Journal for Nature Conservation 55 (2020) 125821

Contents lists available at ScienceDirect

Journal for Nature Conservation

journal homepage: www.elsevier.com/locate/jnc

Endangered species account for 10% of Brazil's documented timber trade

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ARTICLE INFO

Keywords:
Endangered species
Environmental legislation
Protected species
Timber trade
Timber traffic
Wood transport

ABSTRACT

Federally listed endangered plant species have restrictions regulating their extraction and transit in Brazil. However, dozens of endangered species are important for the national timber trade. The present research addresses the question: What endangered tree species were legally traded as timber in Brazil between 2012–2016 and how significant is this trade with respect to the total volume of timber? To answer this question, we surveyed wood taxa and wood volume transported during this period as recorded by the National System for the Environment (SISNAMA). Under Brazil's federal environmental law (L12651 Art. 35) Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) is responsible for the registration of all commercial forest products. The law stipulates that products receive a Document of Forest Origin (DOF) indicating species, quantity, commercial use, origin, and destination. We correlated this data with the federal list of endangered plant species in Brazil to aggregate the number of endangered species transported from 2012 to 2016 and the total volume associated with each species. Among the 2214 species traded, we found 38 endangered species, comprising a volume of 6 million m^3, representing approximately ten percent of the total traffic of 60.9 million m^3. The endangered species *Araucaria angustifolia* (Bertol.) Kuntze and *Mezilaurus itauba* (Meisn.) Taub. Ex Mez were among the twenty species with greatest volume transported and traded, respectively 3.2 million m^3 and 789,522 m^3. The presence of these endangered species at the top of the list of woods transported within the national territory raises serious questions for conservation policy and practices in Brazil. Monitoring changes in deforestation rates inadequately assesses the impacts of timber harvesting on endangered native tree species. The information provided by this study should be of interest to national and international environmental agencies, international trade control agencies, conservation biologists, researchers and policymakers working to produce more effective control of harvest and trade of endangered species.

1. Introduction

Brazil has the world's richest flora. Of 46,629 species catalogued 8304 are trees (BFG, 2015; Flora do Brasil 2020 em construção, 2018; Forzza et al., 2012). Tree species are distributed in six biomes (Mata Atlântica, Amazônia, Cerrado, Caatinga, Pampa e Pantanal), two hotspots, and across several vegetation types, including ombrophilous, semideciduous and deciduous forests (BFG, 2015; Flora do Brasil 2020 em construção, 2018; Forzza et al., 2012; Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000). Globally, tropical forests are being lost to the expansion of plantations, pastures, and logging. The social and environmental consequences of deforestation include significant losses in biodiversity, environmental degradation, changes to regional and global climate patterns, and the violent displacement of traditional communities (Contreras-Hermosilla, Doornbosch, & Lodge, 2007; Keenan et al., 2015). From 2012–2015, despite a decrease in deforestation in the main Brazilian forest biomes, Brazil's national deforestation rates continued to be among the highest in the world. Deforestation spiked again in 2016 and has remained high. In 2018, 694,700 ha of native forests were lost in the Amazon basin, 12,562 ha in the Atlantic Forest and 740,791 ha in the Cerrado (INPE, 2018a, 2018b; Keenan et al., 2015; SOS Mata Atlântica & INPE, 2018). From 2010–2015 Brazil had the greatest annual net loss of forest globally (FAO, 2016).

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https://doi.org/10.1016/j.jnc.2020.125821
Received 31 May 2019; Received in revised form 8 December 2019; Accepted 20 March 2020
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Commercial logging and industrial forestry are the primary causes of deforestation and frequently utilize practices that violate environmental legislation designed to prevent over- harvesting (de Cabral, 2014; de Cabral & Cesco, 2008; Contreras-Hermosilla et al., 2007; Dean, 1996; Noguerón, Cheung, Mason, & Li, 2018). Furthermore, timber extraction is historically linked to the long-term conversion of forestlands to pasture and plantations in all of Brazils major forested biomes (de Cabral, 2014; Dean, 1996; Oliveira & Hecht, 2016; Wellesley, 2014). Timber production accounts for about 1% of the world's GDP and 3% of all international trade (Contreras-Hermosilla et al., 2007). In Brazil, wood is an important commercial product and represents a considerable portion of the country's GDP (3–4 %) (Sociedade Brasileira de Silvicultura, 2008).

The overexploitation of forest resources, threatens forest biodiversity, the viability of many endangered species, and forest ecological interactions. In this context, endangered species lists are created to inform political decisions towards limiting exploitation and setting priorities for species conservation, and legislating the protection of threatened species (Martinelli & Moraes, 2013; Possingham et al., 2002). The current "Official List of Brazilian Flora Species Threatened with Extinction" was expanded by the Environmental Ministry (MMA, acronym in Portuguese) and published in 2014 (Brasil, 2014). The "Red Book of the Brazilian Flora" was used to support the last updated red list, and includes details on the criteria to evaluate the threats to Brazilian flora (Martinelli & Moraes, 2013). The current list comprises 2113 species, including trees, shrubs, herbs and vines. These species are fully protected: collection, harvest, transport, possession, management, processing and trade are strictly prohibited by law (Brasil, 2014).

Timber trade regulations, bilateral agreements, public and private procurement policies, are discursively framed as international efforts to control global markets in forest products and minimize harm to forest ecologies and biodiversity. However, the effectiveness of such treaties and policies is clearly compromised by lack of compliance and limited ability to effectively evaluate changes in biodiversity. Wood is often transported or processed in direct disobedience of local, national, and international laws (Noguerón et al., 2018). Perhaps more concerning are how inconsistencies between treaties produced at the local, national, and international levels provide legal loopholes for traffickers of endangered tree species to continue under the cover of law. Brazil established commercial operations trading native woods with 160 countries between 2006 and 2012 (Fanzeres, 2014), and endangered species are present in international operations (Ferriss, 2014). The significant volume of trade in species known to be at risk begs the question as to whether treaties have been negotiated with adequate deliberation and consideration of all available data and indeed, whether treaties have in fact been designed to privilege conservation over other commercial interests.

The Brazilian Institute of Environment and Renewable Natural Resources (IBAMA, acronym in Portuguese), an executive agency of the National System for the Environment (SISNAMA, acronym in Portuguese), regulates the possession and transport of all commercial forest products within Brazil's national territory. The Document of Forest Origin (DOF, acronym in Portuguese) – implemented by Ordinance nº 253, of August 18, 2006 – records legal transit and registers a forest product's scientific name, popular name, volume, origin, destination and commercial use (Brasil, 2006, 2012). The DOF provides a tool for monitoring the implementation of Brazil's conservation legislation.

We surveyed the transported wood taxa and wood volume registered in the DOF during the years 2012–2016 and correlated this data with the current MMA "Official List of Brazilian Flora Species Threatened with Extinction". These comparisons were used to better understand (1) what endangered wood species are legally transported in Brazil and (2) how does this trade affect the total volume of wood transported within the Brazilian national territory.

2. Material and methods

We produced a wood species list ranked by volume transported during the period 2012–2016 using DOFs reported during the survey period (IBAMA, 2017). The DOFs register timber trade by municipality/state of origin and destination, the specie's scientific name, common name, volume, and commercial use. We calculated the transported volume of each species by year for the period 2012–2016. We excluded forest products without species name, not identifiable as wood (secondary xylem), or measured in units other than volume (including: charcoal, firewood, briquette, chip, particleboard, hardboard, fiberboard, chipboard, oriented strand board, finished product, laminated product, residue for industrial use, sheet, short girdle and products from non-timber species). We included wood products in the following categories: casing door, block, square, rafter, decking, railroad tie, unrolled lamina, weakened lamina, chips (m^3, st), lumber (rafter), lumber (board), lumber (joist), floor, slats, batten, lath, log, and stick. We correlated the list of wood species transported with the "Official List of Brazilian Flora Species Threatened with Extinction" (Brasil, 2014) to determine the list of threatened species transported legally in Brazil between 2012 and 2016, and ranked this list by total volume transported. A previous official threatened flora species list was used between 2008–2014 (Brasil, 2008) but this study used the updated and current list (Brasil, 2014). Previous research identified problems with the prior official list (Moraes et al., 2014; Scarano & Martinelli, 2010) since it included less than a quarter (471) of the endangered species registered in the updated list (2113 species).

3. Results

The DOF reported 2214 native wood species, with a total volume of 60,917,862 m^3, transported within Brazil between 2012–2016. An average of 12,183,572 m^3/year of wood was moved within the national territory. This study observed a trend where the taxa number and volume of wood transported during the period of analysis decreased during the study period (Table 1). Twenty taxa accounted for 54 % of the total wood volume transported, totaling 32,896,971 m^3. Each year, the 20 taxa with highest volumes transported accounted for 53%–58% of the total volume. Several species ranked among the 20 most transported in all the years of this study, including *Manilkara huberi*, *Goupia glabra*, *Araucaria angustifolia*, *Dinizia excelsa*, *Couratari guianensis*, *Erisma uncinatum*, and *Cariniana micrantha* (Table 1).

Thirty-eight federally listed endangered wood species were present in the DOF reports (Table 2). Seventeen of these species are listed as vulnerable, 18 are endangered and 3 are critically endangered. *Araucaria angustifolia*, *Mezilaurus itauba*, *Apuleia leiocarpa*, *Hymenolobium excelsum* and *Cedrela odorata* were the threatened species with the highest transport volumes. Of the endangered species, *Euplassa incana* and *Podocarpus brasiliensis* were the least transported during the years of the study (Table 2). Endangered species (6,056,681 m^3) represented 9.9 % of the total volume of the wood transported within Brazil (60,917,862 m^3) during the study period 2012–2016. The number of threatened taxa transported varied slightly by year, from 32 in 2012 to 38 in 2016, and consistently represented approximately 10 % of the total volume transported by year (Table 1).

A critically endangered species - *Araucaria angustifolia* - was transported most frequently (3,196,789 m^3) and represented 5.2 % of the total volume transported. It also was consistently ranked among the twenty species with the highest volumes transported during each year of the study. *Mezilaurus itauba*, a vulnerable species, was also among the twenty species with the highest transport volumes, reaching a total of 789,522 m^3. *Manilkara huberi*, which is not endangered, was the most transported species in the country during the period studied, (3,825,164 m^3), representing 6.3 % of the total legal timber trade.

Table 1
Data on legal wood species transport in Brazil from 2012 to 2016. Number of taxa, total volume (m^3), total volume of the 20 taxa with highest volume transported (m^3), percentage of the 20 taxa with highest volume transported (% 20 +), number of endangered taxa, total volume of endangered species (m^3), percentage of tree species endangered, and list of the 20 taxa with highest volume transported (descending order).

Period	2012	2013	2014	2015	2016	2012 -2016
Taxa	1,782.00	1,755.00	1,704.00	1,678.00	1,660.00	2,214.00
Volume (m^3)	12,433,732.45	14,190,944.43	12,787,793.27	11,337,809.58	10,167,582.71	60,917,862.40
Volume (m^3) 20 +	6,592,956.38	7,468,090.89	6,995,205.22	6,546,857.81	5,892,358.96	32,896,970.91
% 20 +	53.0 %	52.6 %	54.7 %	57.7 %	58.0 %	54.0 %
Endangered taxa	32	34	33	34	38	38
Endangered volume	1,320,936.57	1,373,154.39	1,359,628.33	1,157,692.84	845,269.13	6,056,681.25
% endangered	10.6 %	9.7 %	10.6 %	10.2 %	8.3 %	9.9 %
Species with highest volume	*Araucaria angustifolia*	*Goupia glabra*	*Araucaria angustifolia*	*Manilkara huberi*	*Manilkara huberi*	*Manilkara huberi*
	Manilkara huberi	*Manilkara huberi*	*Manilkara huberi*	*Goupia glabra*	*Goupia glabra*	*Goupia glabra*
	Goupia glabra	*Araucaria angustifolia*	*Goupia glabra*	*Araucaria angustifolia*	*Dinizia excelsa*	*Araucaria angustifolia*
	Dinizia excelsa	*Dinizia excelsa*	*Couratari guianensis*	*Couratari guianensis*	*Couratari guianensis*	*Dinizia excelsa*
	Qualea spp.	*Couratari guianensis*	*Dinizia excelsa*	*Dinizia excelsa*	*Erisma uncinatum*	*Couratari guianensis*
	Couratari guianensis	*Erisma uncinatum*	*Erisma uncinatum*	*Erisma uncinatum*	*Araucaria angustifolia*	*Erisma uncinatum*
	Erisma uncinatum	*Cariniana micrantha*	*Cariniana micrantha*	*Qualea paraensis*	*Qualea paraensis*	*Cariniana micrantha*
	Cariniana micrantha	*Qualea* spp.	*Apuleia molaris*	*Cariniana micrantha*	*Cariniana micrantha*	*Apuleia molaris*
	Allantoma lineata	*Hymenolobium petraeum*	*Qualea paraensis*	*Apuleia molaris*	*Hymenolobium petraeum*	*Qualea paraensis*
	Dipteryx odorata	*Qualea paraensis*	*Hymenolobium petraeum*	*Hymenolobium petraeum*	*Dipteryx odorata*	*Hymenolobium petraeum*
	Hymenaea courbaril	*Apuleia molaris*	*Dipteryx odorata*	*Dipteryx odorata*	*Apuleia molaris*	*Dipteryx odorata*
	Apuleia molaris	*Hymenaea courbaril*	*Hymenaea courbaril*	*Allophylus edulis*	*Hymenaea courbaril*	*Hymenaea courbaril*
	Hymenolobium petraeum	*Allantoma lineata*	*Allantoma lineata*	*Hymenaea courbaril*	*Tabebuia serratifolia*	*Qualea* spp.
	Qualea paraensis	*Dipteryx odorata*	*Tabebuia serratifolia*	*Tabebuia serratifolia*	*Qualea albiflora*	*Astronium lecointei*
	Astronium lecointei	*Cedrelinga cateniformis*	*Astronium lecointei*	*Astronium lecointei*	*Astronium lecointei*	*Allantoma lineata*
	Caryocar villosum	*Astronium lecointei*	*Cedrelinga cateniformis*	*Cedrelinga cateniformis*	*Allantoma lineata*	*Tabebuia serratifolia*
	Cedrelinga cateniformis	*Caryocar villosum*	*Mezilaurus itauba*	*Mimosa caesalpiniifolia*	*Apuleia leiocarpa*	*Cedrelinga cateniformis*
	Mezilaurus itauba	*Apuleia* spp.	*Mimosa caesalpiniifolia*	*Qualea albiflora*	*Cedrelinga cateniformis*	*Mezilaurus itauba*
	Mimosa caesalpiniifolia	*Tabebuia serratifolia*	*Qualea* spp.	*Mezilaurus itauba*	*Caryocar villosum*	*Caryocar villosum*
	Apuleia spp.	*Mezilaurus itauba*	*Qualea albiflora*	*Hymenolobium excelsum*	*Mezilaurus itauba*	*Mimosa caesalpiniifolia*

4. Discussion

Despite the existence of restrictions regulating the extraction and transit of endangered woods species in Brazil, a robust and ongoing trade includes these species. Thirty-eight federally listed endangered wood species were transported within the Brazilian territory between 2012 and 2016 and represented around 10 % of all wood transported each year. Some endangered wood species being traded in Brazil are not included on international red lists. The IUCN red list of threatened species and CITES species checklist are important international tools to highlight taxa threatened with extinction, to prevent unsustainable or illegal exploitation of wild species and promote their conservation. CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between 183 countries (Parties) providing various levels of protection to numerous species affected by commercialization and trade on international markets (CITES, 2018). Just six of the Brazilian endangered species reported in the present study are covered by the CITES treaty, and only 23 by the IUCN red list (IUCN, 2018; UNEP-WCMC, 2018) (Table 2). These facts suggest that numerous species should be included in future revisions of the IUCN and CITES species lists.

Despite the high diversity of tree species found in Brazil's forests, only 20 species accounted for more than half of total volume of wood transported in Brazil. This result is supported by the findings of other research on Brazil's timber trade. Terezo and Oliveira (2002) reported that just 15 species represented 65.6 % and 64.6 % of all of the commercial wood transported in Amazônia in 1999 and 2000, respectively. Sobral, Veríssimo, Lima, Azevedo, and Smeraldi (2002) showed that 15 species represented 77 % the commercial trade in the state of São Paulo state in 2001. In the state of Mato Grosso, Ribeiro (2013) and Ribeiro et al. (2016) found 10 species represented 88 % of the total transport volume between 2004 and 2010. Some of the species with the high trading volumes reported in these studies are endangered (Nascimento, Brandes, das Brandes, Valente, & Tamaio, 2017; Ribeiro, 2013; Ribeiro et al., 2016; Sobral et al., 2002; Terezo & de Oliveira, 2002; Veríssimo, Lima, & Lentini, 2002). Based on our research, the endangered species *Araucaria angustifolia* was one of the three tree species that had the highest volume transported in Brazil and represented 5% of total wood volume.

These results suggest several crucial problems for Brazil's forest conservation policy. How have national conservation policies failed to address the documented extraction and transport of so many protected taxa? Why do protected species continue to be legally traded? And what are the ecological consequences of continuing to exploit already endangered populations? Although federal regulations prohibit the collection, transport, storage, management, processing and trade of endangered species, these restrictions are not applied under many legally recognized circumstances (Brasil, 2014). The harvest of endangered species grown for purposes of scientific or conservation research, for example, is permitted under federal law, and "sustainable management" is allowed for species classified in the vulnerable category (VU). The utilization and trade of forest products obtained from the suppression of vegetation for certain kinds of infrastructure and development is also allowed by Brazil's environmental agencies (Brasil, 1981, 2012, 2014, 2015). National environmental agencies are not sufficiently equipped to accurately verify the origin of the numerous endangered species involved in this quasi-legal timber trade. Despite numerous studies demonstrating how forest exploitation drives species' extinctions and produces ecological feedbacks where emergent environmental dynamics impede environmental recovery, Brazil's Federal government has never adequately funded conservation efforts nor closed legal loopholes impeding accurate assessments of illicit trade in endangered species (Brook, Sodhi, & Bradshaw, 2008; Laurance, Vasconcelos, & Lovejoy, 2000). Rather than address these evident

Table 2
List of federally listed endangered wood species transported as part of the timber trade within Brazilian territory between 2012 and 2016, threaten category according to MMA (Brasil, 2014), CITES (UNEP-WCMC, 2018) and IUCN (IUCN, 2018), and total species volume (m^3).

Species	MMA	CITES	IUCN	2012	2013	2014	2015	2016	Total
Araucaria angustifolia (Bertol.) Kuntze	CR		CR	808,361	769,604	739,716	567,564	311,545	3,196,789
Mezilaurus itauba (Meisn.) Taub. ex Mez	VU			149,143	160,132	172,408	161,924	145,915	789,522
Apuleia leiocarpa (Vogel) J.F.Macbr.	VU			84,343	149,250	131,036	137,649	166,386	668,664
Hymenolobium excelsum Ducke	VU			127,075	122,890	152,920	155,661	101,153	659,700
Cedrela odorata L.	VU	III	VU	48,320	52,127	58,719	57,158	46,437	262,760
Vouacapoua americana Aubl.	EN		CR	26,905	31,817	38,419	31,839	12,200	141,179
Amburana acreana (Ducke) A.C.Sm.	VU		VU	24,454	22,003	20,562	134	17,758	84,910
Hymenaea parvifolia Huber	VU		LC	7,767	12,920	12,355	16,268	15,969	65,280
Euxylophora paraensis Huber	CR			8,990	9,515	6,583	3,619	1,269	29,975
Virola surinamensis (Rol. ex Rottb.) Warb.	VU		EN	6,425	9,705	3,505	4,183	1,911	25,728
Ocotea porosa (Nees & Mart.) Barroso	EN		VU	7,004	6,332	4,758	4,064	3,021	25,179
Schinopsis balansae Engl.	EN		LC	8,200	9,267	2,641	1,601	821	22,530
Swietenia macrophylla King	VU	II/NC	VU	510	3,994	3,715	2,625	6,615	17,459
Cedrela fissilis Vell.	VU	III	VU	4,568	2,919	4,504	3,189	1,048	16,229
Cariniana legalis (Mart.) Kuntze	EN		VU	619	3,864	1,490	1,752	2,213	9,938
Tabebuia cassinoides (Lam.) DC.	EN			3,554	2,279	1,299	344	219	7,695
Bertholletia excelsa Bonpl.	VU		VU	426	55	822	470	5,310	7,083
Couratari asterotricha Prance	EN		CR	493	266	932	2,713	1,073	5,478
Eschweilera compressa (Vell.) Miers	EN		CR	1,163	1,521	1,146	644	809	5,284
Centrolobium paraense Tul.	EN			147	58	6	2,744	2,278	5,233
Ocotea odorifera (Vell.) Rohwer	EN			451	589	807	704	646	3,197
Ocotea catharinensis Mez	VU		VU	1,311	263	155	128	69	1,927
Paratecoma peroba (Record) Kuhlm.	EN			252	531	109	228	136	1,256
Couratari pyramidata (Vell.) Kunth	EN		EN		310	266	190	121	886
Pradosia kuhlmannii Toledo	EN		EN	170	486	101	21	57	834
Qualea magna Kuhlm.	EN			31	14	437	20	86	588
Terminalia acuminata (Allemão) Eichler	EN		EW	157	227	106	37	46	573
Melanoxylon brauna Schott	VU			21	154	31	9	1	215
Peltogyne maranhensis Huber ex Ducke	VU			27	34	12	50	73	196
Gleditsia amorphoides (Griseb.) Taub.	VU				3		156	22	181
Caesalpinia echinata Lam.	EN	II	EN	0	9	46	0	25	81
Dalbergia nigra (Vell.) Allemão ex Benth.	VU	I	VU	38	10	9	1	1	60
Euplassa cantareirae Sleumer	EN			4	4	4	1	12	26
Dimorphandra wilsonii Rizzini	CR		CR	7	4	11	1	0	23
Cedrela lilloi C.DC.	EN	III	EN					15	15
Quillaja brasiliensis (A.St.-Hil. & Tul.) Mart.	EN							6	6
Podocarpus brasiliensis Laubenf.	VU		LC					1	1
Euplassa incana (Klotzsch) I.M.Johnst.	VU							0	0
Total	38	6	23	1,320,937	1,373,154	1,359,628	1,157,693	845,269	6,056,681

problems, Brazil's Federal government is currently defunding and dismantling existing environmental protections and federal conservation agencies (Abessa, Famá, & Buruaem, 2019; Pereira et al., 2019; Viola & Gonçalves, 2019).

The Brazilian Institute of Geography and Statistics (IBGE, acronym in Portuguese) provides extraction volume data due to forestry extraction operations in Brazil. Data for the extraction of whole logs (not including sawn timber) records the average harvest volume from 2012–2016 at 13,233,927 m^3/year (IBGE, 2012; 2013; 2014; 2015; 2016), which is significantly higher than our data for the same period (12,183,572 m^3/year). The IBGE research is subjective and based on interviews and survey data. The questionnaire does not provide species data, volume by species and does not ensure data precision, since the survey relies on the quantification methods used by the informant. The IBGE data is based only on whole logs, while the DOF data used in our study includes all wood products and records any legal wood movement that occurred within national territory. However, even the DOF system, does not accurately quantify total national wood production and harvest. During the period analyzed, three Brazilian states (Pará, Mato Grosso e Minas Gerais) used independent state-managed controls to estimate intrastate transport. In these states the intrastate transit information was not recorded by the IBAMA DOF system. Notwithstanding these limitations, our research data includes all interstate and intrastate transit in 23 states, revealing substantial threats to the effectiveness of national environmental protection politics.

We detected a reduction in the volume of wood transported between 2012 and 2016, as well in the volume of threatened taxa. These findings are consistent with IBGE log extraction data (IBGE, 2012; 2013; 2014; 2015; 2016) and congruent with the documented reduction in Atlantic Forest deforestation. They are not consistent however with the continued deforestation of the Amazon, Cerrado, Caatinga and Pantanal biomes (INPE, 2018a, 2018b; Miranda, Paranho Filho, & Pott, 2018, 2018; SOS Mata Atlântica, & INPE, 2018). In the Brazilian Legal Amazon (a socio-geographic division that comprehends nine states in the amazon basin), 2012 was the year with the lowest recorded rate of deforestation (4571 km^2/year). From 2012–2016 Amazonian deforestation again increased – reaching 7893 km^2/year in 2016 – but remained lower than the mean of the historical series (1988–2011, 16,341 km^2/year) (INPE, 2018a). In the Cerrado biome, 2011 and 2012 were also the years with the lowest levels of recorded deforestation (9491 km^2/year compared with the historical mean of 19,239 km^2/year, 2001–2011). During the period of our analysis, deforestation in the Cerrado fluctuated and reached its lowest rate in 2016 (6777 km^2/year) (INPE, 2018b). Public policies, law enforcement, monitoring systems, and supply chain interventions have all been shown to affecting logging and the total volume of wood transported in Brazil, with state investment and legislative restrictions consistently associated with reductions in deforestation (Nepstad et al., 2014).

There are 8304 trees presently included in inventories of Brazilian flora (Flora do Brasil 2020 em construção, 2018). Many are commercially exploited for wood use, although surveys of species transported reveal discrepancies. In the state of Mato Grosso 411 species were documented as commercialized between 2004 and 2010 (Ribeiro, 2013; Ribeiro et al., 2016). Veríssimo et al. (2002) reported 350 species

regularly harvested in the state of Pará. In the present study, the number of taxa transported (2214) represents 27 % of Brazilian tree species, a total much higher than found in prior studies. This may be explained by the fact that the DOF must be emitted in the transport of all commercial forest products within Brazil's national territory.

Some taxa are registered in the DOF system at only the genus level, for example: *Apuleia* spp, *Hymenolobium* spp and *Hymenaea* spp. Since threatened species belong to these genera regulatory agencies should require identification at the species level. Our data reveals that environmental agencies are using scientific names presently synonymous with threatened species, many of which are highly commercialized (Brasil, 2014; Flora do Brasil 2020 em construção, 2018; IBAMA, 2017). This is particularly important since endangered species such as *Mezilaurus itauba*, *Cedrela fissilis*, *Couratari asterotricha*, *Ocotea odorifera*, *Apuleia leiocarpa*, are transported under the same names as the non-endangered species *Silvia itauba*, *Cedrela brasiliensis*, *Couratari glabra*, *Ocotea pretiosa*, and *Apuleia molaris*. Updated species nomenclature protects against this kind of illicit commercialization of endangered species under other names.

In summary, this study found that 38 federally endangered wood species legally transited in Brazil between 2012–2016 and represented around 10 % of the commercial timber trade. The information provided by the present study is highly relevant for environmental agencies and international trade control agencies, especially considering that most of the reported species are not presently protected by international treaties. It is important for environmental agencies, policymakers and conservation biologists to include these species in designing new mechanisms to reduce the trade of endangered species. Control of the commercialization of threatened species in Brazil is fundamental for national and international efforts to achieve environmental conservation (Contreras-Hermosilla et al., 2007; Kehoe, Reis, Virah-Sawmy, Balmford, & Kuemmerle, 2019; UNODC, 2016).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We are grateful to Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) for sharing the data base used for this research, the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for providing research funding, and the Universidade Federal Fluminense (UFF) and Instituto de Pesquisas Jardim Botânico do Rio de Janeiro for structural and logistic support. We also thank Christopher Lesser (University of California Berkeley - Environmental Sciences, Policy and Management) for manuscript review.

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