estates in the study region outside the Cross River National park. They were again re-organized into ecozones based on geography and the bioclimatic characteristics of the region.

3.4. Data Analysis

The first step in the data analysis chain is a linear trend analysis of the exploitation data (Tree Felled Analysis) to determine the level to which the present population of trees stocking may reduce over stipulated time frame proposed by IUCN Criteria A2 and C. To assign threat category on the basis of IUCN criteria for A1 and D, the total number of trees felled over the last ten years was deducted from the population size of trees at the base year to determine whether the percentage reduction met with IUCN criteria for the category.

The threat status for the tax on was thus determined on IUCN's Criteria A (1 & 2), C and D. The data sets were subjected to various kinds of arithmetic manipulations using (Microsoft Excel). Various algorithms were thus written on the spreadsheet cells on the basis of the logic provided by the IUCN criteria, which determined species threat category on the basis of projected population reduction estimates (Criteria A2 and C) and previous exploitation levels (Criteria A1 and D).

The Algorithms applied a series of arithmetic manipulations to the data set operationalized by the use of "AND" and "OR" spreadsheet functions using Microsoft Excel Software in a complex nested logical algorithms to identify data that met the IUCN Criteria

3.5. Arithmetic Procedures for Criteria A (1 & 2)

To determine species threat category hinged on Criteria A1 on the basis of population reduction estimates for previous exploitation (see [Table 1](#)), the following arithmetic manipulations were applied to the data set dealing with exploitation records between 1990 and 2004. The procedures entailed a sum of the yearly value of number of trees felled or exploited within last 10 years i.e. from 1995 to 2004.

$$\text{Red 10 yrs\%} = \text{Exploitation between 1995 and 2004} \times 100 / \text{Pop 95} = \text{Red 10yrs} / \text{Pop95}$$

where:

Red 10 yrs% = Percentage reduction in the population of trees exploited in past 10 years

Red 10 yrs (reduction over past 10 years) = Pop 95 – Pop 2004

Pop 95 = Pop 1990 – Pop 95 (Base year Population at 1990 – Sum of exploitation up to 1995)

Pop 90 = base year population of trees in 1990

Pop 2004 = base year population – Sum of exploitation up to 2004

For the species threat category using Criterion A2, based on a projected reduction strategy in the population of species to occur within the next ten years ([Table 1](#)). A sum up of the yearly value of trees projected or suspected to be exploited from 2005 up to 2015 was made. The arithmetic procedures include:

Projected Population = Pop 2005 – Pop 2015

Base Year = Base Yr Pop (1990) – Exploitation Base Year 2015

Pop 2005 = Already Known

Projected Reduction = Pop 2005 – Pop 2015

Projected (%) Reduction = Projected / Pop 2005 \times 100

The output of trend analysis and population reduction estimates based on IUCN Criteria A1 & 2 and C applied on the tree species population and level of exploitation data reduces the bewildering list of commercially exploited tree species to a revised of the most threatened species, as well as providing vital information for conservation planning.

The list of threatened species (Vulnerable to Critically Endangered on the IUCN's criteria) was rescored for a range of factors such as geographic range, commercial value, social utility, keystone characteristics, threat status and taxonomic distinctiveness to determine their conservation priority rating. These scores were summed and to a percentage index score to give an overall as well as group rating in order to guide conservation planning of exploited tree species in the region. Species scoring $\geq 60\%$ on the overall scale were accorded high conservation priority status.

4. Result

4.1. Threat Status of Commercially Exploited Trees of Cross River State

Criteria A (1 & 2)

IUCN Criteria A (1 & 2) were based on a population reduction estimates of species from previous exploitation in past ten years (A1) and projected decline in species population within next ten years (A2). To determine species threat status on the basis of these criteria, exploitation records (1990-2004) of eighty-six (86) commercially exploited trees were obtained from the Cross River State Forestry Commission. From these records, projected

levels of future exploitation (2005-2015) were derived. Both past and projected levels in the population of trees exploited.

The algorithms provided in the method section based on IUCN Criteria A1 & 2 were applied to the data sets. The results obtained. The species that met the critical value for threat category with respect to IUCN's Criteria A1 & 2, namely "Critically Endangered" (CR), "Endangered" (EN) and "Vulnerable" (VU) are shown in [Table 2](#).

The table information reveals that twenty-eight tree species, representing 32 percent of the eighty-six commercially exploited timber species in Cross River State are threatened. On the basis of A1 Criteria, 8 percent (7) of these species are Critically Endangered with greater than 80% reduction in their population in past 10 years, 3 percent (3) are Endangered with 50 to <80% reduction in their population in last 10 years, and 13 percent (11) are Vulnerable having experienced between 20 to <50% reduction in their population. Based on Criterion A2 however, 19 percent (16) of these species are "Critically Endangered" having been projected to decline by >80% in their population within the next 10 years, 2 percent (2) are Endangered with a projected reduction of between 50 to <80% within the next 10 years, and 12 percent (14) are Vulnerable being anticipated to face between 20 to <50% reduction in their population within the next 10 years. It is important to note that many species listed as Critically Endangered (i.e. estimated to have suffered or projected to suffer between 80% - 90% reduction in past or future population stocks) do in fact face near extinction possibilities as they are listed to suffer population decline far in excess of IUCN's threshold of 90%. The algorithms used assigned species with $\geq 90\%$ reduction in past or projected population to threat category of "Near Extinct". All such are however numbered as Critically Endangered.

In [Table 3](#) a few worked examples are presented to show how the criteria for estimating threats were applied. The arithmetic manipulations used to determine past (10 yrs) and future (10 yrs) estimates of reduction in species population are provided in the Table footnote.

The critical columns in the table are:

- 1) Red 10yrs 1995 to 2007 (7) = Reduction in past ten year from 1995 to 2005
- 2) Red 10 yrs 2005 to 2015 (g) = Reduction projected for next ten years from 2005 to 2015
- 3) Past Red% (9) = % of past reduction (past 10 years)
- 4) Proj Red% = % projected Reduction (next 10 years)
- 1) Red_10 yrs_95 to 2005 (7) = Reduction in past ten years from 1995 to 2005.
- 2) Red_10 yrs_2005 to 2015 (8) = Reduction projected for next ten years from 2005 to 2015.
- 3) Past_Red% (9) = % of past reduction (past 10 years).
- 4) Proj_Red% (10) = % of Projected Reduction (next 10 years).

The percentage population reduction estimates given in columns 9 and 10 of the table provides the guide to assigning threat category to species on the basis of IUCN's Criteria A1 and A2 respectively. Using [Table 1](#) information as framework, species are thus assigned to their threat classes as shown in columns 11 and 12 of [Table 3](#).

Table information clearly shows that *Afzelia*, the first listed species is for example endangered on Criteria A2 as 52% of its population is projected to decline within the next ten years (i.e. 2005 to 2015). It is however vulnerable on criteria A1 having experienced 22% reduction in its population in past 10 years.

Further highlight from [Table 3](#) reveals that four of the species, namely, *Amphimas* spp.; *Alstonia* spp.; *Berlinia confusa* and *Brachystegia* spp. are listed as not threatened as they fall short of any of the IUCN criteria set on the basis of population reduction (A1 & 2), while six of the species come under various threat categories from the Critically Endangered and or Near Extinction possibilities (Criterion A2), as for *Anopyxis* and *Bombax* spp. respectively, to Endangered (Criterion A2) for *Afzelia* and *Baillonella* species, and Vulnerable on (Criteria A1 & 2) as in *Antiaris africana* and *Araliopsis yauxil*.

4.2. Threat Status of Species on Criteria C and D

Criterion C is built around species attaining specific population thresholds or minima plus a continued decline in a given proportion of the population over specific time frames (see Method). The application of the algorithms on Criterion D is on the other hand simply straight-forward with species, considered "Critically Endangered", "Endangered" and "Vulnerable" if present population is estimated to number less than 50,250 and 1000 mature individuals respectively.

Table 2. Threatened plants and threat status of commercially exploited trees in Cross River State (IUCN Criteria A1 & 2).

S/N	Species	Past_Red% (Past 10 Yrs) A1	Proj_Red% (Next 10 Yrs) A2	Threat Status on A1	Threat Status on A2
1	<i>Azelia</i> spp.	22%	52%	Vulnerable	Endangered
2	<i>Anopyxis</i> spp.	35%	82%	Vulnerable	Critically Endangered
3	<i>Antiaris africana</i>	14%	26%	No Threat	Vulnerable
4	<i>Araliopsis soyauxii</i>	26%	23%	Vulnerable	Vulnerable
5	<i>Baillonealla</i> spp.	22%	56%	Vulnerable	Endangered
6	<i>Baphia</i> spp.	7%	38%	No Threat	Vulnerable
7	<i>Bombax</i> spp.	42%	227%	Vulnerable	Near Extinct (CR)
8	<i>Diospyros</i> spp.	325%	-167%	Near Extinct (CR)	Near Extinct (CR)
9	<i>Drypetes</i> spp.	70%	141%	Endangered	Near Extinct (CR)
10	<i>Entandrophragma</i> spp.	89%	1541%	Critically Endangered	Near Extinct (CR)
11	<i>Guarea thompsonii</i>	90%	1297%	Critically Endangered	Near Extinct (CR)
12	<i>Khaya ivorensis</i>	48%	432%	Vulnerable	Near Extinct (CR)
13	<i>Lannea</i> spp.	11%	21%	No Threat	Vulnerable
14	<i>Lophira lanceolata</i>	44%	120%	Vulnerable	Near Extinct (CR)
15	<i>Lovoa trichilioides</i>	784%	-187%	Near Extinct (CR)	Near Extinct (CR)
16	<i>Mammea africana</i>	25%	28%	Vulnerable	Vulnerable
17	<i>Milicia excels</i>	31%	101%	Vulnerable	Near Extinct (CR)
18	<i>Mitragyna</i> spp.	131%	-394%	Near Extinct (CR)	Near Extinct (CR)
19	<i>Nauclea</i> spp.	16%	32%	No Threat	Vulnerable
20	<i>Oxystigma manii</i>	150%	-665%	Near Extinct (CR)	Near Extinct (CR)
21	<i>Parinari</i> spp.	17%	28%	No Threat	Vulnerable
22	<i>Piptadeniastrum</i> spp.	13%	21%	No Threat	Vulnerable
23	<i>Poga oleosa</i>	32%	40%	Vulnerable	Vulnerable
24	<i>Pterygota</i> spp.	66%	222%	Endangered	Near Extinct (CR)
25	<i>Staudtia stipitata</i>	2446%	-101%	Near Extinct (CR)	Near Extinct (CR)
26	<i>Sterculia oblongata</i>	13%	30%	No Threat	Vulnerable
27	<i>Symphonia</i> spp.	52%	99%	Endangered	Critically Endangered
28	<i>Triplochiton</i> spp.	39%	104%	Vulnerable	Near Extinct (CR)

Key: Past_Red% = % Past reduction; Proj_red% = % of projected reduction. **Source:** Author's Computation.

The arithmetic manipulations and algorithms designed for Criteria C and D (see method section) were applied to the data set to determine species threatened under Criterion C. The result shows that only three species *Khaya ivorensis*, *Lovoa trichilioides* and *Oxystigma manii* attained various threat categories on Criterion C, while thirteen (13) species attained threat conditions on Criterion D.

A careful observation of the data reveals that *Khaya* spp. might attain a Critically Endangered threat status on Criterion C between 2012 and 2015 where it would have attained a continued decline of no less than 25% in its population within 3 years (CD3 column), in addition to having been reduced to a population size of less than 250 individuals (present population column). Similarly, *Lovoa* spp. will be Critically Endangered between 2003 and 2005, while *Oxystigma* spp. would have attained a Critically Endangered status between 2012 and 2015.

The Thirteen (13) species threatened on IUCN's criteria D are shown in Table 4. Five of these species are Critically Endangered, with present population sizes numbering less than 50 mature individuals, Two (2) are Endangered with population sizes estimated to number less than 250 mature individuals, while (5) are vulnerable with population numbering less than 1000 mature individuals. The list of all threatened species with respect to all criteria utilized on the IUCN scale is shown in Table 5.

Table 5 clearly shows that of the twenty eight (28) threatened species, all are confirmed to be threatened in one or more of the threat category on Criterion A2, twenty one (21) attained threat status on Criteria A1, three (3)

Table 3. Estimating threats for selected species on Criteria A1 & 2.

	1	2	3	4	5	6	7	8	9	10	11	12
Species	Exp_B Y to 95	Exp_BY to 2005	Exp_BY to 2015	Pop 95	Pop 2005	Pop 2015	Red_10 yrs_95 to 2005	Red_10 yrs_ 2005 to 2015	Past_ Red%	Proj_ red%	Threat Status A1 (Past 10 Yrs)	Threat Status A2 (Next 10 Yrs)
<i>Afzelia</i> spp.	150	2900	7890	12367	9617	4628	2750	4990	22%	52%	Vulnerable	Endangered
<i>Amphimas</i> spp.	440	1964	3968	33159	31635	29631	1524	2004	5%	6%	No Threat	No Threat
<i>Antiaris africana</i>	90	1652	4133	11110	9548	7067	1562	2481	14%	26%	No Threat	Vulnerable
<i>Alstonia</i> spp.	90	880	2551	11110	10320	8648	790	1671	7%	16%	No Threat	No Threat
<i>Araliopsis soyauxil</i>	212	846	1252	2423	1789	1383	634	406	26%	23%	Vulnerable	Vulnerable
<i>Anopyxis</i> spp.	94	528	1175	1224	790	143	434	647	35%	82%	Vulnerable	Critically Endangered
<i>Baillonealla</i> spp.	610	3246	8456	11907	9271	4061	2636	5210	22%	56%	Vulnerable	Endangered
<i>Berlinea confusa</i>	144	900	2415	24890	24134	22619	756	1515	3%	6%	No Threat	No Threat
<i>Bombax</i> spp.	54	1812	7421	4228	2470	−3139	1758	5609	42%	227%	Vulnerable	Near Extinct
<i>Brachystegia</i> spp.	4126	12516	22477	223489	215099	205138	8390	9961	4%	5%	No Threat	No Threat

Key: Exp_By to 95 = Exploitation from Base Year to 1995; Exp_By to 2005 = Exploitation from Base Year to 2005; Exp_By to 2015 = Exploitation from Base Year to 2015; Pop 2005 = Population at 1995; Pop 2005 = Population at 2005; Pop 2015 = Population at 2015. Red_10 yrs_95 to 2005 = Reduction in Past Ten Year From 2005 to 2015; % Past_Red = % of Past Reduction; % Projected = % of Projected Reduction. **Source:** Author's Computation.

Table 4. Threatened species using IUCN Criterion D.

S/n	Species	Base Year Pop (1990)	qty Exploited	Exploitation to Date	Present Population (2005)	Threat Status D
1	<i>Anopyxis</i> spp.	1317.6	54	528	790	Vulnerable
2	<i>Diospyros</i> spp.	1317.6	195	2567	−1249	Critical
3	<i>Drypetes</i> spp.	800	36	623	177	Endangered
4	<i>Entandrophragma</i> spp.	6917.4	766	6294	623	Vulnerable
5	<i>Guarea thompsonii</i>	1317.6	117	1212	106	Endangered
6	<i>Lophira lanceolata</i>	1317.6	67	649	669	Vulnerable
7	<i>Lovoa trichilioides</i>	1317.6	490	4502	−3184	Critical
8	<i>Mitragyna</i> spp.	1317.6	100	1566	−248	Critical
9	<i>Oxystigma manii</i>	1317.6	227	1781	−463	Critical
10	<i>Pterygota</i> spp.	1317.6	74	958	360	Vulnerable
11	<i>Staudtia stipitata</i>	1317.6	272	4030	−2712	Critical
12	<i>Symphonia</i> spp.	1317.6	24	758	559	Vulnerable
13	<i>Triplochiton</i> spp.	1317.6	62	598	720	Vulnerable

Source: Author's Computation.

were threatened on Criterion C, and thirteen (13) on Criterion D. Criterion A2 is from the above evidently more robust as a threat predictor via a population reduction strategy on the IUCN's criteria.

5. Discussion

Analysis of information in [Table 2](#) reveals that species threat status fulfils at least three (A, C and D) of the IUCN criteria of threatened species, one of which is sufficient to ensure a listing in the threat category. While Criteria A1 highlights vulnerability to be predicated on a significant reduction in the population of species within the last 10 years, Criteria A2 forecasts or projects significant reduction in species population within the next 10

Table 5. Threatened plants and threat status of commercially exploited trees in Cross-River State (for IUCN's Criteria A1 & 2) C & D.

S/N	Species	Threat Status on A1	Threat Status on A2	Threat Status on D	Threat Status on D
1	<i>Azela</i> spp.	Vulnerable	Endangered	-	Vulnerable
2	<i>Anopyxis</i> spp.	Vulnerable	Critically Endangered	-	-
3	<i>Antiaris africana</i>	-	Vulnerable	-	-
4	<i>Araliopsis soyauxii</i>	Vulnerable	Vulnerable	-	-
5	<i>Baillonealla</i> spp.	Vulnerable	Endangered	-	-
6	<i>Baphia</i> spp.	-	Vulnerable	-	-
7	<i>Bombax</i> spp.	Vulnerable	Near Extinct (CR)	-	-
8	<i>Diospyros</i> spp.	Near Extinct (CR)	Near Extinct (CR)	-	-
9	<i>Drypetes</i> spp.	Endangered	Near Extinct (CR)	-	Endangered
10	<i>Entandrophragma</i> spp.	Critically Endangered	Near Extinct (CR)	-	Vulnerable
11	<i>Guarea thompsonii</i>	Critically Endangered	Near Extinct (CR)	-	Endangered
12	<i>Khaya ivorensis</i>	Vulnerable	Near Extinct (CR)	Critically Endangered	-
13	<i>Lannea</i> spp.	-	Vulnerable	-	-
14	<i>Lophira lanceolata</i>	Vulnerable	Near Extinct (CR)	-	Vulnerable
15	<i>Lovoa trichilioides</i>	Near Extinct (CR)	Near Extinct (CR)	Critically Endangered	Critically Endangered
16	<i>Mammea africana</i>	Vulnerable	Vulnerable	-	-
17	<i>Milicia excels</i>	Vulnerable	Near Extinct (CR)	-	-
18	<i>Mitragyna</i> spp.	Near Extinct (CR)	Near Extinct (CR)	-	Critically Endangered
19	<i>Nauclea</i> spp.	-	Vulnerable	-	-
20	<i>Oxystigma manii</i>	Near Extinct (CR)	Near Extinct (CR)	Critically Endangered	Critically Endangered
21	<i>Parinari</i> spp.	-	Vulnerable	-	-
22	<i>Piptadeniastrum</i> spp.	-	Vulnerable	-	-
23	<i>Poga oleosa</i>	Vulnerable	Vulnerable	-	-
24	<i>Pterygota</i> spp.	Endangered	Near Extinct (CR)	-	Vulnerable
25	<i>Staudtia stipitata</i>	Near Extinct (CR)	Near Extinct (CR)	-	Critically Endangered
26	<i>Sterculia oblongata</i>	-	Vulnerable	-	-
27	<i>Symphonia</i> spp.	Endangered	Critically Endangered	-	Vulnerable
28	<i>Triplochiton</i> spp.	Vulnerable	Near Extinct (CR)	-	Vulnerable

Key: “-” means no threat under given criteria; **Source:** Author's Computation.

years to warrant categorization into a threat class.

The fulfilment of Criteria C and D on the other hand is established on the basis of the threshold size of species population. The fulfilment of the indicated criteria in the establishment of threat categories justifies the relevance and applicability of the theory of small and declining population paradigms in highlighting species threat status. Criteria A1 and A2 give a powerful indicator of the cause of smallness as expounded by the declining population paradigm. In this case, the excessive rate of species exploitation beyond replaceable limits is the major cause of biodiversity decline in trees species population in Cross River State. Twelve out of twenty-eight species fulfilling criteria A2 (see [Table 2](#)), for instance, show the rate of decline projected to occur within the next 10 year to be far in excess of 100%, clearly signalling likely hood of extinction within the given time frame if present exploitation rate continues.

The fulfilment of Criteria C and D clearly implies that processes that the effects of smallness will begin to operate on the persistence of a population unless strong mitigation measures are introduced. Six of the eight species in the high threat category were listed as critically Endangered and/or facing Near Extinction possibilities in the IUCN criteria. The IUCN's criteria on population reduction do help to pinpoint the rate at which species are slipping into extinction. It could also come handy as a fallback threat estimator where vital population data of species are unavailable. Its strongest point remains its multidimensional approach to species threat assessment as well as its being amenable to both qualitative and quantitatively derived data.

6. Conclusion & Recommendations

The conclusion to be made from the above is that a great number of the commercially exploited timber species are slipping into extinction due to over-harvesting. The most vulnerable species with respect to extinction possibilities have been indicated. Strong mitigative measures are required to halt the process of decline in the number of commercially exploited trees. The information presented and analysis made could serve as a frame of reference to guide a proper assessment of the situation by the authorities responsible for forest management and conservation. Urgent steps must be taken to protect the most vulnerable species in accordance with biological and socio-economic imperatives.

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