CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Seventeenth meeting of the Conference of the Parties
Johannesburg (South Africa), 24 September – 5 October 2016

GLOBAL STATUS OF *DALBERGIA* AND *PTEROCARPUS* ROSEWOOD PRODUCING SPECIES IN TRADE

This document has been submitted by Senegal on behalf of Global Eye, in relation to agenda items 55 on *Ebonies (*Diospyros *spp.) and palisanders and rosewoods (*Dalbergia *spp.)* and 62 on *International trade in rosewood timber species [LEGUMINOSAE (Fabaceae)]*, and amendment proposals 53, 54, 55 and 57*.

* *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat (or the United Nations Environment Programme) concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.*

GLOBAL STATUS OF DALBERGIA AND PTEROCARPUS ROSEWOOD PRODUCING SPECIES IN TRADE

FOR THE
CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
17TH CONFERENCE OF THE PARTIES – JOHANNESBURG
(24 SEPTEMBER – 5 OCTOBER 2016)

Cover Picture: Warehouse storing rosewood species in Asia for trade
(Top) *Dalbergia cochinchinensis* (Middle) *Dalbergia oliveri* (Bottom) *Pterocarpus macrocarpus*

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EXECUTIVE SUMMARY

Rosewood and other precious woods have been subject to increasing demand over the past decade, created mostly by the increasing wealth of the middle class in China, but also in Vietnam. As such, tree species that produce precious woods under the umbrella term 'rosewood' have begun to feature more prominently in discussions amongst Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). At this juncture, rosewood species in the *Dalbergia* genera are of particular concern, along with the other four genera listed on the Chinese Hongmu Standard[1] (*Pterocarpus, Cassia, Millettia and Diospyros*) which is reported to be driving much of this trade [1, 2, 3, 4].

The focus of this report is the genera *Dalbergia* and *Pterocarpus*. These two genera were chosen as they are two of the most heavily traded genera listed on the Chinese Hongmu Standard, and are difficult to differentiate once logged and turned into rough logs/sawn wood or finished products. Traditionally *Dalbergia* species have been the main target for this trade, however as these species have become less available, through stricter conservation measures and/or enforcement of logging and export bans, the trade has shifted to alternate species as replacements, particularly in the *Pterocarpus* genus. Despite the impact of regulation, existing loopholes in legislation, corruption, limited enforcement capacity and gaps in political will across the globe allow illegal traders to continue to exploit these precious resources with little to no ramifications, while the local communities and governments lose vital revenue, livelihoods and their habitats.

There have been several previous attempts to list *Dalbergia* species, and numerous other taxa, on CITES. However these attempts have often failed to be supported or have simply been withdrawn at Conferences of the Parties due to a lack of detailed information on the biology, distributions, level of trade and associated range reductions. Notably however, the Convention is specifically designed to take account of this type of uncertainty through the use of "it can be inferred or projected" that a species requires protection in order to stop international trade threatening its survival in the wild. Despite this capability, proposals are often rejected if there is not enough supporting scientific data made available to assess whether the species meets the species listing criteria laid out in Resolution Conf. 9.24 (Rev CoP16) and if so, to subsequently conduct a sufficiently robust Non Detriment Finding (NDF) once a species is listed.

Therefore the content of this report reflects the information fields required to conduct a sufficiently robust NDF (as laid out in Resolution Conf. 16.7), outlining taxonomic uncertainties, biology, population status and structure, disturbances, threats and management arrangements, in species specific detail where possible and in general country level terms if not. The purpose is to provide an in-depth overview of the range of information available on these required fields for species of *Dalbergia* and *Pterocarpus* commonly found in international trade, determine what gaps in knowledge exist, and understand how these gaps can be closed. The report also assesses the risks presented to the species by the failure to address these gaps and take appropriate action.

It is hoped that the information in this document will be of use to Parties considering a series of relevant proposals submitted to CoP17, by providing in-depth scientific information not contained the short proposals. The relevant proposals are:

- **CoP17 Proposal 53** by Thailand for *Dalbergia cochinchinensis* to Replace Annotation 5 with Annotation 4);
- **CoP17 Proposal 54** by Mexico for the listing of 13 species of *Dalbergia* on Appendix II (species include*: D. calderonii, D. calycina; D. congestiflora; D. cubilquitzensis; D. glomerata; D. longepedunculata; D. luteola; D. melanocardium; D. modesta; D. palo-escrito; D. rhachiflexa; D ruddiae; D. tucurensis*);
- **CoP17 Proposal 55** by Argentina, Brazil, Guatemala and Kenya to include the genus *Dalbergia* in CITES Appendix II except those species included in Appendix I.
- **CoP17 Proposal 57** by Benin, Burkina Faso, Chad, Côte d'Ivoire, European Union, Guinea, Guinea‑Bissau, Mali, Nigeria, Senegal and Togo to include the species *Pterocarpus erinaceus* in CITES Appendix II, without annotation

[1] A Draft revision of this standard GB/T 18107-2000 – Rosewood Hongmu, was released for comment on 10 October 2014, and does not appear to have been officially published as yet.

The above proposals have all received the endorsement of the CITES Secretariat and the Plants Committee, and were recommended to be adopted by TRAFFIC's Expert Panel [5]. Should any of the above species be listed on Appendix II of CITES, this document can be utilised by Parties to conduct NDFs.

REPORT STRUCTURE

Due to the volume of information contained in this report it has been divided into four major sections for ease of reference, as follows:

Executive Summary. Provides a snapshot of the information presented in the entire report, including key findings.

Section I – Global Overview. This section is designed to provide a global analysis of the level of trade, threats, biology and population statuses, presenting the major findings that can be utilised by Parties either at CoP, or after to help understand and manage the risks posed to these species, their countries biodiversity and livelihoods.

Section II – Regional Analysis. This section is where the detail of the report is contained outlining the scientific information available against the required NDF data fields, taxonomy, biology, distribution and range, population status and structure, threats, disturbances and level of trade and management measures and legal frameworks for conservation of species. Each region is covered separately, as follows:

- Section IIA – Asia Pacific Region (colour coded in red)
- Section IIB – Africa (colour coded in blue)
- Section IIC – Americas (colour coded in green)

Section III – Non Detriment Finding Gap Analysis

Each individual section covers the species specific information on that topic. It is structured so that users can readily locate any information on specific species by locating the regional section for that, and, depending on the type of information required moving to the associated section i.e. taxonomy, population status or threats. As management measures tend to cut across genera, management sections are more country focused than species specific.

KEY FINDINGS

This is the first document that has attempted to compile all the scientific and trade data information on *Dalbergia* and *Pterocarpus* species. It is often said that there is limited information known about these species, and while we acknowledge that large data gaps exist there is a surprising amount of information available particularly for some of the most exploited species. In fact, given the quantity of data we have not been able to review and present the entirety of data we found. However, what is presented allows for an informed assessment of the status of these species and their associated global trade globally. The key findings in this document are:

1. **Serial depletion of rosewood species across the global is a real and substantial risk to their survival**. There is clear evidence that trade in rosewood species rapidly shifts from one highly valued species to another as stocks become depleted. Following the 1992 listing of *D. nigra* on CITES Appendix I, Madagascan species began to appear in trade data at much higher levels than previously recorded. Similarly, following the 2013 listing of *D. cochinchinensis*, Malagasy *Dalbergia* species and several South American *Dalbergia* species, trade shifted to *Pterocarpus* species, particularly *Pterocarpus macrocarpus* (and its synonyms) in Asia and *P. erinaceus* from West Africa. This pattern is clear in the species specific trade analysis contained in this report. (Refer to Global Overview Section). This finding highlights the need to treat these species as a block, explicitly recognising the inter-related exploitation patterns, and manage them accordingly. A more holistic approach is required to ensure the future survival of these species.
2. **Reliance on Chinese Customs Codes to characterise trade in rosewood species severely underestimates the level of trade.** Analysis of species specific customs data contained in this report indicates a high level of rosewood trade under international customs Harmonised System (HS) Codes that do not correspond with any of the import HS Codes applied by China (<1% for sawn wood and 0% for logs). For example, between 20-25% of the trade into and out of Vietnam for *Dalbergia* and *Pterocarpus* species was conducted under HS Codes specifically for *Dyera* species, which is a genus of tropical tree species known

as Jelutong, and which originate from Borneo, Sumatra, Malaysia and Southern Thailand. Additionally, Sawn wood exports from Vietnam to China range from 350 000 m^3 to almost 500 000 m^3 over the past 3 years according to the Vietnam customs data, however, the data from Chinese customs codes indicates that only roughly 5000 m^3 was exported from Vietnam to China in 2014. The sawn wood exports shown in the Vietnam trade data also dwarf the number 1 ranked country – Lao PDR, which exported approximately 133 000 m^3 according to Chinese Commodity codes for hongmu, as provided in Treanor (2015) [1].

3. **Over 90% of the *Dalbergia* or *Pterocarpus* populations showed unstable or declining populations.** We were able to obtain scientifically reliable population structure information 82 populations of rosewood species (which covered 29 out of the 77 species). Of these, 74 were found to have unstable population demographics with lower recruitment than necessary to sustain the populations. This included populations within Protected Areas, where in some cases recruitment was lower than adjacent hunting zones despite the presence of more adult mature trees capable of producing recruits. One population was found to be extinct.

4. **Geospatial Information Systems (GIS) can be utilised to estimate current range and distributions of data deficient species in a cost effective and time efficient way.** There is inadequate understanding of the range and distributions of many species in these genera, not least because they are hard to identify in the field. However, the use of geo-spatial information systems and datasets that are freely available on the internet to model suitable habitat and remaining likely habitat could provide an effective first step to filling these data gaps. We have used these methods to perform bio-climatic species distribution modelling based on known point locations, and/or known habitat preferences, and then overlayed this with known current forest regions to estimate likely remaining habitat for selected species from each region.

5. **There is sufficient information available to infer or project that all rosewood or other precious timber producing species in the *Dalbergia* and *Pterocarpus* genera are threatened (or likely to be in the near future).** While it is acknowledged that there are significant data gaps for a number of species within this report, there is sufficient information available for a large sample of each genera to infer the risks for data deficient species. This cycles back to point where trade data points to the need to manage rosewood as a 'block'. The biological aspects of the *Dalbergia* and *Pterocarpus* species presented in this report are all remarkably similar, showing very slow growth rates – upwards of 100 years in several cases to reach merchantable size –extremely poor recruitment even in protected areas where it is usually assumed that recruitment is good due to larger numbers of mature trees. In one case populations of *P. angolensis* in Tanzania display recruitment failure for 30 years. Coupling this information with the known threats facing these species including but not limited to increasing trade levels, deforestation due to forest conversion, climate change induced aridification and increasing severity of fires, and the fact that 90% of populations studied so far all showed declining or unstable population dynamics, it is justifiable to *infer or project* that the survival of all these species in the wild is threatened (as is required for a CITES Listing)

6. **Precautionary and adaptive management measures could be applied to data deficient species using the biological parameters of other closely related species presented in this report, assuming viable populations are available to be sustainably managed.** The detailed review of the science and ecology of the genera suggests there are enough ecological and management similarities between species to extrapolate to data deficient species in order to design suitable precautionary management measures. This is essential because the continuation of trade without any justifiable assessment of the ecological sustainability of species needs urgent attention. For example, given the long maturation rates management considerations would suggest that all rosewood populations are dependent on a longer term planning cycles.

7. **Simple log export bans are an ineffective management measure.** Log export bans are circumvented by processing logs into sawn wood, timber veneer or any other minimal processing along an edge so that the products is no longer considered a "log". This may be amplified when a log export ban only applies to a limited number of species, for without adequate timber identification tools along the trade chain

deliberate misreporting of species on export documentation can be applied. Evidence of the limited utility of log export bans can be seen by the fact they have been implemented by many countries, yet trade in rosewood timber products continues to increase. Trade data clearly displays the shift in commodity type, with minimal processing as discussed above. Logs export bans also appear to do little to stop illegal logging, traders simply find black market ways of exporting their materials (Refer to Global Overview and Regional Analysis sections for further details). Unfortunately, most countries that are experiencing the highest levels of illegal harvest and trade have little capacity to enforce these laws, and even less capacity to monitor the forests as necessary to prevent illegal logging.

8. **Lack of timber identification increases the need to treat all species in these genera subject to this trade as a "management block".** Species level timber identification is critical in identifying CITES listed species in trade. Methods are being developed and improved as technology advances, and the complete development of an affordable, robust system that is field-portable should be considered a priority. As with all systems an up-to-date and scientifically robust reference database is also essential. *Pterocarpus* species have already shown a large increase in trade over the past 3 years, and species continue to be mislabelled. Range countries of these species should carefully consider how to manage the risk to these species, and the associated risk that *Dalbergia* species may be deliberately misreported as *Pterocarpus* species in order to circumvent any CITES listing, should it proceed.

SUMMARY OF INFORMATION AVAILABLE AND COLLATED

The importance of accurate data cannot be understated. For any species to be listed on CITES it must be assessed against the criteria in Resolution Conf. 9.24 (Rev CoP16), as discussed above, to determine whether there is enough information to state that a species (or its look-alikes) meets the listing criteria, or whether it can be "inferred or projected" that a species would meet the criteria in the absence of concrete scientific information. Where high risk is determined, the precautionary principle should be applied such that Parties act in the best interests of the sustainability of the species and its potential future trade value.

The following subheadings provide an overview of the information contained in the main regional analysis sections of this report.

Taxonomy

The issues pertaining to taxonomy, particularly for *Dalbergia*, are complex. There is a wide discrepancy in names, synonyms and variations recorded and accepted throughout their ranges. Some names are accepted at an international level, but not accepted at country level and vice-versa. According to the Plant List database, the *Dalbergia* genus has 304 accepted names and 242 synonyms. Currently 61 of these species are listed under CITES, with one species listed on Appendix I, 55 species on Appendix II and five species listed on Appendix III [6]. This report focusses on 77 species of *Dalbergia* and *Pterocarpus* species of rosewood or other precious woods across the Asian Pacific region, Africa and the Americas. While taxonomy for *Dalbergia* and *Pterocarpus* species is somewhat in a state of flux, the same can be said for numerous other genera of various Phyla and Classes, such as coral for example. Taxonomic uncertainty is not, and should not be a reason for not listing a species or group of species on CITES. In fact, taxonomic similarity and look alike species are specifically catered for in the CITES Convention, through the look-alike provisions. Listing all of *Dalbergia* or *Pterocarpus* species on CITES, or applying other management measures to the entire genus, rather than on a species by species basis would avoid many of the current issues associated with trying to manage the risks to these species where the risk assessments are so widely applicable.

Biology

Biologically, species of the Legume family share a number of similarities. This is seen amongst the *Dalbergia* and *Pterocarpus* species assessed for this report, many whom share a number of reproductive and growth traits. The biology of individual species is discussed in more detail in the Regional Analysis Section but the points below highlight some of the key similarities:

- Most of the species studied, with the exception of *D. sissoo*, all experience slow growth rates, taking upwards of 70 years to reach a marketable size (i.e. diameter is of sufficient size to produce useable heartwood);
- Pollination is mainly by bees and to a lesser extent other insects and animals;

- Seed dispersal occurs via wind but can also take place in water, particularly in flood prone areas;
- Species often exhibit mass flowering, however germination rates are recorded as low, despite high rates of seeding. Flowering and fruiting seasons vary greatly depending on the species and geographic locations, with many species exhibiting self-rejection (mechanism to stop self-pollination/inbreeding) and bisexual or hermaphroditic reproductive traits;
- Despite high capacity to produce seedlings, regeneration rates across the globe were low or non-existent in almost all populations studied, even in protected areas.
- Many species exhibit sprouting and coppicing. Nitrogen producing symbiosis is a widely occurring phenomenon amongst many *Dalbergia* and *Pterocarpus* species, making them excellent species for soil and dune rehabilitation.

Distribution and Range and Conservation Statuses

Dalbergia and *Pterocarpus* species are distributed throughout Asia, Africa and the Americas in a wide variety of habitats. However, suitable habitat across their natural range is now limited for many of these species due to a range of threats, namely deforestation, forest conversion for agriculture/human development, and legal and illegal logging to supply domestic and global markets. 45 out of the 77 species considered in this report have been assessed by the IUCN Red List, however 30 of these were conducted in 1998 and require updates. Some of the IUCN assessments also did not consider much of the information researched for this report. 24 out of the 31 American species have not been assessed.

The GIS mapping and predictive modelling of species potential ranges provides a stark assessment of the extent of suitable habitat lost for these species over recent decades. With many regions experiencing an increasing rate of forest cover loss (30% canopy cover), and these regions being the remaining strongholds for several rosewood species, the situation appears unlikely to improve in the near future. Refer to the Regional Analysis Section of this report for detailed information on the historic and current ranges and distributions of these species.

Population Status/Trends

While there has been limited effort expended world-wide conducting range and distribution surveys, there has been a comparatively large amount of work carried out to understand the population demographics in some range countries. There was a surprising amount of information available for a number of *Pterocarpus* species in Africa, mainly the highly exploited species. *P. erinaceus*, *P. lucens* and *P. angolensis.* However, even these studies were restricted to selected Meta populations, thus leaving large data gaps. Without even a basic understanding of existing standing stocks and their structure it is difficult to ascertain what a sustainable level of harvest would or could be for any of these species. What is clear from the studies that have been conducted, is that almost all populations display an unstable population demographic with little to no recruitment occurring.

For example, all populations except one of *P. erinaceus* (one of the species proposed for listing on Appendix II at CoP17) showed declining population demographics and little to no recruitment occurring across its range. Population demographic studies were conducted in Benin, Ghana, Niger, Nigeria, Togo and Burkina Faso. The population within the protected areas of W National Park in Burkina Faso was the only population found with a stable population and adequate recruitment. This study was published in 2011, prior to the trade boom in *P. erinaceus*, so it is unknown what the status of this population is as at the time of writing this report. However, considering the data on the other populations it is unlikely to be positive.

Threats

One of the major threats to all species is habitat loss and deforestation. In Africa alone between the years 2000 and 2010, 3.4 million hectares of forest were converted for other uses [7]. Worldwide close to 10 million hectares was lost from the tropics in 2014 alone, according to Global Forest Watch [8]. International Trade for hongmu furniture is also a consistent threat to all species in the *Dalbergia* and *Pterocarpus* genera as the demand for luxury timber continues to drive up prices and fuel the extraction of these timbers across their range. There are also a number of other threats to rosewood species around the world that hinder the recovery of these species, regardless of any effective trade regulation. These include:-

- Clearing of land for agriculture, road construction, human settlements and animal production and grazing;

- Use of timber for firewood and charcoal;
- Forest loss due to natural forest fires, deliberate burning, climate change, habitat degradation or disease;
- Selective logging for domestic uses ranging from medicinal to dyeing agents;
- Over predation of seeds and seedlings by wildlife and livestock.

If/when any of these species are subject to stricter regulation of trade, these additional threats will continue to exacerbate the current low and unstable population levels. Holistic management measures need to be implemented to tackle all issues threatening these species, before sustainable utilisation of these species can be realistically achieved.

Trade

Trade in *Dalbergia* and *Pterocarpus* species throughout their natural range is widespread. Serial depletion of stocks is apparent across the globe (as discussed above). Along with the species trade shifts in response to CITES listings, it is also apparent that dwindling wild stocks of a species inflates it value. A clear example is the exponential value increase of *D. cochinchinensis* since the 2013 listing [4, 9, 1].

To date, most assessments of trade in species that fall under the rosewood umbrella have focused on publically available world customs statistics provided by UN COMTRADE, and/or Chinese specific customs codes for "Hongmu" which covers the 33 species listed on the current Chinese Hongmu Standard (GT/T18107-2000) [24]. The trade into and out of Vietnam (analysed in this report) can be treated as a microcosm for international trade. Many of the patterns previously discussed by multiple authors [1, 10, 11, 12]with regards to trade into China are evident in the trade into and out of Vietnam. However, our analysis provides further clarity as to exactly which species are being traded globally, using Vietnam as a case study. There has been a definite shift from exporting of logs from Vietnam to China in favour of sawn wood, despite both commodities being banned for export if obtained from natural forests in Vietnam. Whilst China still relies on rosewood species from Asian nations for logs and sawn wood, there has been somewhat of a change in their supply chain with timber exports from African nations recording a 700% increase since 2010 [1]. This pattern is also applicable to Vietnam, where rosewood species in the *Dalbergia* and *Pterocarpus* genera made up 25% of the total trade in rough logs in 2013, which dropped to 11% by April 2016. Of this almost 77% was Asian rosewood species and 15.7% African species, with the remainder made up of generic rosewood names (i.e. "Rosewood" or "*Dalbergia/Pterocarpus* spp") and less than 1% of species from the Americas. This trend in trade reflects the changing nature of the rosewood timber trade which are influenced by species availability, level of protection, demand and supply and the political will of importing and exporting countries.

Management Measures

Widespread trafficking of the *Dalbergia* and *Pterocarpus* rosewood producing species, along with poverty, corruption and the breakdown of governments, among other causes, has led to the overexploitation of many of the species researched for this report [13, 1, 9, 14]. Various governments throughout the three regions have made attempts to curb the threats posed by unrestrained logging, most commonly by implementing logging and/or export bans. However, to date the legal frameworks put in place appear to have been ineffective at preventing or reducing the amount of logging that is occurring throughout these regions, nor arrest the decline of these species. A major concern with these types of measures is that they are a reactive response to already depleted forest levels [14], rather than looking proactively at the risks posed to species in the near to medium term. Another concern is that the implementation of export bans does little to stop illegal logging, with traders easily circumventing the laws by smuggling the logs across porous borders, or applying a range of other tactics such as minimally processing logs and/or deliberately misreporting a species on export documentation. These reasons are amongst many that infer that *Dalbergia* and *Pterocarpus* species should be managed jointly as a single 'rosewood' resource, rather than by species specific legislative instruments. If the worldwide *Dalbergia* listing is successful at CoP17, range states of the replacement species in the *Pterocarpus* genera should consider applying the same management strategies for their *Pterocarpus* species as they would for *Dalbergia* species, as it is highly possible shipments of *Dalbergia* species will be relabelled as *Pterocarpus* to avoid the additional requirements.

From a holistic conservation perspective other management measures, such as forest plantations, appear to be implemented as a reactive response geared towards restoring timber supply rather than improving biodiversity of the depleted forest regions. There is a potential management opportunity to create a sustainable timber industry through eco-labelling or certification processes, similar to the forest certification (FSC) program, particularly for *D. sissoo*

plantations [15]. In India, various Government Institutes have identified *D. sissoo* and *P. santalinus* as a focus species requiring long term tree development and improvement [16].

An issue this report must refer to, though acknowledging it is beyond the scope of this report to analyse in full, is the matter of stockpiles of seized rosewood. There are significant volumes of rosewood, particularly Malagasy rosewood, sitting static around the world CITES Standing Committee and the Malagasy government determine how to treat them. This issue has been closely followed within the CITES Forums of Plants Committee and Standing Committee; however, there has been no resolution to date.

The sale of rosewood stockpiles provides opportunities to launder species out of the country. However, the longer a stockpiles sit dormant the more degraded the wood becomes, making it less useable, if/when a suitable use is determined. Unlike wildlife seizures, particularly ivory and rhino horn, that are routinely destroyed to reduce demand for the product timber stockpiles are rarely treated in the same way. Unfortunately, seized timber auctions have been shown throughout the Asian region to be contributing to the continued illegal logging of forests, as the seized timber is often sold back to the operator it was seized from, who still makes a profit even after paying the associated fine due to the low level fines handed out by most range countries.

Timber Identification

One of the main hurdles associated with managing trade in rosewood species relates to taxonomy and the ability of customs officers or law enforcement officers to distinguish species. The topic of timber identification has been garnering more support and research in recent years.

This document provides an overview of the main timber identification methods currently being used, their advantages and also their limitations. It is clear that not all tools/methods will be suitable for identifying all tree species and timber products. Some methods require laboratory settings and others are yet to have sufficient reference databases available to positively identify specimens. Like many technologies advances are being made all the time and the importance of being able to correctly identify timber species for law enforcement and compliance is paramount, especially if species continue to be listed in a piecemeal fashion on CITES or domestic legislation. With the risk of ongoing depletion to all species in this trade, it is important to be able to confirm that the species listed on the export or import papers is actually the species being moved. With *Pterocarpus* species receiving comparatively less attention than *Dalbergia* species at this current time, there has already been a shift in trading patterns towards this genus. This is likely to continue until suitable identification measures are developed, or the genus is also afforded protection status in line with its risk.

SECTION I – GLOBAL OVERVIEW

INTRODUCTION

Rosewood and other precious woods have been subject to increasing demand over the past decade, created mostly by rising wealth of middle class in China, but also in Vietnam. As such, tree species that produce precious wood such as rosewood have begun to feature more prominently in discussions amongst Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). At this present time, rosewood species in the *Dalbergia* genus are of particular concern, along with the other 4 genera of species listed on the Chinese Hongmu Standard[2] (*Pterocarpus, Cassia, Millettia and Diospyros*) which is reported to be driving much of this trade. The foci of this report are the genera *Dalbergia* and *Pterocarpus*. These two genera were chosen as they are two of the most heavily traded genera listed on the Chinese Hongmu Standard, and are difficult to tell apart once logged and turned into rough logs/sawn wood or finished products. Traditionally *Dalbergia* species have been the main target for this trade, however, as these species have become less available, through stricter conservation measures and/or enforcement of logging and export bans, the trade has shifted to alternate species as replacements, particularly in the *Pterocarpus* genus.

Due to the species specific nature of the CITES Convention, threats to tree species to date have been largely addressed on a species by species basis. These listings are seemingly effective at reducing the legal trade of the listed species; however, demand quickly shifts to alternate species. It is difficult to determine whether this is a genuine shift in species traded or whether traders are simply relabelling the listed species as a non-listed species to avoid the stricter management measures. It is particularly difficult to discern for trade within a region. However, when demand shifts to a new region it is easier to recognise. With the listing in 1992 of *Dalbergia nigra*, Madagascan rosewood species started to feature more prominently in the market [17], as did alternate rosewood species in Asia and Africa once *Dalbergia cochinchinensis* and all Madagascan species of *Dalbergia* were listed on Appendix II at CoP16 in 2013. There is clear evidence [1, 18, 19, 20, 21, 22, 12], that trade in precious woods continues relatively unabated through quasi-legal and illegal channels, despite many varied mechanisms to ensure legal and sustainable harvest including. These mechanisms include the CITES convention, but also:

- European Union Wildlife Trade Regulations, with Scientific Review and Enforcement Groups;
- Forest Law Enforcement, Governance and Trade (FLEGT);
- EU Timber Regulation (EUTR);
- Illegal Logging Prohibition Act (Australian Government 2012);
- The Lacey Act;
- Multiple country level bans on logging and export of logs and/or timber products.

This document is designed to examine species specific risks, presenting a broad cross-section of available scientific information on the species' biology, population status & structure and levels of threat posed to species in the *Dalbergia* and *Pterocarpus* genera. This document also analyse the current situation from a worldwide perspective to generate a clear understanding of the global picture in order that adequate and holistic conservation management measures can be implemented. The stark reality appears to be that existing loopholes in legislation, enforcement and gaps in political will across the globe enable illegal traders to continue to exploit these precious resources with little or no ramifications, while the local communities and governments lose vital revenue, livelihoods and habitats.

BACKGROUND AND CONTEXT

The premise for this document was borne from the notion expressed in the past that very little is known about the ecological and trade status of rosewood and other precious hardwoods, which makes it difficult to either:

A) list the species on CITES as it is unable to be determined whether a species meets the listing criteria (Resolution Conf. 9.24 Rev CoP16) or

B) conduct a Non-Detriment Finding (NDF) once/if a species is listed

2 A Draft revision of this standard GB/T 18107-2000 – Rosewood Hongmu, was released for comment on 10 October 2014, and does not appear to have been officially published as yet.

Therefore, the structure of this report follows the information fields required to conduct a sufficiently robust Non Detriment Finding (as laid out in Resolution Conf. 16.7), including outlining taxonomic uncertainties, biology, population status and structure, disturbances, threats and management arrangements. This is done in species specific detail where possible and in general country level terms where that is not possible.

Table 1 provides a full list of the species covered by this report as they appear in trade transactions or country reports. Some species listed in Table 1 are synonyms, a matter discussed in the Taxonomy section of each region. Synonyms are rationalised following the taxonomy section.

Table 1 – Rosewood Species in Trade in *Dalbergia* and *Pterocarpus* Genera

SCIENTIFIC NAME	LOCATION	IUCN RED LIST	CITES APPENDIX
ASIA			
Dalbergia annamensis	Vietnam	Endangered	Not listed
Dalbergia assamica	Vietnam, China, Lao PDR, Cambodia, Thailand, Myanmar, Bhutan, Bangladesh and India, and has been introduced into tropical Africa	Least concern	Not listed
Dalbergia balansae	China, Vietnam	Vulnerable	Not listed
Dalbergia bariensis	Cambodia, Lao PDR, Thailand, Vietnam, Myanmar	Endangered	Not listed
Dalbergia cambodiana	Cambodia, Vietnam	Endangered	Not listed
Dalbergia cochinchinensis	Cambodia, Lao PDR, Thailand, Vietnam, Myanmar	Vulnerable	II
Dalbergia cultrata	Myanmar, China, Indonesia, Thailand, Lao PDR, Vietnam, India	Endangered/Near Threatened	Not listed
Dalbergia fusca	Myanmar, Thailand, China	Vulnerable	Not listed
Dalbergia latifolia	India, Indonesia, Nepal, Kenya, Malaysia, Myanmar, Philippines, Sri Lanka, Vietnam	Vulnerable	Not listed
Dalbergia mammosa	Vietnam	Endangered	Not listed
Dalbergia oliveri	Myanmar, Thailand, Vietnam	Endangered	Not listed
Dalbergia odorifera	China	Vulnerable	Not listed
Dalbergia sissoo	North India, Nepal, and Pakistan, Western Asia	Not listed	Not listed
Dalbergia tonkinensis	Vietnam and China	Vulnerable	Not listed
Pterocarpus cambodianus	Indo-China Peninsula.	Not listed	Not listed
Pterocarpus dalbergioides	India, Indonesia, Myanmar and Madagascar.	Data deficient	Not listed
Pterocarpus indicus /echinatus -	Cambodia, China, Myanmar, Thailand	Vulnerable	Not listed
Pterocarpus marsupium	India	Vulnerable	Not listed
Pterocarpus macrocarpus	Myanmar	Not listed	Not listed
Pterocarpus pedatus	Thailand, Lao PDR, Vietnam, Cambodia and Myanmar	Not listed	Not listed
Pterocarpus santalinus	India, Lao PDR, Sri Lanka	Endangered	II
AFRICA			
Dalbergia melanoxylon	Angola, Botswana, Burkina Faso, Cameroon, Central African Republic, Chad, Côté d'Ivoire, Democratic Republic of Congo, Eritrea, Ethiopia, Kenya, Malawi, Mali, Mozambique, Namibia, Nigeria, Senegal, South Africa, South Sudan, Sudan, Tanzania, Uganda, Zambia, Zimbabwe	Near Threatened[3]	Not listed
Dalbergia abrahamii	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia baronii	Madagascar	Vulnerable[3]	Listed on Appendix II
Dalbergia bathiei	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia chapelieri	Madagascar	Near Threatened[4]	Listed on Appendix II

3 Conducted in 1998, and requires updating
4 Conducted in 2012

Dalbergia chlorocarpa	Madagascar	Vulnerable[3]	Listed on Appendix II
Dalbergia davidii	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia delphinensis	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia greveana	Madagascar	Near Threatened[3]	Listed on Appendix II
Dalbergia hildebrandtii	Madagascar	Vulnerable[3]	Listed on Appendix II
Dalbergia louvelii	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia madagascarensis	Madagascar	Vulnerable[3]	Listed on Appendix II
Dalbergia maritima	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia mollis	Madagascar	Near Threatened[3]	Listed on Appendix II
Dalbergia monticola	Madagascar	Vulnerable[3]	Listed on Appendix II
Dalbergia normandii	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia purpurascens	Madagascar	Vulnerable[3]	Listed on Appendix II
Dalbergia trichocarpa	Madagascar	Least Concern[3]	Listed on Appendix II
Dalbergia tsiandalana	Madagascar	Endangered[3]	Listed on Appendix II
Dalbergia viguieri	Madagascar	Vulnerable[3]	Listed on Appendix II
Dalbergia xerophila	Madagascar	Endangered[3]	Listed on Appendix II
Pterocarpus angolensis	Angola, Botswana, Congo, Democratic Republic of Congo, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe	Near Threatened[3]	Not Listed
Pterocarpus erinaceus	Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côté d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, Togo	Not Assessed	Currently listed on Appendix III by Senegal, CoP17 Proposal 57 to up-list to Appendix II
Pterocarpus lucens (including sub-species *antunesii* and *lucens)*	Angola, Botswana, Cameroon, Chad, Congo, Democratic Republic of Congo, Ethiopia, Ghana, Guinea, Guinea-Bissau, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Sudan, Uganda, Zambia, Zimbabwe	Least Concern[4]	Not Listed
Pterocarpus soyauxii	Angola, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Nigeria	Not Assessed	Not Listed
Pterocarpus tinctorius	Angola, Burundi, Congo, Democratic Republic of Congo, Malawi, Mozambique, Rwanda, Tanzania, Zambia	Not Assessed	Not Listed
AMERICAS			
Dalbergia brasiliensis	Brazil	Not assessed	Not listed
Dalbergia calderonii	Belize, El Salvador, Guatemala, Honduras, Mexico and Nicaragua	Not assessed	Not listed
Dalbergia calycina	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua	Least concern	App III - Guatemala
Dalbergia cearensis	Brazil	Not assessed	Not listed
Dalbergia congestiflora	El Salvador, Mexico	Not assessed	Not listed
Dalbergia cubilquitzensis	Belize, Guatemala, Mexico	Not assessed	App III - Guatemala
Dalbergia cuscatlanica	Costa Rica, El Salvador, Guatemala, Mexico, Panama	Not assessed	Not listed
Dalbergia darienensis	Colombia, Panama	Not assessed	App. III - Panama
Dalbergia decipularis	Brazil	Not assessed	Not listed
Dalbergia foliolosa	Bolivia, Brazil	Not assessed	Not listed
Dalbergia frutescens	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Guyana, Ecuador, Paraguay, Peru and Venezuela	Not assessed	Not listed
Dalbergia funera	Guatemala, El Salvador	Data deficient[3]	Not listed
Dalbergia glomerata	Costa Rica, Guatemala, Honduras and Mexico	Vulnerable A2c	App III - Guatemala

Dalbergia granadillo	El Salvador and Mexico	Not assessed	App II
Dalbergia hortensis	Brazil	Not assessed	Not listed
Dalbergia longepedunculata	Honduras and Mexico	Not assessed	Not listed
Dalbergia luteola	Guatemala and Mexico	Not assessed	Not listed
Dalbergia melanocardium	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico and Nicaragua	Not assessed	Not listed
Dalbergia miscolobium	Brazil	Not assessed	Not listed
Dalbergia modesta	Mexico	Not assessed	Not listed
Dalbergia nigra	Brazil	Vulnerable A1cd[3]	App I
Dalbergia palo-escrito	Mexico	Not assessed	Not listed
Dalbergia retusa	Belize, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Mexico[5], Nicaragua, and Panama	Vulnerable A1acd[3]	App II
Dalbergia rhachiflexa	Mexico	Not assessed	Not listed
Dalbergia ruddiae	Costa Rica and Mexico	Not assessed	Not listed
Dalbergia spruceana	Bolivia, Brazil, Honduras and Venezuela	Not assessed	Not listed
Dalbergia stevensonii	Belize, Guatemala, Honduras and Mexico	Not assessed	App II
Dalbergia tucurensis	Belize, Costa Rica, Guatemala, El Salvador, Mexico and Nicaragua	Not assessed	App III – Guatemala and Nicaragua
Dalbergia villosa	Bolivia, Brazil	Not assessed	Not listed
Pterocarpus officinalis	Mexico, Honduras, Costa Rica, Panama, Colombia, Venezuela, Ecuador, Guyana, Suriname, French Guiana, Brazil, Jamaica, Hispaniola, Haiti, the Dominican Republic, Puerto Rico, the Lesser Antilles including Guadeloupe and Martinique, Dominica, the island of Marie Galante, St Lucia, St Vincent, Trinidad and Tobago.	Not assessed	Not listed

TAXONOMY – DALBERGIA SPP

Since CITES it is designed to be a species specific convention where possible it is important to understand the regional differences in accepted taxonomy. Where a species may be recognised and classed as a separate species in one country, this may not be so in neighbouring range states, or even at the global level. If the CITES Convention is not cognisant of this when listing species, it can cause a range of significant implementation issues when issuing permits at the national level and when trying to understand the level and scale of trade in a particular species.

The taxonomy for *Dalbergia spp* is complex and displays a wide discrepancy of names, synonyms and variations recorded and accepted throughout their ranges. The table below highlights research undertaken by Vaglica (2014) [23] comparing searches of The Plant List and the International Legume Database & Information Service (ILDIS) web-based databases. While global records such as The Plants List and the IUCN Red list may recognise particular species as synonyms of each other, this is not necessarily applied at a country level, often with many local names or several different synonyms being recognised at a country level (this is discussed more in each Regional Analysis section).

5 This species may not be native to Mexico and is often said to be misreported in trade. It is more likely to be *D. granadillo*.

Table 2 - Taxonomy Issues

SPECIES SEARCH FOR *DALBERGIA SPP.*	THE PLANT LIST	ILDIS
Plant name records	647	445
Accepted names	304	269
Synonyms	242	150
Unresolved	86	-
Misapplied	15	10
Variant	-	9
Provisional	-	6
Doubtful	-	1

TIMBER IDENTIFICATION

Timber identification remains a critical component in establishing the true global extent of legal trade in listed species. Whilst there are a number of ways in which timber can be identified, traced and linked to a specific geographic region, available technology is still in its infancy. Use of such technology by law enforcement or forestry officers in the field (where it is urgently needed), and as a source of reliable evidence in a courtroom, is several years off. However some hope is offered with advances in technology, and a number of new products and prototypes are currently in the testing phase. Currently though, traders can simply relabel a species as a non-listed species and continue to trade as normal [24]. While this can be overcome by ensuring that all species that might be subject to unsustainable levels of harvest and trade are protected under the "look-alike species" provisions of CITES, it is still important to develop identification technologies such that they can be applied in the future. This issue has been gaining increased attention within CITES, such that it has been on the agenda of Plants Committee since CoP16.

With respect to a genus and family level, and the geographic origin of a species, there a range of techniques available to identify timber in trade [25, 26, 27]. These include DNA, wood anatomy (macroscopic and microscopic), near infrared spectrometry, chemical and isotope analysis [28]. Gasson (2011) suggests that the many existing identification techniques only able to reliably identify to genus level. This is particularly so with *Dalbergia* species, which all display microscopic similarities that are difficult to tell apart at the species level [28, 27]. There is also unfortunately no single solution that can be applied as the structural, chemical or genetic differences vary widely across genera, species and geographic regions [27, 29]. Sometimes even being able to extract suitable material (e.g. DNA) from the wood is challenging [27, 28]. Figure 1 graphically displays the different techniques that can be applied in order to determine various aspects of wood biology. It compares the types of identification methods, particularly the non-DNA methods and DNA methods. These techniques, however, are highly dependent on the availability and composition of wood identification samples in reference databases, which is another significant challenges [28, 29, 27].

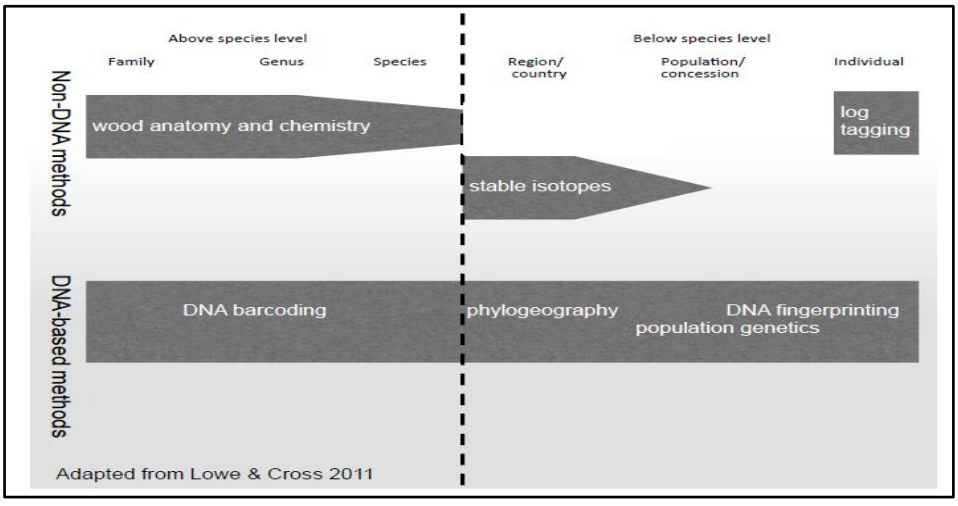


Figure 1: How different molecular, genetic and non-DNA techniques can be applied (taken from Lowe and Cross, 2011) [29]

Use of DNA technology is fast becoming the go-to technology for determining species identification to a high degree of accuracy. However, there are a number of hurdles associated with using DNA analysis for tree species. This includes the ability to physically extract DNA from timber species in trade, especially sawn logs or wood, which is further complicated

once the timber is processed to composite products such as veneer or plywood. DNA becomes highly degraded with this level of processing and the success rate for retrieving DNA from processed samples is generally very low.

Case study – Malagasy rosewood

Hassold et al (2016) recently looked at the effectiveness of DNA barcoding in an effort to ascertain whether it was possible to distinguish between Malagasy rosewood species, and to initiate the development of a molecular reference sample set to assist other regulatory bodies with identification [30]. Whilst there has been significant progress with the development of DNA barcodes for animal species, this is not the case for tree species. Several case-specific identification systems have been developed. *Dalbergia* species have only been included in more recent studies, mainly from Asia, to test factors such as species identification and sample assignment [30]. The important findings were as follows: the DNA barcoding reference dataset was able to differentiate whether timber specimens came from Madagascar or not. However, it is not yet possible to distinguish between Malagasy species because they are too genetically similar. [30].

The recent WRI/World Bank report [27] detailed the scientific and technical capacity within Madagascar to carry out identification methods and other general scientific surveys to determine population statuses. One main hindrance outlined was the extreme difficulty to tell species apart in the forest, in order to collect suitable reference samples. It is virtually impossible to tell many of these species apart in the forest unless they are flowering or fruiting, which unfortunately is not synchronous for many species. Even expert taxonomists and timber identification experts within Madagascar are unable to tell some species apart in the field.

The Naturalis Biodiversity Centre in the Netherlands is a subject matter expert on timber identification for CITES listed species, as recognised in PC21 Document 15 [25]. Table 3 (below) shows the capacity of the Naturalis Biodiversity Centre in the Netherlands to identify a small number of *Dalbergia* and *Pterocarpus* species. Of the species available it would only be possible to identify three species with the help of an anatomy expert (*D. cochinchinensis*, *P. santalinus* and Malagasy rosewood *Dalbergia spp*). However, other researchers have been able to distinguish several *Dalbergia* and *Pterocarpus* species using near-infrared technology. *D. cochinchinensis* can be distinguished from *D. oliveri* by the extractives in their wood using conventional infrared (IR) spectroscopy –Fourier Transform IR "FTIR" [31, 27], as can *Pterocarpus santalinus* and *D. louvelii* using two different wood anatomy techniques (FTIR and 2D correlation IR spectroscopy) [32].

Table 3: Naturalis Biodiversity Centre, Netherlands - *Dalbergia* and *Pterocarpus* identification capability

Naturalis Biodiversity Centre, Netherlands – *Dalbergia* and *Pterocarpus* identification capability					
Species	**CITES App**	**Samples held**	**Type and no of samples**	**Anatomy expertise**	**DNA expertise**
Dalbergia cochinchinensis	II	**YES**	ca. 20 herbarium specimens; No wood samples	NO	NO
Dalbergia dariensis	III	NO	None	NO	NO
Dalbergia granadillo	II	NO	None	NO	NO
Dalbergia nigra	I	**YES**	No herbarium specimens; 4 wood samples	**YES**	NO
Dalbergia spp. (Malagasy)	II	**YES**	ca. 60 including herbarium and wood samples	**YES**	NO
Dalbergia stevensonii	II	NO	None	NO	NO
Pterocarpus santalinus	II	**YES**	4 herbarium specimens	**YES**	NO

Table 4 compares the main types methods currently used for timber identification. It also outlines the main advantages and limitations of each method. The extent to which accurate botanical, anatomical, isotopic or chemical compound databases exist and their accessibility is likely to be the defining factor as to which method is best suited to a particular use (i.e. differentiating between species, genera or determining source country of specimens). Table 1 of Dormontt et al (2015, In Press) provides further detailed analysis of potential methods, please refer to this paper for more detailed analysis than is provided here.

Table 4: Main identification methods, their advantages and limitations

TECHNIQUE	METHOD/USE	ADVANTAGES	LIMITATIONS
DNA [33, 29]	3 Main levels can be differentiated with DNA 1. DNA barcoding - Species differences 2. Population genetics – population differences 3. DNA fingerprinting – individual differences	• It is now available and accepted by law enforcement agencies as a viable method of identification [29]; • It is relatively cheap to add a new species for DNA barcoding [25]; • DNA analysis can be used in a court of law [29].	• Development of biological reference samples to build databases • Ineffective for processed timber with highly degraded DNA [29]; • Currently only available in laboratories, which is time consuming and often expensive [34]; • Low resolution in chloroplast markers has been suggested as a reason why a universal DNA barcode for plants is yet to be identified [30].
Wood anatomy	Identification may be made by observing three planes of the wood; macroscopically or microscopy [27]. Together they provide a three dimensional picture of the wood's cellular structure [25]. There are a number of different techniques that can be used including: - Hand held lens - Light microscopy	• Inexpensive initial analysis particularly to genus level [25]; • Wood identification guides easy to produce once the information has been obtained [25]; • A portable and self-contained unit has been developed in the US that is able to identify many commercial woods of Central America with minimal training [25, 35]. • Portability of prototype machine means it can be used in the field [35].	• Macroscopic identification frequently requires microscopic identification to confirm identification [25]; • Dependent on availability of wood samples and reference material which are difficult to come by at the moment for *Dalbergia* and *Pterocarpus* species [25]; • Microscopic analysis expensive and requires specialist equipment [25].
Chemical analysis	Based on the presence or absence of a specific compound or a variation in the level of that particular compound, as measured by a process known as mass spectrometry. One particular method includes Near Infrared Spectrometry (NIRS); methods including FTIR [27] and 2D correlation IR spectroscopy techniques [32]	• Accurate and consistent result [36]; • Method could be cost effective and easy to use [25]; • Able to be used in a variety of samples, such as wood chips, sawdust, incense and liquids useful to identify products and derivatives [25]; • Able to differentiate between plantation and wild sourced specimens [25]. • Able to do non-destructive testing [37] • Has good prospects to be developed as fast and accurate method for law enforcement [26]	• Method relies upon the isolation of a particular chemical marker to make an identification; • Needs regional specific reference databases, which are hard to come by [26]
Isotope analysis	Items contain various isotopes such as oxygen, nitrogen, hydrogen, carbon and sulphur and these can be found in natural properties such as water and soil and in bones and trees. When analysing trees for example, a sample from a tree may have an isotope that may be traced back to a particular geographic location.	• Well known and established method, increasingly used for timber identification [25, 38];	• Isotopes need to be known or identified at a regional level to be used as a comparison, so the effectiveness of this method depends upon the established database available [25].

SPECIES SPECIFIC BIOLOGY, DISTRIBUTION AND POPULATION STATUS INFORMATION

While it is definitely true that there are significant knowledge gaps in biology and population status & structure, there is nonetheless a large amount of information pertaining to these fields, as discussed in detail in Section II - Regional Analysis. This report uncovered and compiled sufficient data to develop iterative management measures to sustainably harvest these species. What is notable is that there are enough similarities between the species that have sufficient information, to extrapolate suitably precautionary management measures to species with insufficient information.

Somewhat surprisingly, the African region had the most scientific information on population status & structure for a number of highly exploited species, particularly *P. erinaceus, P. lucens* and *P. angolensis*. In fact, there was so much information for *P. angolensis* (African Teak), that we were unable to review all the relevant scientific papers for this report. From the information that is available across the globe, a high proportion of populations studied (over 90%) all show unstable population structures and declining population statuses, refer to Table 5. This table summarises the scientifically peer reviewed and published papers that we were able to find examining and presenting population status & structure information including diameter and height class distribution curves and tree or sapling densities. We note that severe forest loss and fragmentation across the globe likely has important implications for population and meta-population dynamics (such that there may no longer be dispersal or interchange, and that single population may now be multiple meta-populations). However it is beyond the scope of this report to examine these aspects, as such we use the term population in its broadest sense. [6]

One surprising finding was that even in protected areas that generally had higher proportions of adult mature trees capable of producing saplings and seedling, recruitment was poor or absent in almost all regions. One region in Tanzania even reported recruitment failure for 30 years. It is hypothesized by several authors that this curious observation, which is the opposite of what is normally expected, is due to the higher number of ungulates that persist in protected areas, especially where recruitment was better in adjacent hunting zones where there were fewer adult trees but also fewer ungulates. *Dalbergia* and *Pterocarpus* species are favoured by many browsing species, and appear to suffer significant recruitment issues where high numbers of ungulates are present. Only seven of the populations studied showed stable population demographics, and most of these were surveyed more than five years ago, so may no longer be stable with the increased focus of illegal loggers on rosewood species since 2010 in most regions.

Table 5 - Summary of Population Status and Structure Information Analysed.

REGION	# OF SPP STUDIED	# POPs STUDIED	# ↑/ STABLE	# ↓/UNSTABLE	NOTES
Africa	6 (out of 6)	44	5	38	1 population was extinct
- Madagascar	11 (out of 20)	14	0	14	
Asia	7 (out of 21)	15	1	14	5 additional Protected Areas studied had no mature trees
Americas	5 (out of 30)	9	1	8	
TOTAL	**29 (out of 77)**	**82**	**7 (8.5%)**	**74 (90%)**	

While only 29 out of the 77 species covered in this report had any population status or structure information, for most species their general range and distributions are known to some degree. While current exact ranges of these species may not be known, there is generally good historical distribution known. Today there is are a variety of geospatial information systems (GIS) that can be utilised to provide good estimates of current population distribution, though not necessarily abundance or other population parameters. In this report, we have created species distribution models for some of the most highly exploited species, based on their biological and environmental needs (data extracted from known point locations). These models include global forest loss data (full methods in Annex ??). For example, Figure 2 shows the maps produced for *D. cochinchinensis,* starkly displaying the likely range reduction of this species. The figure on the left indicates the suitable habitat and ecological range for *D. cochinchinensis* based on known locations the species has been found in the past, while the figure on the right indicates this same habitat remaining in existing forest areas. The green/blue regions indicate areas of low probability of distribution based on ecological parameters, so the main range for this species is now very restricted within Thailand, Cambodia and extremely small pockets of Lao PDR (shown in red/orange). As shown above in Table 5, only 38% of *Dalbergia* and *Pterocarpus* species have had any sort of scientific survey on one or more of their populations worldwide. Utilising GIS and predictive modelling to understand

6 These last two sentences were added after this section was translated, so do not appear in the Spanish or French versions.

range reductions and likely current range and distributions provides a cost effective alternative to expensive field surveys.

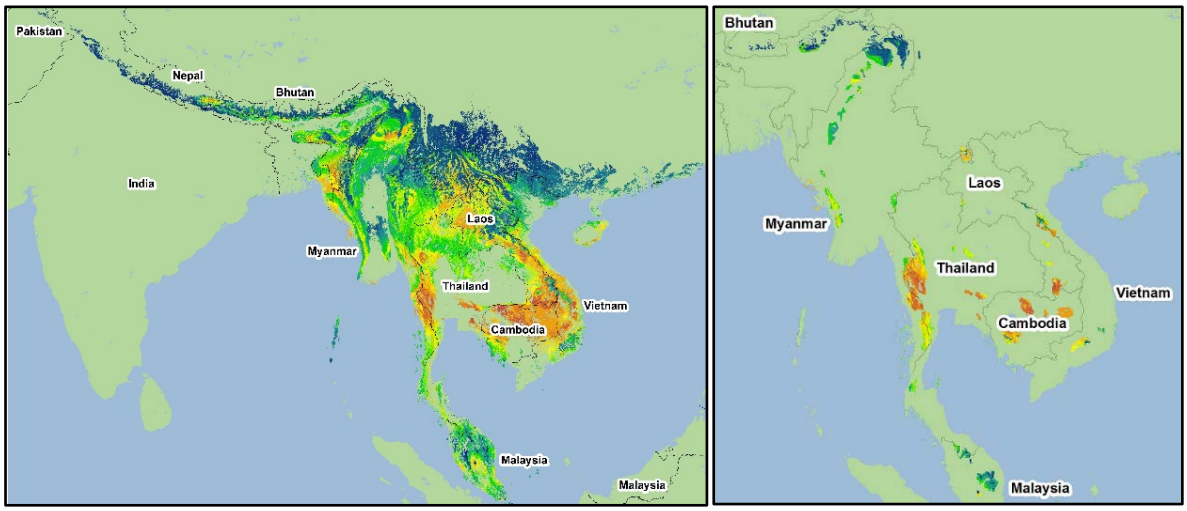


Figure 2 - (Left) Predicted Suitable Range of Environmental Variable (Right) Suitable Habitat Range within intact Forests. Red indicates highest probability; Yellow – medium to high probability; Green - medium probability; Blue – lowest probability

Similar habitat reduction patterns as observed in Figure 2 are repeated for all species we have conduced mapping for. Figure 3 shows a global compilation of all maps produced for this report, showing the predicted suitable habitat for all species on the top, and then the suitable habitat that is remaining in intact forests on the bottom. This demonstrates the large-scale loss of habitat directly affecting these species.

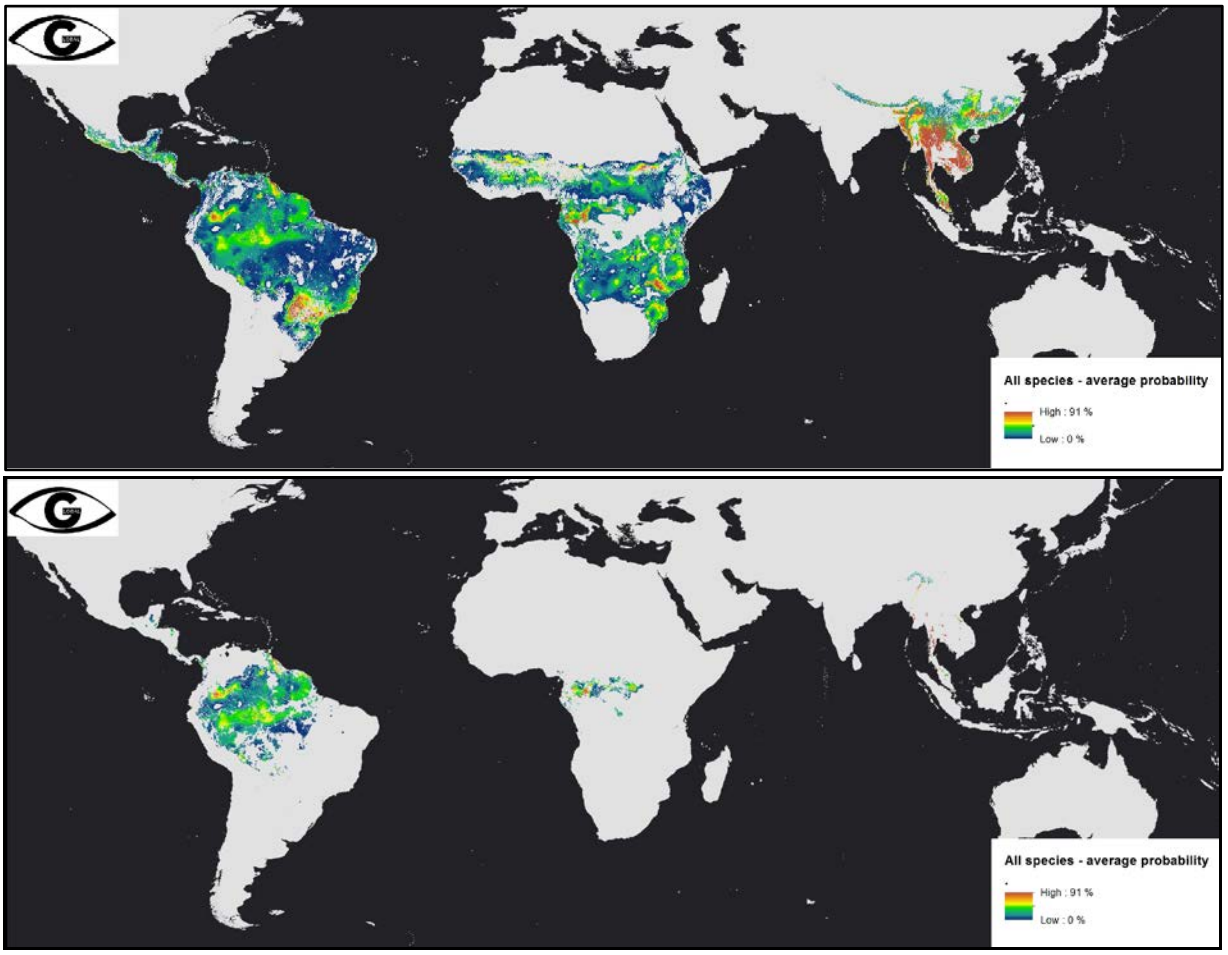


Figure 3 – (Top) World Wide Predicted Suitable Habitat and Climatic Conditions for *Dalbergia* and *Pterocarpus* spp (Bottom) Existing Habitat Remaining with Suitable Environmental Parameters for these Rosewood Species. (Note: Madagascar was not mapped by Global Eye, and is therefore not included on this map)

Ideally all GIS modelling would be backed up by a survey schedule that could validate the findings of the GIS modelling exercise, but in the first instance this exercise provide some clarity as to the likely extent of occurrence given the large

scale deforestation that has been experienced by most of these species since they were last assessed by the IUCN Red List in 1998. Therefore, coupling the known threats facing these remaining populations, such as further deforestation/forest conversion for agriculture, illegal logging and climate change, with the fact that 90% of studied rosewood populations around the world show unstable and/or declining populations it is justifiable to infer or project that the majority of the unstudied rosewood populations are highly likely to be experiencing similar decline/instability and recruitment failure throughout their ranges.

CHALLENGES IN GLOBAL TRADE

There is a plethora of published reports on the trade in *Dalbergia* and other precious wood species, especially over the past 5 years (discussed in detail in the regional sections). Overall, these reports detail the increasing level of trade into China of rosewood logs and sawn wood. These assessments mainly rely on publically available customs statistics data reported by UN COMTRADE and Chinese Customs data. China is the only country that has customs commodity codes specific for "Hongmu" which covers the 33 species listed on the current Chinese Hongmu Standard (GT/T18107-2000), these are [39]:

- 4403 9930 00 – Hongmu Log
- 4407 9910 10 – End-joined sawn wood of Camphor/Nanmu/Hongmu
- 4407 9910 90 – Non-end-joined sawn wood of camphor/Nanmu/Hongmu
- 9403 5010 10 – Bedroom furniture manufactured with endangered hongmu species
- 9403 6010 10 – Other furniture manufactured with endangered hongmu species

The December 2015 report produced by Forest Trends, "China's Hongmu Consumption Boom" [1], fully detailed the level of trade into China using these customs codes, and will therefore not be repeated here. In summary however, what this report clearly demonstrated was that China's consumption of these rosewood and other precious woods is continuing to grow, despite growing concern over the sustainability and legality of harvests, increasing protection and enactment of logging and export bans in source countries. Some of the key findings were:

1. In 2014, rosewood imports reached an all-time high, following its trajectory since 2010.
2. "Rosewood" species import proportion is increasing, now making up approximately 35.1% of all hardwood imports into China.
3. China still relies on rosewood species from Asian nations for logs and sawn wood, however the reliance on African nations is increasing, with a 700% increase since 2010.

To date, there has been very little information available on species specific trade. Unless a species is listed on the CITES Appendices, there are few avenues to gain species specific trade data. Recently however, Global Eye was able to gain access to species specific customs data from Vietnam. Each transaction line item was analysed (approximately 190 000 transactions) to determine what species was being traded, with all *Dalbergia* and *Pterocarpus* species (or their common/local names) tagged for further analysis. The analysis of this information has provided interesting and new insights into how the trade in rosewood and other precious woods is occurring, and some issues associated with relying solely on the Chinese hongmu customs codes listed above.

Figure 4 demonstrates the changing importance of log imports into Vietnam from Asia to Africa, which has been documented several times for China [40, 1]. However, this figure also indicates the changing importance of species across and between each region. It is clear to see that following the CITES listing of *D. cochinchinensis* in 2013 the imports of logs and sawn wood into Vietnam for this species decreased markedly (as shown in Figure 4, Figure 5 and Figure 7), while the imports of *Pterocarpus* species such as *P. erinaceus*, *P. soyauxii*, *P. macrocarpus (*including synonyms *P. pedatus* and *P. cambodiana)* all increased at the same time. Without proper identification available at customs borders, we have to rely on the species listed on the transaction paperwork. However it is possible that traders simply renamed the listed species as the non-listed species in order to evade the stricter trading regulations. Notably, *D. oliveri* log imports also decreased over the same time period without a CITES listing, so it is also possible that this shift in target species is a genuine shift in trading patterns due to dwindling stocks and stricter regulation. These figures provide clear evidence that serial depletion of rosewood species is a high risk factor, and that all species affected by this trade should be managed holistically, rather than species by species.

Figure 5 through to Figure 8 display the imports and exports of rough logs and sawn wood of *Dalbergia* and *Pterocarpus* species alongside each other for easier comparison. While there has been a clear overall drop in rosewood logs exported from Vietnam, log imports into the country remain high, as do sawn wood imports and exports. Log imports of *Dalbergia* and *Pterocarpus* species into Vietnam peaked in 2014 at just under 90 000 m^3, while sawn wood imports into Vietnam also peaked in 2014 at just under 500 000 m^3. Both 2013 and 2015 had similar levels of trade in sawn wood into Vietnam at approximately 350 000 m^3. This pattern closely follows the pattern observed when viewing trade into China under their hongmu codes [1], as well as the patterns observed in Latin American countries. Following the listing of *D. retusa*, also in 2013, the species experienced a peak in exports in 2014 (refer to Threats, Disturbances and Level of Trade – Americas).

Interestingly, particularly for the Asian species, *D. cochinchinensis, D. oliveri and P. macrocarpus*, they are all protected from harvest and export in their range countries (refer to Section on Management Measures and Legal Frameworks for Asia Pacific Region) through domestic legislation and species listings, so the legality of these transactions is questionable. Additionally, Vietnam has a log and sawn wood export ban on timber from natural forests. Therefore, presumably, all the log and sawn wood exports should be re-exports from other countries, and should also presumably be lower than their import values. However, in 2015, sawn wood exports exceeded the volume (m^3) of sawn wood imported (refer to Figure 7 and Figure 8), at 485 748 m^3 (sawn wood) compared to 403 546 m^3. This signals three possible scenarios 1) that rough logs are being processed into sawn wood prior to export; 2) timber obtained from logging of natural forests is being exported or; 3) that timber imported in 2014 was not re-exported until 2015. The total values for imports and exports of sawn wood in 2014 and 2015 are almost identical, which in the third scenario would mean that Vietnam would not be using any of their imported sawn wood in country. However we know from surveys of Vietnamese timber processors that they use sawn timber in manufacture of rosewood products. Either way it is clear there has been a shift from exporting logs to sawn wood.

Figure 9 and Figure 10 display the log imports and log exports (respectively) by country for the time period from 2013-April 2016, broken down by species. Lao PDR has been the largest exporter of logs over that time period, with *D. cochinchinensis* (bright blue shaded) making up the majority of those exports, followed by *D. oliveri* and then *P. macrocarpus* or just "*Pterocarpus spp*". Nigeria is the second largest exporter to Vietnam, which is consistent with Nigeria's ranking for imports into China provided in Treanor (2015), of which all is made up of *Pterocarpus erinaceus* (purple shaded). All other African country exports to Vietnam were dominated by *P. erinaceus* as well. Interestingly, Vietnam imports significant quantities of *P. erinaceus,* both logs and sawn wood, but they do not export any of this species. It is possible that it is re-exported simply as "*Pterocarpus* spp", however this is not able to be ascertained from this dataset. Figure 11 and Figure 12 display log and sawn wood imports and exports by country, side by side, showing the main importer and exporter countries each year. China is the main importer of both logs and sawn wood, however in recent years this has declined somewhat, with Hong Kong becoming more prominent. This is likely due to the tightening of import controls within China, which are not implemented in Hong Kong. Lao PDR, Cambodia and Togo are the biggest exporters of sawn wood to Vietnam. While not shown here, there was also a significant number of transactions from West African nations for Asian species, including *D. oliveri* and *P. pedatus* (synonym of *P. macrocarpus*). While these could be genuine mistakes they are occurring at a frequency that suggests a deliberate move to avoid log export bans of *P. erinaceus*. Either way, these species are clearly labelled on the customs documents and should be picked up when leaving the country if customs officers had basic training and species listings as to what species were actually found in their countries.

Figure 4 - Comparison of Log Imports into Vietnam from Asia and Africa by Species. (Top Row) Shows the changing importance of log imports into Vietnam from Asia and Africa by year. (Bottom Row) Shows the changing importance of each species per year from Africa and Asia.

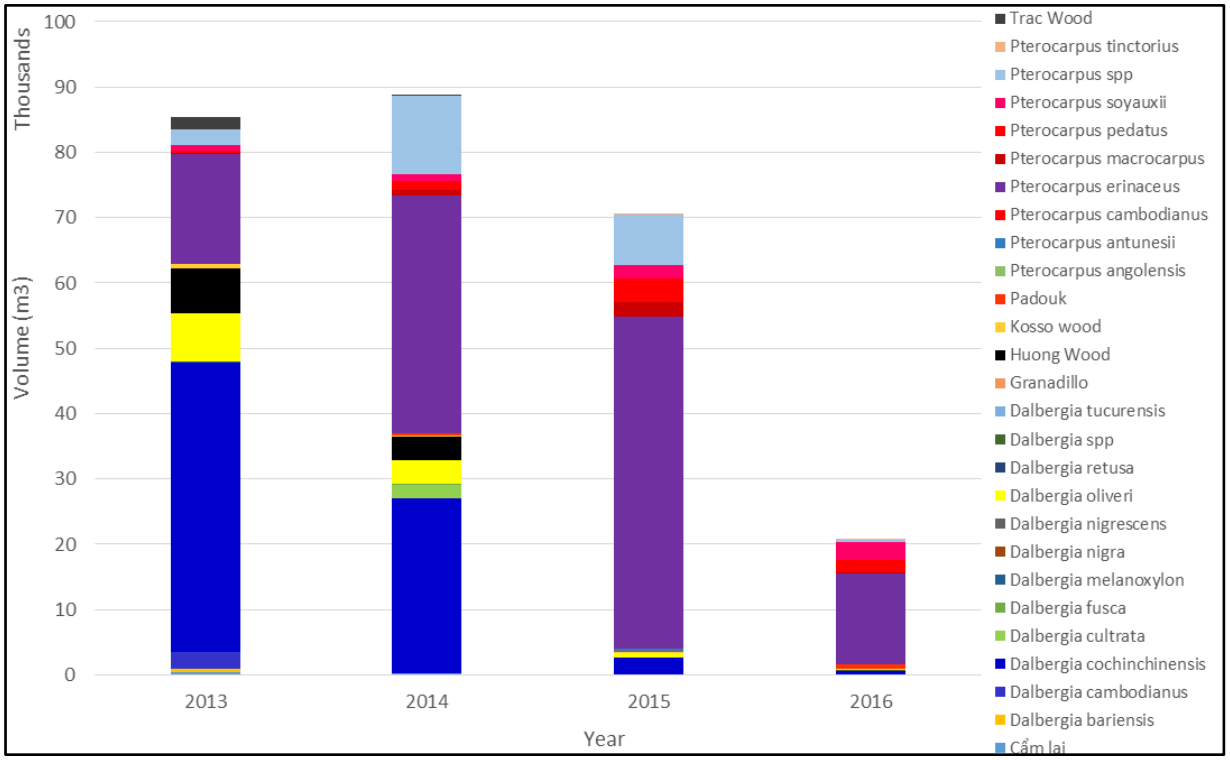


Figure 5 – Log Imports into Vietnam by Species and Year.

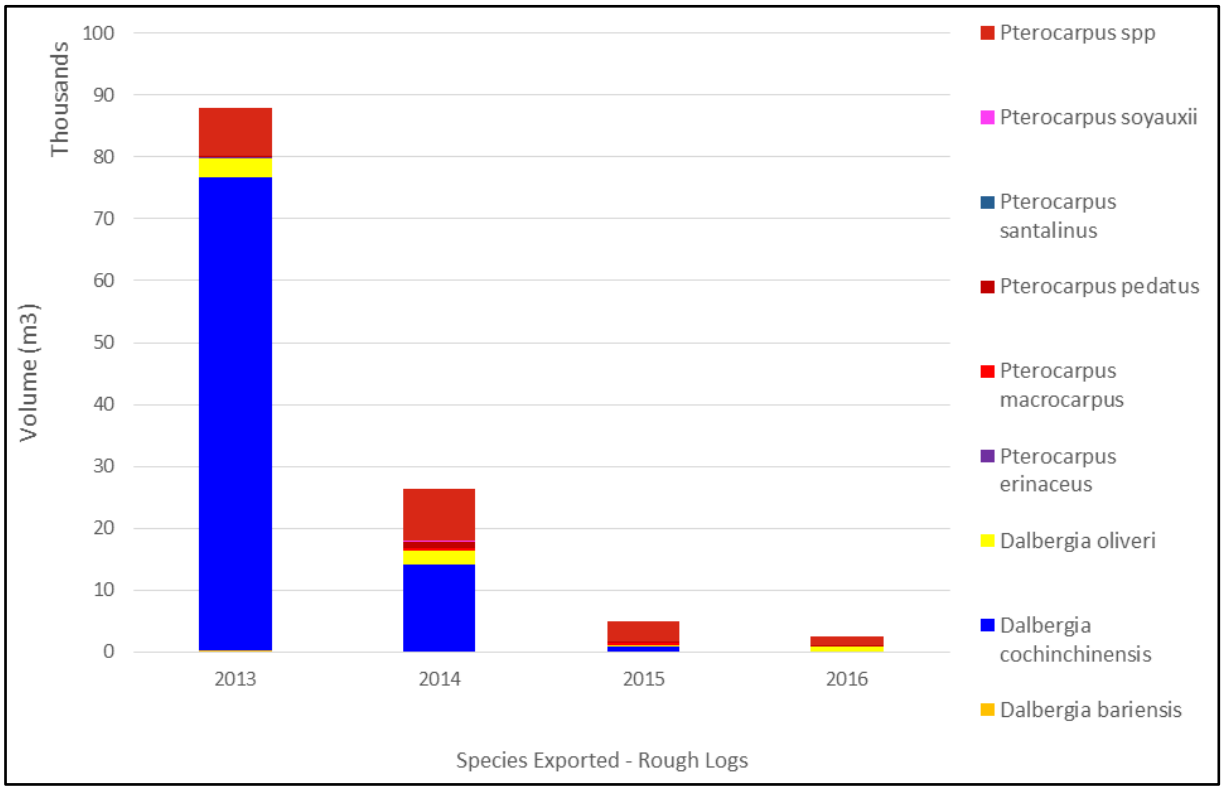


Figure 6 – Log Exports from Vietnam by Species and Year.

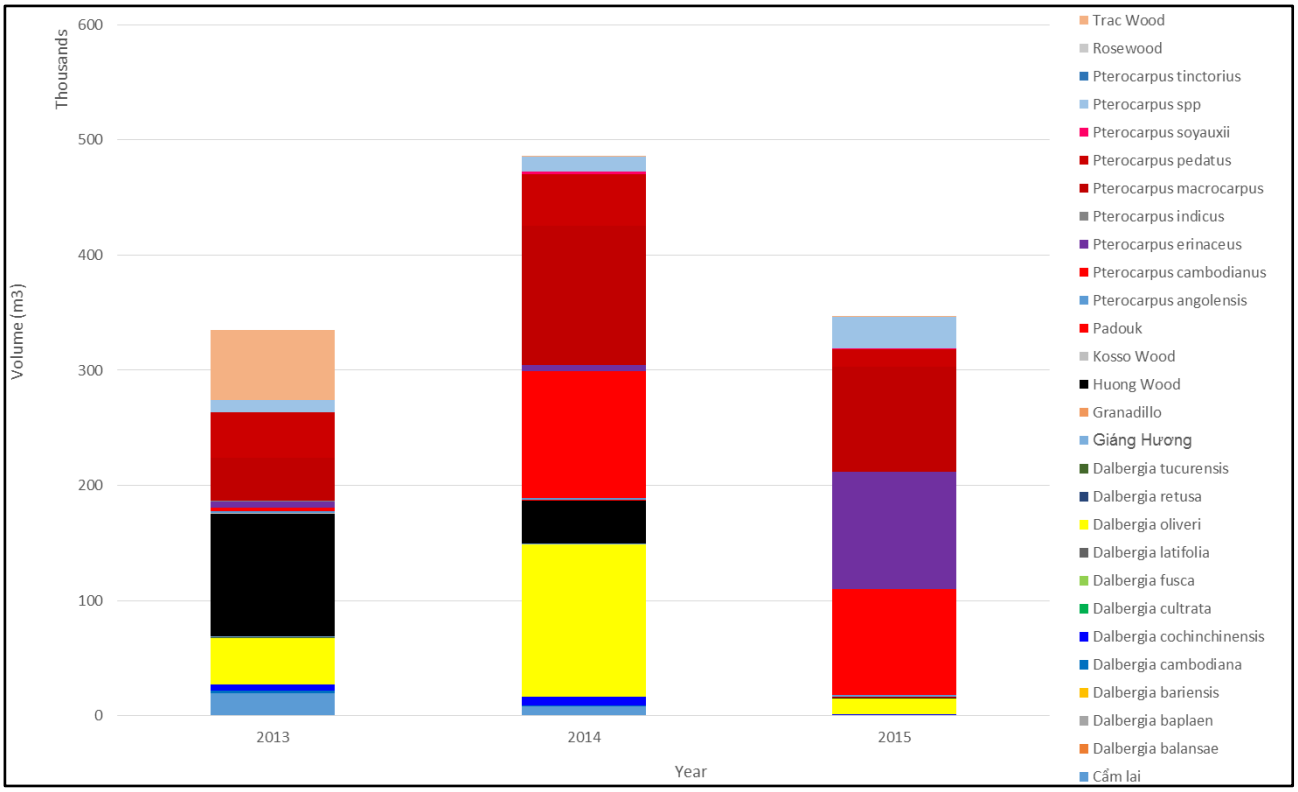


Figure 7 – Volume of Sawn Wood Imports (by Species) into Vietnam from World

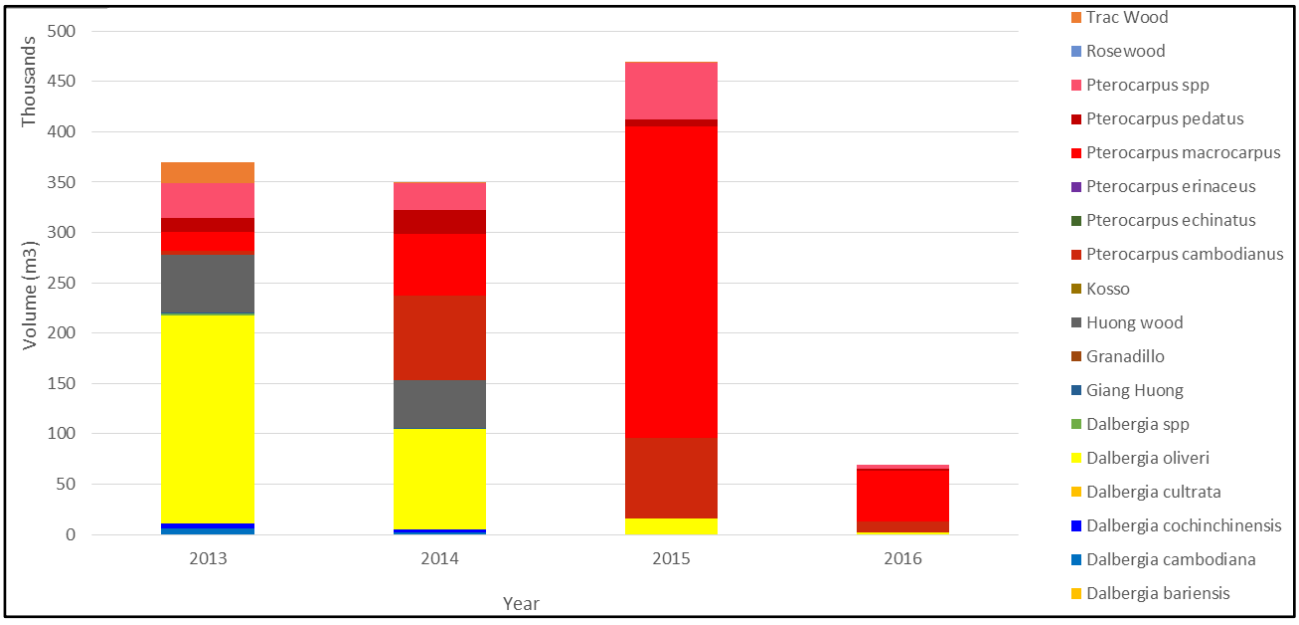


Figure 8 - Volume of Sawn Wood Exported (by Species) from Vietnam to World

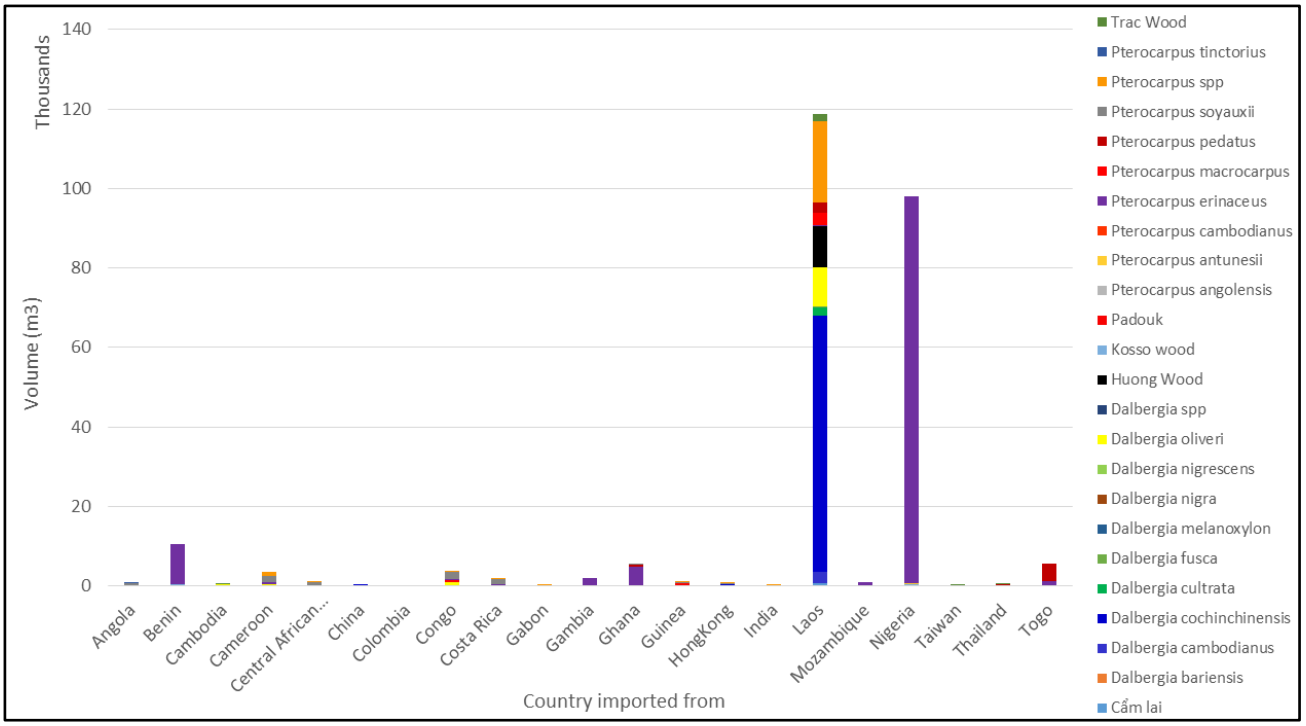


Figure 9 – Volume (m3) of Rough Log Imported into Vietnam by Country and Species (2013 - April 2016)

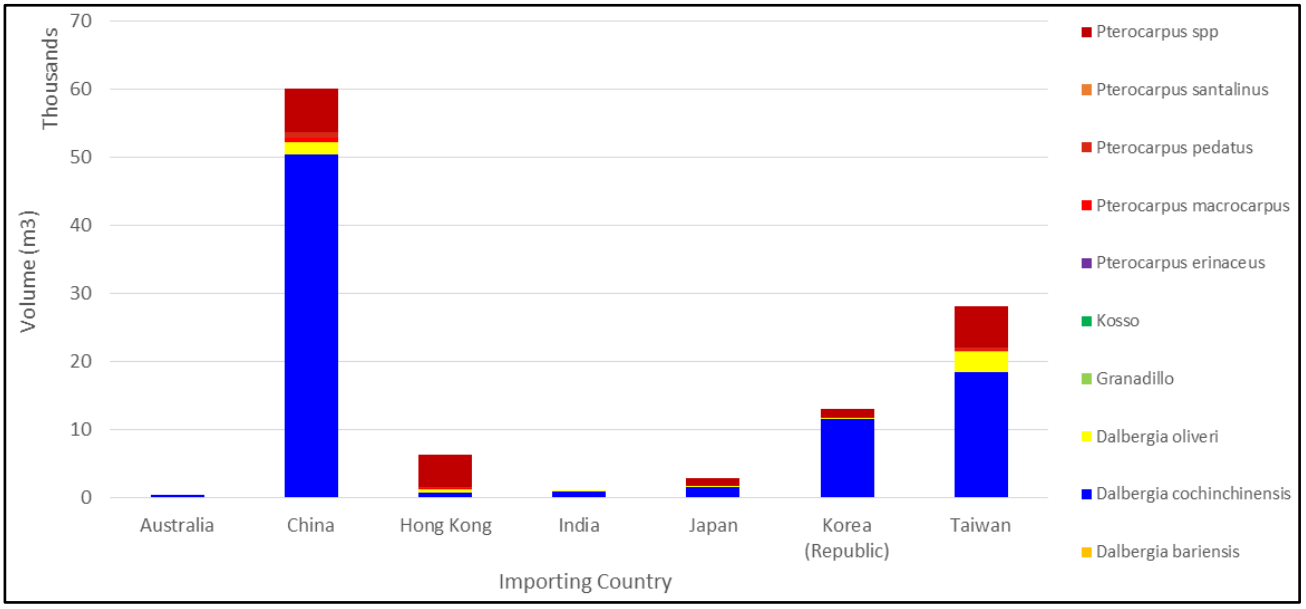


Figure 10 - Volume (m3) of Rough Logs Exported from Vietnam by Country and Species (2013 - April 2016)

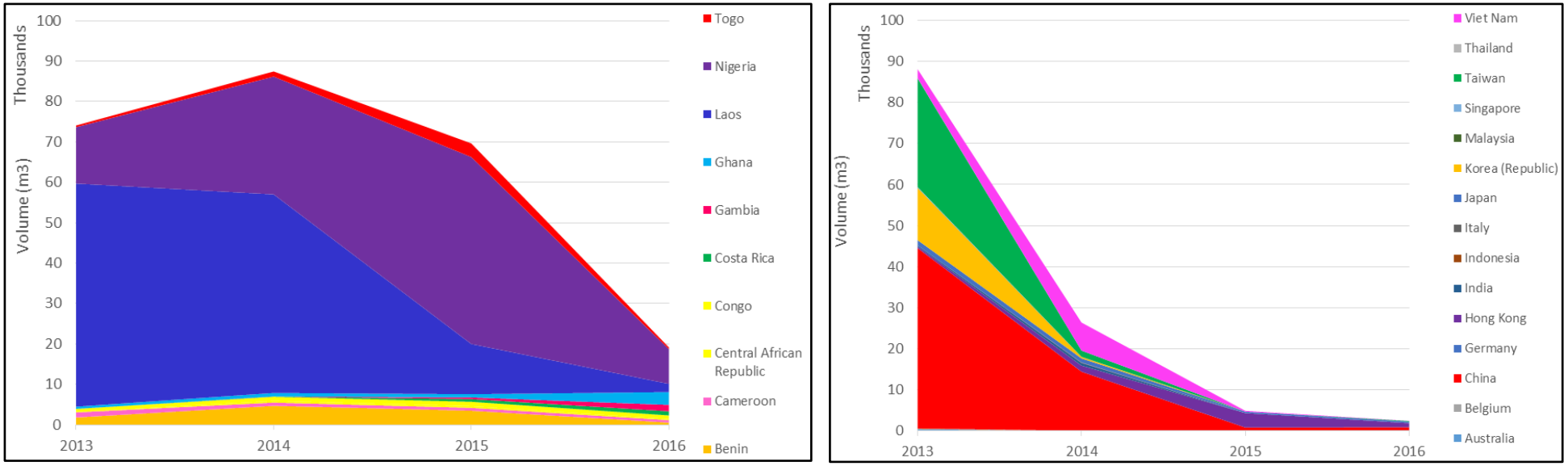


Figure 11 – (Left) Rough Log Imports into Vietnam (Right) Rough Log Exports from Vietnam; of all *Dalbergia* and *Pterocarpus* spp by country

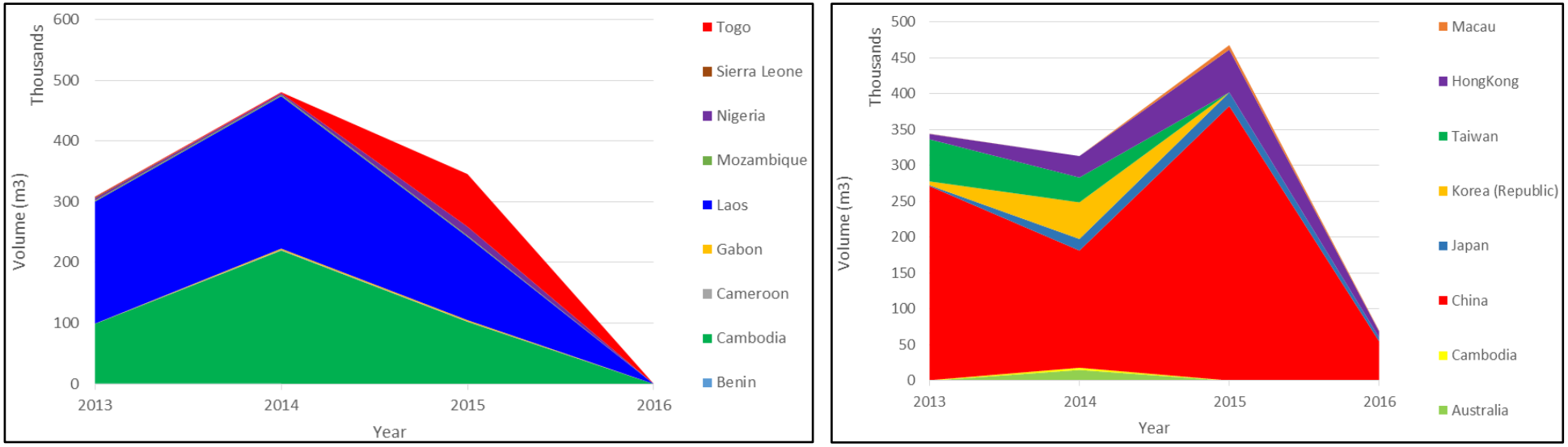


Figure 12 – (Left) Sawn Wood Imports into Vietnam (Right) Sawn Wood Exports from Vietnam; of all *Dalbergia* and *Pterocarpus* spp by country

One of the major shortcomings of utilising the Chinese Customs codes, or in fact any openly available customs commodity codes or HS Codes, is that they are generally not species specific. Therefore, any analysis of trade is only examining a group of species, rather than a particular species. The species specific nature of our analysis allows for a more precise understanding of what percentage of trade the *Dalbergia* and *Pterocarpus* species make up. Table 6 provides details of the number of transactions per year for *Dalbergia* and *Pterocarpus* species for logs imported and exported under HS Code 4403* and sawn wood imported and exported under HS Code 4407*. This is broken down into the proportion of transactions that were for Asian rosewood species or African rosewood species. Rosewood transactions for the Americas are not shown because they accounted for less than 1-2% each year.

Table 6 – Vietnamese Rosewood Imports and Exports for HS Code 4403 and 4407 by Region and Percentage of Total Log Imports

Year	All transactions	All RW	% of Trade	Asian RW Transactions	% of Total Trade	% of RW Trade	African RW Transactions	% of Total Trade	% of RW Trade
Log IMPORTS - 4403									
2013	10880	2718	24.98	2274	20.91	76.96	427	3.92	15.71
2014	13753	2252	16.37	1325	9.63	52.80	912	6.63	40.50
2015	15502	1727	11.14	458	2.95	23.04	1250	8.06	72.38
2016	4455	501	11.25	119	2.67	21.56	360	8.08	71.85
Sawn wood IMPORTS - 4407									
2013	31072	6227	20.04	5888	18.95	94.56	180	0.58	2.89
2014	34561	5514	15.95	5139	14.87	93.20	187	0.54	3.39
2015	35386	3377	9.54	2759	7.80	81.70	441	1.25	13.06
2016	23	5	21.74	2	8.70	40	2	8.70	40
Log EXPORTS - 4403									
2013	1797	1566	87.15	1525	84.86	97.38	1	0.06	0.06
2014	1060	677	63.87	636	60.00	93.94	5	0.47	0.74
2015	639	142	22.22	125	19.56	88.03	1	0.16	0.70
2016	159	24	15.09	16	10.06	66.67	0	0.00	0.00
Sawn Wood – EXPORTS - 4407									
2013	12574	4073	32.39	3697	29.40	90.77	0	0.00	0.00
2014	14629	3123	21.35	2958	20.22	94.72	3	0.02	0.10
2015	10631	1665	15.66	1585	14.91	95.20	0	0.00	0.00
2016	2279	365	16.02	345	15.14	94.52	0	0.00	0.00

With regards to Vietnamese imports, rosewood species in the *Dalbergia* and *Pterocarpus* genera made up 25% of the total trade in logs in 2013, which dropped to 11% by April 2016 Of this almost 77% was for Asian rosewood species and 15.7% was African species, with the remainder comprising generic rosewood names and less than 1% of species from the Americas. For sawn wood imports however, the percentage of total trade was 20% in 2013 and almost 22% by April 2016, after having dropped to 9.5% in 2015, with the percentage of Asian rosewood species almost 95% in 2013, having dropped to 81.7% by 2015. By April 2016 it was only 40%. This is in stark contrast to rosewood species exported as sawn wood from Vietnam, which started at 90% of the rosewood trade and increased only slightly to 95% in 2014 where it has remained in subsequent years. Africa and the Americas are virtually unrepresented in the export transactions for Vietnam of rosewood species, suggesting that African species are being imported are either used domestically, or re-exported as generic rosewood species. The percentage of trade that is being reported under generic trade names such as *Pterocarpus* spp, *Dalbergia* spp or just "Rosewood" has also increased across all years and all commodity codes, up to 20% in some cases.

Chinese hongmu customs codes severely underestimate the amount of rosewood being traded. Table 7 shows the range of different HS Code that were used to import and export rosewood species in the *Dalbergia* and *Pterocarpus* genera into and out of Vietnam. None of the codes used for logs correspond to the first 8 numbers of the HS Codes used for the Chinese Hongmu standard – i.e. HS Code 4403 9930 and less than 1% of the sawn wood transactions corresponded to the HS Code 4407 9910. When viewing the imports into China under their HS codes [1], trade from Vietnam looks minimal – particularly for sawn wood, with Treanor (2015) stating they only exported 5 641 m^3 and Lao PDR was ranked

first with exports of sawn wood over 133 000 m^3. However, when viewing trade across all the HS codes (Table 7) that report *Dalbergia* or *Pterocarpus* genera as the traded species, the trade from Vietnam into China is much more significant, with exports of sawn wood over 380 000 m^3 just for *Dalbergia* and *Pterocarpus* – i.e. not the full 33 species on the Hongmu standard (refer to Table 8). The rows highlighted in green in Table 7 indicate those HS Codes that are correctly used for export of rosewood species, while those highlighted in red indicate HS Codes that are specifically for particular genera of tree species, not including *Dalbergia* or *Pterocarpus*, that also represent a large proportion of the trade (>20%). The other HS Codes are used sporadically and probably represent simple mistakes, however the use of the *Dyera* species specific codes is more likely to be an attempt to avoid taxes or CITES or other protection requirements of those species that are protected in Vietnam.

Table 7 - Analysis of Import and Export Transactions by HS Code

HS Code	HS Code Description	Type	2013	2014	2015	2016	TOT	%
Rough Logs								
44031090	Poles - Treated with paint or preservatives - other	Imp	10	1			11	0.15
		Exp	1				1	0.04
44032090	Poles - Coniferous species - not treated or painted	Imp		1	3	1	5	0.07
44034990	Logs, tropical woods nes: -- Other	Imp	5	4			9	0.13
		Exp		3			3	0.12
44039910	Non-Coniferous - Other: Baulks, sawlogs and veneer logs	Imp	2	10			12	0.17
44037999	No corresponding code was able to be found in any HS Coding system	Exp	1				1	0.04
44039990	Non-Coniferous - Other: Any species not listed in previous HS Codes for logs	Imp	2701	2236	1724	500	7161	99.49
		Exp	1564	674	140	24	2402	99.79
Sawn Wood								
44071000	Sawn Wood - planed, sanded or end-jointed > 6mm - Coniferous spp	Exp	3				3	0.03
44072110	Mahogany **(*Swietenia* spp.):** Planed, sanded or end-jointed	Imp	10	9	12		31	0.21
		Exp	3	7	8	9	27	0.29
44072190	Mahogany (***Swietenia*** spp.): Other	Imp		4			4	0.03
44072290	Lumber - Tropical Wood - *Virola, Imbuia* and *Balsa* spp ***Virola*** - genus of medium sized trees native to South American Rainforests ***Imbuia*** - Brazilian walnut; family Lauraceae, Brazilian Atlantic Forest ***Balsa*** - Ochroma is a genus of flowering plants in the mallow family, Malvaceae, containing the sole species Ochroma pyramidale	Imp	1		1		2	0.01
44072519	Lumber - Tropical Wood - Dark Red Meranti, Light Red Meranti and Meranti Bakau: - - - Dark Red Meranti or Light Red Meranti:- - - - Other Meranti species is a common name used for ***Shorea spp.***	Imp	2				2	0.01
44072939	Sawn Wood - peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm; Other Either Kempas (***Koompassia*** spp) or Jelutang (***Dyera*** spp)	Imp	1				1	0.01
44072941	Other: Jelutong (***Dyera*** spp) - Planed, sanded or end-jointed ***Dyera costulata*** - commonly called Jelutong; Malaysia, Borneo, and various regions in southeast Asia	Exp		2	9		11	0.12
44072989	Sawn Wood - peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm; Other Either **Mengkulang *(Heritiera spp)* -** Cambodia; Jelutang (***Dyera spp***) - Lao PDR	Imp	4	30	12		46	0.30
44072999	***Dyera costulata*** - commonly called Jelutong; Malaysia, Borneo, and various regions in southeast Asia	Imp	1510	827	704	2	3043	20.14
44072999	Other: - - - Jelutong (***Dyera* spp**) - Other ***Dyera costulata*** - commonly called Jelutong; Malaysia, Borneo, and various regions in southeast Asia	Exp	1176	623	507	77	2383	25.83
44079210	Beech Wood (Fagus spp.); - - - Planed, sanded or end-jointed	Exp	1				1	0.01
44079590	Ash wood (Fraxinus spp.); - - - Other	Exp	3				3	0.03

44079900	Lumber: Non-Coniferous - Other:	Exp	2				2	0.02
44079910	Lumber: Non-Coniferous Wood – Other NB: Chinese customs code for Hongmu starts with these digits	Imp	67		1		68	0.45
		Exp		7			7	0.08
44079990	Lumber: Non-Coniferous Wood - Other	Imp	4620	4644	2645	3	11912	78.84
		Exp	2885	2484	1141	279	6789	73.59

Source: Vietnam Customs Data

Table 8 - Exports of Sawn Wood from Vietnam (2013 – 2016) into China by Volume (m³) of *Dalbergia* and *Pterocarpus* species.

Row Labels	2013	2014	2015	2016
Dalbergia bariensis	38.812			
Dalbergia cambodianus	4288.421	613.291		
Dalbergia cochinchinensis	2588.608	1248.373	121.17	
Dalbergia cultrata		14.808		
Dalbergia oliveri	193 880.24	124 667.088	4490.16	674.84
Dalbergia spp	336.608	45.53		
Giang Huong	668.917	612.161	136.94	
Huong wood	17188.246	3192.102	151.19	160.97
Pterocarpus cambodianus	2774.748	25 028.003	43 719.04	6831.96
Pterocarpus echinatus		26.83		
Pterocarpus erinaceus		99.334		
Pterocarpus macrocarpus	12 160.876	38 137.852	278 443.54	43 319.66
Pterocarpus pedatus	9627.941	7740.798	6460.77	1341.42
Pterocarpus spp	21366.345	20035.104	49 226.87	2402.06
Rosewood	6.38	6.2		
Trac Wood*	6096.361	26.27		
Grand Total	**271 022.503**	**221 493.744**	**382 749.68**	**54 730.91**

Source: Vietnam Customs Data. * Trac is the Vietnamese term for rosewood

THREATS TO DALBERGIA AND PTEROCARPUS

Dalbergia and *Pterocarpus* face a diversity of world-wide threats, including illegal logging, forest conversion for agriculture, increasing frequency and severity of forest fires. Threat impacts vary from direct to indirect. For example, increasing atmospheric acidification caused by global climate change can reduce the ability of these species to recover from disturbances [41]. Global Forest Watch (www.globalforestwatch.org) provides detailed information on global forest cover, forest loss, land use and many more factors from 2000 to 2014. Figure 13 shows the global forest loss layer for 30% canopy cover for each region [8].

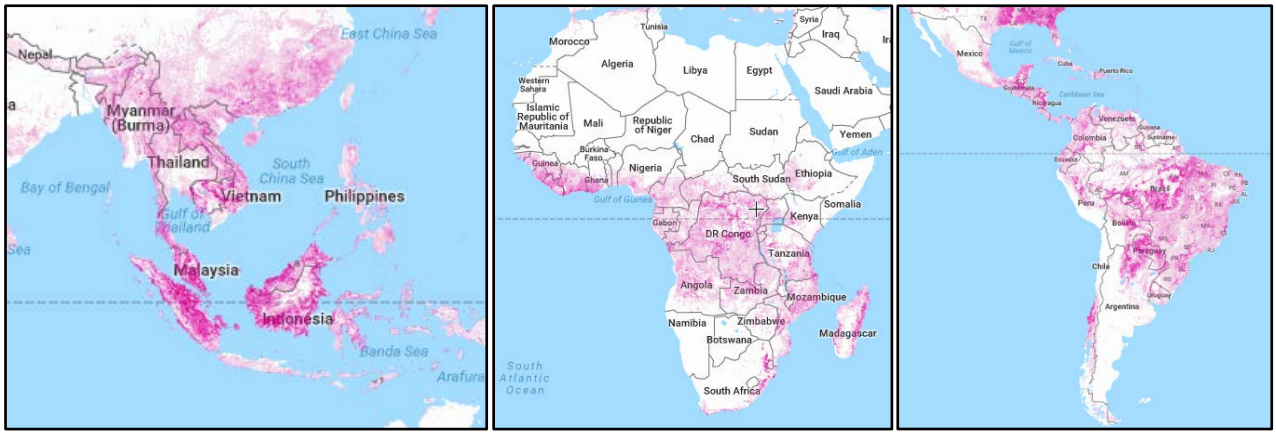


Figure 13 - Global Forest Cover Loss (30% canopy cover) taken from Global Forest Watch

Analysis conducted by the World Resources Institute (WRI) in 2015 [42] on the acceleration rates of forest cover loss found a 14.4% increase in the annual rate of forest loss per year in Cambodia, closely followed by Sierra Leone (12.6%) and Madagascar (8.3%). A large number of countries on the top 10 list are range countries for several of the *Dalbergia* and *Pterocarpus* species discussed in this report. The top 10 list from the WRI article is reproduced in Table 9.

Table 9 – Countries with the Fastest Acceleration of Tree Cover Loss 2001-2014 (Adapted from [42])

RANK	COUNTRY	INCREASE IN ANNUAL FOREST LOSS RATE PER YEAR	RANK	COUNTRY	INCREASE IN ANNUAL FOREST LOSS RATE PER YEAR
1	Cambodia	14.4%	6	Liberia	6.9%
2	Sierra Leonne	12.6%	7	Guinea	6.5%
3	Madagascar	8.3%	8	Guinea-Bissau	6.4%
4	Uruguay	8.1%	9	Vietnam	6.1%
5	Paraguay	7.7%	10	Malaysia	6.1%

This is a major concern for the future of rosewood species. As many of the remaining forests containing rosewood exist in nations experiencing accelerating forest loss, there is an urgent need to ensure adequate management of remaining stocks. Given that trade continues in the absence of any real country-level scrutiny of broader threats and associated declines of *Dalbergia* and *Pterocarpus*, we advise that the question of whether species populations in these genera are ecologically sustainable requires urgent consideration.

MANAGEMENT CHALLENGES AND ISSUES

Management of forests is a mounting concern worldwide, not just for rosewood and other precious wood. There are 81 range countries listed in Table 1, of which only 20 have legislative measures to specifically protect rosewood species. As discussed above, and in the following sections, many countries are experiencing rapid deforestation in the quest to exploit rosewood and other precious woods. Consequently 12 range states for rosewood have implemented log export bans, 6 have implemented logging bans, while 4 have implemented both logging and export bans. While log and sawn wood export bans are good in theory, without adequate governance in place and capacity of customs and police agencies to enforce the export bans, they appear to have limited ability to provide adequate protection to vulnerable forests and species within them. In West Africa, several range countries have implemented log export bans. However, as shown above log exports from the region are still increasing. It is relatively easy to smuggle logs over the border into another country that does not have a log export ban, and then export the species from there. These countries currently have little capacity to control this illegal cross border trade. The same can be said for Asia, where there are ongoing instances of serious conflict along the Thai-Cambodian border caused by Cambodian loggers illegally crossing into Thailand to cut Siamese Rosewood. While Thailand has strong harvest bans for this species, once it is logged and moved into a neighbouring country, it can be effectively laundered and can be exported from there. Alternatively, traders simply conduct some processing of the logs into sawn wood or other minimally worked products to avoid either CITES requirements or domestic legislation and regulations. While many countries have policies or legislation in place to promote sustainable utilisation, there is too little implementation to ensure sustainable utilisation of resources.

In Madagascar, the case is even more complicated. There has been a moratorium on log exports of Malagasy rosewood for several years [27]. There are large stockpiles of “declared” timber, as well as seized timber stockpiles managed by the government, and it is recognised there is high probability of significant amounts of undeclared or hidden timber stockpiles still remaining in the country [27]. There are also significant stockpiles that have been seized in overseas countries. These stockpiles present a real challenge for ensuring sustainable management and use of forest resources within Madagascar. The mere existence of stockpiles offers opportunities to launder timber, with lesser value timber logs substituted for the more valuable rosewood within a stockpile. The issue of stockpiling is not isolated to Madagascar or to timber species. The issue of ivory stockpiles in on the agenda at CoP 17 (Doc. 57.3), as is a general agenda item on stocks and stockpiles (CoP17 Document 47) where Parties will debate the best way to deal with this growing and complex issue. In relation to the stockpiles of timber in Madagascar, the government put forward a plan to audit the stockpiles, which was completed in 2015. It was proposed to auction the seized timber, with subsequent monies injected into conservation and forestry efforts in country. Other suggestions of what to do with the stockpiles have included a proposal for the timber to be used domestically to make furniture or other commodities for sale within Madagascar [43]. The problem with seized timber auctions is that they have been shown to promote continued illegal trade. Asia is a case in point; Thailand ceased allowing seized timber auctions in 2007. Given the extremely low socio-economic status of Madagascar’s people, it seems appropriate to ensure that any future use of these seized timber stocks benefit the local people, rather than the large timber traders that have been responsible for logging most of Madagascar’s forests to date.

SECTION II – REGIONAL ANALYSIS

SECTION IIA – REGIONAL ANALYSIS: ASIA PACIFIC REGION

INTRODUCTION

This section of the report covers 21 *Dalbergia* and *Pterocarpous* species distributed in the Asia Pacific Region that produce rosewood heartwood, and are likely to be exploited in trade. We report on the known information pertaining to taxonomy, species biology including growth rates and regeneration potential, population status and structure, trade and threat assessments and conservation management measures to protect the species from unsustainable harvesting.

The IUCN Red List has assessed six species as endangered, eight species as vulnerable, and one species as data deficient, while four species are yet to be assessed. However the majority of these assessments were completed almost 20 years ago in 1998 [44, 45, 46, 47, 48, 49, 50, 51, 52, 53]. Further, three out of the four unassessed species, namely *Pterocarpus macrocarpus*, *Pterocarpus pedatus* (synonym) and *Pterocarpus cambodianus* (synonym), are now utilised as replacement species for *D. cochinchinensis* as a result of dwindling availability and its 2013 inclusion onto Appendix II of CITES [54, 55]. There are a number of species which have been identified as potentially requiring a different IUCN category class. For example, according to Prasad et al (2008) *Pterocarpus dalbergioides* was identified as a threatened species which could soon become extinct, but it is currently considered data deficient on the IUCN Red list [56, 51]. An intra-specific taxa assessment of *D. cultrata* var. *cultrata* undertaken in 1998 listed this species as endangered [57], while an updated assessment undertaken by Contu (2012) [58] has assessed *D. cultrata* as Near Threatened. There was no reason given for the change in this assessment and this paper did not clearly identify reasons to warrant a downgraded assessment. We argue that updated assessments are urgently required for all species in this region, clearly detailing the current threats and statuses.

SPECIES TAXONOMY

Several of the *Dalbergia* and *Pterocarpus* species within the Asia Pacific region have taxonomic uncertainties as outlined in Table 10. For the purpose of this report, the information included in Table 10 shows which species have been used synonymously for each other. The accepted species name based on most recent science, or country level references is listed first, with synonym species underneath. It also includes a comprehensive list of common and vernacular names for the species in this region, as trade records often use these names as opposed to their scientific names. After this section only the accepted name will be utilised, except where a synonym has been widely used in trade data.

Table 10 - Species Taxonomy in Asia-Pacific Region. A = Accepted Name, S = Synonym RR = Taxonomic Revision Required

A	S	RR	TAXONOMY DISCUSSION	COMMON AND VERNACULAR NAMES
D. annamensis			The Plant List (2013) [59], TROPICOS.org (2016) [60] and WCSP (2016) [61] do not recognise this species. While UNEP-WCMC (2008) [62] noted this species to be accepted in Vietnam, they also identified this species as a priority for taxonomic revision. Niyomdham & Pham Hoang Ho (1996)[7] (as referenced by UNEP-WCMC (2014) [63]) use the name *Dalbergia velutina* var. *annamensis* in their revision of the genus *Dalbergia* for Peninsular Indochina.	Trac day (Vietnamese). [49, 64]
		✓		
D. assamica			*D. assamica* is supported by a number of sources as an accepted species, [59, 65, 60] however, as noted by Chadburn (2012) [66], its taxonomic status is debated. While some sources support *D. balansae* as a synonym for *D. assamica,* [67, 68, 60] other sources recognise *D. balansae* as its own species. [59, 69]. Hartvig et al (2015) [67] supported *D. balansae* as a synonym because they found it to be in the same clade as *D. assamica.* The Plant List (2013) [59] lists '*D. assamica* Benth' as an accepted name and '*D. assamica* Benth, p.p.' as a synonym for *D. sericea,* while also listing *D. balansae* as	South China rosewood. [71] Thai vernacular names for *D. assimica* include *ket dam* (Chiang Mai), *ket deang* (Lampang), *kam pi, kra pi* (Saraburi). [68] Chinese vernacular names that are recognised for *D. assamica* include green seedling (秧青), medicago rosewood (紫花黄檀) Simao rosewood (思茅黄檀), and for *D. balansae* include Nanling Tan (南岭檀), balansae (南岭黄檀), Acacia Water (水相思), Ah rattan tea (茶丫藤) and Yellow Class Tree (黄类树) [12].
✓	✓	✓		

7 An English version of this report was not available to cross reference the information.

D. balansae			an accepted name. *D. balansae* and *D. assamica* have also been assessed differently on the IUCN Red List. Nghia, 1998 [46] assessed *D. balansae* as vulnerable while Chadburn (2012) [66] has assessed *D. assamica* as "least concern". Chadburn (2012) [66] has also acknowledged the taxonomy confusion of both species and has recognised that if *D. balansae* is accepted as its own species, then the two species are likely to have different Red List categories. Further research is required to confirm the taxonomy of both species. *Amerimnon assamicum*, *D. bhutanica, D. lanceolaria*, *D. lanceolaria var assamica* and *D. szemaoensis* are also recognised synonyms for *D. assamica,* [59, 70], while *D. lanceolaria* has been recognised as a synonym for *D. balansae*. [59]	
✓	✓	✓		
D. cochinchinensis			Asian Regional Workshop (1998) [52] and The Plant List (2013) consider *D. cambodiana* to be an accepted species. Numerous other sources confirmed it to be a synonym of *D. cochinchinensis,* [68, 69, 72, 73, 74] including Hartvig in litt. (2012) (results unpublished) who undertook molecular barcoding analysis to confirm this.[8]	Siamese Rosewood, Thailand Rosewood, Rosewood, Vietnamese Rosewood, Asian Palisander (commercial name), Redwood (trade name) and Tracwood (trade name) [52, 75, 73, 76]. Thai vernacular names include phayung mai (Sariburi), Kra-yong, kra-yung (Khmer-Surin), kha yung (Ubon Ratchathani), daeng chin (Prachin Buri), pradu lai (Chon Buri), pradu sen (Trat), pha tung (general). [68] Cambodia vernacular names include Kra-nhourng, [72] Vietnamese vernacular names include Cẩm Lai and Trac (tracwood), [73, 72] while in Lao PDR it has the vernacular name of mai kha nhoung [76] and in China it is known as hua-li-mo, hongmu and Hongsuanzhi (紅酸枝) [68, 73].
✓				
D. cambodiana				
	✓			
D. cultrata			Niyomdham (2002), Van Sam et al (2004), Contu (2012)[9] and Tropicos.org (2016) consider *D. fusca* Pierre to be a synonym of *D. cultrata* Benth. The Wood Database (2015) recognises the species *D. cultrata* but does not recognise the species *D. fusca.* The Plant List (2013) considers '*D. fusca* Pierre' to be an accepted name and lists '*D. fusca* Prain' as a synonym of *D. cultrata* Benth. The Plant List also considers *D. fusca* var. *enneandra* to be a synonym of *D. fusca* Pierre and *D. cultrata* var. *cultrata* to be a synonym of *D. cultrata* Benth. Sun (1998)[10] has assessed *D. fusca* var. *enneandra* as its own species. Nghia (1998) [57] has undertaken an infra-specific taxa assessment of *Dalbergia cultrata* var. *cultrata*, however, acknowledges *D. cultrata* as the parent species. For the purpose of this report, *D. fusca* is considered to be a synonym of *D. cultrata.* However, based on the taxonomic confusion as demonstrated above, this report considers that an updated assessment of both species should be undertaken.	Burmese Blackwood, Burma blackwood, Khamphi rosewood. Black Rosewood. [69, 77] Lao PDR vernacular names include Lamz (Louang Prabang), Pik nhang (Xieng Khouang) [69], Vietnamese vernacular names include Câm lai giao and Trăc giao, [69] and Thai vernacular names include Kra phi (Central), kra phi khao khwai (Udon Thani, Ratchaburi), ket khao khwai (Northern), kam phi, ching chan (Phetchabun), Kam phi khao khwai, daeng dong (loei), chak-chan, wiat (Shan-Chiang Mai), ma kham pa (Chiang Mai), seng-phli-khlaw (Karen-Mae Hong Son), i men bai mon (Udon Thani). [68].
✓		✓		
D. fusca				
	✓	✓		
Dalbergia latifolia			The Plant List (2013) considers *Amerimnon latifolium* (Roxb.) *Kuntze* and *D. emarginata* Roxb to be synonyms of this species. A genetic study revealed that that *D. latifolia* and *D. sissoo*shared a minor cluster relationship with 50% similarity [78].	Bombay Blackwood, Indian Rosewood, Indonesian Rosewood, Malabar Rosewood, Indian palisandre, Java palisandre, Roseta rosewood [50, 79, 77, 80]. Vernacular names include Palisandre De L'Inde, Palissandre Asie, Palissandre d'Asie (French) [50, 81], Sonokeling
✓				

8 As referenced by CoP 16 Prop. 60 [74].
9 ICUN Red List Assessor.
10 Also, an ICUN Red List Assessor.

				(Cambodian) [79, 16], swetasal, sitsal (Bengali), Indischer Rosenholzbaum, Indisches Rosenholz, Palisander (German), kalaruk, shisham (Gujarati), sitsal, bhotheula, shisham, bide, beete, chava (Hindii) sonokeling, sonobrits (Indonesian); pallisander, sonosungu, sonokeling, sonobrits (Javanese); satisal (Nepali); shishapa (Sanskrit); karundoviral, eruvadi, iridi, itti, palkonda (Tamil), shisham (Urdu); tr(aws)c (Vietnamese). [80]
Dalbergia oliveri			The taxonomy of these three species is often confused by different sources but also within various countries. As summarised by UNEP-WCMC (2014), *D. bariensis* is considered to be a synonym of *D. oliveri* in Cambodia. UNEP-WCMC (2014) also noted that Thailand's acceptance of *D. bariensis* as an accepted species was under revision. *D. bariensis* is considered to be an accepted species in Vietnam, *D. oliveri, D. mammosa* and *D. bariensis* are used synonymously for each other. Meanwhile, Van Sam et al (2004), considered *D. mammosa* and *D. bariensis* as synonyms for *D. oliveri*, while Lock and Heald (1994), Chinh et al (1996) (both referenced in UNEP-WCMC (2014), Nghia (1998) [45, 48, 44], The Plant List (2013) [59] and Tropicos.org (2016) [60], consider each individual species as accepted species on their own. *D. bariensis* has also previously been identified as a species that may be closely related to *D. cochinchinensis*. [73] In 2008, all three species were put forward as priority species considered in need of taxonomic revision by range states: Cambodia, Lao PDR, Thailand and Vietnam [82]. Hartvig et al (2015) noted the taxonimic discrepancies between *D. oliveri, D. bariensis* and *D. mammosa* and applied DNA barcoding methods in an effort to revise the discrepancies. Their study found *D. oliveri* to be well supported as monophyletic and they argued that this species name should be used consistently across the distribution range. For this report, *Dalbergia oliveri* will be treated as the accepted name.	Commonly known as Tamalan and Chingchan. [55] Burmese rosewood is reported used for both *D. bariensis* and *D. oliveri* in trade records. [45, 63] Venacular names for *D. bariensis* include: mai ching chan (Thailand), Neang Nuon (Cambodia), Pa dong daeng, Mai Kor phee (Lao PDR), Cam lai (Vietnam),. Bali Huangtan 巴厘黄檀 (China). [63] Venacular names for *D. oliveri* include Neong Nuon (Cambodian), Burmese Rosewood, Asian rosewood, Burma pallisander, Burma tulipwood, Pinkwood, Tamalan tree, Lao PDR rosewood, (English), Kampee (Lao PDR), Tamalan (Myanmar), Tamalan (Singapore), Kham phi leung (Vientiane), Padong deng (Savannakhet), Câ'm lai, Câ'm lai bong, Câ' m lai mât (South), Trăˊc lai (Ninh Thuân) (Vietnamese). [63] Venacular names for *D. mammosa* include Cam lai vu (Vietnam). " (UNEP-WCMC, 2014).
✓				
Dalbergia bariensis				
✓	✓	✓		
Dalbergia mammosa				
✓	✓	✓		
Dalbergia odorifera			According to Yu et al (2015) [83], this species is closely related to *D. tonkinensis* as their colour, density and odour are very similar and it is often hard to distinguish between the two species. However, they found that it was possible to distinguish between the two species by extracting DNA from the sapwood or heartwood. They identified that the DNA barcode trnH-psbA discriminated 100% between the two species.	Huang Hua Li and fragrant rosewood. [9]
✓				
Dalbergia sissoo			The Invasive Species Compendium (2013) states that *D latifolia* and *Amerimnon sissoo* are considered synonyms, while a genetic study undertaken by Rout et al (2003) suggested that *D. latifolia* and *D. sissoo*shared a minor cluster relationship with a 50% similarity. The Plant List (2013) also supports *Amerimnon sissoo* as a synonym. According to the Wood Database (2015), the status of *D. sissoo* as an official rosewood is disputed because its density, hardness, and colour intensity is lower than other rosewoods.	Indian rosewood, Bombay blackwood, Indian teakwood, East Indian rosewood, *Dalbergia,* skuva, Indian *Dalbergia*, Himalaya raintree, penny-leaf tree, shisham, sisso, sissoo, [84, 85, 86] Vernacular names include: sisu (Spanish), *Dalbergia* (Arabic), shinshapa (Sanskrit), sisso, nukku kattai, gette, sisuitti (Tamil), pradu-khaek (Thai), yette (Tamil), du-khaek (Thai), ostindisches Rosenholz (German), aguru (Sanskrit), shishu (Bengali), sissau, sisham (Nepali), sisam, shisham (Hindi), shisu, sisu
✓				

				(Bengali), sonoswaseso (Javanese), sissu, sissai (Hindi), pradu-khaek, du-khaek (Indonesian Bahasa), ébénier juane (French). [86, 87]
Dalbergia tonkinensis			*Dalbergia rimosa* var. *foliacea* is considered to be a synonym [65]. The colour, density and odour of *D. tonkinensis* is very similar to *D. odorifera* (see further discussion above at *D. odorifera*). [83] In Vietnam, *D. tonkinensis* has been used for several different species and was considered to be a priority species requiring further taxonomic research. [63]	Vietnamese vernacular names include Huynh dan, Sua, Huemoc huynh dan and Trac thoi. [63]
✓		✓		
Pterocarpus dalbergioides			*P. advena* and *Lingoum dalbergioides* Pierre are considered to be synonyms of this species. [59, 60] *P. indicus* was previously misapplied as a synonym of this species [59]. This species has been identified as data deficient and in need of an updated Red List assessment. [51]	East Indian Mahogany, Narra, Andaman padauk, Andaman redwood. [82, 9, 51]
✓		✓		
Pterocarpus indicus			*P. zollingeri Lingoum indicum* and *Lingoum wallichii, P. pallidus; P. wallichii* are all considered to be synonyms of this species [69]. *P. macrocarpus* is closely related because their leaves and flowers are almost identical, with their fruits being used to tell the two species from each other. [88] Francis (2002) linked *P. indicus* with *P. santalinus,* based on *Rojo (1977),* but the reasons for this were not stated.	New Guinea rosewood, narra, Malay padauk, pricky narra (*P. echinatus*) or smooth narra (*P. indicus*), red sandalwood, redwood, amboyna and is often traded under the names: amboyna, blanco's narra, Burmese rosewood, Malay padauk, rosewood, Tenasserim mahogany, Philippine mahogany. Vernacular names of this species include ansanah, pashu-padauk (Myanmar), narra (Philippines), amboine, santal rouge (France), sena, linggod, sonokembang, angsana, angsena (Indonesian), Sino-Tibetan, chan dêng (Lao PDR), sena, angsana (Malaysia), praduu baan, pradoo, duu baan (Thailand) and gi[as]ng h[uw][ow]ng (Vietnamese). [69]
✓				
Pterocarpus marsupium			*P. bilobus* and *Lingoum marsupium* have been listed as synonyms of this species [59, 60].	Indian Kino and Bijasal, Malabar Kino [89, 90, 9]. Vernacular names include Venga (Malayalam), Vengi (Tamil), Malbar Kino tree (English) and Bijasal (Hindi) [90].
✓				
Pterocarpus macrocarpus			21 synonyms of *P. macrocarpus* have been recognised, of which *P. pedatus* is the most commonly used [55]. Other recognised synonyms include *P. cambodianus, Lingoum cambodianum; L. macrocarpum; P. cambodianus var. glaucinus; P. cambodianus* var. *gracilis; P. cambodianus* var. *parviflorus* are recognised synonyms of this species.	Commonly known as Padauk or Thnong. [9, 76]. *P. macrocarpus* is commonly referred to as Burmese/Burma padauk [91, 55] and in Lao PDR it's commercial name of padauk and santal rouge [76], while *P. cambodianus* is commonly referred to as Vietnamese Padauk. [9] Vernacular names for these species include thnong krop thom (Cambodia), Du Luad, mai dori and mai dau (Lao PDR), Dáng hu o ng, Sông la, giang hriong trai to (Vietnam), pradu (Thailand), paduak (Myanmar) [69, 92, 76].
✓				
Pterocarpus cambodianus				
	✓			
Pterocarpus pedatus				
	✓			
Pterocarpus santalinus			*Lingoum santalinum* has been listed as a synonym of this species. Please also refer to taxonomic discussion above at *P. indicus*.	Red sanders, red sandalwood, ruby wood, saunderswood, almug [93, 94, 79]. Indian vernacular names of this species include Rakta Chandana (Sanskrit) Lalchandan (Hindi), Sivappu Chandanam, Sensandanam (Tamil), Yerra Chandanamu, Agaru Gandhamu, Rakta Gandhamu (Telugu), Agaru, Rakta Chandana, Kempu Gandanamu, Agaru Gandhamu (Telugu), Agaru, Rakta Chandana, Kempu Gandha (Kannada), Patrangam, Rakta Chandanam, Tillaparni (Malayalam), Lal Chandan, Rokto
✓				

				Chandan (Belgali), Lohoti Chondono, Rokto Chandano (Oriya) Tambada Chndana (Marathi), Chandan lal (Punjabi) Ratanjali (Gurarati). [94] Other vernacular names include rotes Sandelholz (Germany); sandal rouge (France) and sandalo rosso (Italy) [79]

For the rest of this report, only accepted names will be used except where synonyms are used specifically in trade data or within a specific scientific study.

SPECIES BIOLOGY

The vast majority of rosewood species, namely: *D. latifolia* [81], *D. oliveri*, *D. cultrata*, *P. macrocarpus* [69], *D. sissoo* [95], *P. marsupium* [96], *P. indicus* [97], *P. santalinus* [98], distributed in this region are deciduous plants, with the exception of *D. cochinchinensis* and *D. odorifera* which are described as evergreen plants. Height, diameter, flowering and fruiting seasons vary for each species depending on the range country location and ecological conditions. The large majority of the species in this region are slow growing with the exception of *D. sissoo*. As a result, this species have been widely introduced across the region and other continents; however it should be noted that the status of *D. sissoo* as a "rosewood" species is disputed [84]. According to The Wood Database (2015) [84], density, harness and colour intensity of *D. sissoo* are lower than other rosewoods but the wood is highly regarded and very valuable in India, its native country.

D. latifolia. *P. indicus* and *P. santalinus* all have two recognised varieties. In Java, the native variety of *D. latifolia* is called *sonokeling* and it is a straight wood which is used in agroforestry [99]. It seldom produces seeds and is reproduced by suckers [99]. The other form of *D. latifolia* is a naturalised variety called *sonobrits,* which produces seeds on a yearly basis [99]. *Sonobrits* is fast growing and is used in land rehabilitation, however, the wood is less valuable due to its crooked form and because it produces a more dull coloured heartwood [99]. The two varieties of *P. santalinus* trees are also distinguished by their wood. Most *P. santalinus* trees have a normal grain called *Pride of Andhra Pradesh*, however, there is also a rare wavy grain variety called *red gold* which is more valuable in international markets [94, 98]. Studies on the two varieties have noted that seedlings raised from 'Red Gold' were slower growing compared to the straight grained variety [98]. *P. indicus* is also divided into two forms which are distinguished by the spines on the seed-bearing part of the fruit [88]. *P. indicus* forma *indicus* is known as the smooth narra while *P. indicus* forma *echinatus* is known as the prickly narra [88, 100].

Table 11 and Table 12 sets out various biological information for each species in this region. Some species have an abundance of information available (Table 12), while others, like *D. odorifera* and *D. tonkinensis*, have less information (Table 11). This isn't necessarily because there haven't been studies undertaken on the species: it may be that the studies undertaken have not been translated into English. Both of the aforementioned species are collectible classes and very valuable in China so there are likely to be research papers available in the Chinese language that Global Eye has been unable to obtain copies of.

Table 11- Species Biology Summary Table for Species with low levels of information available

ASIAN *DALBERGIA SPP*				
Species	**Species Description**	**Habitat Type**	**Reproduction, Growth, Development etc.**	**Wood Properties**
Dalbergia odorifera		As a predominantly endemic species in Hainan, China, this species can be found in secondary forest and scrub, west and southwest plains or hilly areas and up to 600 m altitude [53, 101].	This species is known to be reproduced from coppiced individuals in stands [53].	Wood density (oven dry mass/fresh volume) - 0.809 – 0.890 g/cm3 (China) [102, 103].
Dalbergia tonkinensis	Tree height = 25 [63] Tree diameter = 80 [63]	According to Chính et al (1996) [11] and Ban (1998), this species prefers deep, fertile soils in primary and secondary forests below 500 m in altitude and is		

11 As referenced by UNEP-WCMC (2014).

ASIAN *DALBERGIA SPP*				
Species	**Species Description**	**Habitat Type**	**Reproduction, Growth, Development etc.**	**Wood Properties**
		found in reserves if Lang Son province and Ha Noi and Phong Nha-Ke Bang National Parks.		

Table 12 - Species Specific Biology Summary for Species with more information available

<table>
<tr><th colspan="4">DALBERGIA ANNAMENSIS</th></tr>
<tr><th>Height (m)</th><th>Diameter (cm)</th><th>Flowering Season</th><th>Fruiting Season</th></tr>
<tr><td rowspan="2">8-9 [104]</td><td rowspan="2">35 [104]</td><td colspan="2">Vietnam</td></tr>
<tr><td>July to August [104]</td><td>February to March [104]</td></tr>
<tr><th colspan="2">Species Description/ Habitat Type</th><th>Reproduction/survival strategy and germination/regeneration potential</th><th>Growth rates and heartwood development information</th></tr>
<tr><td colspan="2">Description: Small tree located in south central coast of Vietnam [49, 63, 105].

Habitat types and locations
- lowland dry open forests [49, 63, 105].
- Kon Ka Kinh National Park: evergreen, subtropical wet rainforest and low mountain forests [106].
- Phu Yen and Khanh Hoa provinces: lowland, dry open forests [105].
- Hoa Kien area: found in low hills. Elevation = -400m. Altitude = 100-200m [104].</td><td>Germination Potential
- Low: due to high temperature and low rainfall where grows [104]
- Seed germination 81.1% (silviculture) [104]
- Cutting propagation achieved in 76.6% [104]

Silviculture experiments
- Artificial propagation by seed and cuttings, with use of stimulates achievable [104]</td><td>Silviculture:

Table 13 - Growth rates of seed and cutting propagation after 6 months using growth stimulants [104]
<table>
<tr><th>Growth Parameter</th><th>Seed</th><th>Cutting</th></tr>
<tr><td>Height</td><td>87.5 cm</td><td>96.1 cm</td></tr>
<tr><td>Diameter</td><td>6.4mm</td><td>8.7 cm</td></tr>
</table></td></tr>
<tr><th colspan="4">DALBERGIA ASSAMICA / BALANSAE</th></tr>
<tr><th>Height (m)</th><th>Diameter (cm)</th><th>Flowering Season</th><th>Fruiting Season</th></tr>
<tr><td rowspan="2">Up to 15 (D. balansae) [71]
7-10 (D. assamica) [107]
15-40 (D. assamica) [68]</td><td rowspan="2">35 [104]</td><td colspan="2">Unspecified</td></tr>
<tr><td>(January -) February to May [75]</td><td>June to November [75]</td></tr>
<tr><th colspan="2">Species Description/ Habitat Type</th><th>Reproduction/survival strategy and germination potential and regeneration potential</th><th>Growth rates and heartwood development information</th></tr>
<tr><td colspan="2">Habitat type:
- lowland and sub-montane mixed deciduous and dry evergreen forest, scrub and wasteland around villages [75, 71, 107, 46, 105].
- Thailand: mixed deciduous forest, 50 to 800 m [68, 69].
Elevation:
D. assamica = 100-2000 m [66, 75], 50-800m (Thailand) [68].</td><td>Regeneration
D. assamica: strong on abandoned shifting cultivation areas [66]. D. balansae: strong on fallow land. Grown on small scale mixed plantations as a hold plant for lac insects (China and Vietnam) [105].</td><td>Wood density (oven dry mass/fresh volume)
- D. balansae - 0.51 g/cm3 – 0.54 g/cm3 (China) [102, 103].</td></tr>
</table>

DALBERGIA CULTRATA/ FUSCA			
Height (m)	**Diameter (cm)**	**Flowering Season**	**Fruiting Season**
10-30 (Vietnam & Lao PDR) [10] 10-20 (Thailand) [9] 20-30 [56]		*Non-specific reference*	
		June to August [58]	September to November [58]
		Vietnam & Lao PDR	
		January to March [69]	March to September [69]

Species Description/ Habitat Type	**Reproduction/survival strategy and germination potential and regeneration potential**	**Growth rates and heartwood development information**
D. cultrata is a medium sized deciduous tree and is typically found in humid, evergreen, bamboo, mixed forests and dry dipterocarp forest and in open areas with altitudes of 100-1500 m [69, 58, 68, 105]. Table 14 below provides an example of the performance of *D. cultrata* in slightly different habitat site locations [108].	Reproduction - Pollination is distributed by wind [58]. Germination - high *germination* rate - 70% [58]. - Thailand: *D. fusca* seeds were soaked for 24 hours before sowing which produced germination rate of 50-60% [109]. Regeneration - China: *D. fusca* has previously been observed to occur quite frequently in scrubland and able to regenerate after the destruction of forested areas [105].	Silviculture study [108] - Thailand: Table 14 below indicates that *D. cultrata* tends to have better growth in closed canopy areas. Wood density (oven dry mass/fresh volume) - *D. cultrata* - 0.770 g/cm3 (India) [102, 103]. - *D. fusca* – 0.852 g/cm3 (China) [102, 103].

Table 14 – Location, Habitat and Max Height Details for D. cultrata in lowland deciduous forest in Chang Kian Valley, Chiang Mai, Thailand. Adapted from various table information in Vaidhayakarn and Maxwell (2010) [59]. Each site survey plot = 50 x 5m.

Site No	Site Location	Max Height (m)	N
1	Pah Laht Temple – 607m elevation. The most intact forest which had been protected from major disturbance for more than 50 years.	7	45
2	Chang Kian Stream – 474m elevation. Above the boy scout camp near Chang Kian Village, severely degraded and frequently burned by mushroom collectors.	2.50	1
3	Mae Yuak Noi 1 – 455m elevation. Near Nong Haw mediation centre, a regenerating forest which has uniform tree regrowth after being cleared 25 years ago.	5	35[12]
4	Mae Yuak Noi 2 – 490m elevation. Near site 3 but with more grass cover.	-	-
5	Huay Dtueng Tao 1 – 439m elevation. Above Huay Dteung Tao Lake. A very exposed, frequently burned, eroded ridge.	0.18	1
6	Huay Dtueng Tao 2 – 453m elevation. Near site 5 and similar to it, but with more trees.	-	-
7	Huay Dtueng Tao 3 – 411m elevation. Gully below site 6 with less frequent fire than site 5, almost closed canopy.	22	60

12 Of which 31 individuals were fire damaged = 88.57%.

DALBERGIA COCHINCHINENSIS

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
15-30 (Vietnam) [69, 73] 25-30 (Thailand and Lao PDR) [68, 76] 25-30 (Cambodia) [72]	60-120 (Vietnam) [73, 69] Up to 80 (Lao PDR) [76]	Non-specific references	
		March to June [73] March to August [74]	July to December [73] October to December [74]
		Cambodia	
		May to June [72]	November to December [72]
		Vietnam	
		March to August [69]	September to December [69]

Habitat Type/natural density	Reproduction/survival strategy and germination potential and regeneration potential	Growth rates and heartwood development information
This species can be found sparsely in open, semi and mixed deciduous forests and sometimes in pure sands [52, 74, 73, 69, 72, 68]. In Thailand, it can also be found in dry evergreen forests [68]. In Vietnam, this species has been located in the Cat Tien National Park [110]. Altitude range - Cambodia: up to 900 [111] - Thailand: 50-200m [68] - Vietnam: 50–500 m [69] Rainfall range: - Cambodia: 1200-1650 mm yearly [72, 73, 111] Soil preferences Cambodia: deep sand, clay or calcareous soils [72, 73, 111]	Reproduction - This species is a self-pollinating crop and pollen can also be distributed by insects [73]. Germination Study [111] - Seeds which were pre-germinated by soaking in water overnight started germinating at about seven days with a 70-80% potential. Regeneration - Ability to regenerate naturally [83] but natural regeneration is often poor [73]. - Regenerates well by coppicing [73]. Silviculture studies [112] [113] - Reforestation of agricultural land through direct seeding viable if good site preparation and intensive weeding undertaken especially in the first six months of planting to strengthen growth potential. - Seedlings had a better survival rate using the gap planting method (see Table 16). While the survival rate was below 50% using either method, *D. cochinchinensis* proved to have a higher survival rate than that of *P. macrocarpus* (see Table 16), by more than 10% in the same study.	A number of sources report this species to have a slow growth rate [69, 73, 72], with young seedlings having a low percentage rate to reach maturity stage [73]. Other sources consider the species to grow quite fast under favourable conditions and it was estimated that over a 50-year rotation, the volume production could reach 400m3 [111]. Silviculture trees grew: - Thailand - Periodic Annual Increment (PAI) of 1 cm in Diameter at Breast Height (DBH) could be attained in 20-29 year-old plantations [73]. - Lao PDR*:* Table 15 below shows the height and diameter growth rates results seven years post planting of seedlings in a logged over tropical mixed deciduous forest. The gap planting method had higher growth rates in both root collar diameter and height. In the same study, the root collar diameter growth rates between *P. macrocarpus* (shown below in Table 18) and *D. cochinchinensis* did not differ significantly, while the height growth for *D. cochinchinensis* was significantly higher using either method. - Table 15 demonstrates some average yearly growth rates following enrichment planting in a number of country locations in this region. Wood density (oven dry mass/fresh volume)/ Heartwood growth - *D. cambodiana* - 0.904 g/cm3 (South-east Asia) [102, 103]. - *D. cochinchinensis* - 0.880 g/cm3 (South-east Asia) [102, 103]. - Heartwood growth rate is slow reaching on average 13cm in 20 year old trees [73].

Table 15 - Average yearly growth of *D. cochinchinensis* under plantation conditions in Cambodia and the Region

Method	Age (Yr)	DBH (cm)	Height (m)	Province, country	Reference
EN	3	0.9*	0.9	Borikhamsai, Lao PDR	Lee, 2005.
MO	5	6.7	5.7	Preah Sihanouk, Cambodia	Thea, unpublished data
MO	7	11.2	8.5	Siem Reap, Cambodia	Thea, unpublished data
MO	12	10	15.4	Sakearat, Thailand	Kamo et al, 2002
MO	38	29	21.8	Dong Nai, Vietnam	Nghia, 200

EN: Enrichment planting in degraded forest , MO: mono species plantation in open area, *:root collar diameter

Table 16 - Survival and growth rates of *D. cochinchinensis* after seven years (2000 - 2007) of planting in gaps and lines in a logged-over, mixed deciduous forest in Lao PDR. Table has been adapted from Tables 2, 3 and 4 in Sovu et al (2010) [113].

Survival rate (Mean ± SE, %)			Root collar diameter (cm) (Mean ± SE)			Height (cm) (Mean ± SE)		
Planting method			*Planting method*			*Planting method*		
Gap	Line	Overall mean	Gap	Line	Overall mean	Gap	Line	Overall mean
44.7 ± 4.2	41.1 ± 4.5	42.9 ± 3.0	2.0 ± 0.1	1.8 ± 0.2	1.9 ± 0.1	199.6 ± 7.9	174.6 ± 19.1	187.1 ± 10.5

DALBERGIA LATIFOLIA

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
20-40 [80]	150-200 [80]	India	
		December to March [80]	January to April [114]

Habitat Type/natural density	Reproduction/survival strategy and germination potential and regeneration potential	Growth rates and heartwood development information
In dry, natural habitats this species is considered a deciduous tree while in moist conditions, the trees can remain evergreen throughout the year [50, 80]. Altitude range: up to 1500m. [50, 80]. Temperature range: 8-44ºc and Rainfall range: 750-5000mm [50, 80]. Soil preferences: well-drained, deep and moist soils and black cotton soils. [50, 80].	Reproduction - Reproduced by seed, root sucker and coppice in natural conditions [115]. - Pollen distributed by wind, bees and insects [80, 114] Germination - 7 to 25 days with rates varying between 45 to 80% [80]. - Seeds can remain viable for approximately 6-12 months, with the potential to extend viability to 9-12 months by storing seeds in airtight containers and drying the seeds to down to 8% moisture content. The latter option will decrease germination potential by 30-40% [80].	Slow growing with shallow, dry soils known to stunt tree growth [80, 115]. Silvicultured tree growth [15]. - In India, ten year old stands = heights of 6m and diameters of 4cm-5cm and with the average age of 60cm diameter trees being as old as 240 years - West Java: 25 year old plantation = average breast height of 1.3 meters and tree height at 20.3 meters. [115]. Wood density (oven dry mass/fresh volume) - 0.800 g/cm3 (India) [102, 103].

DALBERGIA OLIVERI/ BARIENSIS/MAMMOSA

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
15-30 (Thailand) [68] 15 -20 (Vietnam) [69] 20-25 (Cambodia) [72]	60 – 90 (Vietnam) [69] 50-60 (Cambodia) [72]	Cambodia	
		March to June [72]	June to November [72]
		Lao PDR	
		February to June [69]	April – December [69]
		Vietnam	
		February to June [69]	April – December [69]

Habitat Type/natural density

D. oliveri is described as a deciduous tree, *D. bariensis* as an evergreen tree and D. *mammosa* as a semi-deciduous tree [63]. These three species can be found in a wide range of forest types (distribution dependent), including primary, secondary, evergreen tropical or semi-deciduous forests, along streams, rivers and hillsides [69, 72, 44, 48, 45, 63, 68]. *D. oliveri* juvenile trees are shade tolerant while older trees prefer light [72]. *D. oliveri* can be found with *D. cochinchinensis*, occurring on its own or grouped together in five to ten trees. *D. oliveri* can be found in moist areas [68, 72]. *D. bariensis* is mostly situated in forests located at the foothills or lower slopes of a mountain range (also termed sub-montane forest) or in broad-leaved areas [63]. *D. bariensis* and *D. mammosa* have been recorded in Cat Tien National Park in Vietnam [110].

Soil preferences

- *D. mammosa* prefers deep and well drained soils. [63, 105].

Altitude range

- *D. oliveri:* 100 - 800 meters, and rarely at up to 1500m [68, 72].
- *D. mammosa*: up to 800m [63, 105].

Reproduction/survival strategy and germination potential and regeneration potential

Reproduction

- Can produce a high number of seeds [72, 63].

Germination

- Low germination ability [55]

Regeneration

- Natural regeneration due to low germination rates and poor site and weather conditions [72, 63].
- Limited efforts have been made to regenerate this species in mass amounts. This species could face extinction if further efforts not explored [72].

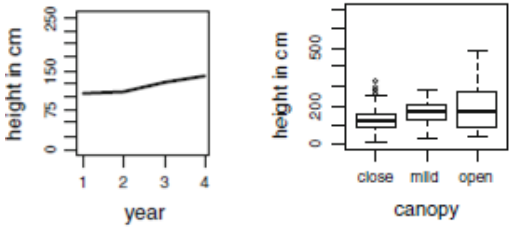


Figure 14 – *D. bariensis:* Mean seedling height and canopy cover effect on seedlings height 4 years post plantation. Taken from Figures 2 and 3 in Millet et al (2013)

Growth rates and heartwood development information

D. oliveri - slow growth rate in both natural and reforestation forests [72, 55].

Silviculture Studies

- In 2008, observed only one *D. oliveri* individual at a height of 60 cm in a regenerating, lowland deciduous forest of which had uniform regrowth after being cleared 25 years earlier. [108].
- Vietnam: Figure 14 shows mean seedling height during the first 4 years after plantation of *D. bariensis*. Effect of canopy density was very significant (canopy open: 58.7%, mild canopy: 87.4% and shade canopy: 94.6%) as it survived better under a high canopy density. Survival rate = 1yr post seedling was 98.6% compared with 91.1% in year four.

Wood density (oven dry mass/fresh volume)

- *D. mammosa* - 0.850 g/cm3 (South-east Asia) [102, 103].
- *D. oliveri* - 0.850 – 0.909 g/cm3 (South-east Asia) [102, 103].

<table>
<tr><th colspan="4">DALBERGIA SISSOO</th></tr>
<tr><th>Height (m)</th><th>Diameter (cm)</th><th>Flowering Season</th><th>Fruiting Season</th></tr>
<tr><td rowspan="2">10-15 (dry areas) [116]
Up to 30 (wet areas) [116]
Up to 30 [87] (favourable conditions)</td><td rowspan="2">80 [87] (favourable conditions).</td><td colspan="2">India</td></tr>
<tr><td>March to April [117]</td><td>March to April [117]</td></tr>
<tr><th colspan="2">Habitat Type/natural density</th><th>Reproduction/survival strategy and germination/regeneration potential</th><th>Growth rates and heartwood development information</th></tr>
<tr><td colspan="2">This is a deciduous tree species located in tropical to subtropical climates in natural and planted forests, mainly along forest margins near streams and rivers, hammocks, canopy gaps, agricultural areas, disturbed sites and roadsides [117, 116].

<u>Rainfall range:</u> [87, 116].
- 500-4570 mm.
- Often associated with seasonal monsoon and periods of drought up to six months.

<u>Altitude range:</u> 0-1500 m [87].

<u>Mean annual temperature:</u> -4 to 45 °C [87].

<u>Soil preference:</u> [87]
- Wide range of soil types, from pure sand and gravel to rich alluvial soil of riverbanks. Growth is slow in poorly aerated sites, like heavy clay soils.
- pH tolerated = 5-7.7.</td><td><u>Reproduction</u>
- Reproduces via seed and vegatively through suckers arising their root system [116] and it is useful for stabilizing eroding sites [87]. In South Asia, it is found in a variety of wastelands where it is known as a colonizing species [87].
- Mature pods remain attached to tree for 7-8 months [87]. Seeds disbursed via wind and water [116, 87].
- Ability to coppice vigorously up to around 20 years of age [87].

<u>Germination rates</u>
- High germination rate [117].
- Up to 83.6% in fresh seeds [117].
- 73.68% in naturally pollinated individuals [117].
- 73.99% in self-pollinated individuals [117].

<u>Regeneration</u>
- Successful regeneration requires plenty of moisture [86, 116, 87].
- Rarely regenerates under shade [116, 85]. Strong light demander from the seedling stage onwards [116].
- Weed growth poorly affects regeneration [116].</td><td>Second most widely cultivated species in South Asia due to its fast growth [15].

<u>Growth rates</u>
- 3.7 meters in one year, 5 meters in three years, 11 meters in in five years and 15 meters in ten years [87].

<u>Wood density (oven dry mass/fresh volume)</u>
- 0.669 (South-east Asia) - 0.760 g/cm3 (India) [102, 103].</td></tr>
</table>

<table>
<tr><th colspan="4">PTEROCARPUS DALBERGIODES</th></tr>
<tr><th>Height (m)</th><th>Diameter (cm)</th><th>Flowering Season</th><th>Fruiting Season</th></tr>
<tr><td rowspan="2">24-37 [84]
30-40 (Myanmar) [118]</td><td rowspan="2">60-120 [84]</td><td colspan="2">Myanmar</td></tr>
<tr><td>June to September [118]</td><td>June to September [118]</td></tr>
<tr><th colspan="2">Habitat Type/natural density</th><th>Reproduction/survival strategy and germination/ regeneration potential</th><th>Growth rates and heartwood development information</th></tr>
<tr><td colspan="2">Grows in deciduous and semi-moist deciduous forests up to 100 m, usually near river banks and on well drained sights [51, 82, 118, 105]. In Andaman Islands, this species is found in deciduous and semi-moist deciduous forests up to 100m [105].</td><td>Germination
Poor seed germination [56].

Regeneration
- Regeneration potential is divided between sources.
- In 1998, reported to regenerate well in natural conditions and is suited for replanting in stand gaps, enrichment line planting and agroforestry systems [82].
- In 2008, reported to have poor regeneration growth in the Andaman Islands which may result in the extinction of the species. Seedling survival affected by factors such as seedling shade intolerance, environmental and human pollution disturbances, seed dormancy and poor seed germination capacity [56].</td><td>An age structure study showed that it will take approximately 10 years for this species to attain a girth of 30 cm with the species at the study site being up to 150 years old as demonstrated in Figure 15 below [56].

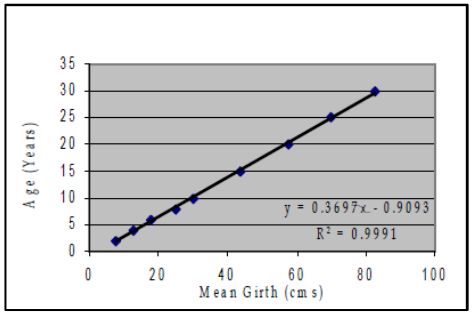
Wood density (oven dry mass/fresh volume)
0.580 – 0.660 g/cm3 (South-east Asia) [102, 103].
 

Figure 15 – Linear regression between age and girth classes of P. dalbergioides. Taken from Figure 2 in Prasad et al (2008) [56].</td></tr>
</table>

PTEROCARPUS INDICUS / ECHINATUS - Adapted to be deciduous and evergreen tree species, likely due to extensive propagation of the species [80, 97].			
Height (m)	**Diameter (cm)**	**Flowering Season**	**Fruiting Season**
May exceed 30 [88] 30-40 [100] 25-35 (Pacific Islands) [97] Up to 40 (Vietnam/Lao PDR) [69]	Up to 100 [88] Up to 200 [100, 80] Up to 350 (Vietnam/Lao PDR) [69]	Vietnam and Lao PDR	
		February to May [69]	December [69]
		Indonesia	
		July to December, occasionally February to May [80]. May to October (Papua New Guinea) [97]. June to July, Oct to Nov or Sept to Dec[13] (Solomon Islands) [97]	
		Philippines'	
		April to May, sometimes as early as January and as late as July [97]. July to September [88]. February to May and occasionally in August to November [80]	

Habitat Type/natural density	**Reproduction/survival strategy and germination/regeneration potential**	**Growth rates and heartwood development information**
<u>Habitat Type</u> - Malaysia: trees generally evergreen. Found by the sea and along tidal creeks and rivers [80]. - In regions with seasonal rainfall = deciduous [80]. - Indonesia: found along coast and in sub-montane forests and seasonal swamps [80]. . - Vietnam and Lao PDR: prefers seasonal climate and found in rainforest or evergreen forest and dry and low land areas [69]. <u>Rainfall range:</u> 900mm to 4000mm [97, 80]. <u>Temperature range</u>: 22-32^{o}C [97, 80]. <u>Altitude range</u>: - Approximately 1300m [97]. - Vietnam and Lao PDR: up to 600 meters [69]. <u>Soil requirements:</u> Preferred soil type = sandy or clay loams with neutral or slightly acidic reaction [80].	<u>Reproduction</u> - Reproduced via seeds, cuttings, grafting and tissue culture, with seedlings and branch. Cuttings is preferred form [97, 100]. - Pollinated by honeybees and insects [88, 100] - Once seedlings reach 0.5 meters in height, they become suitable for forestry plantings [88] and according to Maun (1980),[14] stump plants areas also used to establish plantations. It is important to keep new plantations weed and vine free for the first four years until the trees begin to shade to suppress undergrowth [88, 97]. <u>Germination Studies</u> - Pre-germination treatment unnecessary [88] [100]. - Philippines: 24% [88]. - Puerto Rico: 57% after five days. Completed in three months [88]. - Seeds germinated 3-4 days post sowing. Germination rate of between 24-40% at 4-15 days post sowing [97]. <u>Regeneration</u> - Easily be propagated by seed, stump cuttings taken from seedlings or juvenile plants and tissue culture [82]. - Easily regenerates new shoots at any size or age by lopping and pollarding [80]. - Papua New Guinea: Logged forests noted to readily regenerate new plants from the roots [80].	<u>Growth rates</u> - Moderate growth rate [88, 97]. - Deep, well-watered, fertile and lightly shaded sites = 2m growth in first 3-4 years. [97]. - Open area plants = may only grow 0.5 to 0.75 meters per year. [97]. Plants grow 1.5 to 3 m before bending over, growing laterally before neither upright shoot takes over and helps to self-straighten. [97]. - *P. echinatus* form showed 0.6 to 1.2 meters average yearly growth [97]. <u>Wood density /heartwood development</u> - 0.520 (South-east Asia) - 0.960 g/cm^3 (India) [102, 103]. - Philippines: heartwood development at 18-19 years old [97].

13 Varies depending on location.
14 As referenced by Francis (2002) [73].

<table>
<tr><th colspan="4">PTEROCARPUS MARSUPIUM</th></tr>
<tr><th>Height (m)</th><th>Diameter (cm)</th><th>Flowering Season</th><th>Fruiting Season</th></tr>
<tr><td rowspan="2">15-20[15]</td><td rowspan="2">80 [63]</td><td colspan="2">India</td></tr>
<tr><td>March to June [96]</td><td>March to June [96]</td></tr>
<tr><th>Habitat Type/natural density</th><th colspan="2">Reproduction/survival strategy and germination/regeneration potential</th><th>Growth rates and heartwood development information</th></tr>
<tr><td>Medium to large that grows in deciduous forests throughout India [96].</td><td colspan="2"><u>Reproduction</u>
- Able to reproduce via seeds naturally [96]

<u>Germination</u>
- Low - 30%. [96].
- Conventional seed and vegetative propagation of the tree has been reported to not be very successful due to its fruit hard coat, poor germination and viability [96].

<u>Regeneration studies</u> [96]
- A growth rate regulator produced a 90% regeneration frequency [96]. Tissue culture taken from an 18 day old seedling showed a better response for shoot induction compared with 6, 12 and 24 day old seedlings, therefore, age of species seedlings plays an important role in biology [96].
- Tissue culture technique to propagate an 18 day old seedling obtained an 85% regeneration frequency and an average number of 8.6 shoots.</td><td><u>Wood density (oven dry mass/fresh volume)</u>
- 0.620 g/cm^3 (South-east Asia) [102, 103].</td></tr>
</table>

15 As cited by Warrier (1995) as referenced in Hari and Kaikwod (2011).

PTEROCARPUS MACROCARPUS – *Dominant large deciduous tree that is light demanding, drought tolerant and often mixed with other species* [69, 72, 92, 119].

Height (m)	Diameter (cm)	Flowering Season		Fruiting Season
10 -30 (rarely 39) [69, 91, 75] 25-30 (Cambodia) [72] 25-35 (Lao PDR) [76] 25-30 (Myanmar) [118] Up to 30 (native ranges), up to 39 (ornamental).[16]	Up to 300 [69]. 80-200 (Lao PDR) [76] Up to 70 (native ranges), up to 170 (ornamentals).[17]	Cambodia	March to April [72]	September to October [72]
		Myanmar	March to May [72] March to June [119]	Varies across the year [72] March to June [119]
		Thailand	March to May[18]	
		Vietnam	January to May [69].	April to December [69].

Habitat Type/natural density	Reproduction/survival strategy and germination/regeneration potential	Growth rates and heartwood development information
This species has been reported to grow in open semi-deciduous or deciduous Dipterocarp forest, dry evergreen forests and in natural stands [69, 72, 92, 62, 120, 121]. Myanmar - found in the drier parts of the upper mixed deciduous forests [118]. Soils - prefers sandy loam through clay soils with neutral to very strong acidity levels [72, 69, 120, 121, 62]. Rainfall - 889 to 3,572 mm/year [91] Elevation – SL – 670m Temperature - 24°C average monthly	<u>Reproduction</u> - Entire reproduction cycle takes 8 months [92]. - Pollinated by honeybees and insects [91]. <u>Germination rate</u> - Fast and uniformed - 70 to 90% [72, 91]. - Preferred temperatures 30°C (day), 25°c (night) [91]. - Air dried seeds in pods: 1yr post storage at room temperature. Pods and seeds fragile and difficult to extract by hand [92]. <u>Germination studies:</u> [91]. - Shelled seeds: 5 days with a 70% germination in two weeks. Unshelled seeds began germination in 11 days with 64 seedlings per 100 pods within two months. [91]: - Myanmar: shelled seeds = 80 to 90%. - Seeds from pods from ground after 1 yr germinated better than fresh pods taken from the tree. <u>Silviculture study</u> [113] - Lao PDR: seedlings had a better survival rate using the gap planting method (Table 18). - Survival rate low – less than 35% for both methods. 10% lower survival rate than that of *D. cochinchinensis* (see above in Table 16).	Medium growth rate [91]. <u>Silvicultured trees</u>: [91] 1. Survived years of growth suppression as a sapling or a pole until a canopy gap is created via disturbance and in its native habitat only makes up a small percentage of canopy trees [91]. 2. Myanmar: grew 0.6 to 1.2m (1st yr) and 1.2 to 2.1 (2nd yr) - Hundley (1956) 3. Puerto Rico: small plantation trees = 1.3 meters high after 14 months in clay soil over porous limestone conditions. 4. Ornamental trees able to grown in 12 - 20 L plastic pots until they reach 2-3 m height before out planting [91]. 5. Lao PDR: Table 18 below shows growth rates results seven years post planting a logged over tropical mixed deciduous forest. <u>Wood density (oven dry mass/fresh volume)</u> - *P. macrocarpus*: 0.700 g/cm^3 (South-east Asia) [102, 103].

Table 17 - Location, Habitat and Max Height details of *P. macrocarpus* in lowland deciduous forest in Chang Kian Valley, Chiang Mai, Thailand. Adapted from various table information in Vaidhayakarn and Maxwell (2010) [108]**. Each survey site plot = 50m x 5m.**

Site No	Site Location	Max Height	N.
6	Huay Dtueng Tao 2 – 453m elevation. Located near site 5 which was described as 'Above Huay Dteung Tao Lake, a very exposed, frequently burned, eroded ridge'. Site 6 had more trees than site 5.	1m	1
7	Huay Dtueng Tao 3 – 411m elevation. Gully below site 6 with less frequent fire than site 5, almost closed canopy.	22	16

Table 18 - Survival and growth rates of *P. macrocarpus* after seven years (2000 - 2007) of planting in gaps and lines in a logged-over, mixed deciduous forest in Lao PDR. Table has been adapted from Tables 2, 3 and 4 in Sovu et al (2010) [63].

Survival rate (Mean ± SE, %)			Root collar diameter (Mean ± SE)			Root height diameter (Mean ± SE)		
Planting method (M)			*Root collar diameter (cm)*			*Height (cm)*		
Gap	Line	Mean	Gap	Line	Mean	Gap	Line	Mean
34.3 ± 4.3	28.8 ± 3.4	31.6 ± 2.7	1.6 ± 0.2	1.3 ± 0.1	1.5 ± 0.1	172.4 ± 15.8	145.8 ±10.9	159.1 ± 9.9

16 Based on a 64 year old tree in Puerto Rico according to Francis (1989) as referenced in Francis (2002).
17 Ibid.
18 According to Santisuk and Niyomthamma (1983)

PTEROCARPUS SANTALINUS			
Height (m)	**Diameter (cm)**	**Flowering Season**	**Fruiting Season**
10 - 15 (Natural habitat) [94] 15-18 (Plantations) [94]	150-190 [94] 90-120 [98]	India April to May [94] March to May [122]	February to March [94]

Habitat Type/natural density	**Reproduction/survival strategy and germination/regeneration potential**	**Growth rates and heartwood development information**
A small to medium sized deciduous tree which is mainly located in tropical dry deciduous forest and with thorny plant species [94, 98, 122]. In its natural habitat, this species is found in hilly landscapes and in hot dry climates [94]. Temp Range: 110 to 460 Celsius [98, 94, 122, 123]. Rainfall range: 100mm to 1,000mm [98, 94, 122, 123]. Elevation range: 200-900m [98, 94, 122, 123]. Soil requirements: Shallow, stony, poor and well drained [98] [94] [122].	Reproduction - Pollinated by insects and honey bees [94, 122]. - Fruits reproduce via autogamy (self-pollination of same flower), geitonogamy (self-pollination from same plant but different flower), and xenogamy (cross pollination), indicating a facultative xenogamous breeding system [94] [122]. - Silviculture experiment: Grafting and air-layering technique poor for large-scale reproduction. Root cuttings also poor. In-vitro propagation was successful. Survival - No single treatment better than the other for survival and growth [123]. - Restoration should be tailored to landscapes at different levels of management based on seedling, biotic and abiotic factors and soil type. [123] Germination - Poor - 30-40% [123]. - Generous rate following rain in open areas [94]. - Requires strong light for successful germination [94]. Regeneration - Excellent coppice [94]. - Low survival rate due to recurring wildfires and grazing which is adversely impacting this species regeneration in forests [123].	Slow growing tree under natural conditions [122, 123, 94]. Plantations growth rates are faster [94]. 10-12 years for this species to move from one girth class to the next [94]. Silvicultured experiments 1. Between 1920 and 1926, 32 sample pots showed an average annual increment in girth at breast height, over per stem to be 0.74 cm for stems from seedlings and 1.38 cm for coppiced shoots. [94] 2. Between 1914 and 1924, sample plots in Kodovengammanhavi = girth growth of 0.89 cm/year, coppice shoots at 1.12cm /year. [94] 3. Sample plots in Thummalabailu area, Rajampet = girth increment 0.32 cm. An annual increment of 0.74cm girth = 80-100 years to reach a girth of 60-75cm. A tree of 91.4cm girth = 150 to 250 years old [94]. 4. Red Sanders seedlings showed better survival and growth rates when excess coppice shoots were removed by singling (the process of reducing the number of plants from a multigerm seed to a single plant) [123]. Wood density (oven dry mass/fresh volume) - 0.970 (India) – 1.068 g/cm^3 (South-east Asia) [102, 103]. Heartwood development - Aged between 15 and 20 years [122, 123, 94].

DISTRIBUTION AND RANGES

According to Felbab-Brown (2013) [14], the Southeast Asia region has the highest percentage of deforestation in the world with a forest loss of 1.2% year. This rate will lead to a loss of three-quarters of forests and 42% of the region's biodiversity by 2100. However, in 2015, the Food and Agricultural Organisation (FAO) recorded a total forest area of 593 million hectares in the Asia region, which was equivalent to an annual increase of 0.17% [124]. This change is due to an annual increase of planted forest area (+2.17%), and the definition of what constitutes a forest rather than natural forest, which in Asia decreased by 0.24%, from 1990-2015 (totalling an area of 462 million hectare) [124]. Table 19 provides some data of habitat reduction at a country specific level as well as species specific level where possible and sets out the historical distribution of rosewood producing species by region. Table 19 provides further detail of distribution of each species over what was provided in Table 1 (in the Global Overview Section), which simply listed the range countries.

A number of species that are distributed in the Asia-Pacific region are also distributed throughout areas in Africa and the Americas. *P. indicus* has been recorded in the United States and Puerto Rico [80]. *D. assamica*, *D. latifolia* and *D. sissoo* have all been introduced into parts of Kenya, Tanzania and/or tropical Africa [80, 86, 85]. *D. sissoo* has also been introduced into Cameroon, Cyprus, Ethiopia, Ghana, Iraq, Israel, Mauritius, Nigeria, Sudan, Togo, United States of America and Zimbabwe [80, 117]. *D. sissoo*'s native range is confined to Malaysia, Pakistan and the South Asia region (Afghanistan, Bangladesh, Bhutan and India).

Table 19 - *Dalbergia* and *Pterocarpus* (Rosewood Producing) species historical distribution in Asia Pacific Region

SPECIES AVAILABLE	HISTORICAL DISTRIBUTION	HABITAT REDUCTION ASSESSMENTS
Afghanistan		
D. sissoo	Native [80] but precise distribution not specified.	Global Forest Watch reported that from 2001 - 2014 the tree cover loss was 1,775 ha [8]
Bangladesh		
D. assamica	While *D. assamica* has been recorded in Bangladesh, its specific areas are unknown. [66, 75].	Due to its high population density, the demand for timber in Bangladesh is far greater than what the country is able to supply [125]. *D. sissoo* has reportedly suffered from significant die-back in Bangladesh with mortalities mostly in plantations in the north, southern and central plains of Bangladesh [125]
D. sissoo	Native but precise distribution not specified [80].	
Bhutan		
D. sissoo	Native precise distribution not specified [80].	Global Forest Watch reported from 2001 - 2014 the tree cover loss in Bhutan was 13 642 ha [8]
Cambodia		
D. assamica	While *D. assamica* has been recorded at native to Cambodia, its specific distribution is not specified. [75, 66]	Total forest cover in Cambodia has decreased from approximately 72% in 1973 to 48% in 2014. For the first time in a 41-year period, the percentage of non-forest ground cover (48.4%) is larger than that of forest cover (47.7%) [126]. Cambodia has one of the world's highest deforestation rates with 18 percent of its tree cover lost between 2001 and 2014, mainly from Economic Land Concessions [127]. During 2002-2005/06, there was an estimated 0.5% net annual rate of deforestation which apparently represented a decrease from earlier estimates [128].
D. cochinchinensis	Provinces of Kampong Thom, Preah Vihear, Ratanakiri, Pursat, Siem Reap, Kratie, Koh Kong, Stung Treng, and Modulkiri and Udon Meechai [72].	
D. oliveri	Provinces of Kratie, Ratanakiri and Stung Treng, Preah Vihear and Siem Reap, Pursat and Kampong Thom. [72]	
D cultrata	Unknown.	
P. macrocarpus	Provinces of Kampong Thom, Stung Treng, Preah Vihear, Ratanakiri, Kratie, Siem Reap, Kampot, Pursat and Mondulkiri [72].	
China		

SPECIES AVAILABLE	HISTORICAL DISTRIBUTION	HABITAT REDUCTION ASSESSMENTS
D. assamica	*D. assamica* has been recorded in Southern China, and more specifically in Anhui, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Ningxia, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Zhejiang. [66, 75]. *D. balansae* was recorded as scattered throughout China [105].	Global Forest Watch reported a forest cover loss of 6 848 206 ha from 2001 -2014 in China [8].
D. cultrata	D. *cultrata* - Yunnan *D. fusca* - Simao, Meijiang, Jianchen and Jinghong in southern Yunnan [105].	
D. odorifera	Confined to Hainan Island, mainly in the west and southwest plains or hilly areas with an altitude of between 400 -600m. [53, 83, 105]	
D. tonkinensis	Hainan Island and mainland southern China [105].	
P. indicus	Native but distribution is widely scattered or uncommon [88]	
India		
D. assamica	*D. assamica* has been recorded in Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Sikkim, and West Bengal. [66]	*P. dalbergioides* may be close to extinction in India [56].
D cultrata	Introduced but distribution not specified [58].	Global Forest Watch estimated tree cover in 2000 to be 39 million ha or approximately 12% of the country's land area. Tree cover loss from 2001 - 2014 was estimate at 1 034 010 ha [8].
D. latifolia	Native, specifically southern India, and specifically Andhra Pradesh, Karnataka, Sikkim, Tamil Nadu, Uttar Pradesh [105, 80].	
D. sisso	North India [80, 116] .	
P. dalbergioides	Endemic to Andaman Islands [105, 56]. However, it has been reported by other sources as introduced to other countries.	
P. indicus	Native to Andaman Islands but distribution is widely scattered or uncommon [88].	
P. marsupium	Deccan Peninsula and extends to Gujarat, Madhya Pradesh, Uttar Pradesh, Bihar and Orissa [122].	
P. santalinus	Southern parts of the Eastern Ghats region in the State of Andhra Pradesh, in particular Sesachalam, Veligonda, Lankamala and Palakoda hill ranged in Chittor, Kadapa, Kurnool, Nellore and Prakasam districts [94].	
Indonesia		
D cultrata	Unknown.	38% of lowland forest in Gunung Palung National Park, West Kalimantan was logged and deforested between 1989 and 2003 [129, p. 29]. Global Forest Watch estimated Indonesia's tree cover to be 161 million ha or 86% of its land area in 2000. Indonesia's tree cover loss from 2001 - 2014 accounted for 1 507 771 ha [8].
D. latifolia	Native, specifically Java [105, 80].	
D. sisso	Introduced, specifically to Java [80, 116].	
P. dalbergioides	Unknown. Previously introduced in ex-situ plantations.	
P. indicus	Native to Java, Sunda Islands, Moluccas, the Solomon Islands, Carolinas, Vanuatu and Papua New Guinea but distribution is widely scattered or uncommon [88].	
Lao PDR		
D. assamica	While *D. assamica* has been recorded in Lao PDR, its specific distribution is unknown. [75, 66]	Forest cover declined from 17 million hectares in 1940 to 11 million hectares by 1993 [113].
D. cochinchinensis	Central and southern provinces, specifically Savannakhet, Attapeu, Bolikhamxay, Champasak,	

SPECIES AVAILABLE	HISTORICAL DISTRIBUTION	HABITAT REDUCTION ASSESSMENTS
	Khammouanem, Salavan and Sekong /Xekong. [69, 73]	Forest cover was reduced from 70% of the land area in the 1940's to 47% or less by 1999 [130]
D cultrata	Sayabouri (Pak Lai), Louang Prabang (Phou Khouang), Xieng Khouang (Moung Soui, Phou Kabo, and Moung You), and Savannakhet provinces.	
D. oliveri	*D. oliveri* - Nationally distributed Provinces of Savannakhet and Saravane.	
P. dalbergioides	Unknown	
P. indicus	Unknown.	
P. macrocarpus	Sayabouri (Phou Sak, Paklay), Louang Prabang (Phou Khouang), Vientiane (Tha Ngon, Hatxiafong, Ban Khuay Daeng), Bolikhamsai (Borikhane Distr.), Savannakhet, and Saravane provinces [69].	
Malaysia		
D. latifolia	Introduced but precise distribution not specified [80].	Global Forest Watch estimated that in 2000 Malaysia had some 90% or 29 million ha of tree cover. By 2014 this amount had reduced by 5 632 714 ha. Only 23% of forests in Malaysia are said to be primary forests. Forest loss outside of forest plantations in 2013 and 2014 was 88 815 ha and 200 715 ha respectively [8].
D. sisso	Native but precise locations not listed [80].	
P. indicus	Borneo and Singapore but distribution is widely scattered or uncommon [88].	
Myanmar		
D. assamica	While *D. assamica* has been recorded in Myanmar, its specific areas are unknown. [75, 66, 68]	From 2010-15, Myanmar lost 546,000 hectares of forests (approx. 8.5 % forest cover) [131]. From 2002-14, Myanmar lost a total of 2.07 million ha or 11.3% of its intact forest. From this, loss of intact forest was 10.3%, loss of non-reserved areas was 11.7%, loss of 2.3% within protected areas. Overall, degraded forest increased by 1.8% (0.47 million ha), non-forest areas increased by an overall 4.7% (0.99 million ha) and national area of plantations increased by a 58.4% (0.54 million ha). Large tracts of intact forest are still found in remote parts of particularly Kachin state and Tanintharyi region. [132].
D cultrata	Native but distribution not specified [58, 84, 132].	
D. latifolia	Introduced but precise distribution not specified [80].	
D. oliveri	*D. oliveri/bariensis* – populations in Sagaing (over 2 million trees) followed by Shan state, Mandalay and Kachin state.	
P. dalbergioides	Unknown. Previously introduced in ex-situ plantations.	
P. macrocarpus	Shan state, Mandalay division, Magway and Sagaing	
P. indicus	Native to Southern Myanmar but distribution is widely scattered or uncommon [88].	
Nepal		
D. latifolia	Introduced but precise distribution not specified [105, 80].	With an estimated 5 million ha of tree cover or 35% of the land covered by trees, Nepal recorded a tree cover loss of 38,504 ha from 2001 to 2014 [8].
D. sisso	Introduced/exotic. Precise distribution locations unknown [80].	
Philippines		
D. latifolia	Introduced but precise distribution not specified [80].	Global Forest Watch reported that the Philippines had an estimated 64% tree cover in 2000. During the period 2001 to 2014 tree cover loss was estimated to be 761 174 ha [8].
Pakistan		
D. sisso	Native [80], specifically Punjab [117].	Pakistan is said to have 4.5 million ha or 4.0% of the total land area of 87.88 million ha under forest [125] although according to Global Forest Watch this had reduced to 1% in 2000. Tree cover loss from 2001 to 2014 was reported to have been 9 265 ha [8].

SPECIES AVAILABLE	HISTORICAL DISTRIBUTION	HABITAT REDUCTION ASSESSMENTS
Sri Lanka		
D. latifolia	Introduced but precise distribution not specified [80].	With an estimated tree cover of 61% in the year 2000, Sir Lanka recorded a loss of tree cover from 2001 to 2014 of some 112,884 ha [8].
D. sisso	Introduced, distribution unknown [80, 117].	
P. marsupium	Unspecified. [105]	
P. santalinus	Introduced.	
Thailand		
D. assamica	*D. assamica* is distributed in Chiang Mai, Lampang, Kanchanaburi and Saraburi [68, 66] and Mae Ngao National Park [66].	*D. cochinchinensis* - 300,000 trees in 2005, reduced to 80,000-100,000 trees (≈ 63,500 cubic meters) in 2011 [73] From 2006-2013, *Dalbergia* wood seized by Dept. of National Parks Wildlife & Conservation consisted of: 23,812 logs/squares/plates (2,239.90 m^2) and worth over 16.14 million US dollars (559m Thai Bhat) [133]. In 2014, the Dept. of Forestry announced that Thailand had a forest area of 162,200.00 square kilometres (31.6% of total land area). In 1961, the forest area covered 53.3% total land area [133].
D. cochinchinensis	567 km^2 of *D. cochinchinensis* habitat – severely fragmented in protected areas (126 km^2 of lower North-Eastern provinces (Phu Wiang National Park, Phu Phan National Park, Phu Sithan Wildlife Sanctuaries, Thap Lan National Park, Ta Phraya National Park) [73] Also, found in Surin, Ubon Ratchatatani, Saraburi, Sa Kaeo, Prachin Buri, Chachongsao, Chon Buri, Rayong, Chanthaburi, and Trat. [68]	
D cultrata	Recorded as distributed in Chiang Mai, Mae Hong Son, Chaing Rai, nan, Lamphun, Lampang, Uttaradit, Tak, Phetchabun, Loei, Udon Thani, Nakhon, Phanom, Khon Kaen, Nakhon ratchasima, Ratchaburi, Kanchanaburi, Saraburi [68]. *D. fusca* - the Mae Soi valley catchment, which lies 74 km southwest of Chiangmai in the rain-shadow of Doi Inthanon, Thailand's highest mountain [68]..	
D. oliveri	North-eastern parts of the country.	
D. sisso	Introduced [80].	
P. indicus	Native but distribution is widely scattered or uncommon [88]	
P. macrocarpus	Scattered populations throughout Thailand, particularly along forest areas which border Lao PDR and Myanmar [92].	
Vietnam		
D. annamensis	This species is endemic to Vietnam, specifically Bin Dinh, Phu Yen and Khanh Hoa provinces – restricted to lowland dry open forests of the south central coast. [49, 63, 104, 105].	In 1943, the total forest area was 14.3 million ha or 43% of the total land area. In 1990 - only 9.2 million ha or approximately 27% remained. In 2005, the forest area had recovered to 12.6 million ha, or 37%, of the total area of the country [134]. In 1943, no planted forests, 1995 = reached about 1 million ha, 2005 = 2.3 million ha. [134]. *D. cochinchinensis* - 2010 survey of five protected areas; low density = 1- 10 tree/hectare Rosewood is illegally harvested in from protected areas, especially in Quang Binh province [73].
D. assamica	*D assamica* has been recorded in Ha Noi and Cuc Phuong National Park (Ninh Binh). [135, 66] *D. balansae* was recorded as scattered in Northern Vietnam [105].	
D. cochinchinensis	Central and southern provinces, specifically in Quang Nam to Da Nang southwards, mainly in Gia Lai and Kom Tum; (Dacto, An Khe, Sa Thay). Sparsely distributed in provinces like Dak Lak, Lam Dong, Binh Duong, Tay Ninh, Dong Nai, Ba Ria-Vung Tau and Kien Giang. [69, 73, 111].	
D cultrata	Provinces of Dac Lac, Lâm Dông, and Dông Nai. [105, 58]. Reported to have a scattered distribution through these areas [58].	
D. latifolia	Introduced but precise distribution not specified [80].	
D. oliveri/ D. bariensis/ D. mammosa	*D. oliveri/bariensis* - distributed in Gia Lai, Kon Tum, Dac Lac, Lam Dong, Ninh Thuan, Binh Thuan, Dong	

SPECIES AVAILABLE	HISTORICAL DISTRIBUTION	HABITAT REDUCTION ASSESSMENTS
	Nai, Song Be and Tay Ninh and Tan Phu forest, Quang Tri, Dac Lac, Phu Yen, and Ba Ria-Vung Tau [68] *D. mammosa* – endemic to Vietnam and located in central and southern parts of the country specifically Kon Tum, Gia Lai and Đắk Lắk, Đồng Nai and Sông Be. [105].	
D. tonkinensis	Provinces of Lạng Sơn and Ha Bac, and in the north eastern coast in the provinces of Quảng Ninh and Ninh Bình [63]. Found in primary and secondary forests [105].	
P. indicus	Native but distribution is widely scattered or uncommon [88]	
P. macrocarpus	Hà Nôi, Nghê An, Quang Tri, Dac Lac, Khanh Hoa, Ninh Hoa, Ninh Thuân, Sông Bé, Tây Ninh, Dông Nai, Hô Chi Minh, and Kiên Giang provinces [69].	

A lack of up-to-date distribution and range information specific to each species limits the overall picture provided in Table 19. As such country-wide assessments of habitat lost are provided as a proxy for the reduction in available habitat for these species. In an attempt to overcome this limitation, Global Eye conducted a Geographic Information System (GIS) mapping exercise using known localities and bioclimatic parameters to predict possible range extent, overlaid with known forest loss data up to 2014 (see Annex A for further details on the methods used). This allows for a justifiable prediction of the current possible distributions for the selected Asian rosewood or other precious wood species. Figure 16 to Figure 18 show the maps for *D. cochinchinensis, D. oliveri and P. macrocarpus*. The species distribution modelling showed a wide area of potentially suitable habitat and environmental variables, due to the forest loss layer including degraded forest habitats. In order to understand the most likely current habitat for these species, an additional data layer was added, showing forest areas that are considered "intact". These maps are the second map provided in Figure 16 to Figure 18 (with black oceans) which displays the extent of reduction in available suitable habitat for these species. Ideally these types of exercises would be verified by field surveys to check the accuracy of the GIS modeling, but this was outside of the scope of this report. Nonetheless the GIS models provide important analysis on the pressures to these species. They can also be developed further with a sample of on-ground surveys in order to validate/refine the modeling techniques. Overall it is cost effective and important exercise to undertake.

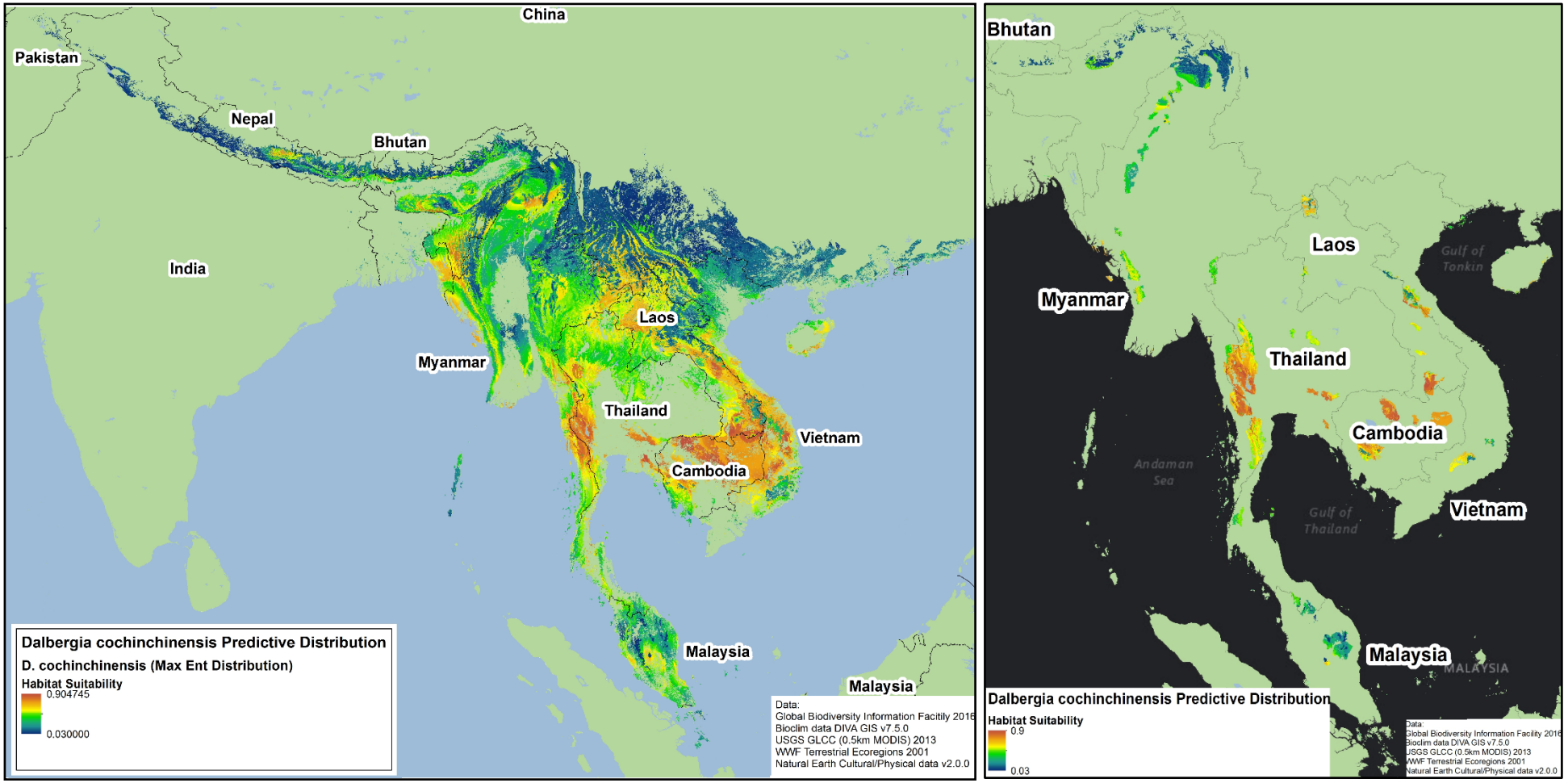


Figure 16 - *D. cochinchinensis*. (Left) Predicted Suitable Habitat Range. **(Right) Suitable habitat contained within "intact forests".** Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

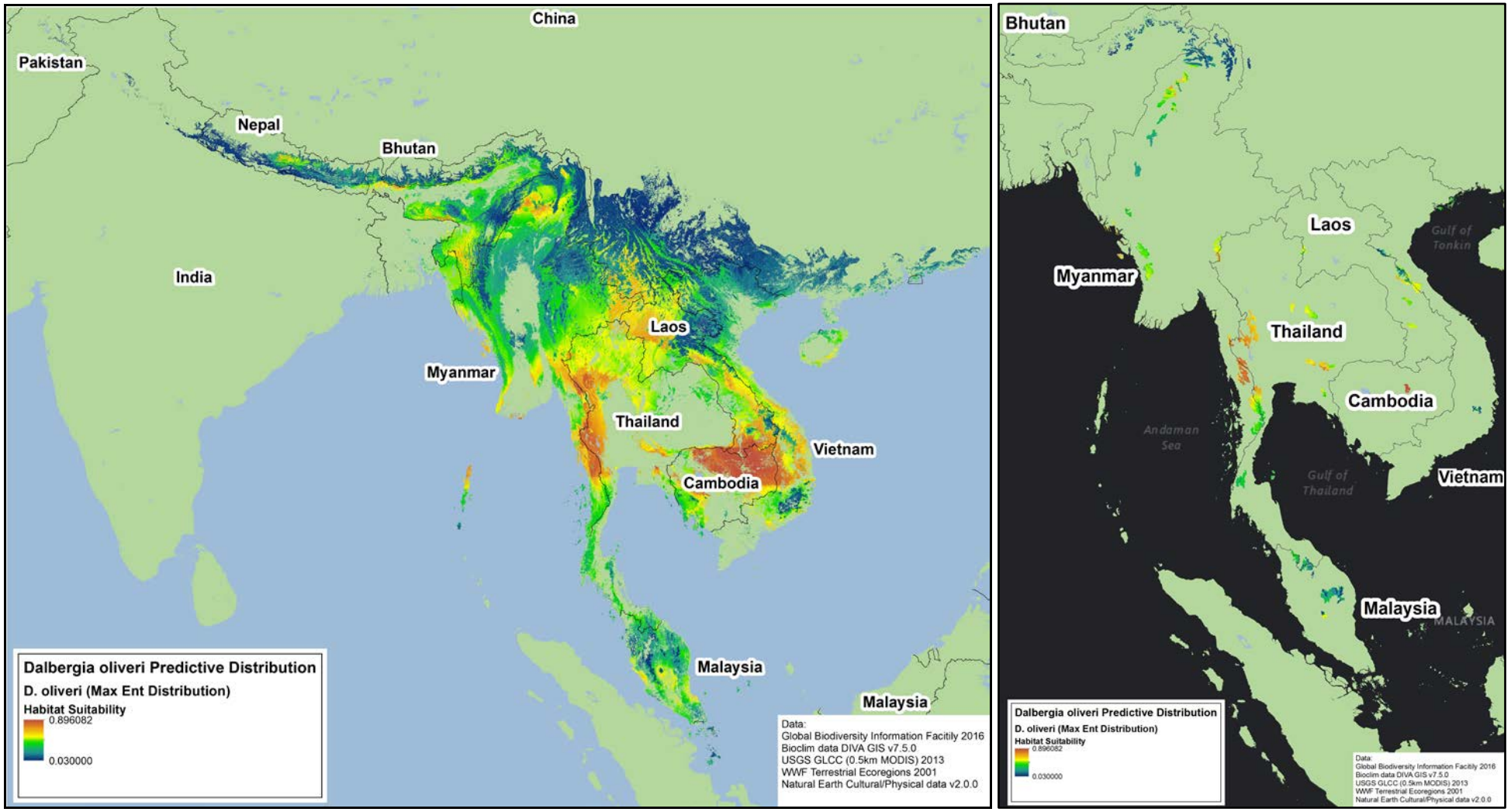


Figure 17 - *D. oliveri*. (Left) Predicted Suitable Habitat Range. **(Right) Suitable habitat contained within "intact forests".** Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

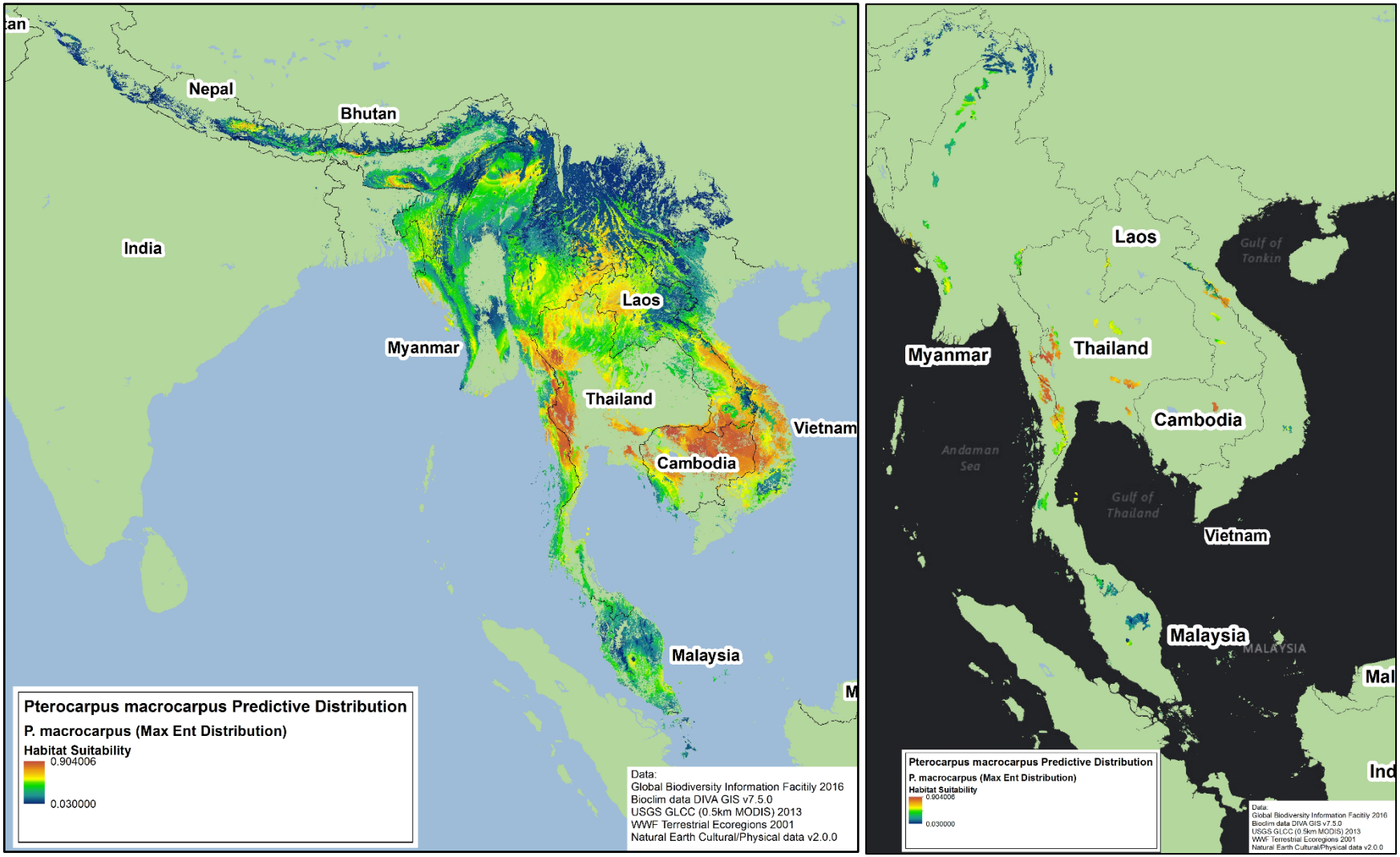


Figure 18 – *P. macrocarpus* (Left) Predicted Suitable Habitat Range. **(Right) Suitable habitat contained within "intact forests".** Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

POPULATION STRUCTURE AND STATUS

While there have been a number of population studies outlining the status and structure of Asia-Pacific species, the majority of them appear to relate to the most exploited. There are number of species in this region, for example *D. annamensis*, *D. odorifera* and *P. santalinus,* which are endemic to particular areas so it is surprising that there are not more studies for at least these species given their distribution areas are vastly smaller compared to the others. It is possible that there are more studies available in local languages, however Global Eye was only able to source English papers. A large number of the studies have also been undertaken in areas which have already been logged over, some on more than one occasion.

From the studies that have been obtained, several important findings have emerged. While all species are over-exploited in this region, there are some which are exploited more than others such as *D. cochinchinensis*, *D. oliveri* and *P. macrocarpus* and their associated synonym species. The vast majority of the studies have found only a scattered number of mature trees while others have failed to find any at all. Studies have noted that some species, like *D. bariensis* (synonym of *D. oliveri*) are rare, close to extinction and require urgent conservation efforts before the species is no longer found in their natural distribution ranges [136]. We note that severe forest loss and fragmentation in Southeast Asia likely has important implications for population and meta-population dynamics (such that there may no longer be dispersal or interchange, and that single population may now be multiple meta-populations). However it is beyond the scope of this report to examine these aspects, as such we use the term population in its broadest sense.

Table 20 indicates the known population structures and statuses of these species across their ranges, and highlights where the populations are declining. Note that a number of the studies are only estimates made by the study authors, which indicates that more robust studies may be required. There is an urgent need for range states to undertake more in-depth population studies of current trends, as the majority of studies covered here over 5 years old and many of those 10 – 15 years old.

Table 20 – Literature Review of various Asia-Pacific Species population assessments

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES
	ROSEWOOD SPP.	
RANGE COUNTRY - VIETNAM		
In 2013, this document noted that there had been no comprehensive survey undertaken of rosewood in Vietnam.	This document reported that the population size of rosewood has been declining about 50-60% during the past 5-10 years. The document also noted that no reference had been made in relation to which rosewood species the assessment included in the study.	CoP Prop 60 (2013) [73].
	DALBERGIA ANNAMENSIS	
RANGE COUNTRY – VIETNAM		
In 1998, this species was assessed as being endemic to the Phu Yen and Khanh Hoa provinces.	Population Status In 1998, the IUCN Red List Assessment found that this species was Endangered ("EN A1cd"). This assessment was reached because it was observed, estimated, inferred or suspected to have a population reduction of at least 50% over the last 10 years or three generations, whichever was longer, based on: 1. a decline in the area of occupancy, extent of occurrence and/or quality of habitat; and 2. actual or potential levels of exploitation. It is unknown whether this species remains in the assessed population area.	Nghia (1998) [49].

<table>
<tr><th>POPULATIONS STUDIED</th><th>POPULATION PARAMETERS</th><th>REFERENCES</th></tr>
<tr><td colspan="3">DALBERGIA ASSAMICA/BALANSAE</td></tr>
<tr><td colspan="3">RANGE COUNTRY – UNSPECIFIED</td></tr>
<tr><td>The document does not specify which D. assamica (meta) populations that it refers to.</td><td><u>Population Status</u>
In 2012, Chadburn (2012) [66] reported that there had been recent collections for the D. assamica and therefore assessed the population as a whole to be large and stable. However, no specific population data was provided to supplement this assessment.</td><td>Chadburn (2012) [66]</td></tr>
<tr><td colspan="3">RANGE COUNTRY – VIETNAM</td></tr>
<tr><td>In 1998, D. balansae was assessed as being scattered throughout Northern Vietnam.</td><td><u>Population Status</u>
In 1998, the IUCN Red List Assessment found that this species was <u>Endangered</u> (“EN A1cd”). This assessment was reached because it was observed, estimated, inferred or suspected to have a population reduction of at least 50% over the last 10 years or three generations, whichever was longer, based on:
1. a decline in the area of occupancy, extent of occurrence and/or quality of habitat; and
2. actual or potential levels of exploitation.
It is unknown whether this species remains in the assessed population area.</td><td>Nghia (1998) [46]</td></tr>
<tr><td colspan="3">DALBERGIA COCHINCHINENSIS/CAMBODIANA</td></tr>
<tr><td colspan="3">RANGE COUNTRY – CAMBODIA</td></tr>
<tr><td>Table 21 identifies the population locations reported in 2003 by the Cambodia Tree Seed Project.</td><td><u>Population Status</u>
In 2003, The Cambodia Tree Seed Project produced a document recording a number of D. cochinchinensis trees for seed sources in natural forests throughout Cambodia as indicated below in Table 21.

<u>Natural Density</u>
As demonstrated in Table 21, the natural density in the population studied was low with an average of 1.37 trees per hectare.

Table 21 - Seed Sources in the Natural Forest. Table adapted from Table 3 in Cambodia Tree Seed Project (2003) [15]
<table>
<tr><th rowspan="2">Area (Ha)</th><th colspan="3">Location</th><th rowspan="2">N</th><th rowspan="2">UTM Coordinate</th></tr>
<tr><th>Province</th><th>District</th><th>Commune</th></tr>
<tr><td>50</td><td>Siem Reap</td><td>Varinn</td><td>Sre Nauy</td><td>67</td><td>04 00 757, 15 20 273</td></tr>
</table></td><td>Cambodia Tree Seed Project (2003) [72]</td></tr>
<tr><td>Not specified.</td><td><u>Population Status</u>
This document referred to work undertaken Hartvig in litt. (2012) and reported that while populations were found in many provinces, mature individuals were very rare outside strictly protected areas. The document also reported that populations faced severe depletion.</td><td>Hartvig et al (2013) [137]</td></tr>
<tr><td colspan="3">RANGE COUNTRY – LAO PDR</td></tr>
<tr><td>In 2012, field surveys were conducted in central provinces of Bolikhamxay and Khammouane.</td><td><u>Population Structure and Status</u>
In 2012, EIA (2014) [4] reported that field surveys conducted confirmed natural populations of this species were under severe threat and no mature trees were found.</td><td>EIA (2014) [4]</td></tr>
</table>

<table>
<tr><th>POPULATIONS STUDIED</th><th>POPULATION PARAMETERS</th><th>REFERENCES</th></tr>
<tr><td>In 1980, Paklay in Saybouri province
Latitude: 17°50’ to 18°55’N
Longitude: 100° and 100°30’ E
Area: 590 000 ha; including 330 000ha forest made up of
- 20% - closed production forest
- 60% semi deciduous/ deciduous degraded forest
- 20% deforested land/rice fields and agricultural forest</td><td><u>Population Status</u>
All trees with a breast diameter height (D.B.H) of more than 20 cm were measured within circular inventory plots comprising of 40ha of forests. The area of the circular inventory plots was 0.25 ha. Table 22 and Figure 19 show the population parameters in this study.

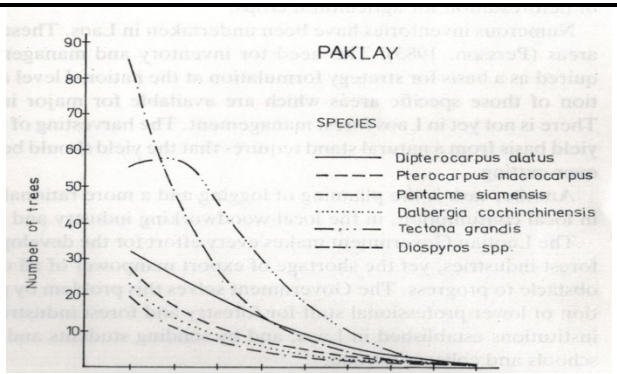
Table 22 -Theoretical data of breast height-diameter distribution of trees, Paklay Region –adapted from Table 38 in Borota (1991).
<table>
<tr><td>Median DBH (cm)</td><td>25</td><td>35</td><td>45</td><td>55</td><td>65</td><td>TOT</td></tr>
<tr><td>Density (N/ha)</td><td>22</td><td>15</td><td>10</td><td>6</td><td>3</td><td>56</td></tr>
</table>


Figure 19 - Compensated values of the diameter distribution of trees species in the Paklay region, Lao PDR (taken from Borota (1991) - Figure 60)</td><td>Borota (1991) [76, pp. 143-147]</td></tr>
<tr><td>The study side was located at Napo and Nongboua villages in Sang Thong District, 70km north west of Vientiane

Latitude: 18°16’26” North
Longitude: 102°10’31” East.

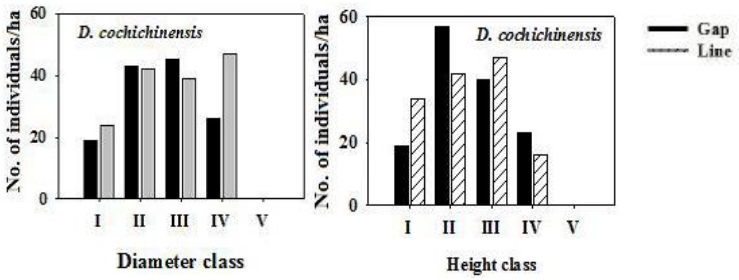
Area: 40 ha of logged-over tropical mixed deciduous forest.

2 study sites x 20 ha blocks, one for gap planting and one for line planting.

The populations in this study were derived from nursery raised seedlings of this species which</td><td><u>Population Structure</u>
The study examined the population structure by grouping individuals from each planting method and species into five collar diameters (≤ 1.0cm, 1.0-1.9cm, 2.0-2.9 cm, IV = 3.0-3.9cm, ≥ 4 cm) and height (≤ 100cm, 100-190cm, 200-290 cm, 300 - 390cm and ≥ 400 cm) classes.

As shown in Figure 20, the pattern of diameter class distribution differed between gaps and planting lines, although neither method produced any individuals with more than 4cm in diameter distribution. The pattern of height class distribution also different for this species, although a large number of individuals reached a height of 100-190cm in the gap planting method. Neither method produced individuals with heights over 400cm, although a good number of planted seedlings grew up to 300cm in height using both methods. It is unknown whether this particular population remains in the study area.

<u>Natural Density</u>
Figure 20 shows that almost 60 individuals per hectare in the second height distribution class appeared at the gap planting site followed by approximately 40 individuals per hectare for the third height distribution class. Conversely, around 50 individuals per hectare appear in the third height distribution class at the line planting site compared with around 40</td><td>Sovu et al (2010) [113]</td></tr>
</table>

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES
were then planted into the study sites using either gap or line planting methods.	individuals per hectare for the second class. The amount of individuals per hectare for the second and third classes are similar for the diameter class distribution densities.  **Figure 20 – Diameter (I = ≤ 1.0cm, II = 1.0-1.9cm, III = 2.0-2.9cm, IV = 3.0-3.9cm, V = ≥ 4cm) and height (I = ≤ 100cm, II = 100-190cm, III = 200-290cm, IV = 300-390cm, V = ≥ 400cm).class distribution used in gap and line enrichment planting.** Adapted from Figures 2 and 3 in Sovu et al (2010) **[113].**	
RANGE COUNTRY – THAILAND		
This was an estimated assessment. No specific location areas were provided in the document aside from advising that natural stands of the species were found scattered in 30 protected areas comprising of 557.76 km^2.	Population Status This document reported the following for this species: In 2005, it was estimated there were 300,000 natural stands. In 2011, it was estimated that 80 000- 100 000 trees (approximately 63 500 cubic meters) of this species remained.	CoP Prop 60 (2013) [73].
RANGE STATE – VIETNAM		
Five protected areas. The document does not specify which areas.	Natural Density This document reports that a 2010 survey of five protected areas found a low density of just one to 10 trees per hectare. Population Status This document also reports that in 2014, traders were claiming there was no Siamese rosewood left in Vietnam.	EIA (2014) [4]
DALBERGIA CULTRATA/ FUSCA		
RANGE COUNTRY – UNSPECIFIED		
Unspecified.	Population Status In 2012, overexploitation was identified as the main cause of the population decline for this species.	Contu (2012) [58].
RANGE COUNTRY – THAILAND		
Doi Setep-Pui National Park, Chiang Mai. Seven sites were studied which are detailed below in Table 23.	Population Status In 2008, Vaidhayakarn and Maxwell (2010) [108] undertook an ecological assessment of lowland deciduous dipterocarp-oak, seasonal, hardwood forest in Chiang Mai, Thailand. The relevant population results for *D. cultrata* of which are shown in Table 23 below. It is unknown whether these individuals still remain at the study site.	Vaidhayakarn and Maxwell (2010) [108]

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES

Table 23 - Location, Habitat and No. of Individuals of *D. cultrata* in lowland deciduous forest in Chang Kian Valley, Chiang Mai, Thailand. Adapted from various table information in Vaidhayakarn and Maxwell (2010) [59]. Each site survey plot = 50 x 5m.

Site No	Site Location	N
1	Pah Laht Temple – 607m elevation. The most intact forest which had been protected from major disturbance for more than 50 years.	45
2	Chang Kian Stream – 474m elevation. Above the boy scout camp near Chang Kian Village, severely degraded and frequently burned by mushroom collectors.	1
3	Mae Yuak Noi 1 – 455m elevation. Near Nong Haw mediation centre, a regenerating forest which has uniform tree regrowth after being cleared 25 years ago.	35[19]
4	Mae Yuak Noi 2 – 490m elevation. Near site 3 but with more grass cover.	-
5	Huay Dtueng Tao 1 – 439m elevation. Above Huay Dteung Tao Lake. A very exposed, frequently burned, eroded ridge.	1
6	Huay Dtueng Tao 2 – 453m elevation. Near site 5 and similar to it, but with more trees.	-
7	Huay Dtueng Tao 3 – 411m elevation. Gully below site 6 with less frequent fire than site 5, almost closed canopy.	60

DALBERGIA OLIVERI

RANGE COUNTRY – NON SPECIFIC

In 1998, *D. bariensis* was assessed as being a species widely distributed and scattered in Indo-China.

Population Status

The IUCN Red List Assessment reported that there had been a rapid decline in the number of large *D. bariensis* trees because of over-exploitation of the precious timber. It found that this species was Endangered ("EN A1cd"). This assessment was reached because it was observed, estimated, inferred or suspected to have a population reduction of at least 50% over the last 10 years or three generations, whichever was longer, based on:

1. a decline in the area of occupancy, extent of occurrence and/or quality of habitat; and
2. actual or potential levels of exploitation.

It is unknown whether this species remains in the assessed population area.

Nghia (1998) [45]

RANGE COUNTRY – CAMBODIA

Table 24 identifies the population locations studied.

Population Structure

In 2003, this project reported that regeneration effort for this species on a large scale have been few and limited and that mature and large sized trees were rarely to be found in many areas of its natural range.

Population Status

In 2003, this project recorded a number of *D. oliveri* trees for seed sources in Natural Forests throughout Cambodia as indicated below in Table 8. The project noted the number of remaining individual trees was very low and were disappearing on a local level. This project considered that the species was facing extinction in no effective protection measures were implemented.

Cambodia Tree Seed Project (2003) [72]

Table 24 - Seed Sources in the Natural Forest. Table adapted from Table 3 in Cambodia Tree Seed Project (2003) [72]

Area (Ha)	Location			No tree	UTM Coordinate
	Province	District	Commune		
12.5	Preah Vihear	Tbeng Meanchey	Parl Harl	78	04 94 650, 15 16 781
50	Rattanak Kiri	O Chum	Cha Uong	21	07 06 931, 15 20 149

19 Of which 31 individuals were fire damaged = 88.57%.

<table>
<tr><th>POPULATIONS STUDIED</th><th>POPULATION PARAMETERS</th><th>REFERENCES</th></tr>
<tr><td></td><td>
<table>
<tr><td>18</td><td>Rattanak Kiri</td><td>Lumphat</td><td>Patang</td><td>41</td><td>07 21 623, 15 15 900</td></tr>
<tr><td>20</td><td>Rattanak Kiri</td><td>Kaun Mum</td><td>Teun</td><td>17</td><td>07 04 001, 15 04 648</td></tr>
</table>
</td><td></td></tr>
<tr><td colspan="3">RANGE COUNTRY – MYANMAR</td></tr>
<tr><td>In 2014, the Environmental Protection Agency (EIA) used figures adapted from information supplied by the Ministry of Environmental Conservation and Forestry (2014) [138] for the Sagaing division, Shan State, Mandalay and Kachin states.</td><td><u>Population Status</u>
In 2014, total estimated stocks of D. oliveri/bariensis were 1.6 million cubic meters. This document reported that rosewood species in Myanmar, including tamalan (D. oliveri), were rapidly declining and, if harvesting continued at the same rate, stocks would be completely consumed in as little as three years.

<u>Natural Density</u>
In 2014, the highest density was in the Sagaing division with an estimate of over two million trees embodying 850,000 cubic tons / 1,203,600 m^3. Shan state have an estimated density of 900,000 trees embodying 250,000 tons/354,000 m^3. Mandalay and Kachin and other states have an estimated 100-150,000 tons/ 141,600 – 212,400 m^3 combined. It is unknown whether this estimated population figures are true and correct or whether they remain in the area studied.</td><td>EIA (2014) [139].</td></tr>
<tr><td>Unspecified.</td><td><u>Population Status</u>
In 2014, the document reports that D. oliveri stocks in Myanmar are rapidly declining on account of trade growth rates. The Environmental Protection Agency (2014) [139] estimates that if current rates of harvest were to continue, stocks would be completely consumed in as little as three years.</td><td>EIA (2014) [139]</td></tr>
<tr><td colspan="3">RANGE COUNTRY – THAILAND</td></tr>
<tr><td>Ban Pong Forest Sanctuary
Latitude: 18°56N’
Longitude: 99°3’E
Elevation: 400 ASL in the Huai Jo low-hill watershed located on the San Sai Mountain Range surrounding the Chiang Mai Basin, 20km NE of Chiang Mai in Northern Thailand.</td><td><u>Natural Density</u>
In 2009, a study was undertaken to determine the site requirements of D. oliveri in a tropical deciduous forest in Northern Thailand. Figure 21 demonstrates the results of the stand characteristics of three study sites of the population site studied. It is unknown whether the population remains at the study site.</td><td>Aerts et al (2009) [140].</td></tr>
</table>

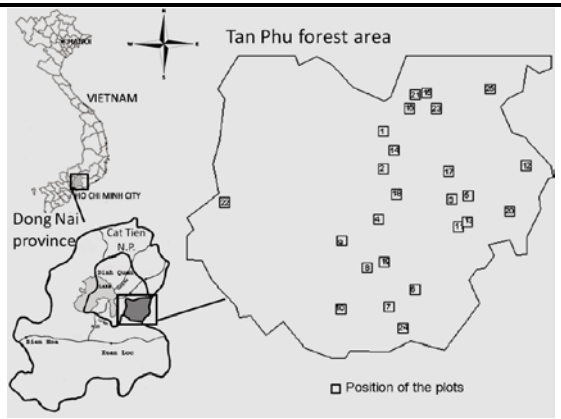
POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES

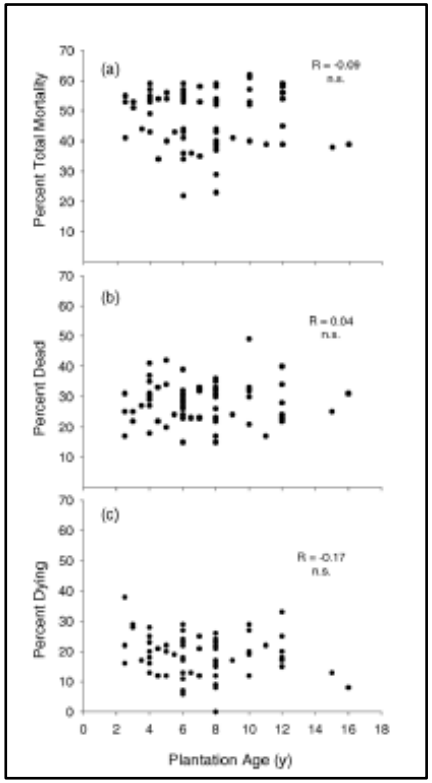
	Mixed deciduous forest	Deciduous dipterocarp forest		H	P
		Mesic phase	Dry phase		
	N = 3	N = 13	N = 5		
Tree density (stems ha^{-1})	785 (91)^{a,b}	830 (52)^{a}	1623 (324)^{b}	7.99	0.018
Basal area of trees (m^2 ha^{-1})	24.5 (3.9)	20.6 (1.6)	24.2 (5.2)	0.82	0.66
Mean tree height (m)	13.1 (1.9)	11.2 (0.7)	9.9 (1.9)	1.61	0.45
Maximum tree height (m)	32.7 (2.4)^{a}	21.8 (0.8)^{a,b}	19.1 (3.8)^{b}	7.46	0.024
Dominant tree height (m)	29.9 (1.6)^{a}	19.2 (0.8)^{a,b}	16.8 (3.1)^{b}	7.36	0.025

Values are group means followed by standard errors of mean between brackets. Letters represent significant differences between groups at level $P < 0.05$. N is the number of plots in the specified vegetation group used for Kruskal–Wallis ANOVA.

Figure 21 - Stand characteristics of 3 tree communities with *D. oliveri* in deciduous forest in the Ban Pong Forest Sanctuary, Chiang Mai, Thailand. Taken from Aerts et al (2009) [140], table 3.

RANGE STATE - VIETNAM		
In 1998, *D. mammosa* was assessed as native to central and southern Vietnam.	Population Status In 1998, The IUCN Red List Assessment reported that overexploitation of *D. mammosa* timber had led to declines throughout the entire population. This species as was assessed as Endangered ("EN A1cd"), as it was observed, estimated, inferred or suspected to have a population reduction of at least 50% over the last 10 years or three generations, whichever was longer, based on: 1. a decline in the area of occupancy, extent of occurrence and/or quality of habitat; and 2. actual or potential levels of exploitation. It is unknown whether this species remains in the assessed population area.	Nghia (1998) [44]
In 1998, this document reported *D. oliveri* at the Cat Tien National Park.	Population Status The IUCN Red List Assessment reported a protected subpopulation of *D. oliveri* occurred within the Cat Tien National Park. This species was assessed as Endangered ("EN A1cd"), as it was observed, estimated, inferred or suspected to have a population reduction of at least 50% over the last 10 years or three generations, whichever was longer, based on: 1. a decline in the area of occupancy, extent of occurrence and/or quality of habitat; and 2. actual or potential levels of exploitation. It is unknown whether this species remains in the assessed population area.	Nghia (1998) [48]
Tai Phu Forest, Dinh Quan District, Dong Nai Province Latitude: 11°2i to 11°10'N Longitude: 107°20' to 107°27'E	Population Status Millett et al (2010) reported that a large number of plant species that made up the forest stands 60 years earlier no longer characterise them and that D. bariensis species have nearly disappeared from the Forest study site.	Millet et al (2010) [141]
The study area was the Tai Phu Forest, located in Southern Vietnam as shown below in Figure 22.	Population Status Millet and Truong (2011) [136] did not include the date that their study was undertaken in their research method. *D. bariensis* was barely represented in the population area studied, representing a total of 0.02% of the total number of trees. *D. bariensis* was one of three species out of 176 species studied that were close to extinction in the area.	Millet and Truong (2011) [136]

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES
	 **Figure 22 - Location of the study area in Dong Nai Province, Vietnam**	
DALBERGIA SISSOO		
RANGE COUNTRY - BANGLADESH		
Plantations covering five districts within Bangladesh including Rangpur, Nilphamari, Dinajpur, Chuadnaga and Khulna. Seventy-two plantations of 0.5 -1.0 ha.	The purpose of the study was to examine the relationship between the mortality of the *D. sissoo* trees and the age of the plantation, planting strategies, soil types and textures and the geographic location of the plantations studied [142] Populations studied looked at the age of the populations and the density of the population. Planting arrangements were also looked at, however these varied considerably with some plantations having mixed species being planted and others planting in rows or in random arrangements [142]. **Table 25 - Medium mortality of *Dalbergia sissoo* according to soil textural classes in plantations of five districts in Bangladesh (source: Taken from Webb and Shaik 2005)** Median mortality of *Dalbergia sissoo* according to soil textural classes in plantations of five districts in Bangladesh Soil textural classes / Rangpur (*N*, Mortality) / Nilphamari (*N*, Mortality) / Dinajpur (*N*, Mortality) / Chuadanga (*N*, Mortality) / Khulna (*N*, Mortality) / Total (*N*, Mortality) Loam: 7, 52.0 / 4, 47.5 / 6, 43.0 / — / — / 17, 49.0 Silt-loam: 7, 52.0 / 3, 43.0 / 2, 40.00 / 12, 55.5 / 5, 39.0 / 29, 43.0 Sandy-loam: — / 3, 55.0 / 7, 54.0 / — / — / 10, 54.0 Silty-clay: — / — / — / 4, 55.0 / 7, 40.0 / 11, 44.0 Silty-clay loam: 1, 39.0 / — / — / 4, 48.5 / — / 5, 41.0 Total: 15, 52.0 / 10, 52.0 / 15, 54.0 / 20, 55.0 / 12, 39.5 / 72, 52.0 Significance (Kruskal–Wallis ANOVA): $p > 0.05$ Table 25 indicates that the highest level of mortality amongst the plantations studied occurred in the Chuadanga District with a median of 55% of *Dalbergia sissoo* trees affected. Nilphamari, Dinajpur and Rangpur followed closely with mortality rates of 52%, 54% and 52% respectively as shown in Table 25. In comparison with other countries within Asia, *D. sissoo* in Bangladesh recorded a much higher mortality rate than did trees with die-back recorded in countries such as India and Nepal [142].	Webb and Shaik (2005) [142]; Sharma et al (2000) [143].

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES
	 **Figure 23 – Scattergrams of tree mortality** The scattergrams in Figure 23 looked at the age of the plantation (y axis) and the percentage mortality including (a) the total *D. sissoo* mortality; (b) the percentage of dead trees and (c) the percentage of dying trees. Khan (2000) cited in Webb and Shaik (2005) suggests that there is an increased mortality in plantations with an age distribution of between 6-10 years whereas Figure 23 (c) suggests that there is no relationship between the old and young age classes and mortality [142]. Research by Webb and Shaik (2005) contrasted with previous studies undertaken by Bakshi et al, cited in Sharma et al 2000) were there was no incidence of mortality occurring is sandy loam soils. Webb and Shaik's research indicated that the sandy loam soils had recorded the highest level of mortality thus resulting in management implications for *D. sissoo* plantations in Bangladesh [143, 142]. Researches highlighted the fact that there were not any plantations that recorded zero mortality rates, thus all plantations to some extent suffered mortality of *D. sissoo* as a result of die-back [142]	
DALBERGIA TONKINENSIS		
RANGE COUNTRY – VIETNAM		
Unspecified.	Population Status In 2008, this document reported that the heavy exploitation of the timber had led to considerable population declines for *D. tonkinensis* in Vietnam. The IUCN Red List Assessment found this species was Vulnerable, with significant habitat loss due to logging	UNEP-WCMC (1998) [82]
PTEROCARPUS MACROCARPUS		
RANGE COUNTRY – CAMBODIA		
Table 26 identifies the population locations reported in 2003 by the Cambodia Tree Seed Project.	Population Status In 2003, The Cambodia Tree Seed Project produced a document recording a number of *P. macrocarpus* trees for seed sources in Natural Forests throughout Cambodia as indicated below in Table 26.	

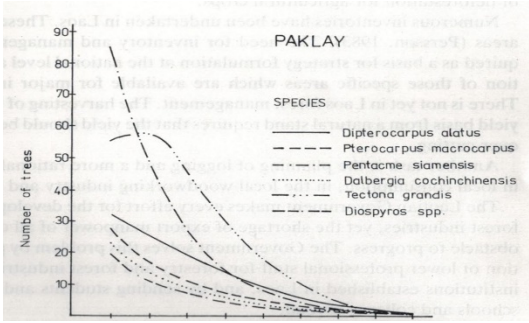
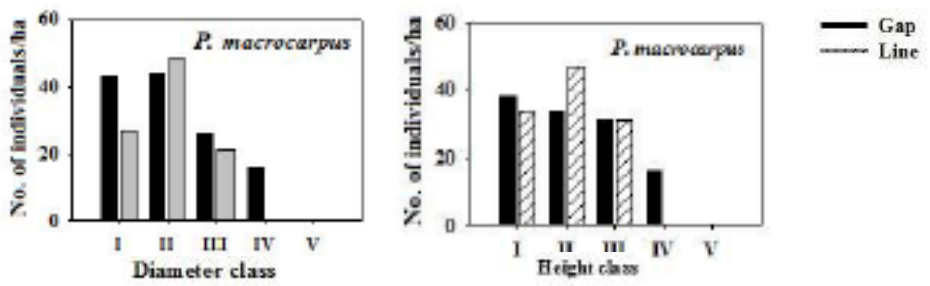
<table>
<tr><th>POPULATIONS STUDIED</th><th>POPULATION PARAMETERS</th><th>REFERENCES</th></tr>
<tr><td></td><td>
Table 26 - Seed Sources in the Natural Forest. Table adapted from Table 3 in Cambodia Tree Seed Project (2003) [15]
<table>
<tr><th rowspan="2">Area (Ha)</th><th colspan="3">Location</th><th rowspan="2">N</th><th rowspan="2">UTM Coordinate</th><th rowspan="2">Density (N/ha)</th></tr>
<tr><th>Province</th><th>District</th><th>Commune</th></tr>
<tr><td>20</td><td>Siem Reap</td><td>Chikreng</td><td>Khvao</td><td>83</td><td>04 51 140, 14 84 668</td><td>4.15</td></tr>
<tr><td>50</td><td>Rattanak Kiri</td><td>O Chum</td><td>Cha Uong</td><td>20</td><td>07 06 931, 15 20 149</td><td>0.4</td></tr>
<tr><td>18</td><td>Rattanak Kiri</td><td>Lumphat</td><td>Patang</td><td>14</td><td>07 21 623, 15 15 900</td><td></td></tr>
</table>
</td><td>Cambodia Tree Seed Project (2003) [15]</td></tr>
<tr><td colspan="3">RANGE COUNTRY – LAO PDR</td></tr>
<tr><td>In 1980, Paklay in Saybouri province
Latitude: 17°50’ to 18°55’N
Longitude: 100° and 100°30’ E
Area: 590 000 ha; including 330 000ha forest made up of:
- 20% - closed production forest
- 60% semi deciduous/ deciduous degraded forest
- 20% deforested land/rice fields and agricultural forest</td><td>
<u>Population Structure and Status</u>
All trees with a breast diameter height (D.B.H) of more than 20 cm were measured within circular inventory plots comprising of 40ha of forests. The area of the circular inventory plots was 0.25 ha. Figure 24 and Table 27 show the population parameters of this survey, which also included Dalbergia cochinchinensis.


Figure 24 - Compensated values of the diameter distribution of trees species in the Paklay region, Lao PDR (taken from Borota (1991) - Figure 60).

Table 27 - Theoretical data of breast height-diameter distribution of trees, Paklay Region – adapted from Table 38 in Borota (1991).
<table>
<tr><td>Median DBH (cm)</td><td>25</td><td>35</td><td>45</td><td>55</td><td>65</td><td>75</td><td>85</td><td>95</td><td>105</td><td>TOT</td></tr>
<tr><td>Density (N/ha)</td><td>27</td><td>16</td><td>11</td><td>7</td><td>4</td><td>31</td><td>1</td><td>1</td><td>1</td><td>56</td></tr>
</table>
</td><td>Borota (1991) [76, pp. 143-147]</td></tr>
<tr><td>The study side was located at Napo and Nongboua villages in Sang Thong District, 70km north west of Vientiane

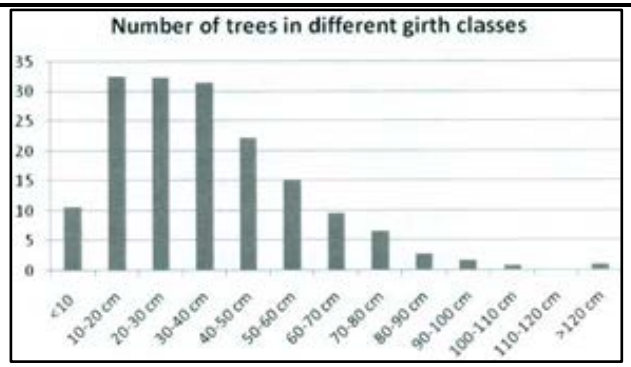
Latitude: 18°16’26” North
Longitude: 102°10’31” East.</td><td>
<u>Population Structure</u>
The study examined the population structure by grouping individuals from each planting method and species into five collar diameters (≤ 1.0cm, 1.0-1.9cm, 2.0-2.9 cm, IV = 3.0-3.9cm, ≥ 4 cm) and height (≤ 100cm, 100-190cm, 200-290 cm, 300 -390cm and ≥ 400 cm) classes.
As shown in Figure 25, 80% of individuals were distributed in the first two lower diameter classes in both methods Neither method produced individuals with heights over 400cm and only the gap planting method produced large sized individuals (≥ 3cm) but as many as 16 individuals were recorded in gaps per hectare. A relatively high number of individuals reached a height of 100-190 using the line planting method.
</td><td>Sovu et al (2010) [113]</td></tr>
</table>

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES
Area: 40 ha of logged-over tropical mixed deciduous forest. 2 study sites x 20 ha blocks, one for gap planting and one for line planting. The populations in this study were derived from nursery raised seedlings of this species which were then planted into the study sites using either gap or line planting methods.	It is unknown whether this particular population remains in the study area. <u>Natural Density</u> Figure 25 shows that more than 40 individuals per hectare appeared at the gap planting site in the first two diameter classes for this species. This density pattern also occurs for individuals in the second diameter class at the line planting site for both diameter and height class distributions for *P. macrocarpus*.  **Figure 25 – Diameter (I = ≤ 1.0cm, II = 1.0-1.9cm, III = 2.0-2.9cm, IV = 3.0-3.9cm, V = ≥ 4cm) and height (I = ≤ 100cm, II = 100-190cm, III = 200-290cm, IV = 300-390cm, V = ≥ 400cm) class distribution used in gap and line enrichment planting.** Adapted from Figures 2 and 3 in Sovu et al (2010) **[113]**.	
RANGE COUNTRY- THAILAND		
The study was conducted at Mae Yuak Planation Station, managed by the Royal Forest Department in Ngao District, Lampang Province, Northern Thailand Latitude: 18°55'N Longitude: 99°56'E	<u>Population Structure</u> The stand used for the study was a 37 year old teak stand in a mixed deciduous forest. The total area studied was 160ha. Three sites were selected based on the differences in topographic conditions, stand structure and distance from natural forest. Site one was on the upper part of a hill (elevation: 400-470m), its canopy dominated by teak and regenerated vegetation and was connected to the mixed deciduous forest. Site 2 was on the top and the ridge of another hill (elevation: 400-440m), the canopy dominated by small teak and associated with bamboo and approx. 1000 meters away from the mixed deciduous forest. Site 3 was located near a small stream, on a foot hill (elevation: 400m) and was dominated by large teak and connected to the mixed deciduous forest. The mixed deciduous forest was the reference site (elevation: 450-560m) and dominated by various native tree species. [144, p. 248] <u>Natural Density</u> This study was undertaken in November 2004 and July 2005. *P. macrocarpus* had the highest density of 73.3 stems per hectare. *P.macrocarpus* was also the most dominent species with an importance value (IV) of 21.5 (using the woody regeneration IV ranking).[20] Table 28 below shows the data results for this species following the study. It is unknown whether this species remains in the planation and forest site studied.	Koonkhunthod et al (2007) [144].

20 The importance value (IV) was calculated as the sum of the relative density and the relative frequency. The IV was used to evaluate the dominance of the species in the area.

<table>
<tr><th>POPULATIONS STUDIED</th><th>POPULATION PARAMETERS</th><th>REFERENCES</th></tr>
<tr><td></td><td>Table 28 - Woody Plant Species with DBH 4.5cm in teak plantation and Mixed Deciduous Forest (MDF), Mae Tuak Planation Station. Adapted from Table 2 in Koonkhunthod et al (2007) [144].
<table>
<tr><th colspan="3">Number of Stem</th><th rowspan="2">MDF</th><th colspan="2">Importance Value</th></tr>
<tr><th colspan="3">Plantation</th><th rowspan="2">Plantation excl. Teak</th><th rowspan="2">MDF</th></tr>
<tr><th>Site 1</th><th>Site 2</th><th>Site 3</th></tr>
<tr><td>32</td><td>5</td><td>7</td><td>4</td><td>21.5</td><td>10.8</td></tr>
</table></td><td></td></tr>
<tr><td colspan="3">RANGE COUNTRY- MYANMAR</td></tr>
<tr><td>Unspecified.</td><td><u>Population Status</u>
In 2000, this source estimated that there was approximately 15,527 ha (out of 675,197 ha) of forest plantations of P. macrocarpus which comprised a total of 2% of the total area. It is unknown whether the plantation population</td><td>Aung (2002) [119].</td></tr>
<tr><td>Shan State, Magway and Mandalay and Sagaing.</td><td><u>Population Status and Density</u>
In 2011, this source estimated 1.4 million cubic meters of P. macrocarpus with the highest densities being between 15,527 and 17,426 ha.</td><td>EIA (2014) [139].</td></tr>
<tr><td colspan="3">PTEROCARPUS DALBERGIOIDES</td></tr>
<tr><td colspan="3">RANGE COUNTRY – INDIA</td></tr>
<tr><td>The Andaman Islands</td><td><u>Population Structure and Status</u>
Based on their study, Prasad et al (2008) considered that anthropogenic disturbances did not particularly influence the population structure of the species, but higher rates of forest fragmentation and illicit cutting of large trees, coupled with poor seedling germination, may soon lead to the extinction of species. It is unknown whether the population that was studied still remains.</td><td>Prasad et al (2008)</td></tr>
<tr><td colspan="3">PTEROCARPUS INDICUS</td></tr>
<tr><td colspan="3">RANGE COUNTRY – MYANMAR</td></tr>
<tr><td>Unspecified.</td><td>This document reported an overall population decline because of overexploitation, illegal exploitation and general habitat loss. The document does not specify where this information came from.</td><td>WCMC (1998) [145].</td></tr>
<tr><td colspan="3">RANGE COUNTRIES – INDIA, INDONESIA AND PHILIPPINES</td></tr>
<tr><td>Unspecified.</td><td>This document reports that information on populations in these countries indicated that the species was serious threatened. The document does not specify where this information came from.</td><td>WCMC (1998) [145].</td></tr>
<tr><td colspan="3">RANGE COUNTRY – SRI LANKA</td></tr>
<tr><td>Unspecified.</td><td>This document reports that an extensive field study has failed to find the species. The document does specify which field study that it refers to.</td><td>WCMC (1998) [145]</td></tr>
<tr><td colspan="3">RANGE COUNTRY – VIETNAM</td></tr>
<tr><td>Unspecified.</td><td>In 1998, this source reported that the Vietnam population of this species has been extinct for some 300 years</td><td>WCMC (1998) [145]</td></tr>
</table>

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES
PTEROCARPUS SANTALINUS		
RANGE COUNTRY – INDIA		
Sri Lankamalai Reserve Forest, approximately 8 km from Siddavatam towards Badvel in the Cuddapah District Latitude 14°28'N. Longitude 78°58'E Area: 22 ha study site	Population Status and Structure Prior to 2002, this study reports that there were natural populations of this species distributed in regeneration plots, however, no specific information was provided about the structure of the population that was studied. The forest was comprised of dry deciduous forest mixed with thorny plant species and was subjected to grazing and burning.	Rao and Raju (2002) [122]
The Chittoor District, Andhra Pradesh Forest.	Population Structure In 2006, the total tree inventory data collected by the Andhra Pradesh Forest Department revealed that 85% of this species in forests had a height of less than 75cm and less than 1% were above 100cm girth at breast height. Population Status In 2009, the total growing stock of this species found in Andra Pradesh forests was estimated at 118,000 m^3 according to data obtained from the Andhra Pradesh Forest Department.	Kukrety (2011) [123]
Eastern Ghats in the State of Andhra Pradesh in the Rayalseema Region, specifically Kadapa Forest, Chitor and Nellore.	Population Status In 2011, this document reported the extent of occurrence is estimated to be less than 5000 km^2 extending over an area of 9600 km^2. This species comprised of over 16% of the total growing stock in the population studied. This information was obtained from TRAFFIC Bulletin Seizures and Prosecutions.	Jenkins (2012) [77]
In 2014, this document reported on information supplied by the European Forest Institute specific to India as a whole.	Population Status The document reported that in recent years, the amount of this species being smuggled out of India has declined due to the increasing scarcity of the species.	Treanor (2015) [1]
In 2011, this study was undertaken in the Eastern Ghats of Andhra Pradesh.	Population status Population size was estimated to be 3.98 kha in its natural range. 1.68 kha of this range occurred in protected areas including wildlife sanctuaries and National Parks Population Structure The document reported that the average number of plants (including saplings, poles and trees of all girth classes) was 16.75 per sample plot studied (0.1 ha area). The average number of seedlings below 137cm height were estimated at 0.74 per sample plot area (1m^2 area). The average number of trees above 30cm girth at breast height were 9.19 per sample plot. The average number of trees above 70cm girth class were 13.2 per ha. Figure 26 shows the diameter class distribution for this population indicating that recruitment is lower than required for a stable population. The source stated that the skewed distribution was as a result of high amounts of illegal fellings of higher girth classes for heartwood extraction.	Hegde et al (2012) [94].

POPULATIONS STUDIED	POPULATION PARAMETERS	REFERENCES
	 **Figure 26 - Average girth class distribution of *P. santalinus* in natural forests of Andhra Pradesh State. Taken from figure 2 in Hegde et al (2012) [94]**	

THREATS, DISTURBANCES AND LEVEL OF TRADE

The biggest threat to the Asia-Pacific region are the threats imposed by illegal logging and timber smuggling. All Asia-Pacific species are threatened by deforestation and logging as shown in Table 29. These threats are compounded by other threats such as timber deforestation, global warming or degradation and biodiversity losses. These threats need to be adequately accounted for when determining where to set a sustainable level of harvest now or in the future.

Table 29 – General Overview of Threats and Disturbances for each Asian-Pacific Species

SPECIES	THREAT AND/OR DISTURBANCE TYPE									REF.
	AC	AG	D	FF	HD	HF	I	L	U	
D. annamensis									✓	[63, 49, 105]
D. assamica	✓							✓		[105, 66]
D. cochinchinensis	✓							✓	✓	[73]
D. cultrata	✓					✓		✓		[58, 105]
D. latifolia			✓				✓	✓	✓	[50, 15, 80, 146, 105]
D. odorifera								✓		[53, 147]
D. oliveri					✓			✓	✓	[63, 105, 55]
D. sissoo	✓	✓	✓	✓			✓	✓		[15, 116, 146]
D. tonkinensis								✓		[63, 105]
P. dalbergioides								✓		[56]
P. indicus	✓		✓					✓		[82, 145, 80]
P. macrocarpus	✓				✓			✓	✓	[72, 55]
P. marsupium										[146, 105]
P. santalinus		✓		✓				✓		[123, 105]

AC - Agricultural cultivation, AG = Animal Grazing / Animal Ranching, D = Diseases, FF= Forest Fires, HD = Degradation (climate change etc.), HF= Habitat Fragmentation for Roads and/or Infrastructure Development, L = Logging (legal or illegal), I – Insects, U = Unspecified/ general reference to habitat loss / deforestation.

Table 30 provides a summary of species specific commercial value assessments and various uses of the species. *D. annamensis* and *D. assamica* have not been specifically included in the table as there was limited value assessments and species use information compared to other species in this region. However, many sources concur that these species are being over-exploited for their value timber [63, 49, 105, 66]. A common theme throughout the commercial value assessments is that as the availability of species reduces, the commercial value increases. However, according to Webin and Xiufang (2013) [147] the driving force behind the market value of a species is actually due to the cultural preferences in China rather than the diminishing availability of the species. For example, collectible rosewoods imported to China like *D. odorifera* and *D. tonkinensis* fetch higher prices despite the latter species not being listed in the Chinese National Standard [147].

Table 30 – Summary of available information on commercial value assessments and uses of various species in Asia-Pacific Region.

DALBERGIA SPP
Commercial Value Assessments • 2006-2013: *Dalbergia* wood seized by the Thai Dept. of National Parks Wildlife & Conservation consisted of: 23,812 logs/squares/plates (2,239.90 m^2) and worth over 16.14 million US dollars (559M Bhat) [133].
DALBERGIA OLIVERI/BARIENSIS/MAMMOSA
Commercial Value Assessments • US $2-3,000.00 per m3 (Mekong region) [63, 1]. • 2013: US$7,000.00 per ton (Myanmar) [20]. • Vietnam: *D. bariensis* and *D. mammosa* have high economic value [148].
Uses Timber, high quality furniture, luxury cabinets, art and handicrafts, decorations, handles of agricultural implements, tone wood and medicinal [69, 63, 72, 77].
DALBERGIA COCHINCHINENSIS/ CAMBODIANA

Commercial Value Assessments

- 2008: estimated US$1,900-3,900.00 per cubic meter for sawn wood, US$1,500 to $2,000 per cubic meter for logs (Cambodia) [111].
- 2012: US$15,000 per m^3 = 15% value increase since 2005 [147].
- Vietnam: high economic value [148], US$80/kg (approx. US$76,000 m^3) sale to China. Traders pay approx. US$43-62/kg (approx. US$40,000-$59,000$m^3$) to import [111].

Uses

High quality furniture, wood turnery, fine-art articles, musical instruments, sewing-machines, sports equipment, interior decorations, doors, windows and stairs and high quality art handicrafts. Stem is boiled and used for curing syphilis and anti-tumour and blood stasis [69, 72, 77, 111, 74].

DALBERGIA CULTRATA/ FUSCA

Commercial Value Assessments

- 2014: est. 76.5M Kyat (approx. US$64,632) worth of seized timber near Myanmar Thai border [149].

Uses

Precious/ luxury furniture, cabinets, doors, window frames, agricultural implements, musical instruments/ tone wood, plywood veneer, rifle-butts, handicrafts, fuel wood and shade trees [58, 77, 69].

DALBERGIA LATIFOLIA

Commercial Value Assessments

- US$49,656 per cubic m^3 (instrument blanks) [77].
- US$16,575 per cubic m^3 (sawn wood) [77].

Tone wood, luxury furniture and consumer items, Chinese furniture, panelling, veneers, interior and exterior joinery, knife handles, agricultural implements calico-printing blocks, mathematical instruments, boat keels and screws [77, 80].

DALBERGIA ORDIFERA

Commercial Value Assessments

- 2005: US$15,000 per m^3 (China) [147].
- 2006: US$100,000 per m^3 (China) [147].
- 2007: US$500,000 per m^3 (China) [147].
- 2012: US$1.5 million per m^3 (China) [147].

Uses

Medicinal properties and luxury furniture and crafts [150, 147].

DALBERGIA SISSOO

Commercial Value Assessments

- Priced similarly to Teak (India) [84].

Uses

High quality furniture, cabinets, decorative veneer, carvings, marine and aircraft grade plywood, tone wood and musical instruments, carving, engraving, tool handles, sporting goods (mallet heads, croquet balls, tennis racket frames), boat building, tool handles, gun cartridges and fuelwood, foliage used as a fodder, traditional medicines, heartwood used as a lubricant oil root wood used to make tobacco pipe [80, 86, 117, 77, 84].

DALBERGIA TONKINENSIS

Commercial Value Assessments

- 2012: US$2 million per m^3 [147].

Uses

Medicinal uses but predominantly used as a collectible for high class furniture [77, 63].

PTEROCARPUS DALBERGIOIDES

Commercial Value Assessments

- This species is one of the top value durable timber species in India [56].

Uses

Joinery, flooring, furniture, decorative veneers, panelling, parquet, cabinetwork, carving and sculpting, billiard tables, knife handles, tool handles, boat building, paddles, oars, agricultural implements, inlay, flooring and decorative woods. Flowers and leaves used for minerals and vitamins. Stems used for dye/tannin. [56, 151]

PTEROCARPUS INDICUS

Commercial Value Assessments

- US$6,357 per m^3 (sawn wood) [77].

Uses

Rosewood substitute, high class furniture and cabinetry, cart wheels, carving, construction, musical instruments, decorative sliced veneer, interior wall panelling, feature flooring (including strip and parquet), gun stocks, rifle butts, turned articles, knife handles, boat building and joinery, shade and ornamental tree. Leaves and bark used as anti-emetic, folk remedy for numerous conditions [69, 77, 62, 80].

PTEROCARPUS MACROCARPUS / CAMBODIANUS / PEDATUS

Commercial Value Assessments

- China: mid to low market value (China) [1].
- Vietnam: high economic value [148]. In 2014, Imported nearly 192,000m^3 of *P. pedatus* from Myanmar [147].
- Thailand: Before export ban, export earnings considered second most valuable timber species after teak [92].
- US$ 2,000 to 3,000 per m^3 (from South-east Asia)
- *P. cambodianus:* $2million per m^3 (in China as collectible rosewood) [1].

Uses

Cabinetry, cart wheels, carving, construction, ship timber, floors, pillars, posts, joists, beams, furniture, shafts of carnages, agricultural implements, luxury furniture, musical instruments, fine art articles, resin used as a red dye, bark and root used for indigenous medicine, folk remedy for bladder ailments and diarrhoea [69, 72, 63, 91, 92].

PTEROCARPUS MARSUPIUM

Commercial Value Assessments

- 2016: Sale 800-900 Rupee/cubic ft. (approx. US$420-472.50 per m^3) (high quality logs) at auction (India) [152].
- 2016: Sale 400-500 Rupee/cubic ft. (approx. US$210-262.50 per m^3) (medium quality logs) at auction (India) [152].

Uses

Medicinal uses, Chinese furniture,

PTEROCARPUS SANTALINUS

Commercial Value Assessments

- Wavy grain class more valuable than straight grained class [153].
- 2002: US$ 6,870–9,160 per metric tons, finished wood products worth even more [123].
- US$150,000 per m^3 (India) [56].
- 2014: Andhra Pradesh Government earned approx. 10 billion rupee (approx. US$149.8 million) from 3,615 metric tons of confiscated logs [149].

Uses

Medicinal qualities (including skin diseases, bone fracture, leprosy, spider poisoning), red dye, pharmaceutical preparation, agricultural implements, hut material, carvings, high end furniture, musical instruments, toys [77, 123, 154]. It is also used as a food dye and incense. The red dye is used as a colouring agent [77]. The rare wavy grain variant of the timber is particularly highly valued in Japan where it is used to make a traditional musical instrument called a shamisen [123]. Wood powder is used to control haemorrhage, bleeding piles and inflammation [154]. Wood paste is applied on boils and other skin eruptions, infections, inflammations and on the forehead to relieve headache [154]. Wood and bark brew taken orally relives chronic dysentery, worms, bloody vomiting, weak vision and hallucination [154].

Table 31 details which Asia-Pacific countries were the top suppliers to China of Rosewood logs and sawn wood in 2014, with Lao PDR being the top supplier, closely followed by Myanmar and Vietnam.

Table 31 – Top Suppliers of Rosewood Logs and Sawn Wood to China in 2014 from the Asia-Pacific Region. Adapted from Table 1 in Treanor (2015) [2].

Country	Logs				Sawn Wood			
	Rank	Volume (m3)	Rank	Value (USD)	Rank	Volume (m3)	Rank	Value (USD)
Lao PDR	1	430 626	1	756.4 million	1	133 831	1	237.6 million
Myanmar	3	221 995	2	402.7 million	13	1 018	10	2.0 million
Vietnam	5	136 449	3	243.7 million	4	5 641	4	10.6 million
Cambodia	10	57 128	5	123.2 million	8	2 477	7	4.1 million
Indonesia	18	9 351.00	16	16.6 million	2	50 459	2	109.9 million
Malaysia	15	12 179	15	22.7 million	6	4 266	6	5.4 million
Thailand	25	1 233	23	2.0 million	10	1 497	8	2.7 million

There are various papers by peer reviewed authors and various NGO's [9, 1, 73, 4, 147] which detail recent levels of trade of rosewood pecies in the Asia-Pacific Region. While this report will not be repeating this information, there are several important points that come out of these papers, including:

1. Serial-exploitation occurs from one species to the next to coincide with supply and demand. In Northern India, the demand for wood craft materials has shifted from ebony (*Diospyros ebenum*) to *D. latifolia* to *D. sissoo* [15]. This was largely due to the increased demand at both domestic and international markets for these species. In China, the trade demand for Hongmu species has seen a shift from *Dalbergia odorifera* (a 'collectible and precious native species) to *D. tonkinensis* (also a 'collectible' and often mistaken for *D. odorifera*) to *D. cochinchinensis*. In the last few years, there has been an increasing shift from *D. cochinchinensis* to *D. oliveri* and *P. macrocarpus* [4, 139, 20, 1, 63, 9, 147].
2. Despite CITES protection of *D. cochinchinensis* and *P. santalinus,* along with logging and/or sawn wood bans in most range countries across the Asia-Pacific Region, the trade in high value hongmu species is still high. Consequently, this trade is considered to be leading towards the commercial extinction of some species [4].

3. Illegal logging practices have led to deaths of forest rangers in certain high-risk range states to the point where trafficking of rosewood has been termed a 'blood-war' [155, 156, 157].
4. *P. macrocarpus* - its natural habitats are being destroyed, and the species is facing the possibility of extinction if protection measures are not taken [72].

Species Specific Trade Data Analysis

As discussed in the Global Overview section, relying solely on the Chinese specific HS codes for hongmu can significantly under estimate the level of trade in rosewood species. Analysis of Vietnamese customs data has highlighted that 99% of the trade between China and Vietnam in these species is conducted using alternate HS codes. This section outlines the trade in Asian rosewood species into and out of Vietnam, as a proxy for understanding the trade into China, and throughout Southeast Asia and parts of Africa. This is because Vietnam is a primary transit and processing country for rosewood from Southeast Asia, and part of Africa.

Figure 27 and Figure 28 provide details of the volume in cubic meters by species of sawn wood and logs imported into Vietnam. Figure 29 and Figure 30 detail the volume in cubic meters, by species, of sawn wood and logs exported from Vietnam. Many reports have recently stated that Asia is becoming a less important source of rosewood due to dwindling reserves, however the trade data does not support this. The volume of rosewood being imported into China from Vietnam is still high, and much higher than from other parts of the world. What has occurred however is that there has been a shift in imports into Vietnam from logs to sawn wood, as demonstrated in Figure 27 and Figure 28. This is most likely as a direct result of the log export bans in the majority of range countries. It suggests that log export bans do very little to curb excessive trade in vulnerable species. Traders simply process the timber into a form that can be transported.

The maximum log imports, which occurred in 2013, was just short of 70 000m^3. In that same year there was approximately 330 000m^3 of sawn rosewood imported. In the subsequent years – 2014 and 2015 – the log imports drastically reduced, while in 2014 the sawn wood imports increased to almost 500 000m^3, and then reduced in 2015 to approximately 250 000m^3. The majority of the imports are now being reported are *Pterocarpus macrocarpus* or its synonyms/local names (red shaded), for both sawn wood and logs, rather than any of the protected species (i.e. *Dalbergia cochinchinensis* or *Dalbergia oliveri*). The majority of imported wood into Vietnam consists of species supposedly originating from Lao PDR or Cambodia irrespective of any log bans or suspensions that were in place at the time (Figure 31 and Figure 28). There were also a number of countries (in particular Cameroon, Congo and Togo) exporting Asian rosewood species that they are not range countries for (Figure 31). It is probable that these species are local African or South/Central American species that are being mislabelled.

The ongoing trade in South East Asia of *D. cochinchinensis* remains strong, despite being listed under Appendix II of CITES. Of particular concern, the export volumes of *D. cochinchinensis* as reported by Vietnam to CITES (see Figure 34) is considerably lower than what is recorded in their own customs data (Figure 33). In 2013, Vietnam reported to CITES that no logs were exported, yet their customs data records show a total volume exceeding just over 76 500m^3. However the CITES listing only became effective in June 2013 so some of these exports would be pre-listing. However, in 2014 there was a discrepancy of approximately 9 000m^3 of logs exported from Vietnam between what was reported to CITES (5 000m^3) versus customs data records (14 000m^3) in log exports. The volume of *D. cochinchinensis* reported to CITES by Vietnam compared with the respective importing country also differs considerably (Figure 35).

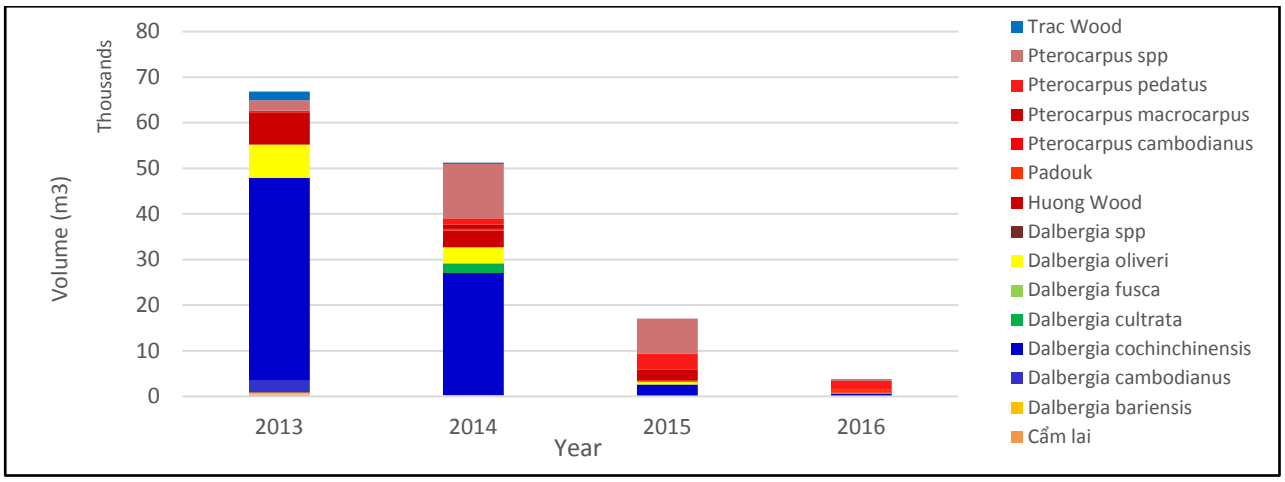


Figure 27 – Log imports into Vietnam of Asia-Pacific species. Red shaded = *Pterocarpus macrocarpus* with synonyms or local names; Blue shaded = *Dalbergia cochinchinensis* with synonyms or local names; Yellow shaded = *Dalbergia oliveri* with synonyms or local names

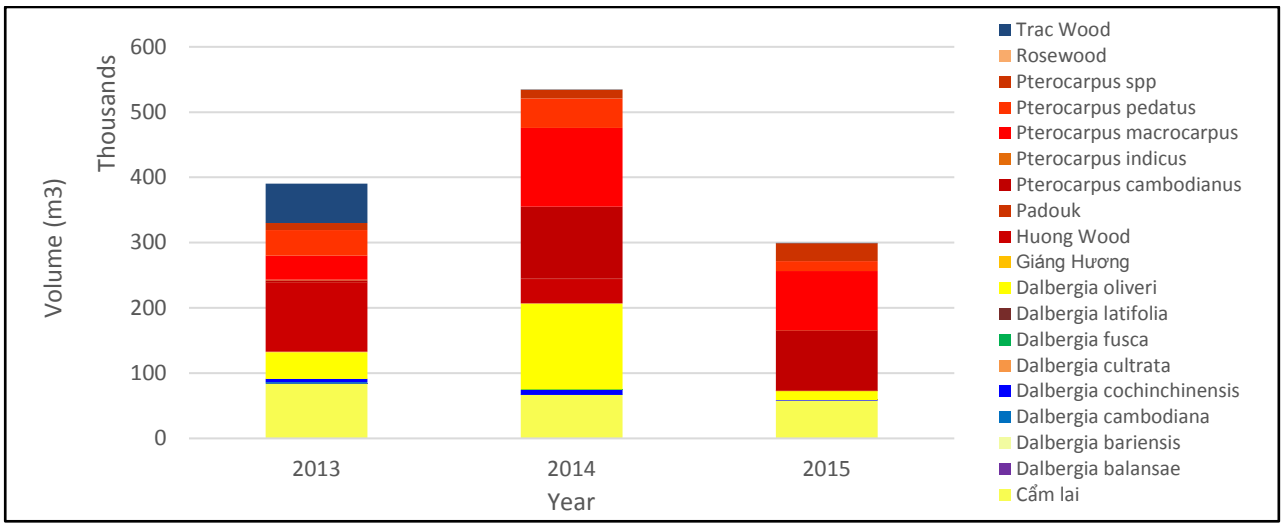


Figure 28 – Sawn wood imports into Vietnam of Asia-Pacific species. Red shaded = *Pterocarpus macrocarpus* with synonyms or local names; Blue shaded = *Dalbergia cochinchinensis* with synonyms or local names; Yellow shaded = *Dalbergia oliveri* with synonyms or local names

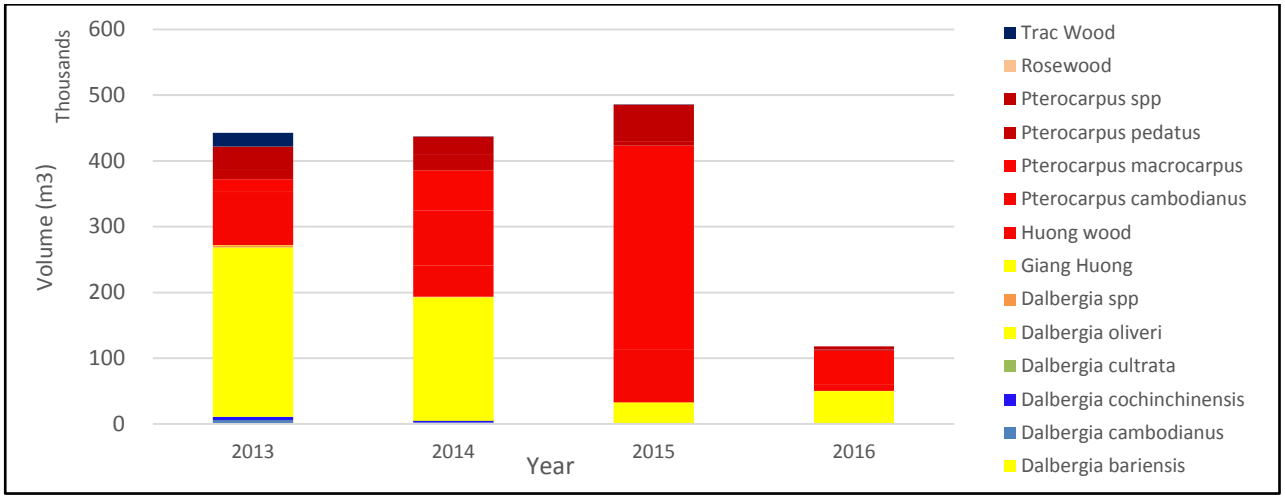


Figure 29 - Sawn wood exports from Vietnam of Asia-Pacific species. Red shaded = *Pterocarpus macrocarpus* with synonyms or local names; Blue shaded = *Dalbergia cochinchinensis* with synonyms or local names; Yellow shaded = *Dalbergia oliveri* with synonyms or local names.

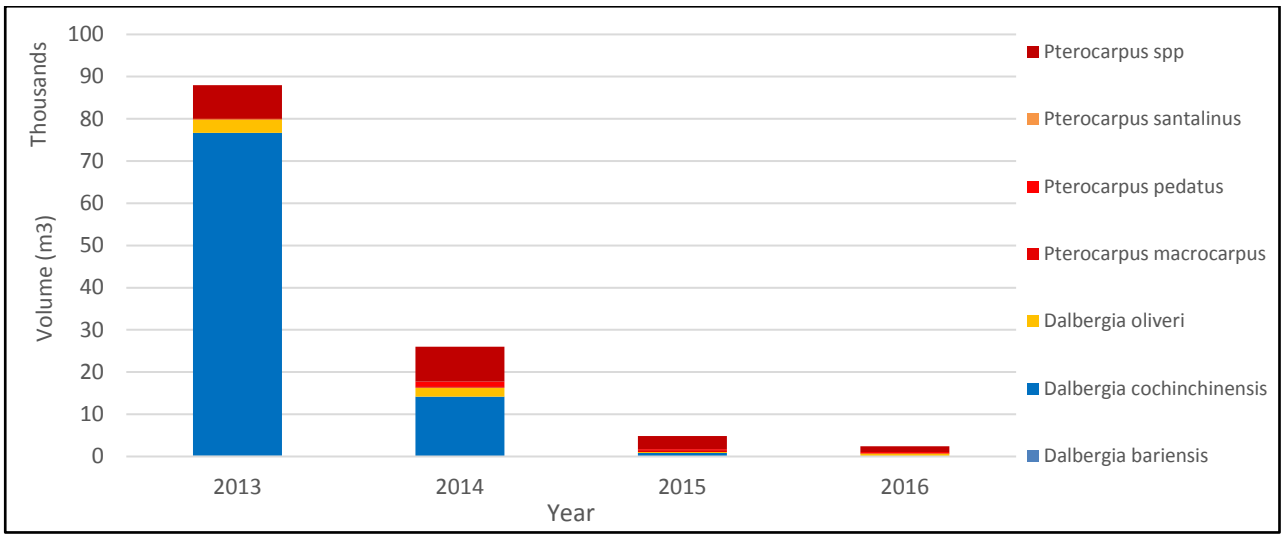


Figure 30 – Log exports from Vietnam of Asia-Pacific species. Red shaded = *Pterocarpus macrocarpus* with synonyms or local names; Blue shaded = *Dalbergia cochinchinensis* with synonyms or local names; Yellow shaded = *Dalbergia oliveri* with synonyms or local names.

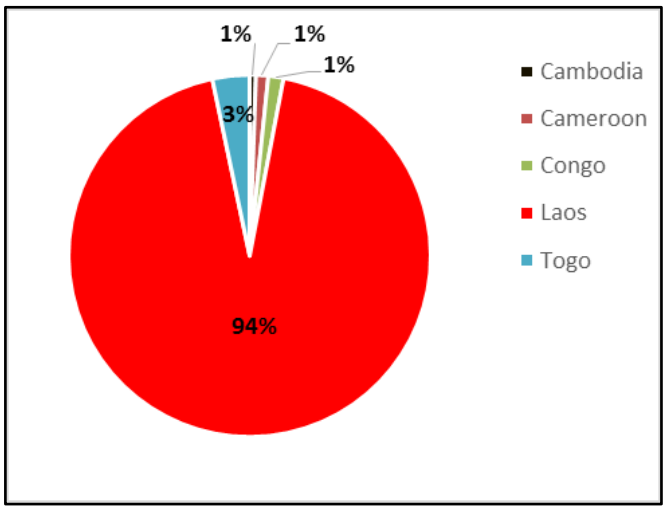


Figure 31 - % Log Imports into Vietnam of Asian species

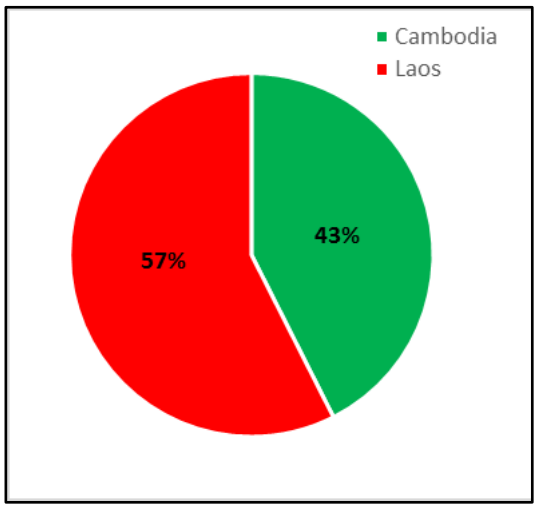


Figure 32 -% Sawn Wood imports into Vietnam of Region specific species

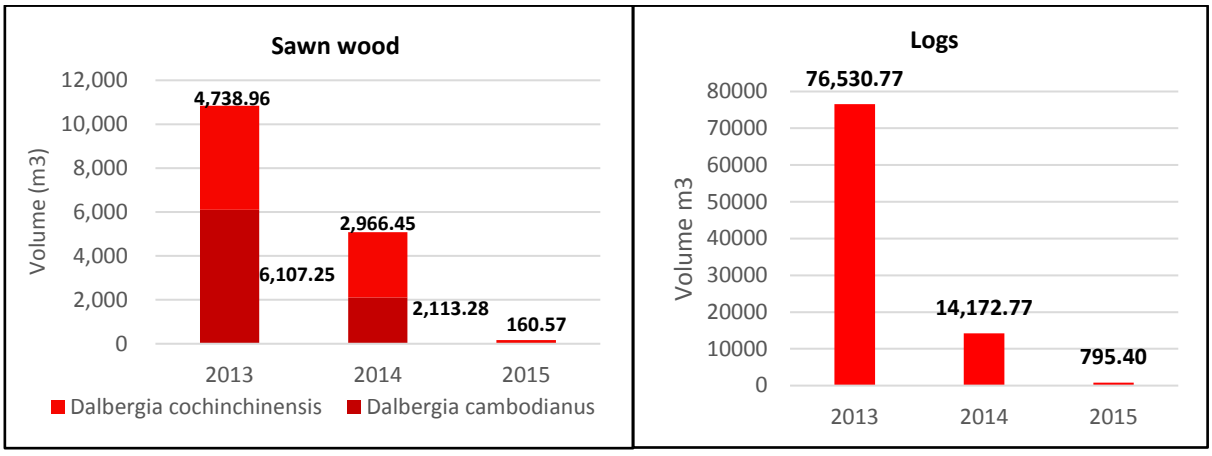


Figure 33 – Customs recorded exports from Vietnam of *Dalbergia cochinchinensis* (including syn *D. cambodianus*).

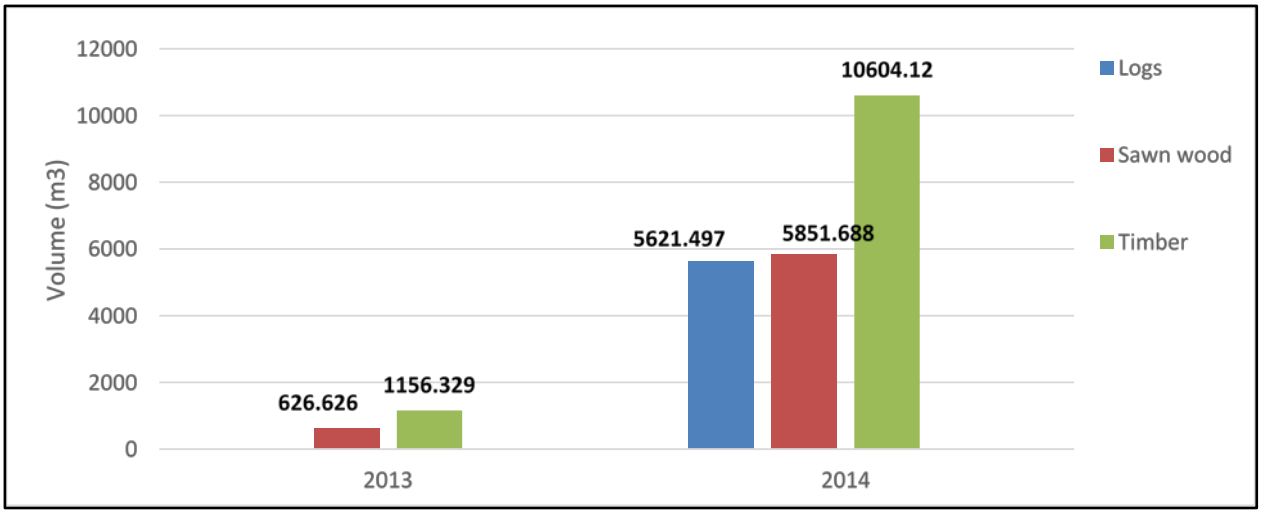


Figure 34 – Export trade data for *Dalbergia cochinchinensis* as reported by Vietnam to CITES.

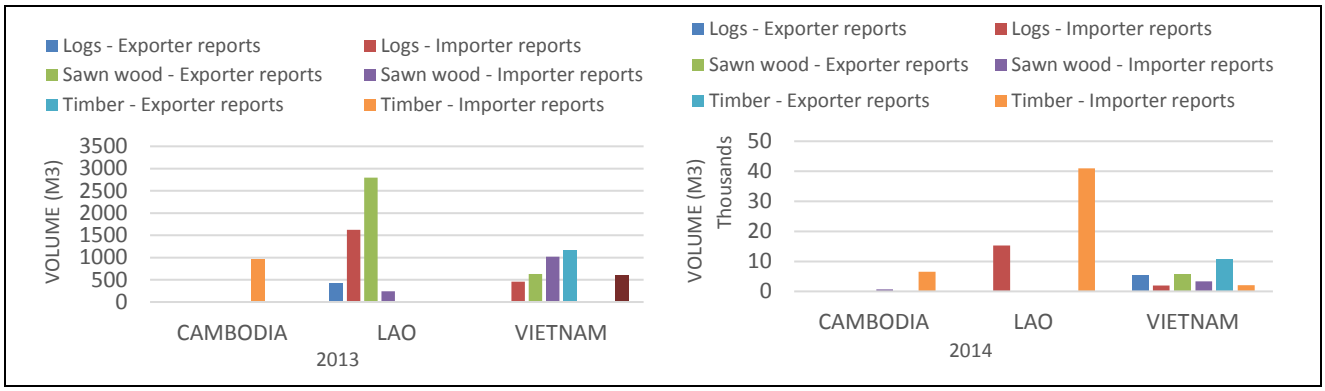


Figure 35 - CITES Trade Data - *D. cochinchinensis:* Vietnam reported volume VS Importing countries reports.

MANAGEMENT MEASURES AND LEGAL FRAMEWORKS

The common theme that has emerged throughout the various literature is that China's high demand for timber and related products is the driving force behind the Asia Pacific regions involvement in the trafficking of the *Dalbergia* and *Pterocarpus* rosewood producing species, along with poverty, corruption and the breakdown of governments among other causes [13, 1, 9, 14].

Various governments in the Asia-Pacific region have made attempts to curb the threats posed by unrestrained logging, the most common method is by implementing a harvest and/or log export ban. However, to date the legal frameworks appear to have been ineffective at preventing or reducing the amount of illegal logging that is occurring across the region. A major concern with these types of government responses is that they are a reactive measure to already depleted forest levels [14]. The problem is though that logging bans do little to stop illegal logging, for as mentioned above the problem of illegal logging and trafficking is complex and multi-faceted. Indeed, inappropriate government responses may end up driving logging from one depleted forest area to another [14]. While these concerns indicate a greater need for improved regulations and law enforcement, unfortunately there is no 'one size' fits all solution.

Other management measures, such as forest plantations, also appear to be implemented as a reactive measure geared towards restoring timber supply rather than improving the biodiversity of depleted forest regions. A potential management opportunity that has been identified as a path towards a more sustainable timber industry is through eco-labelling. Eco-labelling or certification can be linked to international markets, particularly through sourcing from *D. sissoo* plantations [15]. In India, various government institutes have identified *D. sissoo* and *P. santalinus* as focus species requiring long term tree development and improvement [16].

There has been a rapid decline of natural forests throughout Asia, particularly in countries involved in cross border timber trade with China. There too there have been efforts to establish plantations, however there are various issues associated with this, and many plantations are not likely to be suitable for large scale production for many decades

[158]. White et al (2006) estimated that Papua New Guinea would be logged out in 13-16 years, Indonesia 10 years and that Indonesia and the Philippines had already logged out most of their natural forests. Table 32 provides an overview of the domestic legislation and other management measures for these species in each range state.

Table 32 - Assessment of domestic legislation for rosewood harvest and trade – Country Specific

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION
CAMBODIA	
D. assamica *D. cochinchinensis* *D. oliveri* *D cultrata* *P. macrocarpus*	**Bans and Quotas** • 1996 – Export of logs and sawn timber were prohibited [125]. • 2006 - Export ban is in place for unprocessed logs and rough sawn timber thicker than 25cms in diameter under the Royal Government of Cambodia Sub-Decree No. 131, Article 3. • 2013 - Siamese Rosewood (*Dalbergia cochinchinensis*) in all forms is prohibited from being collected, stored and processed for domestic use or from being exported [19]. **Legislative Prohibitions or Restrictions** • 2002 – Rare tree species and tree species with diameters smaller than the minimum allowed diameter are prohibited from being harvested from within Permanent Forest Reserve Areas pursuant to Article 29 of the Cambodian Law on Forestry 2002. The Cambodia Government has not issued an official sub-decree naming the species considered to be rare species. There is reportedly a list of agreed endangered or rare tree species, described as 'luxury timber species (first quality)' from 2000 that is being used by Forestry officials [19]. • 2016 – Cambodia Sub-decree No. 76 declared official protection and establishment of Western Siem Pang Wildlife Sanctuary. This area protects approximately 65,000.00 hectares in Northern Cambodia. This area includes high-value timber species like thnong (*P. pedatus*) [127]. • Cambodia priorities 1 and 4 in the list of "endangered or rare species" include D. *oliveri* and *D. cochinchinensis* [159]. • *D. cochinchinensis, D. oliveri* and *P. macrocarpus* are all protected under the Cambodian Forestry Law No. 3 [72]. **Allowed Trade** • 90% of Cambodia's timber supply originates from Economic Land Concessions [19]. A recent United Nations High Commission on Refugees (UNHCR) report stated that the process for allocating these economic land concessions was a human rights violation [158].
	CHINA
D. assamica *D. cultrata* *D. odorifera* *D. tonkinensis* *P. indicus*	**Bans and Quotas** • 2000 – The Chinese Government implemented the National Forest Protection Program which introduced logging bans and harvesting reductions in 68.2 million ha of forest land [160]. • 2014 - The State Forestry Administration expanded on the National Forest Protection Program and implemented a trial ban on commercial logging in state-owned natural forests in the Heilongjiang Province [160]. • 2015 - The State Forestry Administration expanded the 2014 trial ban to natural forest areas in other northeast provinces [160]. • 2016 –China is reportedly planning to ban commercial logging in all natural forests by the end of the year [160]. **Legislative Prohibitions or Restrictions** • 1999 -*D. odorifera* was listed in the second-class category of the National List of Local Protected Flora issued by the Chinese Government [83]. • 2006 - China signed a bilateral agreement with the Myanmar government in 2006 to strengthen efforts to combat illegal timber trade [147]. • China is bound by the following national standards specific to Rosewood species [1]: 1. National Hongmu Standard issued in 2000 by the State Administration for Quality Supervision and Inspection and Quarantine (SAQSIQ) in order to regulate quality, 2. SAQSIQ regulation specifying label requirements in manufacturing processes (2011),

	3. National Development and Reform Commission directive identifying appropriate species for industry use, and 4. Two sectoral standards issued by the Ministry of Commerce (MofCOM).
	INDIA
D. assamica *D cultrata* *D. latifolia* *D. sisso* *P. dalbergioides* *P. indicus* *P. marsupium* *P. santalinus*	**Bans and Quotas** • The export of *D. latifolia* logs and sawn timber are banned under the Indian Forest Act [50]. **Legislative Prohibitions or Restrictions** • Unauthorised possession or transportation of forest products are recognised offences under the Andhra Pradesh Forest Act 1967, other State Forest Acts and the Indian Forest Act 1927 which has been adopted by most of the States and directly applies to the Union Territories of India [94]. • Removal of any trees from protected areas are prohibited under the Wild Life Protection Act 1972. This includes *P. santalinus*. • Under the Foreign Trade Policy 2015-2020, Red Sanders (*P. santalinus*) is listed as an item which is prohibited for export in any form, raw or processed, with the exception of value added products of Red Sanders wood such as extracts, dyes, musical Instruments and parts of musical Instruments made from the wood and procured from legal sources. Value added products are still restricted and require appropriate permits before they are able to be exported. • *D. latifolia, P. santalinus* and *P. marsupium* are listed as a "reserved tree" under the Andhra Pradesh Preservation of Private Forest Rules 1978. Felling of these species is prohibited unless the trees exceed 1.3 meters in height and 120cm girth. Cutting, transport and sale also require permission from the Divisional Sale Officer in accordance with the Rules set out by the State Government [94]. • In Puducherry/Pondicherry, Rosewood and Red Sanders (*P. santalinus*) are protected wood and such species cannot kept be in possession or transported by any individual/farm without special permit under the Pondicherry Timber Transit Rules 1983. **Allowed Trade** • 2014 - The Andhra Pradesh Government was granted permission to export Red Sanders logs obtained from confiscated/seized stock by e-auctions only. [161].
	INDONESIA
D cultrata *D. latifolia* *D. sisso* *P. dalbergioides* *P. indicus*	**Bans and Quotas** • 1985 - Log export ban implemented and re-introduced in 2001. This ban amended in 2009 to allow plantation-grown logs to be exported [162]. **Legislative Prohibitions or Restrictions** • 2014 – Indonesia signed and ratified a Voluntary Partnership Agreement with the EU aiming to improve forest governance and promote trade in legal timber from Indonesia to the EU [163]. **Conservation Legal Framework** • Act No. 5/1990 on Conservation of Living Resources and Their Ecosystems – this Act emphasises conservation efforts including protection, biodiversity preservation and conservation areas, which are divided into two distinct areas: sanctuary reserves and nature conservation. The sanctuary reserves consist of nature reserves and wildlife sanctuaries. The nature conservation areas comprise national parks, grand forest parks and nature recreation parks [16]. • The Forestry Law (No 41/1999) – This Act defines conservation forest as a forest area with specified characteristics and where its main function is conservation of biological diversity and the ecosystems. The Act divides conservation forests into 3 categories: sanctuary reserve, nature conservation area and hunting area [16].
	LAO PDR
D. assamica *D. cochinchinensis* *D cultrata* *D. oliveri* *P. dalbergioides* *P. indicus* *P. macrocarpus*	**Bans and Quotas** • 2008 – Provision 20.3 of Prime Ministerial Order No-17/PM prohibits the logging of "*some protected natural timber species of extinction."* The Order specifically refers to "mai khayoung" (*D. cochinchinensis*), "mai khamphi" (*D. oliveri*) and "*Pterocarpus* spp", among others, as natural timber species of extinction. The Order also includes a blanket statement that there were "other protected timber species" included in this ban. Some sources have interpreted this provision to include all *Dalbergia* spp as protected by this logging ban [63].

	• 2011 - Prime Minister's Order No 010/PM bans the exploitation, trading and export of *D. cochinchinensis* wood. • 2016 – Prime Minister's Order on Enhancing Strictness on the Management and Inspection of Timber Exploitation, Timber Movement and Timber Business No. 15/PM prohibits the export of timbers exploited from the natural forests of Lao PDR. Timbers for export shall be processed according to the Decision No. 2005/MoIC. DOIH. The order also bans illegal timbers and forestry products from abroad being able to transit through Lao PDR territory to a third country. • 2016 - Ministry of Industry and Commerce issued Instruction No.1050/MoIC. DIMEX and an Additional Instruction No. 1102/MoIC. DIMEX to supplement and enhance responsibilities and assist with the implementation of the Prime Minister's Order No. 15/PM. **Legislative Prohibitions or Restrictions** • 2007 – Lao People's Democratic Republic (PDR) Forestry Law 2007. Article 27 provides specific measures that should be carried out in relation to any natural prohibition species and other species at risk of extinction in natural forests to increase and enrich trees and Non-Timber Forest Products (NTFP). Specific measures stipulated include:- survey of the species, classification of seed stands, inventory and registration of species, planning of conservation and protection areas with local participation, elaborating and implantation of regulations and measures on the preservation and utilisation and other necessary activities. This legislation also prohibits the cut, purchase, sell and transport of natural prohibition species or species at risk of extinction without permission from the Government under Articles 101 and 102. The legislation specifically included *P. macrocarpus, D. cochinchinensis* and *D. bariensis* as natural prohibition species and/or species at risk of extinction.
	MYANMAR
D. assamica *D cultrata* *D. latifolia* *D. oliveri* *P. dalbergioides* *P. macrocarpus* *P. indicus*	**Bans and Quotas** • 2014 - Log Export Ban –illegal to export unprocessed logs [132]. • 2016 –a temporary national logging ban until March 2017 and a 10 year logging ban in the Pegu Yoma region has been agreed to by the Myanmar Government. However, this is yet to be officially implemented by the Government of Myanmar [131][21]. **Legislative Prohibitions or Restrictions** • Forest areas are legally protected in the form of (i) Reserved Forests (RF), (ii) Public Protected Forests (PPF), and (iii) Protected areas (National Parks, Wildlife Sanctuaries, and Nature Conservation Areas). Forested areas not included are termed Unclassified Forests (UCF) by the Forest Department [132]. • Timber extraction from National Parks, Wildlife Sanctuaries, and Nature Conservation Areas is prohibited [132]. • 2006 - Myanmar and China signed a bilateral agreement to strictly regulate exports over their shared land border including the overland trade of timber illegal [20]. • Voluntary Partnership Agreement (VPA) process with the European Union's Forest Law Enforcement Governance and Trade (FLEGT) initiative, requiring transparency and compliance improvements that are mutually agreed upon between the government, the timber sector and civil society [132]. **Allowed Trade** • Wood is considered legal if it has the stamps of the Myanmar Timber Enterprise (MTE) under the Ministry of Environmental Conservation and Forests (MOECAF) and is exported via Yangon's seaports [20]. • *Pterocarpus macrocarpus* and *Dalbergia oliveri* are classified as "reserve" species. This means that any harvesting and trading must be authorised by MOECAF [1].
	PHILLIPINES
D. latifolia	**Bans and Quotas** • 2007 – Department of Environment and Natural Resources (DENR) Administrative Order No. 2007 – 01 and Order No 2007- 24: Collection and Trade of *P. indicus* (both forms) is prohibited unless permitted by DENR under an official permit. **Conservation Legal Framework** [16] • The Philippine Constitution – contains seven provisions relevant to the conservation of tree species.

21 Global Eye has been unable to locate an official Order issued by the Myanmar Government to confirm this.

	• Presidential Decree No. 705 – orders the Bureau of Forestry Development (BFD) with the responsibility for protecting, developing, managing and preserving National Parks, Game Refuges and Wildlife. Also prohibits vandalism and occupation of national parks and recreation. • Executive Order No. 192 - ordered the DENR with the primary responsibility to promote the well-being of the Filipino people through sustainable development of natural resources, optimal utilization of forest lands, social equity and efficiency of forest resource use and effective forest management. • Republic Act No. 9147 (the Wildlife Resources Conservation and Protection Act) - provides for the conservation and protection of wildlife resources in protected areas and critical habitats. Also assigned jurisdiction over terrestrial plants and animal species to DENR.
	THAILAND
D. assamica *D. cochinchinensis* *D cultrata* *D. oliveri* *D. sisso* *P. indicus* *P. macrocarpus*	**Bans and Quotas** • 1989 – National ban against logging of natural forest specimens [1, 159]. • 2007 – Ceased sale of seized timber through auctions [73]. **Legislative Prohibitions or Restrictions** • Thai Forest Act, section No. 53 – *D. cochinchinensis* is listed as Category A restricted timber.
	VIETNAM
D. annamensis *D. assamica* *D. cochinchinensis* *D cultrata* *D. latifolia* *D. oliveri* *D. tonkinensis* *P. indicus* *P. macrocarpus*	**Bans and Quotas** • 1992 – A logging ban is in place for natural forest, protected forest and special purpose forest. This ban does not cover two areas covered by FSC Forest Management certificates, and for non-commercial harvesting activities by households, individuals and rural communities [164]. • 2006 –An export ban is in place covering logs and sawn wood from natural forests, excluding plantations [164, 165]. • 2014 – The Ministry of Industry and Trade issued a Notice (Ref. No. 37/2014/TT-BCT) temporarily ceasing importing and re-exportation of logs and semi processed wood from natural forest of Lao PDR and Cambodia. • 2014 – One of Vietnam's top three timber industry associations is developing a Code of Conduct that would make membership contingent on refusing to trade in wood imported from Cambodia and Lao PDR [1] **Legislative Prohibitions or Restrictions** • 1992 – *P. indicus* is included in the Council of Ministers Decision 18/HDBT as a species with high economical value which is subject to over-exploitation [82]. • 2006 – Vietnam Decree No. 32/2006/ND-CP – *D. tonkinensis* is strictly prohibited from commercial use and may only be used for scientific research or international cooperation. Under Article 6, use of *D. tonkinensis* for scientific research or international co-operation must be approved by the Minister of Agriculture and Rural Development and any transportation must be accompanied with appropriate documentation and proof of origin. • Use of *D. annamensis, D. cochinchinensis/ cambodiana, D. oliveri/bariensis, P. indicus* and *P macrocarpus/cambodianus/pedatus* are permitted to be used for scientific purposes (including breeding and artificial propagation) and international co-operation only. • According to the EIA (2012) [159], commercial harvesting of *D. cochinchinensis* is prohibited and in 2007 the Ministry of Agriculture further prohibited individuals' collection of the species. **Conservation Legislation** • According to UNEP-WCMC (2014) [63], Vietnam has implemented a Forestry Development Strategy 2006-2020 aimed at ensuring the sustainable management and development of forests.

In-Situ Conservation Management of Species

In-situ conservation management is defined as:

> *'The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties'.* [166]

Protection areas are the most common *in-situ* measure used to conserve species in their native habitats. Other measures can include habitat restoration, recovery rehabilitation, agroforestry initiatives and implementation of regulatory, legislation or other governmental frameworks needed to deliver protection [166]. The various regulatory, legislative and/or government frameworks have already been detailed above in Table 32. Alternative *in-situ* management measures which have been implemented within this Region for the documented species are summarised below in Table 33.

Table 33 – Summary of *In situ* management measures implemented in the Asia-Pacific Region

<table>
<tr><th>Protected/Management Area</th><th>Information</th><th>Reference</th></tr>
<tr><td colspan="3">CAMBODIA</td></tr>
<tr><td>A total of 16 stands covering an area of 691 ha distributed within 6 of the 10 gene ecological zones. The following species were identified as the most threatened:
1. D. cochinchinensis,
2. D. bariensis,
3. D. oliveri and
4. P. macrocarpus

They were therefore included as priority species in the gene conservation stands in Cambodia and D. cochinchinensis and P. macrocarpus are considered to be “National Priority Species”.</td><td>In 2003, a National Forest Gene Conservation Strategy was launched in Cambodia. The objective of the program was to ensure that the conservation of endangered, economically valuable and indigenous tree species populations, and secure the availability of quality planting materials deemed fundamental to the success of future tree planting and improvement.

The strategy identified public participation as having the potential to contribute to poverty reduction through improved resource management and creation of sustainable livelihoods and is therefore essential for in situ conservation. It was also identified that the conservation activities should be integrated into wider forestry-related activities, like gene conservation establishment areas within community forests because it would provide a larger protection area for forest genetic resources while providing access to a range of non-timber forest products for communities.

Table 34 - In-Situ Stands of Rosewood Forest in Cambodia (as at 2003)
<table>
<tr><th>Species</th><th>Stands</th><th>Total Area</th><th>Mother trees</th></tr>
<tr><td>D. bariensis</td><td>6</td><td>186 ha</td><td>263</td></tr>
<tr><td>D. cochinchinensis</td><td>2</td><td>69 ha</td><td>147</td></tr>
<tr><td>P. macrocarpus</td><td>5</td><td>177 ha</td><td>310</td></tr>
</table></td><td>Cambodia Seed Tree Project (2003) [72] and Jalonen et al (2009) [16].</td></tr>
<tr><td>72.5 ha – details of where are not provided however</td><td>It was reported that a 72.5 ha in situ conservation area existed in Cambodia for D. bariensis, which is a synonym of D. oliveri.</td><td>UNEP-WCMC (2008) [62].</td></tr>
<tr><td colspan="3">INDIA</td></tr>
<tr><td>Various areas as detailed under each heading.</td><td>It was reported that seed stands of various species in India have been established for in situ conservation in the following areas:
• Arunachal Prades: D. sissoo in an area of 975 ha.
• Jammu and Kashmir: D. sissoo (among other non-relevant[22] species) in area of 250 ha.
• Kerala: D. latifolia in an area of 46ha.
• Madhya Pradesh: D. latifolia in an area of 5ha.
• Tamil Nadu: P. santalinus in an area of 21ha.
• Uttar Pradesh: D. sissoo in an area of 146ha.

It was also reported that plus trees (defined as phenotypically superior tree) selection was another method used to conserve diversity at species level. D. sissoo plus trees were selected in Maharashtra (12), Uttar Pradesh & Uttarakhand (302) and Rajasthan (50).</td><td>Jalonen et al (2009) [16]</td></tr>
<tr><td colspan="3">INDONESIA</td></tr>
<tr><td>Non-specific.</td><td>This source reported that a database of 60 priority species, including D. latifolia and P. indicus, for genetic resources and tree improvement has been compiled, including the taxonomy, ecological characteristics, reproduction biology, usefulness, genetic variation and status of conservation. The source also reported that demonstration plots have been established in villages in order to conserve endangered species and to demonstrate to local communities how to realise forest conservation and management activities.</td><td>Jalonen et al (2009) [16]</td></tr>
<tr><td colspan="3">LAO PDR</td></tr>
</table>

22 To this report.

Protected/Management Area	Information	Reference
An area of 40 ha located in Napo And Nongboua Villages in Sang Thong District, 70km north-west of Vientiane.	An enrichment planting study was undertaken to assist the natural regeneration of species in a logged over tropical mixed deciduous forest. The objective of the study was to determine whether gap or line planting of seedlings were the more optimal enrichment planting method. Two of the species used in the study relevant to this report were *D. cochinchinensis* and *P. macrocarpus*. Their study identified that, given both species had relatively low survival rates, an essential requirement for their survival and growth was to have gap sizes of 400-500 m^2 or line widths of 4-6 meters to enhance light availability to the species when using enrichment planting in natural distribution sites.	Sovu et al (2010) [113].
THAILAND		
Khong Chiam *In Situ* Gene Conservation Forest, Ubon Ratchathani Province	In 1983, an area of 700 ha was reserved within this forest. The objective was to protect the genetic resources of local tree species which included *D. cochinchinensis* and *P. macrocarpus.*	Granhof (1998) and Isager et al (2002) as referenced in [167].
Ban Pong Forest, Chiang Mai (integrated into a Conservation Scheme in 1995).	This source argued that there is a need for species specific, site selection before planting native trees to complement and support recovery of biodiversity in degraded forests. They investigated the site requirements of *Dalbergia oliveri* with the purpose of restoring degraded deciduous forests in Northern Thailand. Their study noted *D. oliveri* as a suitable candidate as the species exists despite a range of environmental limiting factors and is found within various sites within their study. In this regard, they found that the species grew taller than "*Dipterocarpus* on highly degraded sites" where it can "assist in restoring a *mesic forest microclimate"* [140, p. 123]. They concluded that planting *D. oliveri* in degraded forests may assist remaining wild rosewood stands and therefore increase both economic production and biodiversity conservation.	Aerts et al (2009) [140]
Mae Ngao National Park – protected area	*Dalbergia assamica* is listed as a major tree of this mixed forest protected area.	Chadburn (2012) [66]
Unspecified	This source reported that *D. oliveri* was reportedly planted in gene conservation stands, covering an area of 34 ha and was considered to be a "very high priority" for conservation.	Sumantakul (2004) as referenced in EIA (2012) [159].
VIETNAM		
Tan Phu forest	This source reported that an area of approximately 100 ha had been set aside as an enrichment plantation for high value tree species present in the forest and *D. bariensis* was included in the list of species for which seeds had been harvested for the plantation.	Millet et al. (2004) as referenced in UNEP-WCMC (2014) [63]
Not specified.	This source reported that *D. bariensis* was in a list of priority species for gene conservation in Viet Nam.	Lieu (2001) as referenced in UNEP-WCMC (2014) [63].
There are: -16 National Parks - 65 Nature Reserves - 33 historical/cultural environmental areas As at 2003, natural forest which was protected = 537 997 ha of 9 444 198 ha of forest available. 3 167 781 ha was classified as "production forest"	Conservation of forest genetic resources has been research continuously since 1988 by the Forest Science Institute of Vietnam (FSIV). They have prioritised the following rosewood species as "Threatened species with high economic value": - *D. annamensis; D. cochinchinensis, D mammosa, D. tonkinensis, P. macrocarpus* This means they require both *in-situ* and *ex-situ* management.	Nghia (2003)

Ex-Situ Management of Species

Ex-situ conservation is defined as the *'conservation of components of biological diversity outside their natural habitats'* [166]. There have been a number of *ex situ* management techniques employed in this Region. In India, seed orchards were implements for *D. sissoo* and *P. marsupium* as they were reported to contribute greatly to the production of quality planting stock of the desired species [16]. Table 35 sets out various *ex-situ* measures that have been implemented in this region. The table includes some country specific references and some species specific assessments.

Table 35 - Summary of *ex-situ* management measures implemented in the Asia-Pacific Region

Management Area	Information	References
CHINA		

Southern tropical and subtropical areas of Yunnan, Guangxi and Guangdong	Eight rosewood species have been introduced into these areas with the largest rosewood plantation being in Zhaoqing city (Guangdong province), covering a total area of more than 20,000 ha. Species which have been introduced from this region include *P. indicus*, *P. macrocarpus*, *P. santalinus* and *P. marsupium.*	Webin and Xiufang (2013) [147].
MALAYSIA		
Seed gene-banks	Research has found that gene-banks have not always been successful for many forest species as they are known to produce recalcitrant seeds which do not survive storage for long periods of time. As a result various research institutes are looking at options such as cryogenic and *in-vitro* preservation techniques to be used in *ex-situ* conservation. *Pterocarpus indicus* has been identified as a priority species. Priority species are generally described as those species that are both popular species for plantations or produce high value timber specimens. At present there are approximately ten accessions for field trials involving *P. indicus*. With regard to *in-situ* conservation there are no natural areas listed and insufficient information on plantations exists.	Jalonen et al (2009) [16]
THAILAND		
Conservation stands were planted at: • Sakaerat Silvicultural Station • Nakhon Ratchasima, Surat Thani Silvicultural Research Station • Kamphaeng Phet Silvicultural Research Station.	Stands were established from 2003-2007, with the following rosewood species included: - *D. cochinchinensis = 43 trees,* - *D. oliveri = 20 trees,* - *P. macrocarpus = 85 trees* Tree improvement programs and progeny tests (for planting of seeds in orchards) were also established for *P. macrocarpus* and *D. cochinchinensis*.	Jalonen et al (2009) [16]
PHILLIPINES		
Gene-banks, plantations and provenance trials	*Pterocarpus* species were included in these projects however, they have mostly faltered due to insufficient support at government level.	Jalonen et al (2009) [16]
DALBERGIA ANNAMENSIS		
Vietnam	From 1990 – 2000, *ex-situ* conservation stands consisting of 1000 trees were reported to have been established by the Forest Science Institute.	UNEP-WCMC (2014) [63].
DALBERGIA ASSAMICA		
Cultivated *ex-situ* and contained in the Millennium Seed Bank Project	No details were provided as to where this species is cultivated.	Chadburn (2012) [66]
DALBERGIA COCHINCHINENSIS		
Cambodia Seedling Orchard established at Khbal Chhay in Sihanoukville in 2003	A species elimination trial was conducted including *D. oliveri, D. cochinchinensis, and P. macrocarpus.* After 3 years, it was recommended that *D. cochinchinensis* be planted as it was found to be "*fast growing with a high survival rate in plantations*" The second choice in the trial was *P. macrocarpus.*	Jalonen et al (2009) [16]
Lao PDR	According to this source, a demonstration plot in Lao PDR has shown that this species can grow quite fast if cultivated under suitable conditions. Planting of the species can provide a high income and protect the genetic resource of the species. Efforts have been made to support the identification and collection from good seed sources to be used for plantings. Plantings can serve as seed sources for commercial seed procurement and form the basis for future domestication of the species in large parts of Lao PDR. The source states that it is important that planting is carefully planned, documented and not based on collection from a few random trees.	Thielges et al (2001) [168].
DALBERGIA CULTRATA		
Lao PDR	With support from the Danish Government the Lao Tree Seed Project is currently improving the supply of seeds. The seeds of *D. cultrata* have been collected due to the socio-economic importance of the species and its role as a priority conservation species in Lao PDR.	Contu (2012) [58]
DALBERGIA OLIVERI		
Thailand	*D. oliveri* was reportedly planted in gene conservation stands, covering an area of 34 ha and was considered to be a "very high priority" for conservation (Sumantakul, 2004). The species was considered to be a "top priority" in terms of research required on distribution and status and a "high priority" in terms of conservation strategy (Tangmitcharoen, 2009). It was considered to be "well conserved" *in situ* and "partly conserved" *ex-situ* in Thailand	UNEP-WCMC (2014) (Aerts et al., 2010)

	(Tangmitcharoen, 2009). *D. oliveri* was reported to occur in the Ban Pong Forest Sanctuary.	
	This study identified that this *D. oliveri* could be employed in *ex situ* plantations of mixed species on open sites or under the canopy of young swidden forests.	Sovu et al (2010) [113]
Vietnam	Phong et al (2011) reported that a protected subpopulation of *D. oliveri* was found within the Nam Cat Tien National Park and in the Yok Don National Park.	Nghia (1998) [48]
Vietnam	The Forest Science Institute of Vietnam established an *ex-situ* conservation stand of *D. mammosa* from 1990-2000. The stand is believed to consist of approximately 1 000 trees. Vu and Quang Vu (2011) also reported that *D. mammosa* was located within Bu Gia Map National Park in Southern Vietnam.	UNEP-WCMC (2014) [63]
DALBERGIA SISSOO		
India	This source reported that in 2003, seed orchards for *D. sissoo* were recorded in Binhar (2ha), Haryana, Jharkhand, Marashtra (1ha), Punjab (4ha) and Uttar Pradesh (95ha).	Jalonen et al (2009) [16].
Unspecified.	This source reported that: • *D. sissoo* plantations are established in block or strip plantations at 1.8 x 1.8 m to 4 x 4 m. Closer spacing is used for straight timber of good quality. • Seed storage behaviour is orthodox; viability is maintained for 4 years in hermetic storage and 1-2 years when stored in airtight containers under dry, cool (5-22 deg. C) conditions. Produces approximately 45 000-55 000 seeds/kg.	Orwa et al (2009) [87]
Cameroon	A number of plantations were established in Cameroon about 30 years ago reported to have had good results; species included *Dalbergia sissoo.*	(Blaser et al 2011)
Bangladesh	This source reports that farmers in the north are cultivating species, such as along with their agricultural crops. India – This source reports that there are 24.6 ha of Seed Production Areas (SPAs) for *Dalbergia sissoo* available. Around 300 kg of seeds can be obtained from the 24 ha of SPAs, which is sufficient to plant 9000 ha.	(Luomo-aho et al, 2004)
India	*D. sissoo* has been reported to have been developed along irrigated sites in Pujab, Uttar Pradesh and Rajasthan. The Indira Gandi Nahar Project (IGNP) also contains established *Dalbergia sissoo*tree plantations. Growing stocks of *D. sissoo* are said to include 898,000 trees out of the total 18 million trees planted in 1998, accounting for 4.9% of the total project, which equates to 187,866 cubic meters.	Cunningham, Belcher and Campbell (2005) [15, pp. 113-115]
India and Pakistan	*Dalbergia sissoo* is usually grown in block plantations with irrigation or on floodplains within both India and Pakistan. Survival rates of up to 100% can be obtained using stump plants from 1-2 year old nursery seedlings. Thinning and pruning of lower branches appears to help produce a clear bole. In India and Pakistan, harvest rotations of 10-22 years are frequent for harvests for fuelwood and smaller timber, whilst larger sized timber requires 40-60 years between rotations. Plantations can record annual growth rates of 10-22 m^3/ha. *D. sissoo*has been recorded as occurring amongst agricultural crops, along boundaries, as windbreaks or shelters and as scattered trees. Before the onset of winter farmers practice lopping and cutting of individual branches to promote coppicing. Many different agricultural crops can be grown alongside *D. sissoo*including maize, cotton, sugarcane and tobacco.	Invasive Species Compendium (2013) [116]
PTEROCARPUS INDICUS		
	This species is easily propagated by seed. Stump cuttings taken from seedlings or wildlings can also be used as planting material and narra can be propagated successfully by tissue culture. It is cultivated in Africa, India, Sri Lanka, Taiwan, Okinawa, Hawaii and Central America. It is also cultivated in Singapore and Papua New Guinea.	UNEP-WCMC (1998) [82] UNEP-WCMC (1997) [169].
	It is reported that stump plants of *P. indicus* are also used to establish plantations . It is suggested that new plantations should be kept weed free and protected until the trees crown begins to cover the understory. In the Philippines, cuttings of *P. indicus* of approximately 8cm in diameter are rooted following hormone treatment in order to produce instant trees.	Francis (2002) [88]
PTEROCARPUS MACROCARPUS		
Lao PDR	This study identified that this species could be employed in plantations of mixed species on open sites or under the canopy of young swidden forests.	Sovu et al (2010) [113].

	Vozzo (2002) reported that seedlings that are intended for ornamental use are grown in 12-20L plastic pots. They remain in the pots until the reach a height of 2-3 m in height before out planting. In Burma plantation seedlings grew from 0.6 to 1.2m in the first year then adding a further 1.2 to 2.1 m in their second year.	Webin and Xiufang (2013) [147].
Thailand	Liengsiri (1999) suggests that the optimal strategy for *ex-situ* conservation of *P. macrocarpus* would be to include a wide geographic sample of populations in order to ensure a significant difference in genetic structure. Obvious populations for sampling would include Kong Chiam (Population II) as this particular population exhibits significant genetic differentiation which allows for genetic improvement and conservation best practice. Where the plantation is to be used for seed and wood production, sampling should also take into consideration climatic variability and adaptability which is of a similar nature to the sampling site. Deployment zones for *P. macrocarpus* within Thailand could possible include three broad regions including the northern region, the north-eastern region and the central and western region. As the natural range for *P. macrocarpus* also extends to other nearby countries, samples could also be used from these populations although more test sites and research would need to be undertaken.	Liengsiri (1999) [92]
PTEROCARPUS MARSUPIUM		
India	This source reported that in 2003, seed orchards for *P. marsupium* were recorded in Tamil Nadu (2ha).	Jalonen et al (2009) [16].
China	This source reported that the largest rosewood plantation is in Zhaoqing city, Guangdong province and covers an area of 20 000 ha	Webin and Xiufang (2013) [147]
PTEROCARPUS SANTALINUS		
India	Plantations of the species *P. santalinus* have been produced outside of its natural range in plantings undertaken by the State Forest Departments. Approximately 3 000 ha of plantations exist in both Tamil Nadu and Andhra Pradesh. Smaller plantations may exist in several other states.	Hegde et al (2012) [94].
India	One way to meet the timber demand may be to look at encouraging private and communal land owners to establish plantations of Red Sanders on their land. A potential barrier to this process involves administration, harvesting and marketing under both state and CITES regulations, which are time consuming and complex. Such factors are known to deter landowners from raising Red Sanders trees. The Andhra Pradesh Forest Department established plantations covering 4099 ha during 1960-1975 in Chittoor, Kadapa and Kurnool districts of AP which are not to have been commercially exploited.	Kukrety (2011) [123]

CONCLUSIONS & SUMMARY

The Asian region features prominently both in terms of trade in *Dalbergia* and *Pterocarpus* species, as well as the availability of scientific and trade data. In relation to the gap analysis prepared for this report to assess available information to undertake a non-detriment finding (refer to Section III – Non Detriment Finding Requirement Gap Analysis), the Asian region has the most detailed and species specific information of the three regions studied. The following is a summary of the key points raised in the above 6 sections:

- There are a number of species requiring taxonomic review, particularly *D. assamica* and *D. balansae*; *D. oliveri*, *D. bariensis* and *D. mammosa*; and *D. cultrata* and *D. fusca*. Without taxonomic clarity, opportunities to traffic timber and deliberately misreport species to avoid detection will continue to occur.

- The level of scientific effort expended on biological traits in this region reflects the importance of Asian species in the global rosewood trade, but pales in comparison to the value of these species in trade, with many billions of dollars traded each year [1]. However there is significant information available on height and diameter growth rates, flowering and fruiting information, reproduction traits, habitat type, wood density and germination rates from both *in-situ* and *ex-situ* studies. Many species share similar traits with other legume tree species such as sprouting and coppicing, nitrogen symbiosis, mass flowing and low fruiting, slow growth rates (with the exception of *D. sissoo*) and a reliance of bees for pollination.

- Unlike biological traits, there has been relatively little effort expended in the region to understand population status, structure or current distributions and ranges. The use of GIS modelling in this region is particularly useful given the quality of data available on geospatial platforms such as Global Forest

Watch (among others). GIS modelling is also cost effective and produces justifiable results, though would be improved with field verifications sampling. The combination of the available survey information and the GIS distribution modelling suggest species in Asia are under significant threat from declining habitat availability.

- The international demand for rosewood species is the single biggest driver of the exponential increases in trade in lower value species such as *P. macrocarpus and P. erinaceus* in recent years.
- The risk of serial depletion of rosewood producing species is evident from the trade data analysis conducted. Demand from China in the past has seen a shift from *D. odorifera* to *D. tonkinensis* then to *D. cochinchinensis* [4, 1, 147]. More recently this trend has seen a shift from the more highly prized rosewood (or hongmu) species such as *D. cochinchinensis* and *D. oliveri* to *P. macrocarpus* to meet market demand and to avoid restricted species protection and compliance measures.
- Use of Chinese specific customs commodity codes for Hongmu substantially underestimate the level of trade in the associated species, particularly between Vietnam and China. There has also been a clear shift in this trade between Vietnam to China over recent years from logs to sawn wood, with exports of sawn wood of rosewood species eclipsing exports of logs for Asian species.
- Legislation, management measures and conservation initiatives are all undertaken to varying degrees by the Asian range states of rosewood producing species. Despite these measures deforestation and exploitation is still occurring at a rapid rate. Lack of political will, systemic corruption, poverty, lack of resources (both financial and human) and poor forest governance are all factors that need to be considered in any decision to develop conservation management measures to holistically tackle rosewood exploitation.

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SECTION IIB- REGIONAL ANALYSIS: AFRICA

INTRODUCTION

There are 60-70 species of *Dalbergia* species currently known to exist in Africa, with 43 in Madagascar [170]. However, only one currently produces commercially exploitable precious hardwood on the mainland, *Dalbergia melanoxylon,* otherwise known as African Blackwood. All other *Dalbergia* species currently considered to produce hardwood, either rosewoods or *palisander*[23] are only known to occur in Madagascar. While Madagascar is dominated by *Dalbergia* hardwood producing species, the rest of Africa has 15 *Pterocarpus* species [17], with five that produce rosewood or other precious hardwoods, such as African Teak (*Pterocarpus angolensis*). Many *Dalbergia* and *Pterocarpus* species have limited information about their current range and distributions, and even the taxonomy is in a state of flux. Most of the species in Africa were assessed by the IUCN Red List almost 20 years ago, the assessments are in urgent need of being updated.

SPECIES TAXONOMY

Species taxonomy, particularly for *Dalbergia* species, is not well resolved. A recent report by WRI and the World Bank detailed many of the taxonomic and simple identification issues related to *Dalbergia* species in Madagascar [27]. It is essential when doing field surveys to be able to tell species apart in order to conduct accurate surveys and understand the population ecology of forests, however for most *Dalbergia* species it is virtually impossible to tell them apart unless either their flowers or fruit are available. This also applies to several look-alike species that come from other genera [27].

The most recent taxonomic revision for Madagascan *Dalbergia* species was conducted by Bosser & Rebevohitra (2002) [171], with a later paper in 2005 detailing newly described species, none of which are considered to be rosewood or palisander [172]. Recent DNA analysis of several *Dalbergia* tree species (Hassold et al, unpublished data) indicates that even this taxonomy assessment is likely to be inaccurate, with several described subspecies likely to be species in their own right, while others should be combined [27]. It is well recognised that *Dalbergia* species, particularly in Madagascar, require more detailed and thorough analysis to more accurately describe and determine species boundaries. The case for *Pterocarpus* species is even less clear. There does not appear to be many taxonomic references or studies for *Pterocarpus* in Africa, and all references utilised in this information paper do not describe difficulties in identifying species in the genus. The major synonyms are discussed below, along with local or vernacular names used throughout the regions where these species grow.

Table 36 - Species Taxonomy in Asia-Pacific Region. A = Accepted Name, S = Synonym RR = Taxonomic Revision Required

A	S	RR	TAXONOMY DISCUSSION	COMMON AND VERNACULAR NAMES
Dalbergia chapelieri			Synonyms - *Dalbergia pterocarpiflora* Baill. [173, 174]	
✓				
Dalbergia louvelii			This species has similar flowers and wood to *D. maritima,* but no actual synonyms are listed on IUCN Red List Assessment. [17]	French: Volombodipona à grandes feuilles [17]
✓				
Dalbergia greveana			*D. ambongoensis*, *D. eurybothrya*, *D. ikopensis*, *D. isaloensis, D. myriabotrys and D. perrieri* are listed as synonyms in Tropicos, Catalogue of Vascular Madagascar Plants (CVMP) and African Plants Database (APD) [174] One study found that *D. greveana* was most closely related to *Dalbergia trichocarpa* [65], however, another study found that it was most closely related to *Dalbergia baronii* [30].	English: French rosewood, Madagascar rosewood French: Palissandre violet, palisandre de Madagascar [17]
✓		✓		
Dalbergia hildebrandtii			*D. boivinii* is listed as a synonym on CVMP, APD and Tropicos [174, 60].	
✓				
Dalbergia madagascarensis			This species is similar to two other Madagascan species that are considered Endangered on the IUCN Red List – *D. bathiei*	

23 Palisander has lighter heartwood than traditional "rosewoods", and are highly prized on the domestic Madagascan wood market.

✓			and *D. erubescens* but no actual synonyms are listed [175]. However, Tropicos (2016) [60] lists several variations (.var)[24] and sub-species under this species, some of which also have synonyms: - *D. madagascarensis* subsp. *madagascarensis* - *D. madagascarensis* var. *madagascarensis* - *D. madagascarensis* subsp. *antongilensis* - *D. madagascarensis var. poolii (synonyms)* Synonyms for *D. madagascarensis var. poolii* are *D. cloiselii* and *D. poolii* [174, 60]	
Dalbergia melanoxylon			No listed synonyms	English: African blackwood, African ebony, African grenadillo, African ironwood, Senegal ebony, zebra wood. French: Grenadille d'Afrique, ébénier du Sénégal Portuguese: Grenadilha, pnu preto
✓				
Dalbergia mollis			The IUCN Red List Assessment states that *D. malacophylla* is a synonym. The name was not officially published but had filtered through the global tree assessment process and was previously listed under this name, but it not considered accurate [176]. The CITES Plants Committee 19 (PC19) Document 14.3 [174], written by a taxonomy expert from Madagascar did not list any synonyms for this species. However, it did list the following varieties, which do have synonyms: - *Dalbergia mollis* var. *mollis* Synonym: *D. stenocarpa* var. *typica* - *Dalbergia mollis* var. *menabeensis* Synonym: *D. stenocarpa* var. *typical & D. chermezonii*	
✓				
Dalbergia monticola			No listed synonym, however, this species is very similar to *D. baronii,* and was only distinguished approximately a decade ago [17].	French: Coamboana, palissandre brun, palissandre de Madagascar [17]
✓				
Dalbergia trichocarpa			No synonyms are listed on the IUCN Red List assessment however, PC19 Doc 14.3 [174], states that *D. bernieri* and *D. perrieri* are, according to Tropicos, APD and CVMP. They are also recognised in Louppe et al (2008) [17].	
✓				
Pterocarpus angolensis			*P. bussei* Harms (1902) is listed as a synonym [17].	English: African bloodwood, mukwa, kiaat, muninga Portuguese: Ambila, umbila, njila sonde Swahili: Mninga, mdamudamu, mtumbati
✓				
Pterocarpus erinaceus			No synonyms listed	English: African rosewood, Senegal rosewood, African barwood, African teak, African kino tree, madobia; French: Vène, ven, palissandre du Sénégal, kino de Gambie, santal rouge d'Afrique, hérissé ; Portuguese: Pau sangue
✓				
Pterocarpus lucens			*Synonyms:* [177] *P. abyssinicus* Hochst. *P. leucens* Guill. & Perr. *P. lucens Lepr. ex Guill. & Per. ssp. antunesii (*Taub.) Rojo	English: small-leaved bloodwood, barwood Portuguese: Muvilu
✓				
Pterocarpus soyauxii			No synonyms listed	English: African padauk, African padouk, barwood. African coral wood; French: Padouk d'Afrique, pudauk d'Afrique, bois corail; Portuguese: Ndimbu, nkula
✓				
Pterocarpus tinctorius			*P. chrysothrix* Taub. (1895), *P. stolzii* Harms (1915) listed as synonyms [17]	Tacula (Po). Mninga maji (Sw).
✓				

24 Variety names are used (.var abbreviation) when a mutation has occurred in nature

SPECIES BIOLOGY

As described in the Global Overview section, there was a significant amount of information available on the biology of African rosewood species. There are 47 recognised species in the *Dalbergia* genus in Madagascar, up to 63 when including subspecies. However, not all are trees that are exploitable for rosewood or palissandre. Only one exploitable precious wood producing species in the *Dalbergia* genus is found on the mainland. As such, the Madagascan *Dalbergia* species are treated separately in the following tables to the mainland species.

Dalbergia species in Madagascar are found in a range of habitats from arid steppe areas to perhumid evergreen forests (meaning ever-wet rain forests) [27, 178]. 27 taxa are found in humid areas, 22 taxa are found in dry areas and 14 taxa are found in both wet and dry habitats [27]. Regeneration is generally considered to be low [179], however there is little scientific information available on species specific regeneration or growth rates. CoP16 Proposal 63 [179] states that the general growth in thickness is 3mm/year. More details of information available is provided in Table 37 for Malagasy species, while Table 38 - Table 40 provide details of the mainland African species. Species in both *Dalbergia* and *Pterocarpus* display common traits such as slow growth rates (some species staying in the suffrex stage for up to 20 years), nitrogen fixing ability, bisexual flowers, ability to regenerate through coppicing and low germination rates (unless intervention from silvicultured specialist). The group with the most information available were the *Pterocarpus* species that are highly exploited on mainland Africa, i.e. *P. erinaceus, P. angolensis* and *P. lucens*.

Table 37 - Biological Information for Malagasy *Dalbergia* Species (little scientific information available)

MALAGASY ROSEWOOD – *DALBERGIA* SPP				
Species	**Species Description**	**Habitat Type**	**Reproduction and Growth, Development and other Biology factors**	**Wood Properties**
Dalbergia abrahamii	Average sized tree Height: 8-15m [180]	Found in areas of limestone outcrops [181] and dry dense deciduous forests with low altitude on chalky or volcanic soils [180].	- white flowers, reddish/brown fruit	
Dalbergia baronii	Deciduous, medium sized tree. Height 25-30m Bole length = 6-20m Diameter = 100-140cm [17, 180]	Found in lowland evergreen humid rainforests, often in marshy areas and near mangroves. Altitude : 0-150m (rarely up to 600m) Soils – sandy, sometimes salty [182]	- it is very similar to *Dalbergia monticola* and often not able to be distinguished - Flowers are bisexual [17] - 1-3 seeds in fruit - roots are nitrogen fixing	12% moisture: [17] Wood density = 620-950 kg/m^3 Modulus of rupture = 132-221 N/mm^2 Compression (parallel to grain) = 58-86 N/mm^2 Cleavage = 14-20 N/mm Chalais-Meudon hardness = 2.9-7.8
Dalbergia bathiei		Found in a few small areas of lowland, evergreen, humid forest, mainly along river margins [183]		
Dalbergia chapelieri	Deciduous shrub or small tree up to 15-18 m high [173, 17] Diameter = 60cm [17]	Found in evergreen humid forest, littoral forest, on lateritic or sandy soil up to 1000m. It can be found in humid valleys as well as on drier crest [173, 17]	- Flowers are bisexual - Flower when leafless, from August to April	
Dalbergia chlorocarpa	Deciduous small to medium sized tree; Height = 15-20m	Found in lowland deciduous forests and woodlands that are seasonally dry [184], up to 400m [17] Soil preference – mainly sandy [17]	- bisexual flowers, with 1-2 seeds in the fruit - flower from March to June - prolific seed bearers - abundant natural regeneration [17]	
Dalbergia davidii		Found in lowland, seasonally dry, deciduous forest [185]		

MALAGASY ROSEWOOD – *DALBERGIA* SPP				
Species	**Species Description**	**Habitat Type**	**Reproduction and Growth, Development and other Biology factors**	**Wood Properties**
Dalbergia delphinensis		Found in lowland, evergreen, humid forest [186]		
Dalbergia greveana	Deciduous small to medium tree; Height = 15-20m tall; Diameter = 50cm max [17]	Found in deciduous, seasonally dry forest and woodland up to 800 m. [187] Soil preference = sandy to limestone and ferrallitic [17]	- bisexual flowers - 1 seed in fruit usually - regeneration potential appears lower than other western Madagascan species [17]	12% moisture: Wood density = 1080 kg/m^3 [17] Modulus of rupture = 181-226 N/mm^2 Compression (parallel to grain) = 98 N/mm^2 Cleavage = 21.5 N/mm Janka hardness = 13350 N Chalais-Meudon hardness = 18.6
Dalbergia hildebrandtii	Small tree which grows up to 10m	Found in deciduous seasonably dry forests and woodlands, up to 600m with sandy or rocky soils. [17]	- Flowers from March – May and are bisexual [17] - 1-3 seeds in a pod [17]	
Dalbergia louvelii	Deciduous medium sized tree (up to 20m) [17, 180].	Species is restricted to "drastically reduced lowland humid forests" [188], including evergreen and coastal forests up to 700m in sandy and ferralitic soils [17].	- Flowers (whitish) are bisexual [17, 180] - 1-2 seeds in pod [17] - Flowers in Jan and Feb - roots are nitrogen fixing	Wood density (12% moisture) = 800-900 kg/m^3 [17] - Anti-plasmodial properties (i.e. anti-malaria)
Dalbergia madagascarensis	Deciduous small to medium tree growing up to 15-20m tall [17, 180]	Found along river margins in the humid, evergreen forest, up to 1000m. [175, 17, 180] Prefers sandy soils resulting from igneous or basaltic rocks [17]	- Flowers are bisexual and are dark purple at base and yellow at ends [17, 180] - Seeds usually contain 1-2 seeds, but can have up to 4. - Roots are nitrogen fixing [17]	
Dalbergia maritima	Lowland tree	Restricted to humid, evergreen, coastal forest. [189]		
Dalbergia mollis	Shrub or small to medium-sized tree Height: 15-20m [180]	Found in lowland, deciduous forest and woodland in west Madagascar [105]	- Flowers are dark purple at base and yellow at ends [180].	
Dalbergia monticola	Evergreen tree [190] Deciduous medium sized tree Height – 8-15 usually, up to 20-30m [17, 180] Bole height = up to 20m Diameter = 100cm	Found in lowland humid forest [190, 17] to sub-montane ever green forests, along eastern escarpments [105]. Altitude: 250-1600m Mean Temp – 18-23° Mean Rainfall – 750-2500mm Soils - ferrallitic	- it is very similar to *Dalbergia baronii* and often not able to be distinguished [17] - flowers are bisexual (whitish [180])and pollinated by insects [17] - 1-3 seeds in fruit [17] - fruits fall to ground, seeds may be dispersed by animals [17] - seedlings found with 20m of parent tree Longevity = at least 200 years [17] - *this species has a relatively wide geographic range and shows genetic differentiation between the north and south populations*. [191]	12% moisture: [17] Wood density = 620-950 kg/m^3 Modulus of rupture = 132-221 N/mm^2 Compression (parallel to grain) = 58-86 N/mm^2 Cleavage = 14-20 N/mm Chalais-Meudon hardness = 2.9-7.8

MALAGASY ROSEWOOD – *DALBERGIA* SPP				
Species	**Species Description**	**Habitat Type**	**Reproduction and Growth, Development and other Biology factors**	**Wood Properties**
Dalbergia normandii	Tree up to 15 m tall [180].	Found in fragmented humid evergreen coastal forests (from only 2 locations) [192, 105]	- Fruits are reddish brown, with 1-2 seeds [180].	
Dalbergia purpurascens	Deciduous small to medium tree Height – up to 25m [17, 180]	Found in deciduous seasonably dry forest and woodland Altitude: up to1000m Soils – sandy/rocky, limestone derived [17]	- flowers are bisexual and flower from Jan to May - 1-3 seeds in fruit - growth is slow – 7 yr. old trees are between 1 and 5 m tall - nitrogen fixing roots - germination rate from seed propagation = 40-80% - 1 year old seedlings ≈ 50cm tall [17]	
Dalbergia trichocarpa	Deciduous small to medium tree Height – up to 15 m usually, rarely 25m [17, 180]	Restricted to lowland seasonably dry forests and woodlands. Altitude: up to 600m, rarely up to 1000m Soils: sandy/rocky and basalt/limestone derived May also exist as a small tree on grasslands [17]	- flowers are bisexual, pollinated by insects and flower from January to April - 1-3 seeds in fruit - can be coppiced [17]	- "excellent" wood properties - fire resistant [17]
Dalbergia tsiandalana		Coastal, lowland, moist forest but restricted to Mahajanga region in west Madagascar [193]		
Dalbergia viguieri		Restricted to broadleaved transitional forest in north east Madagascar [194]		
Dalbergia xerophila	Deciduous shrub to small tree approximately 4 m tall [180].	Restricted to woodland and scrubland on sand in south east Madagascar [195]	- Yellowish to white flowers - Light brown fruit with 2-3 seeds [180].	

Table 38 - Biological Information for *Dalbergia melanoxylon*

DALBERGIA MELANOXYLON						
Maturity Age	**Height (m)**	**Diameter (cm)**	**Rotational Length**	**Life Expectancy**	**Flowering Season**	**Fruiting Season**
70-100 years [196, 77] DBH = 38-40cm[25] [197]	Avg 4.5m-7.5m, up to 15m max Bole length: 1.2-1.8m (3.6 max)		Up to 200 years [197] Intensively managed – 50-80 year [197]			
Habitat Type		**Reproduction/survival strategy and germination potential and regeneration potential**		**Growth rates and heartwood development information**		
This deciduous species grows in low altitude savannahs and woodlands, across a range of sites, particularly on gravely soils. Light demanding. [198] Soil Requirements: [198] - sufficiently moist soils - preferably near water - listed as having high sensitivity to *shallow soils on petroferric outcrops* – with 7.9% of individuals in Burkina Faso study found in such habitat [199] Altitude Range: Sea Level to 1300m [198] Has been recorded up to 1900m in Ethiopia [200] Rainfall Range: 600mm-1000mm [198] 700-1200mm according to CoP9 proposal [200] Temperature Range: 0-20°C [198] 0-35°C according to CoP9 proposal, with no frost [200]		Seed production Seed pods are about 4cm long with 1-4 seeds each 42000 seeds per kg [198] Germination Rate 30% [198] Seeds germinate readily, but have short viability periods [199] Survivability Ratio of mortality = 0.22 ; 39% on shallow soils [199] Regeneration potential This species appears to have reasonable ability to regenerate, with one study finding large numbers of seedlings, however, only a low percentage of these ever make it to bole size [197]. However, FAO (1993) noted that this species does not regenerate well [196]. It does regenerate well via coppicing [77, 197], however this ability declines with age [196]. The CoP9 proposal stated that it will no regenerate under heavy cover.		- Growth Rates are "slow" [198], as it takes 70-100 years for this species to reach maturity. - Silvicultured trees grew: [198] Height = 0.6m to 0.7m per year Diameter = 1 to 1.5 cm per year A more recent paper states that this species is a "relatively fast growing species" which can produce wood of a suitable size and quality for use in wood carving in less than 10 years. [201] Wood Density/heartwood development [197] From Tanzania - Heartwood – 1.14 g/cm^3; Sapwood – 0.76 g/cm^3; Heartwood/sapwood – 1.06 g/cm^3 Heartwood content of standing trees estimated to be 83% Average dry weight density = 1200 kg/m^3 [26]		

Table 39 - Biological Information for *Pterocarpus* Species with Limited Scientific Data Available

PTEROCARPUS SPP				
Species	**Species Description**	**Habitat Type**	**Reproduction and Growth, Development and other Biology factors**	**Wood Properties**
Pterocarpus tinctorius	Evergreen tree [202] Height = 5-25 (max 30)m [202, 203] Bole length = Up to 15m [203] Diameter = 75cm [203]	Found in a variety of habitats including wooded grasslands, dry ever green thickets, rocky hills, sometimes found on termite mounds [202, 203]. Munishi *et al* (2011) found that *Brachystegia bussei-Pterocarpus tinctorius* woodlands were associated with steep slopes on mid-high elevations in Miombo woodlands of southern Tanzania [204] Soil Requirements: Stony soils [202] Altitude Range: 50-1800 m [202, 203]	- Flowers are bisexual - In Democratic Republic of Congo – Flowering season is from March to May [203]	At 12% moisture content: Density: 450 (Congo forest) – 900 (Burundi savannah) kg/m^3 Congolese wood/Burundi wood Modulus of rupture = 91 N/mm^2 / 147 N/mm^2 Modulus of elasticity = 9100 Nmm^2/ 15000 Nmm^2 Compression parallel to grain = 45 N/mm^2/77 N/mm^2 Cleavage = 8 N/mm Chalais-Meudon hardness = 2.2

25 Depending on site quality

[26] As provide don the Sound and Fair website – www.soundandfair.org

Table 40 - Biological Information for *Pterocarpus* Species with Scientific Data Available

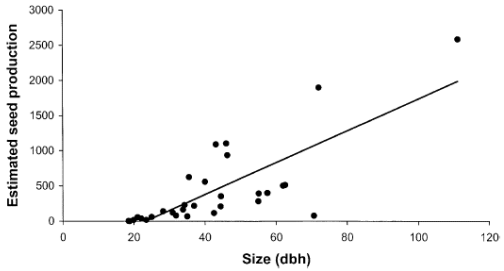
<table>
<tr><th colspan="6">PTEROCARPUS ANGOLENSIS -</th></tr>
<tr><th>Maturity Age</th><th>Height</th><th>Diameter</th><th>Rotational Length</th><th>Life Expectancy</th><th>Flowering Season</th><th>Fruiting Season</th></tr>
<tr><td>20 years
[198]
13-15cm
[205]</td><td></td><td></td><td>40-75 years [198], however more recent growth rate studies suggest this would be too short given it takes 50 years for each 5cm of growth [206]
Minimum cutting circumference = 84cm; can take up to 82 years, based on Shackleton (1997) [207, 15]</td><td>60-90 years
[198]</td><td>Tanzania</td><td>August to October
[198]</td></tr>
<tr><th colspan="2">Habitat Type</th><th colspan="2">Reproduction/survival strategy and germination/regeneration potential</th><th colspan="2">Growth rates and heartwood development information</th></tr>
<tr><td colspan="2">This species grows widely across the Miombo woodlands (mostly classes as deciduous).
Miombo woodland habitat covers 2.7 million km² from Tanzania/Democratic Republic of Congo to northern regions of South Africa, and from Angola to Mozambique. [206, 208]
Soil Requirements [198]
- Adaptable to red loams & deep sandy soil
- Rapidly draining through first 30cm
- Not in coastal sands or black clay
Altitude Range: Sea Level to 1650m [198]
Rainfall Range: 700mm-1500mm [198]
Light demanding [198]
Fire resistant [209]</td><td colspan="2" rowspan="2">Seed Production
Tanzania - Katavi National Park and Msaginia Forest [206]
Relationship between tree size and seed production to be highly significant in Katavi National Park and Msaginia Forest Reserve (Tanzania). There was larger error factors related to larger trees, as smaller DBH trees showed far less variability.
 

Figure 36 - Relationship between tree size and seed production in KNP and MFR
This paper estimated the total seed production for the MFR for all live trees left in the reserve to be 613.1 seeds/hectare
Seed Germination Rate
Silviculture trials indicated that this species produces 4200 seeds per kg and germinate at a 50% rate. [198]
Survival Strategy
Seedlings develop a robust taproot which expands during the rainy season compared to the above ground shoot which develops during year 1 that dies back during the dry season. The shoot or root system architecture of seedlings is therefore dependent on the time of year. (Tanzania – Morogoro [208])</td><td colspan="2">Growth Rates
- Boaler (1966) found annual diameter increment varied from 0.08-0.45cm, with variations over the life of the tree noted. [209]
- Humidity and minimum temperature most influential factors for growth rate [209]
- Mean tree ring width (i.e. growth rate) in Katavi National Park and Msaginia Forest predicted to be 0.49mm, resulting in each 5cm diameter class equaling 50 years [206]
- Shoots are said to rarely grow more than 15cm [198]
For rapid growth from seedling to sapling the following conditions are needed [198]: 1. full light 2. absence of fire 3. no root competition 4. adequate supply of mineral nutrients
Table 6.2 of [209] lists growth rates in Western Zimbabwe as 0.03 cm/year based on Holdo (2006) and 0.30–0.41 based on Stahle et al (1999)</td></tr>
<tr><th colspan="2">Seed/Fruit Dispersal</th><th colspan="2">Fruiting Behaviour</th></tr>
<tr><td colspan="2">Wind can sometimes disperse fruit and seeds, however this is uncommon. The peak distance for fruit dispersal from mother tree is 2.1-3m (Figure 37). Whereas more seedlings are found further away from mother tree [205], presumably due to the light demanding nature of the species.</td><td colspan="2">Fruiting starts at 20 years of age and is light until 35 years of age and will fruit until death. However, it is estimated that only 50% of Pterocarpus fruits contain seeds and the rest are barren. [198]
2% of fruits germinate in Tanzania (Boaler 1966) [208]

First fruit bearing individuals appeared in 13-15 cm diameter size class, with the highest proportion of fruiting trees occurring in the 25-27cm size class. 24% of trees bore fruit in this survey (refer to Figure 38.) [205]</td></tr>
</table>

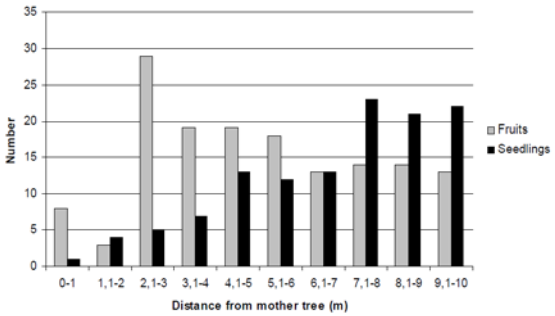


Figure 37 - Seed/Fruit Dispersal

This species is known to stay in the suffrutex stage for up to 20 years, which can make aging the species difficult [15].

A hostile climate and annual fires hinder natural regeneration of this species. Termites and crickets present problem to seedlings [198]

Symbiosis with soil bacteria is also an important survival strategy. This species forms a double symbiosis with Vesicular Arbuscular or VA *mycorrhizae,* that is important in Phosphorus uptake from the soil [210] (as do most tropical trees) and also forms nodules that fix Nitrogen in the soil. Both these nutrients are limiting in the Miombo savannahs due to the annual fires that consume organic matter

Poor re-sprouting ability, therefore cut trees normally die [15].

Shackleton (1997) [207]– 50% of trees 60cm circumference (59years) had fruit

– 100% of trees 80cm circumference (78years) had fruit [15].

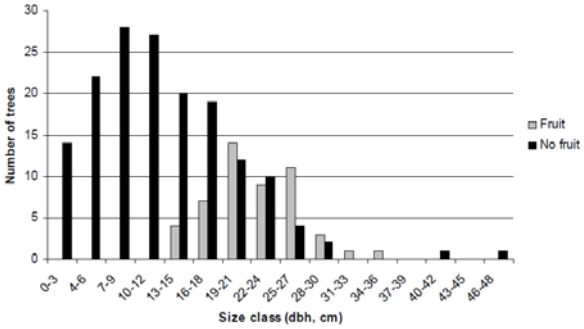


Figure 38 - Size Class Distribution of Fruiting Trees vs Non Fruiting Trees

PTEROCARPUS ERINACEUS – this species comes in two forms; 1. Low branching spreading form, associated with drier climate 2. Large tree specimens with straight trunks, associated with more favourable and wet conditions [211]

Maturity Age	Height (m)	Diameter (cm)	Rotational Length	Life Expectancy	Flowering Season	Fruiting Season
	12-15m [212, 11, 211]	1.2–1.8 m. [211]			December–February [40]	

Habitat Type

This species is found across semi-arid and sub-humid Africa, mainly in open forest and wood savannahs that have moderate to long dry seasons up to 9 months. It can tolerate a range of climatic and soil conditions [40, 212, 11]

Soil Requirements
- Can thrive even on shallow soils [40]
- Main soils in Burkina Faso - Luvisols, lixisols and leptosols [213]

Altitude Range: 0-600m [40]

Rainfall Range: 600-1200 mm [211]
Burkina Faso Study – 750-900mm [213]

Temperature Range: 15-32°C, can tolerate up to 40°C [211]

Survival Strategy

This species appeared to suffer during early development due to fire and drought, however, survivability and consequently growth rates appear to recover after the first 10 years when the tap root system can cope with drought and fire better [214].However, drought was found to have a low relative importance on actual seedling mortality for planted seedlings, of 20% and 30% for 3 month and 9 month olds respectively [215]. This same study found that herbivore browsing was the main cause of seedling mortality for watered seedlings that didn't lose their leaves as quickly [215]
Seedlings survival rates are higher when they are protected from livestock or wild ungulates [212]

Reproduction/survival strategy and germination/regeneration potential

Seed Production
Average 1000 seed weight(g): 135.56 (Duvall 2008)

Seed Germination Rate
Duvall (2008) states that germination rates of untreated seeds is approximately 50% (although no direct reference is provided). Different treatment methods including soaking in water or sulphuric acid, raising and lowering the temperature and exposing to different light levels. Germination rates under these different treatments has ranged from 70-100% [212]. However, how these rates compare to wild populations is unknown.

Regeneration potential
The regeneration potential has been stated as being "often abundant" in the CoP17 proposal, based on Duvall (2008). Studies in Burkina Faso, confirmed the assumption of high regeneration potential, as they found a high density of seedlings in the protected area of W National Park. However, this potential was not realized, as there was no correspondingly high density of saplings, indicating that recruitment was still low [213].

This appears to be common throughout areas where population status assessments have been conducted, refer to Population Structure and Status Section. Most populations showed little to no recruitment occurring, even in protected areas where it is usually expected that recruitment and therefore regeneration potential would be high due to the presence of larger reproductive trees. In fact, recruitment was often worse in protected areas, than non-protected areas, which has been attributed to over-browsing or trampling by the abundant ungulate populations in protected areas .

Growth rates and heartwood development information

Growth Rates
A study conducted across 5 protected areas in South Senegal from 2002 – 2004 estimated the growth rates, as shown in Table 41. The growth rings showed alternating bands, that got slightly smaller towards the end of the growing season, they also showed increasing biomass production as the tree aged, refer to Table 41.

Table 41 - Growth Rates of *P. erinaceus* in South Senegal (n=3) [Adapted from Table 3 and 4 of [214]]

Tree Age	mean annual D increment	mean annual biomass increment
0-10 years	0.40cm	0.51kg
0-20 years	0.58cm	2.75kg
0-end of life*	0.60cm	3.71kg

*mean end age = 22
Duvall (2008) states the following (but does not explicitly state which references the information comes from):
- **Mali:** After 1 year – seedlings only 15cm; 2 years up to 42cm, however, up to 100cm after 2 years has been reported under better conditions
- **Côte d'Ivoire:** planted seedlings H_{ave} = 9cm (3 months); 50cm (18 months); 2.8m (2.5 years). H = 10m (5.5 years) for fastest growing

Ecological Role/Significance

As for all *Pterocarpus* species, bar a few, this species develops nitrogen fixing bacteria nodules in their root systems. The nitrogen fixing potential of this species is much lower than other species in this genera, such as *P. lucens* [212]

PTEROCARPUS LUCENS – This species comes in two forms; a low-branching deciduous shrub to a full tree [216, 217]. This species is distributed in two bands across Africa, and as such, has two subspecies, *lucens* and *antunesii* (discussed in Taxonomy section) [177, 17]

Maturity Age	Height (m)	Diameter (cm)	Rotational Length	Life Expectancy	Flowering Season	Fruiting Season
	18 m [216] 8-18 m [217]	80cm [216]			General [217, 216]	
					November - December	January - May
					Sahelian area of Burkina Faso [218]	
					Late June to August	Lasts 6-7 months – Aug to early March
					Senegal	
						Begins in November [219]

Habitat Type

Found across semi-arid regions in tropical Africa, in wooded grasslands, savannahs, low altitude woodlands and on rocky hills [177]

In Burkina Faso, found to be the dominant species in Tiger Bush pastures [218]

In Senegal, "*P. lucens bushland is mainly found only valley slopes between the northern and southern plateaus"* [220]

Soil Requirements: [177]
- deep sandy soils
- stony, gravely
- lateritic i.e. rich in iron and aluminum
- listed as moderate sensitivity *to shallow soil on petroferric outcrops* with 9.5% of individuals found in such habitat [199]

Altitude Range: 550m to 1520 [177]
Sub species – *antunesii* - Up top 1000m [221]

Rainfall range: 200-800 mm/yr – In Senegal [220]

Reproduction/survival strategy and germination potential and regeneration potential

Seed production [217]
Each seed pod contains 1 or 2 seeds.
Approximately 5000 seeds per kg

Germination Rate [217]
In silvicultured stands, seeds achieved 80% germination under set conditions, and 100% under different conditions which are no natural.
Seeds did not germinate below 15°C

Survivability
Ratio of mortality = 0.22 ; 30% on shallow soils [199]
High mortality of this species occurs in areas with "weak hydric balance such as upland and open shrubby-savannas" whereas areas where water is retained more readily such as dense savannas and depressions, this species has higher survivability. [222]

Field observations in Burkina Faso [222] found this species has a versatile morphology dependent on habitat type:
- Hills/coarse soils: pruned phenotype with small/multi-stemmed individuals and poor vitality
- Depressions/near water with well drained and sandy soils – taller, larger diameter single stemmed individuals that were thriving

Growth rates and heartwood development information

None available

Ecological Significance

This species is known as a "nitrogen fixing" species, where nodules are formed in the root system to help capture and store nitrogen from the soil to help the plant survive, particularly in low nutrient soil [219]. In fact, nitrogen fixing "nodules" have been found on all species of *Pterocarpus*, except those found in Brazil. [201]

As such, this species can play a role in soil fertility and dune improvement in degraded habitats [219].

Closely Related Species

This species was recently studied using molecular techniques to study the evolutionary relationships of the *Pterocarpus* genera. It showed this species is most closely related to *P. brenanii* and *P. rotundifolius*, also southern African species [216]

Flowering/Fruiting Behaviour

- Flowering only lasts a few days [217]
- Wind dispersed fruits remain on tree for long time after maturity [216]
- Pollinated by bees that are attracted to yellow flowers [216]
- Wind dispersal occurs during rainy season [216]
- Fruits were only observed on trees > 3m in height in Burkina Faso [218]

PTEROCARPUS SOYAUXII – perennial plant, however can sometimes be found in deciduous forests [223]

Maturity Age	Height	Bole Length	Diameter	Rotational Length	Life Expectancy	Flowering Season	Fruiting Season
	9-16.8 m [224]; 30-40 m [225]; Up to 55 m [226, 227]	20-30 m [226, 225]	140-200 cm [227, 226]			Cameroon	
						wet and dry season [223]	

Habitat Type

Soil Requirements
- The distribution of this species was not found to be associated with any particular soil chemicals [225]
- Prefers deep and well-drained soil [227]

Altitude Range: SL – 500m [227]

Rainfall Range: 150-170 cm [227]

- Light demanding

Reproduction/survival strategy and germination/regeneration potential

Seed Germination Rate
Seeds will germinate in the shade but seedlings are light demanding, requiring abundant light to recruit adequately [225]

From silviculture experiments:
Congo – germination within 3 days with 92% germinating within 30 days
Nigeria – treated fruits/seeds germinated within 7 days

Survival Strategy
Stump regrowth is weak [80]

Seeding/Fruiting Behaviour
Seeds are flat, circular (diameter about 1.5 - 2 cm) and papery (0.1 g). [228]
P. soyauxii seeds are wind dispersed [225, 229], and also by animals [226]
Flowers are bi-sexual [226]

Gabon – Lope Reserve

December – February	January - April

Growth rates and heartwood development information

Growth Rates [226]
In Nigerian plantations – annual increment of wood estimated = $40m^2$
Côte d'Ivoire trial plantations – annual height growth for first 7 years = 1.6 – 2.7m (from 1964 & 68)
– annual diameter growth = 2.5cm at 17 years old
– mean annual volume growth was 20-30 m^3/ha

Seedling growth rates were improved in silviculture experiments when the soil was treated with appropriate fungi

Ecological Significance/Role

- Nitrogen fixing
- Suspected to have "antiplasmodial" bioactivity[27], interpreted from phylogenetic analysis of the *Pterocarpus* genus showing all species with medicinal uses to fight malaria are contained within the same clade. [230]

Structural Properties of Wood [226]

Density Range – Average between 675-815 kg/m^3 at 12% moisture (upper and lower limits of 650 and 900) – therefore do not float in water

At 12% moisture content:
Modulus of rupture = 101-218 N/mm^2
Modulus of elasticity = 10800-15900 Nmm^2
Compression parallel to grain = 54-79 N/mm^2
Shear force = 7-8 N/mm^2
Cleavage = 11-18 N/mm
Janka side hardness = 6850-8320 N

27 Properties that counter parasites of the genus plasmodium, which contain protozoans which can cause malaria

DISTRIBUTION AND RANGES

It appears to be generally accepted that the ranges and distributions of many of these species have become reduced and fragmented due to heavy deforestation and targeting for selective felling throughout much of their historical ranges. However, there has been little scientific research to understand the current distribution and ranges of most of these species in Africa. Most of the information available for African species is from IUCN Red List Assessments that were carried out almost 20 years ago. Particularly for Madagascan species, the distribution and range reductions can be inferred from the overall loss of forest cover. In other parts of Africa, particularly West Africa, logging intensity has increased in recent years as well.

Table 42 and Table 43 detail the known historical distributions of the species of interest across mainland Africa and Madagascar respectively. Where possible, habitat reduction specific to the species in question is provided, otherwise overall habitat reduction is provided to give a sense of the potential current ranges and distributions. In the absence of detailed field surveys, it can only be inferred what the actual ranges are of these species at present.

Table 42 - Historical Distribution and Habitat Reduction on Mainland Africa. This table outlines the species distribution in each range country, and the habitat or range reduction that has occurred.

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
ANGOLA		
Dalbergia melanoxylon	Cuando to Cubango [200]. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	In 2000, % tree cover = 44%. The country experienced an acceleration of tree cover loss between 2003-2011 from 52 000 ha/year to 180 000 ha/year, where it has remained stable until 2014 [8]. As at November 2015, Angola was considered to have 59 Mha of forest cover, and a deforestation rate of -0.2% [231]. While 53 Mha is classified as forest, only 2% of this is considered to be high productivity forest [231].
Pterocarpus angolensis	Species recorded here [17, 232, 105].	
Pterocarpus lucens	Species recorded here [177, 217]. Subspecies *P. lucens antunesii* recorded in Southern Angola [221, 217].	
Pterocarpus soyauxii	Species recorded here [17]	
Pterocarpus tinctorius	Species recorded here [202, 17]	
BENIN		
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	In 2000, this country had 169 kha of 30% tree canopy cover – equivalent to 1% of land mass. From 2000-2014; 31 382 ha of tree cover was lost [8].
BOTSWANA		
Dalbergia melanoxylon	Species recorded here [233]. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	81% landcover classes as "significant tree and shrub cover", however, only 20% considered forest. Forest cover reduced by 17.3% between 1990-2010 [231]. In 2000, tree cover was estimated at 20 kha, and tree cover loss between 2001-2014 was 500 ha(total) [8].
Pterocarpus lucens	Subspecies *P. lucens antunesii* recorded here [221]	
Pterocarpus angolensis	Species recorded here [17, 232, 105].	
BURKINA FASO		
Dalbergia melanoxylon	Species recorded here [233]. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	In 2000, there was only 132 ha of 30% tree canopy cover left, between 2001-2014 tree canopy cover loss was 131 ha [8]. In 2010, the reforestation rate was 14 000 ha/year.
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	
BURUNDI		
Pterocarpus tinctorius	Species recorded here [202, 234]	In 2000, 22% of country had 30% tree canopy coverage, equivalent to 538 kha. From 2001-2014, 17 119 ha of tree cover was lost [8].
CAMEROON		
Pterocarpus lucens	Species recorded here [177, 217]. Subspecies *P. lucens antunesii* recorded in Southern Angola [221, 217, 17].	In 2000, 31 Mha was considered to have 30% canopy tree cover (or 68% of the country). From 2001-2014 a total if 657 057 ha of this was lost, however approximately 200 000 of this occurred in 2013/14 alone [8]. Annual deforestation rate from 2010-15 was just over 1% [235]
Dalbergia melanoxylon	Species recorded here [233]. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique [77].	
Pterocarpus soyauxii	Species recorded here [80]. Considered to be unevenly distributed at low densities [236]. Discussed as occurring in Mount Cameroon region [236]	This species is said to have a limited distribution in 1998, scarcely found in forests, due to past selective exploitation [236].
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	(see above)
CENTRAL AFRICAN REPUBLIC		

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
Dalbergia melanoxylon	Species recorded here [233]. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	In 2000, 76% of country had 30% tree canopy cover, equivalent to 47 Mha [8]. From 2001-2014, 546 920 ha of this was lost.
Pterocarpus erinaceus	Species recorded here [17], but not recorded on CoP17 proposal as a range state [40].	
Pterocarpus soyauxii	Species recorded here [17]	
CHAD		
Dalbergia melanoxylon	Species recorded here [233]. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	In 2000, 0% of country had 30% tree canopy cover, equivalent to 410 kha [8]. From 2001-2014, 21 047 ha of this was lost.
Pterocarpus erinaceus	Species recorded here [17], but not recorded on CoP17 proposal as a range state [40].	
Pterocarpus lucens	Species recorded here in 2012 IUCN Red List Assessment [177].	
CONGO		
Pterocarpus soyauxii	Species recorded here [17]	In 2000, 78% of country had 30% tree canopy cover, equivalent to 26 Mha [8]. From 2001-2014, 409 526 ha of this was lost. Annual forest loss rate of 0.1% at 15700 ha per year from 1990-2015 [237]
5Pterocarpus lucens	Species recorded here in 2012 IUCN Red List Assessment [177].	
Pterocarpus angolensis	Species recorded here [232]	
Pterocarpus tinctorius	Species recorded here [17]	
CÓTÉ D'IVOIRE		
Dalbergia melanoxylon	Species recorded here [233]. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	In 2000, 47% of country had 30% tree canopy cover, equivalent to 15 Mha. From 2001-2014, 1 650 236 ha of this was lost [8]. In 2014 alone over 260 000 ha was lost.
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	
DEMOCRATIC REPUBLIC OF CONGO		
Dalbergia melanoxylon	Species recorded here [233]. Recorded in Kasai, Lake Albert and Haut-Katanga [200], formerly known as Zaire. Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	In 2000, 87% of country had 30% tree canopy cover, equivalent to 199 Mha. From 2001-2014, 7 977 009 ha of this was lost [8]. Annual forest loss rate of 0.2% at 311 400 ha per year from 1990-2015 [237], however, in 2014 alone over 1.1 million ha was lost [8].
Pterocarpus angolensis	Species recorded here [17, 232, 105].	
Pterocarpus lucens	Species recorded here in 2012 IUCN Red List Assessment [177].	
Pterocarpus soyauxii	Species recorded here [17, 80]	
Pterocarpus tinctorius	Species recorded here [202, 234, 17]	
EQUITORIAL GUINEA		
Pterocarpus soyauxii	Species recorded here, found in Nsork rain forest [17, 238]	In 2000, 99% of country had 30% tree canopy cover, equivalent to 3 Mha. From 2001-2014, 67 303 ha of this was lost, with the annual lost in 2014 more than double any previous year [8]. From 1990-2015 annual forest loss rate was 0.7% at 11 700 ha per year [237]
ERITREA		
Dalbergia melanoxylon	Recorded in Eritrea West [200]	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]. In 2000, 4% of country had 30% tree canopy cover, equivalent to 4 Mha [8]. Annual forest loss rate of 0.3% at 4400 ha per year from 1990-2015 [237]
ETHIOPIA		
Dalbergia melanoxylon	Recorded in Tigray Highlands (Dogu'a Tembien district in Northern Ethiopia) and Gondar (Begemdir) near Sudan border [200, 233]	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
Pterocarpus lucens	Species recorded here [217, 177] Subspecies *P. lucens antunesii* recorded to occur here. [221, 17, 217]	In 2000, 11% of country had 30% tree canopy cover, equivalent to 12 Mha. From 2001-2014, 295 611 ha of this was lost [8]. Annual forest loss rate of 0.8% at 104 600 ha per year from 1990-2015 [237]
GABON		
Pterocarpus soyauxii	Species recorded here [17, 80]	In 2000, 94% of country had 30% tree canopy cover, equivalent to 25 Mha. From 2001-2014, 277 413 ha of this was lost [8]. Prior to 2013, annual forest loss was lass than 20 kha, however in 2013-14, the rate was in excess of 40 kha. [8].

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
GAMBIA (THE)		
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	In 2000, 0% of country had 30% tree canopy cover, equivalent to 5 kha. From 2001-2014, 621 ha of this was lost [8].
GHANA		
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40]. Found in Ashanti, Brongahafo, Northern, Upper East, Upper West and Volta regions [11]. Mostly distributed in the forest savannah transitional zone and parts of the northern savannah woodland ecological zone. [11].	In 2000, 30% of country had 30% tree canopy cover, equivalent to 7 Mha. From 2001-2014, 616 484 ha of this was lost [8]. In 2010, the reforestation rate was 20 000 ha/year [8].
Pterocarpus lucens	Species recorded here in 2012 IUCN Red List Assessment [177]	
GUINEA		
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	In 2000, 33% of country had 30% tree canopy cover, equivalent to 8 Mha. From 2001-2014, 483 224 ha of this was lost [8]. From 2001-2012, annual loss was not greater than 33 kha, however, in 2013 this rate jumped to over 146 183 ha [8]
Pterocarpus lucens	Species recorded here in 2012 IUCN Red List Assessment [177] Subspecies *P. lucens lucens recorded here* [221, 216]	
GUINEA-BISSAU		
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	In 2000, 32% of country had 30% tree canopy cover, equivalent to 1 Mha. From 2001-2014, 79 882 ha of this was lost, with over 20 kha alone lost in 2013 [8].
Pterocarpus lucens	??? Red list Assessment states "distributed in two bands across tropical Africa from Senegal to Ethiopia", which takes in this country, but it is never directly referred to as occurring here [177]	
KENYA		
Dalbergia melanoxylon	Formerly widespread and scattered in low altitude savannas and woodlands below 1300m [200], used extensively in commercial extraction, however, only remnant trees remain in this country now [77, 233].	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]. In 2000, 6% of country had 30% tree canopy cover, equivalent to 3 Mha. From 2001-2014, 250 306 ha of this was lost, with a reforestation rate in 2010 of 5.4 kha [8].
LIBERIA		
Pterocarpus erinaceus	Species recorded here [17], but not recorded on CoP17 proposal as a range state [40].	In 2000, 98% of country had 30% tree canopy cover, equivalent to 9 Mha. From 2001-2014, 711 476 ha of this was lost [8]. Annual forest loss of over 141 kha in 2013 and 105 kha in 2014 [8].
MALAWI		
Dalbergia melanoxylon	Formerly widely distributed, commonly found in clay soils in lowland areas [77, 233].	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
Pterocarpus angolensis	Species recorded here [17, 232, 105].	In 2000, 16% of country had 30% tree canopy cover, equivalent to 2 Mha. From 2001-2014, 106 593 ha of this was lost, with a reforestation rate in 2010 of 3000 ha [8].
Pterocarpus lucens	Subspecies *P. antunesii* recorded here [221]	
Pterocarpus tinctorius	Species recorded here [17]	
MALI		
Dalbergia melanoxylon	This species has been recorded in the north eastern part of Sudano-Sahel zone. Specifically known to occur in the Nara demonstration site - which covered 3100 km^2 in the semi-arid zone ecosystem [233].	A 1998 project proposal by the United Nations Development Program [169], stated that this species was "threatened, disappearing or recently disappeared" from the Nara demonstration site in Mali.
Pterocarpus lucens	Species recorded here as subspecies *P. lucens lucens* [217] and the Red list Assessment states "distributed in two bands across tropical Africa from Senegal to Ethiopia", which takes in this country [177]. This species has been recorded in the north eastern part of Sudano-Sahel zone. Specifically known to occur in the Nara demonstration site - which covered 3100 km^2 in the semi-arid zone ecosystem [233].	A 1998 project proposal by the United Nations Development Program [169], stated that this species was "threatened, disappearing or recently disappeared" from the Nara demonstration site in Mali.
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	In 2000, 0% of country had 30% tree canopy cover, equivalent to 25 kha. From 2001-2014, 2209 ha of this was lost, with a reforestation rate in 2010 of 67 000 ha [8].

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
MOZAMBIQUE		
Dalbergia melanoxylon	Formerly widespread from Rio Savo to the north, on coastal plains to upland areas [200]. This species grows in the Miombo woodland. Range is now limited [77] [233]	In 2000, 37% of country had 30% tree canopy cover, equivalent to 29 Mha. From 2001-2014, 2 048 678 ha of this was lost [8].
Pterocarpus lucens	Species recorded here [177, 17]. Subspecies *P. antunesii* recorded here [221, 217]	
Pterocarpus tinctorius	Species recorded here [202, 17]	
Pterocarpus angolensis	Species recorded here [17, 232].	
NAMIBIA		
Dalbergia melanoxylon	Caprivi Strip [233] [233]	In 2000, 0% of country had 30% tree canopy cover, equivalent to 4 kha. From 2001-2014, 1210 ha of this was lost [8].
Pterocarpus angolensis	Species recorded here [17, 232, 105].	
Pterocarpus lucens	Species recorded here [177, 17]. Subspecies *P. antunesii* recorded here [221, 216]	
NIGER		
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	In 2000, 2% of country had 30% tree canopy cover, equivalent to 2ha. From 2001-2014, 1 ha of this was lost [8].
Pterocarpus lucens	Red list Assessment states "distributed in two bands across tropical Africa from Senegal to Ethiopia", which takes in this country. [177] Subspecies *P. lucens lucens* recorded in Southern Angola [221, 217]	
NIGERIA		
Dalbergia melanoxylon	Occurs mainly in the north, from Kano, Bauchi, Bornu and Adamawa [200]. [233] Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]	Between 1990 and 2000, Nigeria lost about 2.7% of its natural forests to deforestation [239]. In 2000, 11% of country had 30% tree canopy cover, equivalent to 10 Mha. From 2001-2014, 439 032 ha of this was lost [8]. A cumulative 47.5% of Nigeria's natural forests were lost to deforestation between 1990 and 2010 [239]
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	
Pterocarpus lucens	Species recorded here [177, 17]. Subspecies *P. lucens lucens* recorded in here [221, 217]	
Pterocarpus soyauxii	Species recorded here [17, 80]	
RWANDA		
Pterocarpus tinctorius	Species recorded here [202, 234]	In 2000, 21% of country had 30% tree canopy cover, equivalent to 497 kha. From 2001-2014, 19 357 ha of this was lost [8].
SIERRA LEONE		
Pterocarpus erinaceus	Species recorded here [17], but not recorded on CoP17 proposal as a range state [40].	In 2000, 78% of country had 30% tree canopy cover, equivalent to 6 Mha. From 2001-2014, 498 424 ha of this was lost [8]. From 2001-2012, the annual rate of forest loss was less than 35 000 ha, however, in 2013, this jumped to over 170 000, remaining at 113 000 in 2014 [8].
SENEGAL		
Dalbergia melanoxylon	Species recoded here [233]	Annual destruction of dry savannah was estimated at nearly 100 000 ha in a 2001 FAO assessment [240], with these two species being listed as among the most vulnerable. In 2000, 0% of country had 30% tree canopy cover, equivalent to 40 kha. From 2001-2014, 2175 ha of this was lost, with a reforestation rate in 2010 of 19 000 ha [8].
Pterocarpus lucens	Species recorded here [177, 17]. Subspecies *P. lucens lucens* recorded in here [221, 217]. Populations of *P. lucens* occupy a dominant part of ecosystems in the natural semi-arid lowland of Ferlo [219].	
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	
SOUTH AFRICA		
Dalbergia melanoxylon	Limpopo Province, Mpumalanga [233]	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
Pterocarpus angolensis	KwaZulu-Natal, Mpumalanga, Northern Provinces [232, 105]	In 2000, 5% of country had 30% tree canopy cover, equivalent to 6 Mha. From 2001-2014, 1 027 884 ha of this was lost, with a reforestation rate in 2010 of 50 500 ha [8].
SOUTH SUDAN		
Dalbergia melanoxylon	Species recoded here [233]	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77] In 2000, 18% of country had 30% tree canopy cover, equivalent to 11 Mha. From 2001-2014, 101 812 ha of this was lost [8].

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
SUDAN		
Dalbergia melanoxylon	Recorded from Blue Nile Province, South Kordofan province & South Darfur provinces northwards to Jebel Marra. Occurs in patches along the savanna belt [200].	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
Pterocarpus lucens	Red list Assessment states "distributed in two bands across tropical Africa from Senegal to Ethiopia", which takes in this country [177] Subspecies *P. lucens lucens* recorded here [221, 217]	In 2000, 0% of country had 30% tree canopy cover, equivalent to 74 kha. From 2001-2014, 838 ha of this was lost [8].
SWAZILAND		
Pterocarpus angolensis	Species recorded here [232, 105].	In 2000, 27% of country had 30% tree canopy cover, equivalent to 467 kha. From 2001-2014, 76 708 ha of this was lost [8].
TANZANIA		
Pterocarpus angolensis	As at 1995 - Widespread throughout the woodland in the coastal plan; in savannah woodlands and grasslands in Kilwa, Lindi, Morogoro and Tabora (RSCU 1992); in Miombo savannah and in Miombo dry forests as scattered trees. It is found in the north to Lake Victoria (Borota 1975) [198, 17, 105]. Recorded here in the 1998 IUCN Red List Assessment also [232].	In 2000, 30% of country had 30% tree canopy cover, equivalent to 26 Mha. From 2001-2014, 1 699 305 ha of this was lost, with a reforestation rate of 27 000 in 2010 [8].
Pterocarpus tinctorius	Species recorded here [202, 17]	
Dalbergia melanoxylon	Formerly widespread across most of sub-Sahara Africa, this species grows in the miombo woodland, mainly in south-east region now. [77] It is found in low altitude savannahs near Morogoro and Itigi, all the way to the coast [196] [233]	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
TOGO		
Pterocarpus erinaceus	CoP17 Listing Proposal lists this as a range state [40].	In 2000, 10% of country had 30% tree canopy cover, equivalent to 559 kha. From 2001-2014, 31 754 ha of this was lost [8]. Other references estimated forest cover to only be 449 000 ha in 1970, which decreased to 287 000 ha by 1980, and 140 000 ha by 1990, which made up only 5% of the land surface [211]
UGANDA		
Dalbergia melanoxylon	Species recoded here [233]. Recorded in Bunyoro, West Nile, Madi, Acholi, Karamoja and Mbale Districts, restricted to low elevation locations <1000m [200].	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
Pterocarpus lucens	Species recorded here [177, 17]. Subspecies *P. lucens lucens* recorded in here [217]	In 2000, 99% of country had 30% tree canopy cover, equivalent to 3 Mha. From 2001-2014, 15 181 ha of this was lost [8]. Annual forest loss rate of 0.7% at 11 700 ha per year from 1990-2015 [237]
ZAMBIA		
Dalbergia melanoxylon	Species recoded here [233]. Recorded in south and east parts – Western, Southern and Eastern Provinces, southern half of Central Province and parts of Mpika, Chinsali and Isoka districts [200].	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
Pterocarpus angolensis	Species recorded here [17, 232, 105].	In 2000, 33% of country had 30% tree canopy cover, equivalent to 24 Mha. From 2001-2014, 1 025 306 ha of this was lost, with the highest annual rate in 2010 o 174 000 ha [8].
Pterocarpus lucens	Red list Assessment states "distributed in two bands across tropical Africa from Senegal to Ethiopia", which takes in this country [177] Subspecies *P. lucens antunesii* recorded here [221]	
Pterocarpus tinctorius	Species recorded here [202, 17]	
ZIMBABWE		
Dalbergia melanoxylon	Species recorded here [233] and considered widespread and common in 1994 [200].	Jenkins (2012) states that only remnant trees exist outside of Tanzania and Mozambique. [77]
Pterocarpus angolensis	Species recorded here [17, 232, 105].	In 2000, 4% of country had 30% tree canopy cover, equivalent to 1 Mha. From 2001-2014, 140 022 ha of this was lost, with a reforestation rate in 2010 of 6000 ha [8].
Pterocarpus lucens	Red list Assessment states "distributed in two bands across tropical Africa from Senegal to Ethiopia", which takes in this country [177]	

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
	Subspecies *P. lucens antunesii* recorded here and known to occur in Lower Guruve District [221, 241]	

As there have been no recent scientific investigations on the actual distributions of the above species. In an attempt to overcome this limitation, Global Eye conducted a Geographic Information System (GIS) mapping exercise using known localities and bioclimatic parameters to predict possible range extent, overlaid with known forest loss data up to 2014 (see Annex A for further details on the methods used). This allows for a justifiable prediction of the current possible distributions for the selected African rosewood. Figure 39 - Figure 42 show the maps for *P. erinaceus*, *P. lucens, D. melanoxylon and P. tinctorius* using this method. For *P. soyauxii* we also overlaid current forest reserves that are considered "intact", to show the likely areas that still have suitable forest (Figure 43). Figure 43 clearly shows the extent to which habitat has been reduced for this species. This was not able to be completed for all mainland African species, as we could not source not sufficient GIS data layers for much of West and Central Africa showing intact forests.

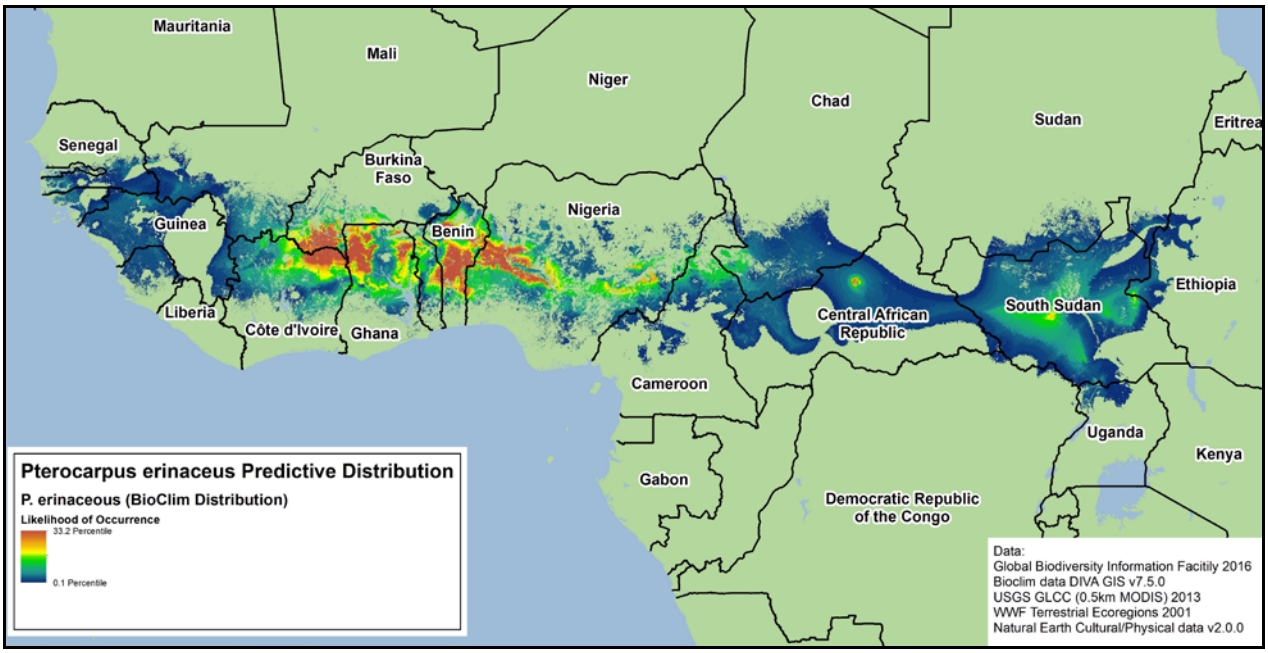


Figure 39 - *Pterocarpus erinaceus* Predicted Suitable Habitat Range. Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

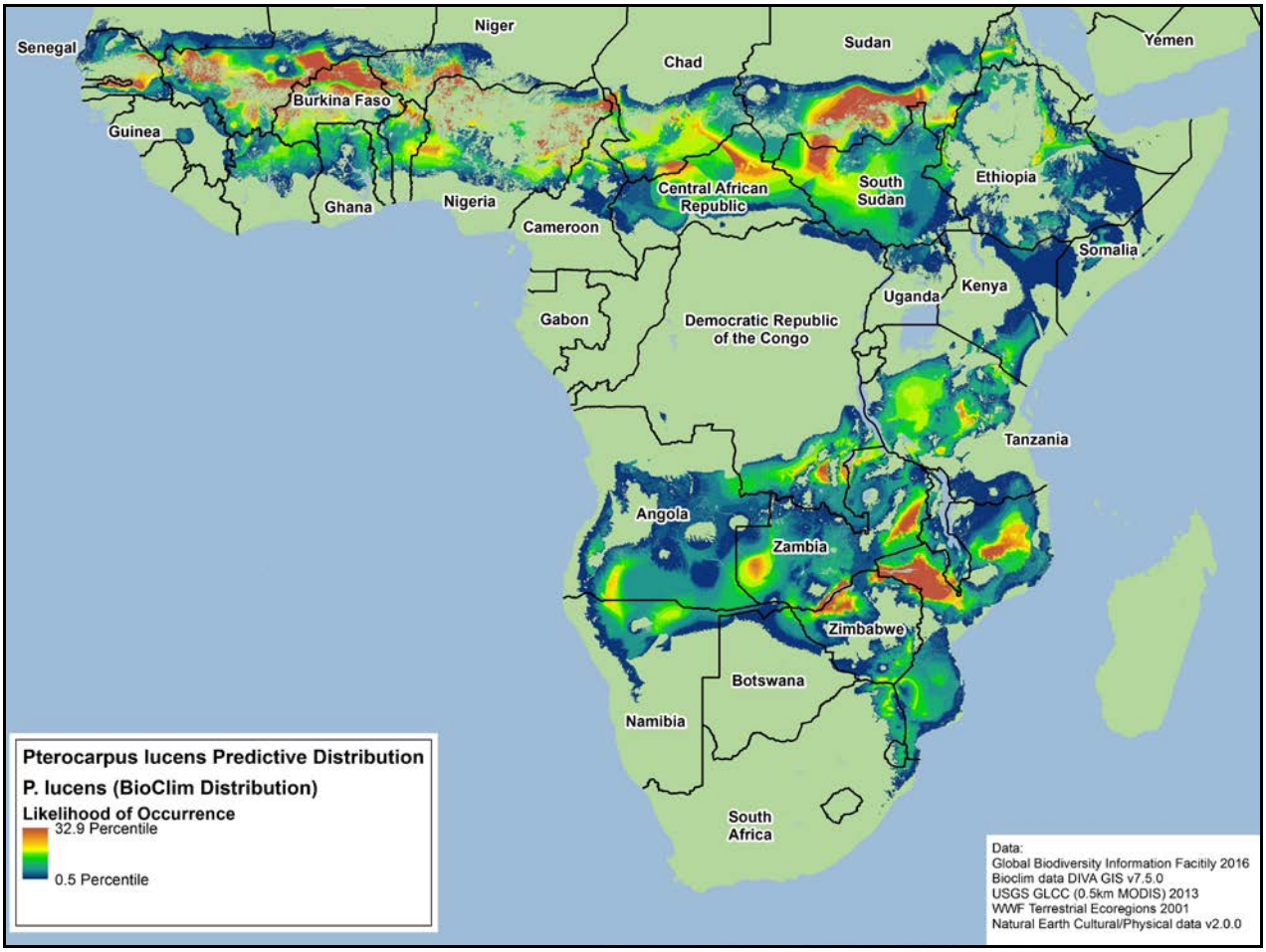


Figure 40 - *Pterocarpus lucens* Predicted Suitable Habitat Range. Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

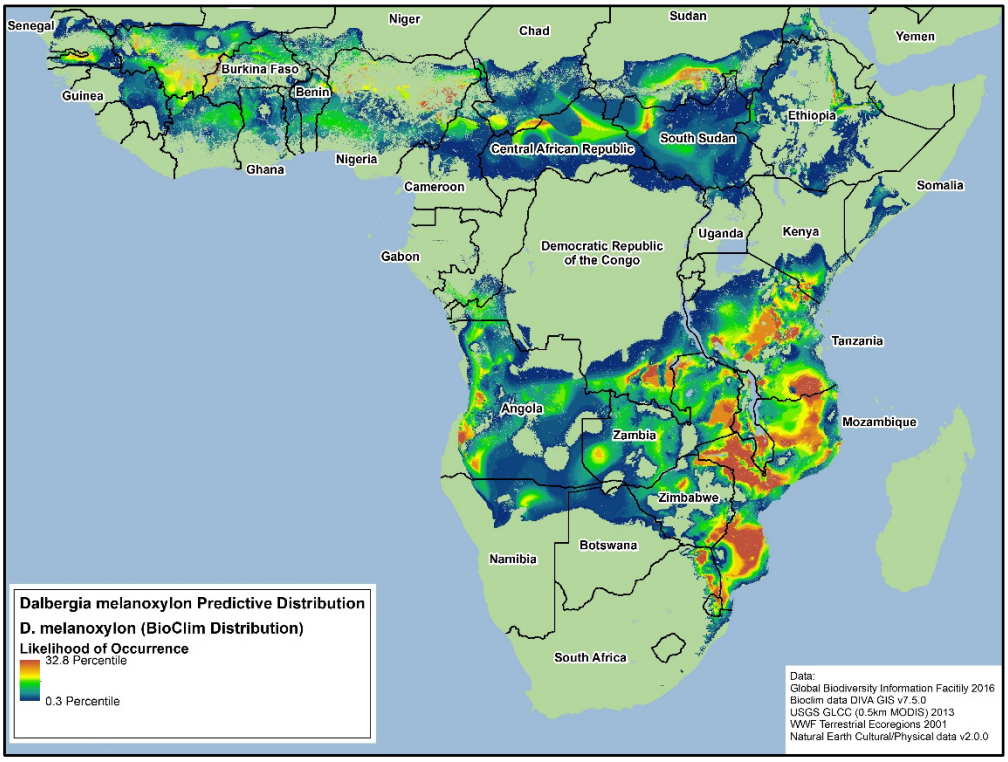


Figure 41 – *Dalbergia melanoxylon* Predicted Suitable Habitat Range. Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

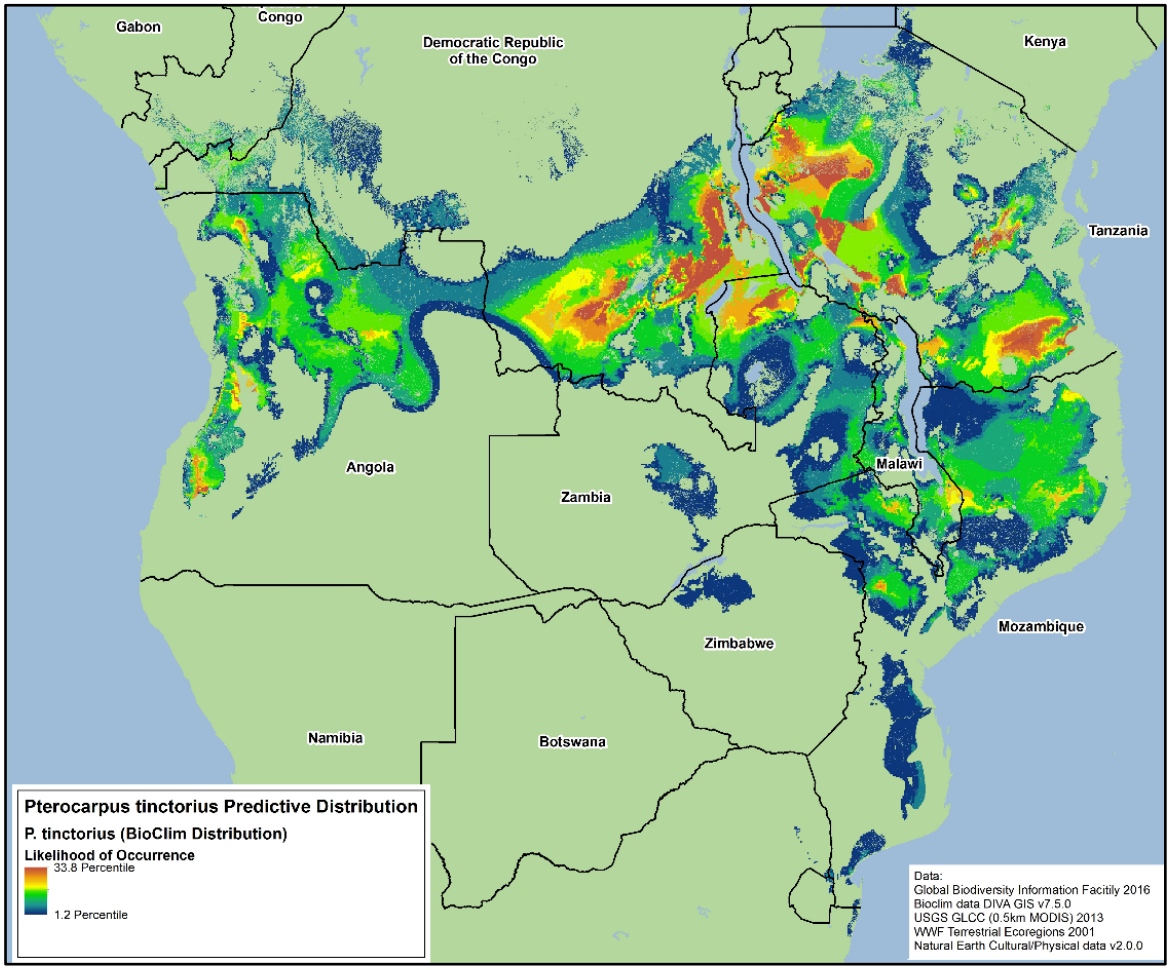


Figure 42 – *Pterocarpus tinctorius* Predicted Suitable Habitat Range. Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

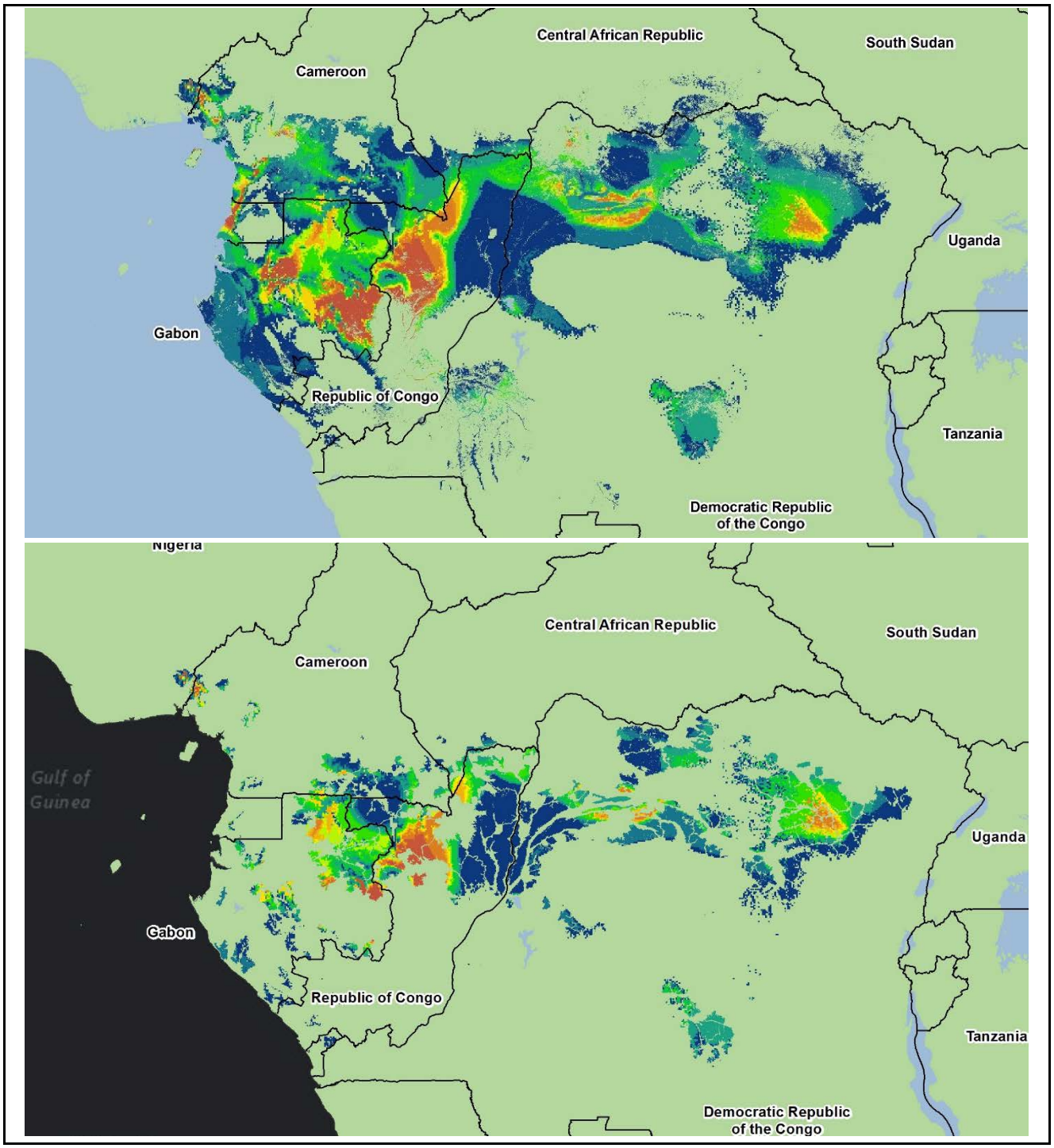
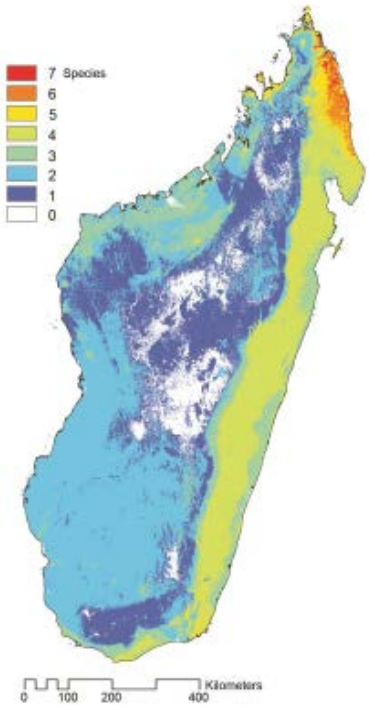
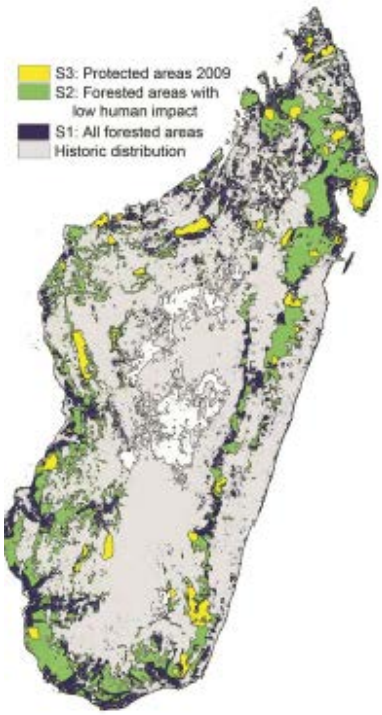


Figure 43 - *Pterocarpus soyauxii* (Top) Predicted Suitable Habitat Range (BioClim). (Bottom) Suitable habitat contained within "in tact forests". Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

As for mainland Africa, there has been little scientific effort expended to understand fully the ranges and distributions of many of the species in Madagascar. However, unlike most of the mainland African species, Madagascan rosewood and palisander species have been highly sought after internationally, and have therefore been the subject of some scientific work in recent years to quantify the magnitude of the known range reductions that have resulted from excessive exploitation over the past 5-7 years [242, 180]. In 2010, the CITES Scientific Authority for Flora of Madagascar published a paper [180] outlining their understanding of the current distributions, and specific locations where particular rosewood/palisander species were still considered to be found, and were observed. There is limited information in the document about how these species were correctly identified in the field. It is presumed that surveying was conducted when species were flowering or fruiting, but this was not able to be confirmed from the report. Table 43 and Figure 46 provide details on where the species were surveyed and their current expected habitats. A GIS mapping exercise has also been completed previously by Barrett et al (2010) [242] (Figure 47). We did not repeat this exercise for other Madagascan species due to time constraints.

Table 43 - Historical Distribution and Habitat Reduction on Madagascar. This table outlines the species distribution, and the habitat or range reduction that has occurred across the island

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
	MADAGASCAR	
Dalbergia spp (general)	Barrett et al (2010) [242] estimated the historical distribution of several rosewood species[28] using known locations and bioclimatic modelling, as shown in Figure 44.  **Figure 44 - Historical Distributions of 10 Commercially Important *Dalbergia* spp. (Taken from Barrett et al (2010) [242])**	Barrett et al (2010) [242] also predicted the possible current range and distribution of 10 commercially important *Dalbergia* species, using forest loss data. The overall picture for range reductions is shown in Figure 45, which each individual species is discussed below.  **Figure 45 - Possible Distributions based on Different Scenarios. S1: All forested areas, S2: Forested areas with low human impact, S3: Protected areas 2009 (Taken from Barrett et al (2010) [242])** It has been anecdotally stated that rosewood only occurs in protected areas, which account for approximately 3% of land mass on Madagascar [242]. Madagascar has seen large scale loss of habitats, particularly since 2009 following government instability [18]. Humid forest cover is estimated to have reduced by 33% since the 70s [173] and approximately 100 000 rosewood/ebony trees and 500 000 other "collateral" trees[29] were removed from protected areas of Marojejy National Park and Masoala National Park in 2009 alone [243].
Dalbergia abrahamii	In 1998, known from only 2 locations: [181] - Autsiranana and Ankarana Massif Range was found to be decreasing and populations were becoming fragmented. In 2010, stated that it is mainly found in northern Madagascar from the following locations (as shown in Figure 46) [180] :	Extent of Occupancy (EOO) estimated to be = 637 km^2 [244, 245]. Area of occupancy (AOO) estimated to be = 27km^2 [245].

28 Species mapped included *D. baronii, D. bathiei, D. davidii, D. louvelii, D. mollis, D. monticola, D. normandii, D. purpurascens, D. tsiandalana and D. viguieri*

29 Trees removed to aid removal of hardwood species from forest and transport to ports via rivers (i.e. to make rafts)

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
	1. Ankarana National Park; 2. French Mountain (protected area); 3. Andramaimbo [180]. Locations 2 and 3 are both within the Autsiranana region mentioned in the IUCN Red List Assessment.	
Dalbergia baronii	In 1998, IUCN Red List assessment stated it was a widespread species, but confined to lowland plains in Eastern Madagascar [182]. In 2010, said to be found mainly in the eastern coastal areas of dense humid low land forest in: [180] 1. Masoala Protected Area 2. Ranomafana Mananara Protected Area 3. Antongil Bay, Antsohihy 4. Maroantsetra Sonierana Ivongo 5. Ampasimaneva Nosy Varika 6. Ambohimanana 7. Anjanavovona Mananjary Refer to Figure 46 and Figure 47A for current estimated distribution.	In the 1998 assessment, the habitat that this species is found in was said to have been "greatly reduced". It was also estimated in 2012 that humid forest in Madagascar has been reduced by 33% since the 1970s [173]. AOO estimated to be = 45km^2 [245].
Dalbergia bathiei	In 1998, IUCN Red List confined to some small areas of lowland evergreen humid forest, along river margins. Refer to Figure 47B for estimated current distribution. 2011 – Distributed from Toamasina to Mananjary Betampona	It was estimated in 2012 that humid forest in Madagascar has been reduced by 33% since the 1970s [173] EOO estimated to be = 11 965 km^2 [244, 245] AOO estimated to be = 45km^2 [245]
Dalbergia chapelieri	In 2012, IUCN Red List assessment stated it is currently widespread throughout Madagascar's eastern evergreen humid forests, existing in 25 locations from Maroantsetra and the Baie d' Antongil to north of Taolanaro (Fort Dauphin) (Fianarantsoa, Toamasina and Toliara provinces). It was also known to occur in the following protected areas: - Manombo Special Reserve - Analamazaotra-Périnet Reserve - Andohahela National Park - Betampona Reserve, - Midongy du Sud National Park, - Pic d'Ivohibe Reserve and - Ranomafana National Park [173]	The humid forests where this species is found are under increasing pressure from selective logging and deforestation. In 2012, this habitat in Madagascar was estimated to have been reduced by 33% since the 1970s [173].
Dalbergia chlorocarpa	In 1998, IUCN Red List Assessment considered this species to be "fairly widespread" in west Madagascar in lowland, deciduous forests. Known to occur in the following protected areas: [184] - Ankarafantsika Natural Reserve, Namoroka Reserve, Bemaraha Reserve.	This assessment also stated that the primary vegetation in this area has been "extensively destroyed" and is decreasing.
Dalbergia davidii	In 1998, species only known from one location, the protected area - Ankarafantsika Nature Reserve, in north western part of Madagascar [185].	Species has been selectively felled throughout this protected area [185]. EOO estimated to be = <100 km^2 [245] AOO estimated to be = 10km^2 [245]
Dalbergia delphinensis	Found near Taolagnaro in South East Madagascar in lowland ever green humid forests [186].	It was estimated in 2012 that humid forests in Madagascar have been reduced by 33% since the 1970s [173].
Dalbergia greveana	Found in western Madagascar and was considered to be widespread in 1998, despite population numbers having declined over its range [187]. Also found in the following protected areas: - Ankarafantsika Nature Reserve - Ankarana Special Reserve	EOO estimated to be = 423 423 km^2 [244, 245].

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
	In 2010, CITES Scientific Authority of Madagascar (Flora) – DBEV – stated that this species still had a wide distribution on the western side of the island in dense dry forests, and the largest concentrations were observed in the extreme north of Madagascar in Ankarafantsika National Park and in Morondava in the South West region [180]. Refer to Figure 46 for forest locations where this species can be found.	
Dalbergia hildebrandtii	Found in norther and western Madagascar, in lowland dry forests [246]. It has a widespread range but considered uncommon [17].	The habitat is being gradually reduced and fragmented [246].
Dalbergia louvelii	Found in Eastern Madagascar from Maroantsetra in North to Manakara in the south; in lowland humid forests but were severely fragmented in the 1998 IUCN Red List assessment [188, 17]. As of 2010, found only in small areas on east of island, limited to Ambila lemaintso region and Tampolo Fenoarivo Atsinanana. Refer to Figure 46 and Figure 47C for current estimated distribution.	Habitat has been "drastically reduced" as of 1998 [188]. It was estimated in 2012 that humid forest in Madagascar has been reduced by 33% since the 1970s [173] EOO estimated to be = 5358 km^2 [244, 245] AOO estimated to be = 500 km^2 [245]
Dalbergia madagascarensis	North and east Madagascar, in humid evergreen forests [175, 17]. In 2010, stated to be in high concentrations in northern Madagascar, and existing in locations on the east coast. Localities included (refer to Figure 46) [180]: 1. Marojejy Protected Area, 2. Amber Mountain National Park, Diana Region 3. Manongarivo Reserve, Diana Region 4. Lokobe Reserve, NW Madagascar 5. Betampona Reserve, Toamasina Province	It was estimated in 2012 that humid forest in Madagascar has been reduced by 33% since the 1970s [173]. EOO estimated to be = 195 960 km^2 [244, 245]
Dalbergia maritima	Found in lowland humid, coastal forests of Madagascar, however, populations were considered severely fragmented in the 1998 IUCN Red List assessment [189].	The 1998 assessment stated that this type habitat had been almost completely destroyed, leaving highly fragmented and therefore threatened populations remaining. [189].
Dalbergia mollis	In 1998, said to be widely distributed across western Madagascar in fragmented forest [105]. In 2010, stated that it occupies western part of island on dry formation and has high concentrations in NW, near Ankarafantsika National Park. Some populations also exist in the south near Zombitse-Vohibasia National Park and Betioky [180]. Refer to Figure 46 and Figure 47D for current estimated distribution.	Said to occur in regions that were experiencing rapid declines in 1998 [105]. EOO estimated to be = 423 423 km^2 [244, 245].
Dalbergia monticola	In 1998, found by IUCN Red List assessment to have *"extensive distribution along the eastern escarpment of Madagascar, including areas with extensive forest cover."* Also found to exist in protected areas in Perinet/Andasibe, Zahamena and Ranomafana regions [190]. In 2010, stated to be found in the rainforests on the east coast, specifically: [180] 1. Ankeniheny-Zahamena Forest Corridor 2. Fandriana-Marolambo Forest Corridor 3. Anjozorobe National Park 4. Masoala Biosphere Reserve Refer to Figure 46 and Figure 47E for current estimated distribution.	Noted in 1998 Red List assessment that it was already highly targeted for selective logging due to its high quality of timber [190]. In [190]; species said to occur along fragmented patch of forest 1000km X100km from Antalaha to Fianarantsoa. EOO estimated to be = 122 991 km^2 [244, 245] AOO estimated to be = 297 km^2 [245]

SPECIES AVAILABLE	DISTRIBUTION INFORMATION	HABITAT REDUCTION
Dalbergia normandii	This species is only known from two locations – Antalaha (Masoala National Park) and Isle Sante Marie in north east Madagascar in humid evergreen forests [192, 105]. This was still current as at 2010 [180].	It was estimated in 2012 that humid forest in Madagascar has been reduced by 33% since the 1970s [173]. EOO estimated to be < 5000 km^2 [244, 245] AOO estimated to be <500 km^2 [245]
Dalbergia purpurascens	In 1998, found by IUCN Red List assessment to be *"widespread in east, west and south-west"* and locally common, also occurring in the following protected areas: - Ankarana Special Reserve - Namoroka Reserve - Bemaraha Reserve [247] In 2008, it was stated as being widespread but scattered through that same region – east, west and south-west [17]. This was restated in 2010 [180]. Refer to Figure 46 and Figure 47F for current estimated distribution.	This species occurs in two of the same reserves as *Dalbergia chlorocarpa,* where the assessment of that species indicated that the habitat in the west of Madagascar where it exists was "extensively destroyed" and decreasing. Presumably this also applies for this species which occurs in the same habitat [184]. EOO estimated to be 480 363 km^2 [244, 245] AOO estimated to be 405 km^2 [245]
Dalbergia trichocarpa	Restricted to lowland seasonably dry forests and woodlands from Analalava (in north) to Morondava (south), including protected area – Ankarafantsika Nature Reserve [17, 248]. In 2010 – said to be mainly located on NW of island now, thus has a restricted range. There have been some observed locations in central west and in south of island, however, no reference is provided for these [180].	EOO estimated to be = 101 370 km^2 [245]
Dalbergia tsiandalana	Very restricted, poorly known species from western Madagascar: Soalala and Mahajanga regions [193]. Refer to Figure 47G for current estimated distribution.	In 1998. the moist lowland coastal forest this species is found in was considered very reduced and fragmented [105]
Dalbergia viguieri	In 1998, it was known to be three rapidly diminishing sites in north east Madagascar, however, further details are not provided [194]. Refer to Figure 47H for current estimated distribution.	In 1998, the habitat that this species is found in was considered to be fragmented and isolated [105]
Dalbergia xerophila	In 1998, it was considered to have a very restricted distribution in south east Madagascar, where vegetation was considered to be very fragmented [195]. In 2010, known in the following locations: Soalary, Itambono, Ranobe forest near Toliara, Mikea forest near Manombo [180]. Refer to Figure 46 for current locations where this species is considered to still exist.	EOO estimated to be 1859 km^2 AOO estimated to be 54 km^2 [245]

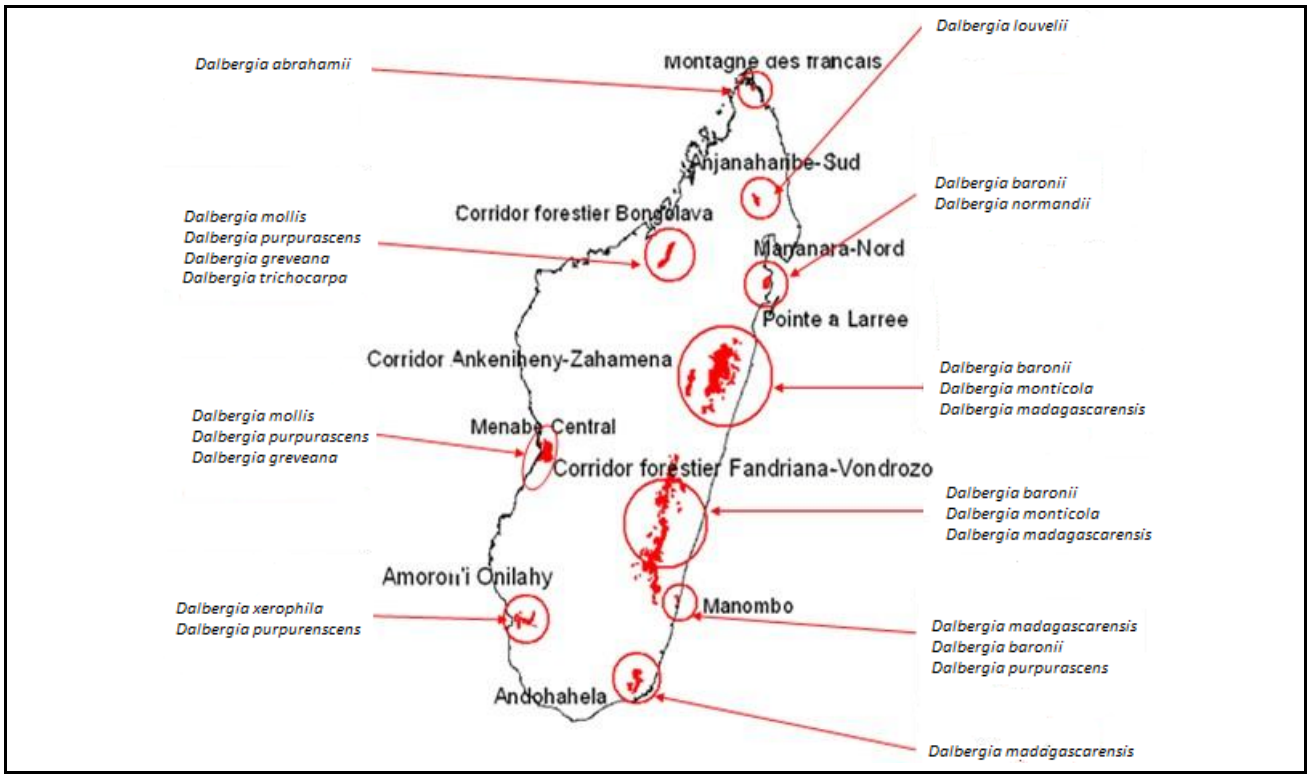


Figure 46 - Forest locations where *Dalbergia* species still exist (modified from [180]).

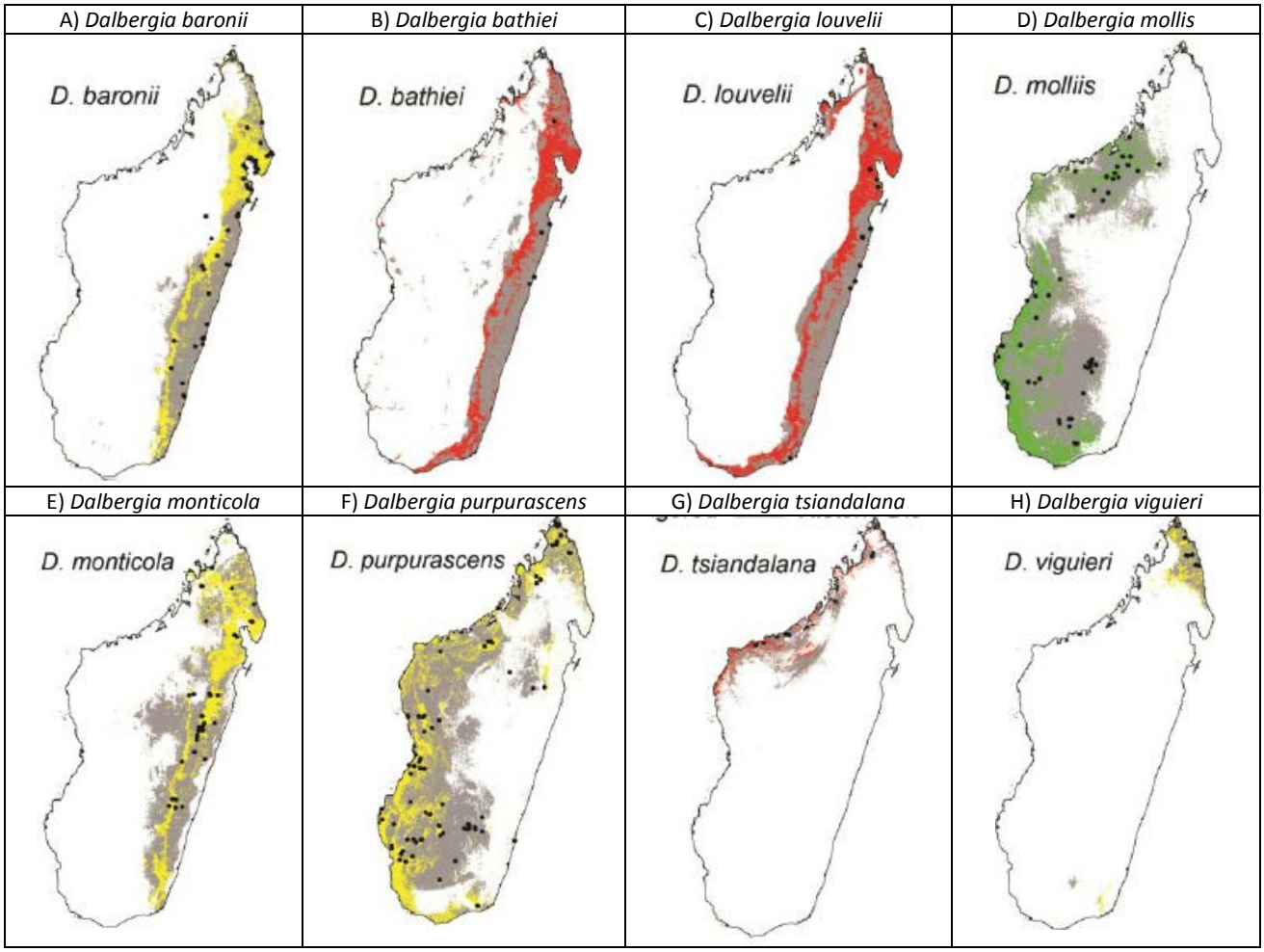


Figure 47 - Predicted Current Distributions for 8 Commercially Exploited Malagasy Rosewood Species (taken from Barrett et al (2010) [242])

POPULATION STRUCTURE AND STATUS

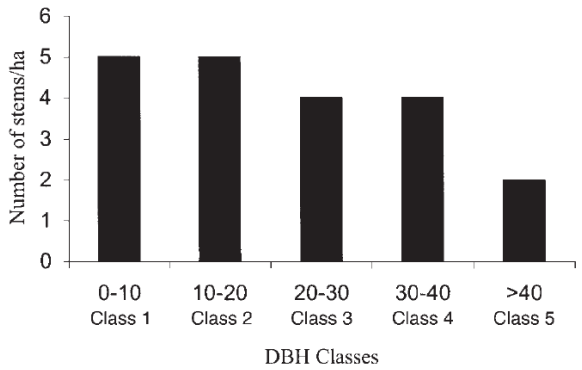
There are a surprising number of research papers outlining the population structures of some of the most exploited species in Africa, compared to Asia and the Americas. For wide ranging and highly exploited species such as *Pterocarpus erinaceus, P. angolensis, P. lucens* and *D. melanoxylon* a significant number of range countries have conducted size class distribution and other growth rate qualifying studies, particularly over the past 15 years. Almost every one of these surveys has shown a size class distribution typical of an unstable population, which is a key indicator of unsustainable harvesting practices. Many of these studies also cited poor recruitment into the populations, both within and outside protected areas. It is often thought that protected areas can act as source meta/populations for species genetics where larger, more mature trees contribute to survival of the population. However, the recruitment failure noted in a number of national parks for several rosewood producing species is of serious concern to the long term viability of many populations. Table 45 indicates the known population structures across these species ranges, and highlights where the populations have been noted as declining. In many range states, there have been no studies on population status and structure of specific species, however, there have been general forest stock assessments. Table 44 shows the results of a limited number of stock assessments that have been conducted in Africa.

Table 44 - General Forest Stock Assessments in Africa

Country	Species Available	Generic Forest Stock Assessments
Zambia	*P. lucens* *P. angolensis*	Forestry assessment conducted by Zambia Forestry Department and Fao from 2005-2008 [209] found that only 12.4% of 2941 million cubic meters of forest was consisted of the 19 species classified as commercial tree species. This equated to only 6.8 m^3 per hectare.
Mozambique		Forestry assessment found that Mozambique's forests had the equivalent of one to two mature commercial timber trees per hectare (or 5m^3). This was estimated to be only 7% of the standing volume of forests in 2007 [209].
Benin	*P. erinaceus*	Estimates found that density of species in the Sudanian woodlands ranged from one to ten individuals per hectare [209].
Tanzania		In Miombo woodlands of Tanzania, commercial trees species over 50cm DBH were estimated to make up 4% of density, 23 % of the basal area and 25 % of volume. [209]
Zimbabwe		In the teak forests, it was estimated that 80% of the trees were exploitable timber species from the *Baikiaea, Guibourtia* and *Pterocarpus* genera, from a total basal area of 21m^2/ha, a growth rate of 0.17m^2/ha per year, 80 per cent of which was of exploitable timber species [209]

Table 45 - Summary of Population Status and Structure for Rosewood Producing Species in Africa

DALBERGIA MELANOXYLON			
POPULATIONS STUDIED	**POPULATION STRUCTURE AND STATUS**	**NATURAL DENSITY**	**REFERENCES**
General – Louppe et al. (2008) stated the following about general population status of this species across its range: - Mali populations were under pressure due to successive droughts, and large scale felling - Sudan listed as endangered in 2000 - Kenya: commercial stocks were almost completely exhausted - Tanzania: considered to not be commercially exploitable, even though permits were still able to obtained, even though protected by law - Malawi: occurs where human populations are high, and tree numbers have been drastically reduced – assessed as endangered in this country - Constant removal of large straight trees threatens genetic viability			Louppe et al. (2008) [17]
Burkina Faso			
In 1993 on 10.24 ha plot on savanna of the Gondo Plain Latitude: 14°12'27" N Longitude: 2°27'23" W	Biological Volume = 5.6% of total BV in study area Average tree height = 4.3m	Density = 14.8 N/ha Density of dead individuals = 3.3 N/ha (with 30% on shallow soils)	Couteron & Kokou (1997) [199] & Couteron (2001) [249]
Cameroon			
In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.	Document stated that this species was threatened at the species level in this country.		FAO (2001) [240]
Ethiopia			
Conducted in Metema district, North Gondar approximately 975km NW of Addis Abada. Latitude: 12°39' N Longitude: 36°17' E Altitude range: 550-1608 m Above SL	Basal Area = 0.39% or 0.165 m^2/ha Importance Value Index (IVI) = 7.44% - ranked 11th	- The density of wooded trees decreased with increasing diameter class Density = 12.76 individuals /ha Relative density – 3.38% Relative frequency – 3.67%	Wale et al. (2012) [250]
Mozambique			
Cabo Delgado province	Total overbark volume of 2.2 m^3/ha	-	Malimbwi *et al.* (2000) [197] – which referenced Macome (1996)
Senegal			
From 1976 to 1995, 0.25 km^2 study site in Fété-Olé within the Sahelian zone; Latitude: 16°14'N Longitude: 15°06'W	Expatriated in this study area as of 1995	Overall tree density reduced from 868 trees/ha in 1976 to 680 trees/ha in 1995, and *Dalbergia melanoxylon* disappeared completely over that time.	Vincke et al (2010) [251]

DALBERGIA MELANOXYLON			
POPULATIONS STUDIED	**POPULATION STRUCTURE AND STATUS**	**NATURAL DENSITY**	**REFERENCES**
In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.	- Document stated that this species was threatened at the population level in this country.		FAO (2001) [240]
Sudan			
In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.	- Document stated that this species was threatened at the population level in this country.		FAO (2001) [240]
Tanzania			
42 sites across Miombo woodland forest were sampled in east central Tanzania – Ihombwe Village, Mikumi Division, Kilosa District Latitude: 7°17'S Longitude: 36°55'E Elevation of 635m above SL	- Survey found virtually no large diameter individuals - Stumps were more common than standing trees (unpublished data) - Regeneration was very low (unpublished data) - Stated the species "*is bound to disappear with the present logging practice*"	Sapling No = 7 Seedling No. = 22	Backéus et al. (2006) [252]
44 sites in community forests on public lands across the following 4 villages: - Mtua Village – 2000 ha (14 plots) - Kipara and Nalengwe Villages – 2500 ha (20 plots) - Mkonjela Village – 1000 ha (10 plots) Dates of field work are not provided, presumably approximately 1998/99 based on the trade data included being up to 1999.	- Basal Area = 1.2 m^2/ha - Volume = 8.6 m^3/ha  **Figure 48 - Diameter Size Class Distribution (Taken from [253])**	Density = 20 N/ha	Opulukwa et al (2002) [253]
120 plots in each of the following: 1. <u>Mitature Forest Reserve (Coastal Kilwa district)</u> Latitude: 8°45' - 9°03'N Longitude: 38°53' - 39°14'E	Overbark[30] volume: inland (av) – 10.4 m^3/ha coastal (av) – 5 m^3/ha Merchantable volume: inland forests – 4.4 m^3/ha (43% of total overbark volume)	Reported that Hansen (1996) observed: Inland seedlings – 267 N/ha Coastal seedlings – 4638 N/ha	Malimbwi *et al.* (2000) [197]

[30] Defined by the FAO as "stem volume of all living trees more than 10cm diameter at breast height (or above buttresses if these are higher), over bark measured from stump to top of bole", from http://www.fao.org/docrep/004/y1997e/y1997e07.htm#fn1 Accessed on 26 July 2016.

DALBERGIA MELANOXYLON			
POPULATIONS STUDIED	**POPULATION STRUCTURE AND STATUS**	**NATURAL DENSITY**	**REFERENCES**
2. Lionja Forest Reserve (Inland Nachingwea district) Latitude: 10°12' - 10°20'N Longitude: 38°20' - 38°30'E	coastal – 1.7 m^3/ha (33% of total) Net biomass[31]: inland – 3.9 tonnes/ha coastal – 1.2 tonnes/ha Table 5 of this reference gives the basal area of this species against other species across forest reserves and public (unprotected) lands. There is no difference in basal area between forest reserves and public lands, indicating that there is lower than expected restocking of juveniles into the populations despite harvest being controlled in reserves. "Re-stocking" was found to have been "poor for some time".	However, few of these seedlings attain sapling or pole size. This species was only found on 7% and 13% of forest and public land sites in coastal areas (respectively), as opposed to inland forests where it was found on 47% and 41% respectively of sites sampled. Reports that in Mikumi National Park (near Morogoro) also in Tanzania, that this species was only 0.7% of the mean density of 20 trees/ha found by Hawkins et al (1995)	
Lindi region (unpublished data from Sound & Fair)	Standing population of forest in Lindi region was apparently assessed as 100 000 m^3 in 2012, however, this is unverifiable data. This was extrapolated to the other commercially viable region of Tanzania (Mtwara) to suggest the population in Tanzania is of the order 200 000m^3. This data is unpublished and not able to be verified but is stated to carry a "great deal of uncertainty" as to the accuracy of the figures.		Jenkins et al (2012) [77]
COP9 PROPOSAL POPULATION ASSESSMENT			
CoP9 proposal summarises the situation as it was known in 1994, covering a range of countries. This is included here for completeness.	- Tanzania was listed as having rapidly depleted this species, with *"little regeneration"* and was considered endangered - Occurrence in Uganda listed as high in Butyaba, Packwach, Moyo and Ajumani, but has been reduced in some areas - Kenya listed as increasing scarce - Considered threatened in Sudan, with the range retreating southwards		CoP9 Proposal 79 [200]

[31] Not including sapwood

DALBERGIA SPP - MADAGASCAR		
POPULATIONS STUDIED	**POPULATION PARAMETERS (I.E. STRUCTURE, STATUS, NATURAL DENSITY ETC.)**	**REFERENCES**
DALBERGIA ABRAHAMII		
This species was surveyed at French Mountain near Anosiravobe camp [180]. Latitude: 12° 21' 58,2''S Longitude: 049° 21' 49,1"E Altitude: 246m	Population Status Assessments 1998 IUCN Red List Assessment found that this species was Endangered, as it is only known from a few locations that were under threat from deforestation, creating fragmented sub-populations. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species still met the **Endangered** criteria. DBEV/WWF (2010) [180] states that this species is known to exist in three populations, one (1) inside a protected area and two (2) external to protected areas, and were assessed as declining. Population parameters DBEV/WWF (2010) [180] provided the information in Table 48, some of which were also reported in the CoP16 Proposal.	[181, 174, 179, 180, 105]

Table 46 - Population Parameters as provided in CoP16 Proposal 63 and DBEV/WWF (2010)

	Density (N/ha)	% mature (with seeds)	Basal Area (m^2/ha)	Bio-Volume (m^3/ha)	Regeneration Rate
French Mountain	120	7 individuals; total number surveyed is not provided	1.9	6.63	28.7 %

The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees. This is not a density of adult trees that are capable of reproducing. The size class distribution is shown in Figure 49. The CoP16 source document for the above, DBEV/WWF (2010), also reported that this species had a "poor regeneration rate" of only 28.7%[32]. The health status of this population was described as "disturbed".

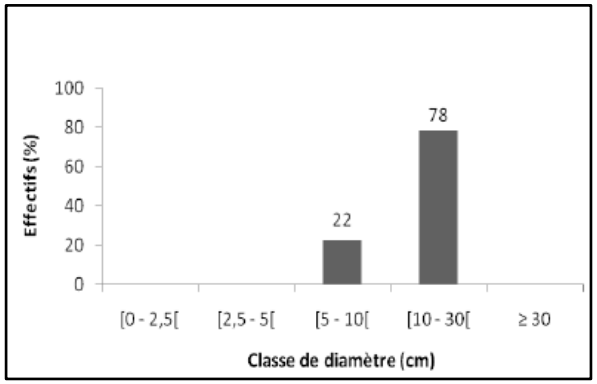


Figure 49 - Size Class Distribution of *Dalbergia abrahamii* in French Mountain

32 Regeneration Rate (TR) <100% considered "poor regeneration; 100% < TR < 1000% considered "average to good"; TR > 1000% = "good regeneration" [174]

<table>
<tr><th>POPULATIONS STUDIED</th><th>POPULATION PARAMETERS (I.E. STRUCTURE, STATUS, NATURAL DENSITY ETC.)</th><th>REFERENCES</th></tr>
<tr><td colspan="3">DALBERGIA BARONII</td></tr>
<tr><td>This species was observed at Manombo Protected Area, [180]
Latitude: 23° 1’
Longitude: 47° 41’
Altitude: 40-70m
Slope: 15-30%</td><td>
<u>Population Status Assessments</u>
1998 IUCN Red List Assessment stated that large individuals of this species were rare due to selective logging, and their habitat being greatly reduced, and it was assessed as <u>Vulnerable</u> under the IUCN Criteria almost 20 years ago. Reported that this species is over-exploited and would soon disappear in 2008. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species still met the Vulnerable criteria. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria <u>(Resolution Conf 9.24 (Rev CoP14)</u>[33] and found that it met the criteria for listing in Appendix I. DBEV/WWF (2010) [180] states that this species is known to exist in 28 populations, eight (8) inside a protected area and 20 external to protected areas, and were assessed as declining.

<u>Population parameters</u>
DBEV/WWF (2010) [180] provided the information in Table 48, some of which were also reported in the CoP16 Proposal.

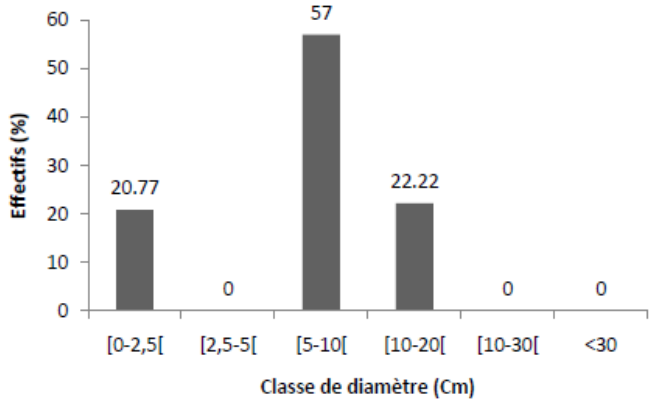
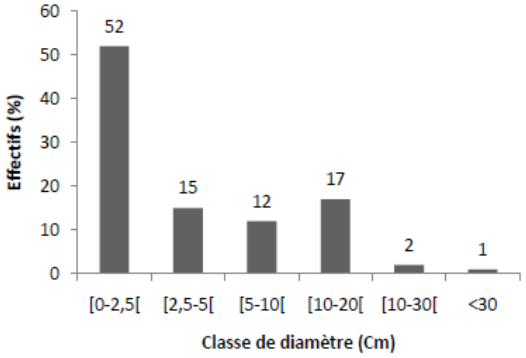
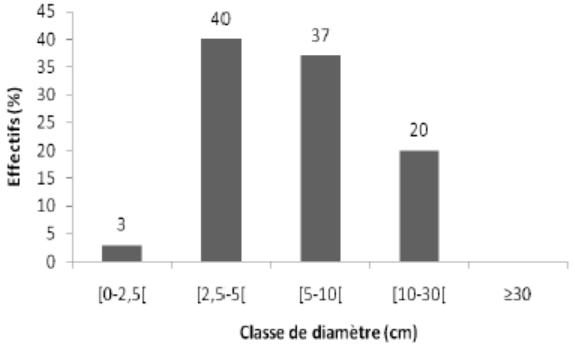
Table 47 - Population Parameters as provided in CoP16 Proposal 63 and DBEV/WWF (2010)
<table>
<tr><th></th><th>Density (N/ha)</th><th>% mature (with seeds)</th><th>Basal Area (m²/ha)</th><th>Bio-Volume (m³/ha)</th><th>Regeneration Rate</th></tr>
<tr><td>Manombo Protected Area</td><td>10</td><td>22</td><td>1.5</td><td>5.7</td><td>500%</td></tr>
</table>
DBEV/WWF (2011) [180] also reported that there was a lack of seedlings during the field surveys conducted and that the regeneration rate was 500% (average to good). The diameter size class distribution of trees surveyed in Manombo Protected Area is shown in Figure 50. The health status of this population was described as “disturbed”.


Figure 50 - Size Class Distribution of Dalbergia baronii in Manombo Protected Area Forest [taken from [180])
</td><td>[182, 17, 174, 179, 242, 180]</td></tr>
</table>

[33] This was the current version of this resolution at the time of that paper, it has since been amended at CoP16.

POPULATIONS STUDIED	POPULATION PARAMETERS (I.E. STRUCTURE, STATUS, NATURAL DENSITY ETC.)	REFERENCES
DALBERGIA BATHIEI		
No populations have been surveyed.	Population Status Assessments 1998 IUCN Red List Assessment found that this species was Endangered, and that it was considered rare. Only a small number of adult individuals have been recorded, and the population was considered severely fragmented in 1998. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species now meet the **Critically Endangered** criteria. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14)[33] and found that it met the criteria for listing in Appendix I.	[183, 174, 105]
DALBERGIA CHAPELIERI		
No populations have been surveyed.	Population Status Assessments Although the 2012 IUCN Red List Assessment stated that this species was "widespread" as it was known from 25 locations, it was also stated that the populations were severely fragmented, with an estimated 33% of humid forests having disappeared since the 1970s. It was assessed as Near Threatened.	[173]
DALBERGIA CHLOROCARPA		
No populations have been surveyed.	Population Status Assessments 1998 IUCN Red List Assessment stated that this species habitat has been "extensively destroyed", was still decreasing and the species was considered Vulnerable.	[184]
DALBERGIA DAVIDII		
No populations have been surveyed.	Population Status Assessments This species is only known from a very restricted range – namely Ankarafantsika Nature Reserve in NW Madagascar, and was assessed as Endangered in 1998 due to selective logging occurring despite existing in a protected area. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species now meet the **Critically Endangered** criteria. Barrett et al (2010) didn't have enough information to adequately assess whether this species meets the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14)[33] for Appendix I, and simply stated it was assumed it would meet this criteria due to endangered status. Given that this species was recently assessed for Plants Committee as meeting the Critically Endangered status, and the large scale selective logging and deforestation in the regions where this species is found, it can be inferred that this species meets the criteria for Appendix I.	[185, 174]
DALBERGIA DELPHINENSIS		
No populations have been surveyed.	Population Status Assessments 1998 IUCN Red List Assessment considered this species as Endangered with fragmented and declining habitat available. It was also noted that the species restricted distribution overlapped with a proposed titanium mine which would further threaten the species. This mine was given the go ahead in 2005, and as recently as 2013 was causing local protests over the destruction to habitats and dispossession of the local people's land [254]. This project has resulted in the loss of approximately 1665 ha of littoral forest habitat around Mandena, Petriky and Sainte Luce. [254]	[186, 254]

Populations Studied	Population Parameters (i.e. structure, status, natural density etc.)	References
DALBERGIA GREVEANA		
Populations of this species were localised to Beroroha region, and found in the Bongolava Forest Complex [180]. Latitude: 22° 51’ 2,4”S Longitude: 43° 30’ 53.5”E Altitude: 80m	Population Status Assessments 1998 IUCN Red List Assessment found that this species was Near Threatened, as it was still considered widespread despite population declines across its range from selective felling. Considered to make up the bulk of wood exports from the west of Madagascar. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species now meets the **Least Concern** criteria. DBEV/WWF (2010) [180] states that this species is known to exist in 79 populations, 13 within protected areas and 66 external to protected areas, and were assessed as declining. Population parameters Populations in Morondava region were found to produce lots of seeds, and had apparently abundant regeneration [17]. DBEV/WWF (2010) provided the information in Table 48, some of which were also reported in the CoP16 Proposal. **Table 48 - Population Parameters as provided in CoP16 Proposal 63 and DBEV/WWF (2010)** The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees, as demonstrated by the fact that 20% of the Bongolava Forest Complex was mature trees. DBEV/WWF (2010) [180], provides additional details as to the population structure of the individual forests this species is found in (shown on the left), as shown in Figure 51 and Figure 52. The health status of this population was described as “disturbed”.  **Figure 51 - Size Class Distribution in Bongolava Forest Complex taken from [180]**  **Figure 52 - Size Class Distribution in Beroroha Region taken from [180]** The regeneration rate for Bongolava was found to be 170% and the population was considered imbalanced, while in Beroroha region, the regeneration rate was a very low 24% indicating the unhealthy status of the population [180].	[187, 17, 174, 179, 180]

	Density (N/ha)	% mature (with seeds)	Basal Area (m^2/ha)	Bio-Volume (m^3/ha)	Regeneration Rate
Borgolava Forest Complex	270	20%	4.2	16.65	170%
Beroroha	310		4.7	34.7	24%

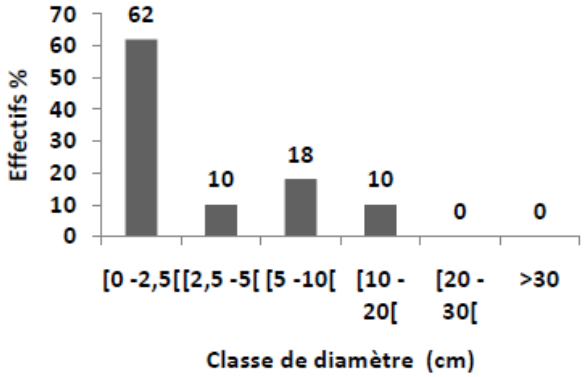
<table>
<tr><th>Populations Studied</th><th>Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td colspan="3">DALBERGIA HILDEBRANDTII</td></tr>
<tr><td>No population surveys conducted</td><td>Population Status Assessments
1998 IUCN Red List Assessment found that this species was Vulnerable, with the habitat being gradually reduced and fragmented.</td><td></td></tr>
<tr><td colspan="3">DALBERGIA LOUVELII</td></tr>
<tr><td>Species surveyed in Ambila lemaintso costal forest
Latitude: 18° 49' 10.1''
Longitude: 49° 9' 26.9 ''</td><td>Population Status Assessments
1998 IUCN Red List Assessment found that this species was Endangered, with severely fragmented populations. It is reported that large trees of this species have been rare for over 80 years, as at 2008 [17]. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species still met the Endangered criteria. This species was included in Appendix III of CITES at the end of 2011 due to the increase in illegal logging of this species. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14)[33] and found that it met the criteria for listing in Appendix I. DBEV/WWF (2010) [180] states that this species is known to exist in four (4) populations, zero (0) within protected areas and four (4) external to protected areas, and were assessed as declining.
Population parameters
DBEV/WWF (2010) provided the information in, some of which were also reported in the CoP16 Proposal.
Table 49 –Population Parameters of Dalbergia louvelii as provided in CoP16 Proposal 63 and DBEV/WWF (2010)
<table>
<tr><th></th><th>Density (N/ha)</th><th>% mature (with seeds)</th><th>Basal Area (m²/ha)</th><th>Bio-Volume (m³/ha)</th><th>Regeneration Rate</th></tr>
<tr><td>Ambila Lemaintso</td><td>200</td><td>10%</td><td>0.34</td><td>3.98</td><td>214%</td></tr>
</table>
The density per hectare is quite large, especially when compared to basal area and bio-volume. The percentage of mature trees is low at only 10%, however, DBEV/WWF (2010) considered the population to be stable due to the shape of the diameter size distribution graph (Figure 53), even though the regeneration rate was considered to be poor at only 214%. The health status of this population was described as “disturbed”.
 

Figure 53 - Size Class Distribution of Dalbergia louvelii in Ambila Lemainsto Forest [taken from [180])</td><td>[188, 174, 179, 242]</td></tr>
</table>

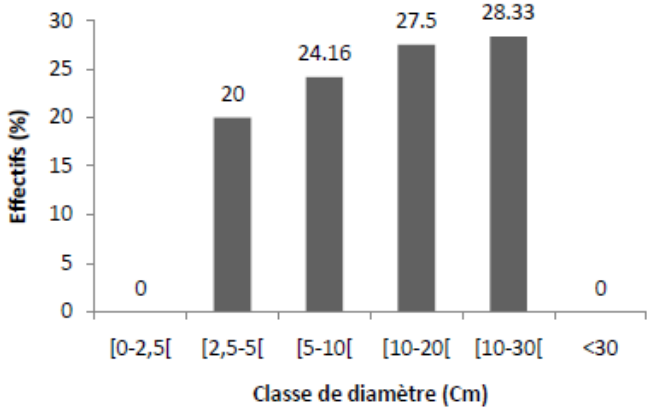
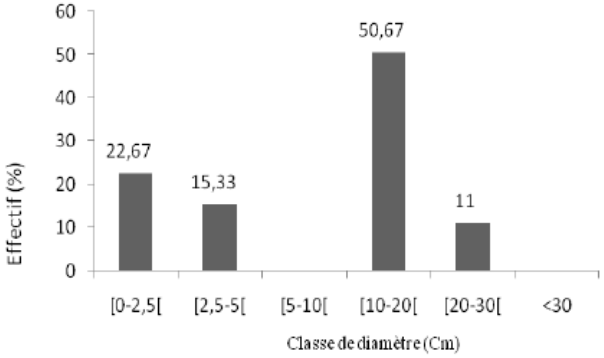
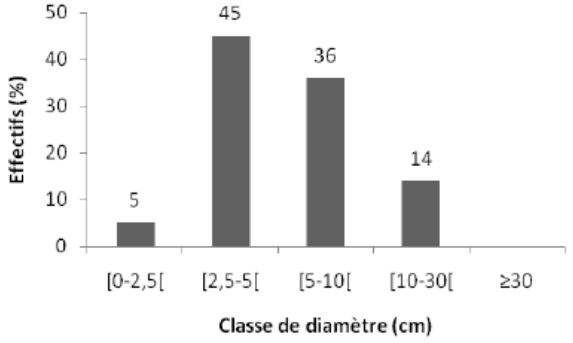
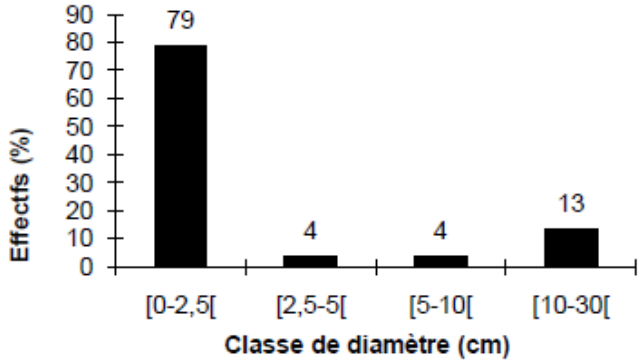
<table>
<tr><th>Populations Studied</th><th>Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td colspan="3">DALBERGIA MADAGASCARENSIS</td></tr>
<tr><td>Populations were surveyed in Manombo Forest [180]
Latitude: 23° 1’ S
Longitude: 47° 41’ E</td><td>Population Status Assessments
1998 IUCN Red List Assessment found that this species was Vulnerable and that the extent of the forest was in decline. It is found in humid evergreen forests, which a later 2012 assessment of another Dalbergia species estimated that this habitat has reduced by 33% since the 1970s. A more recent analysis conducted in 2002 suggested that the declining numbers warranted further protection of remaining stands, but provided little detail about where these stands exist. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species now meets the Least Concern criteria. DBEV/WWF (2010) [180] states that this species is known to exist in 26 populations, six (6) within protected areas and 20 external to protected areas, and were assessed as declining.
Population parameters
DBEV/WWF (2010) provided the information in Table 50, some of which were also reported in the CoP16 Proposal.
Table 50 - Population Parameters for Dalbergia madagascarensis as provided in CoP16 Proposal 63 and DBEV/WWF (2010)
<table>
<tr><th></th><th>Density (N/ha)</th><th>% mature (with seeds)</th><th>Basal Area (m²/ha)</th><th>Bio-Volume (m³/ha)</th><th>Regeneration Rate</th></tr>
<tr><td>Manombo Forest</td><td>250</td><td>30%</td><td>4.1</td><td>16.5</td><td>50%</td></tr>
</table>
The density per hectare listed in the CoP16 proposal is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees, as indicated in the DBEV/WWF (2010) which stated that only 30% of this density was mature trees, and there was only a 50% regeneration rate. The health status of this population was described as “bad”.
 

Figure 54 - Size Class Distribution of Dalbergia madagascarensis in Manombo Forest taken from [180]</td><td>[175, 17, 174, 179, 180]</td></tr>
<tr><td colspan="3">DALBERGIA MARITIMA</td></tr>
<tr><td>No populations have been surveyed.</td><td>Population Status Assessments
1998 Red List Assessment stated that this species habitat had been almost completely destroyed and only severely fragmented populations remained. It was assessed as Endangered.</td><td>[189]</td></tr>
</table>

Populations Studied	Population Parameters (i.e. structure, status, natural density etc.)	References
DALBERGIA MOLLIS		
Two locations were surveyed: 1. Bongolava Forest Complex Latitude: 15° 56'S Longitude: 47° 56'E Altitude: 140-250m 2. Beroroha Region Latitude: 15° 57'S Longitude: 47° 56'E	Population Status Assessments 1998 IUCN Red List Assessment found that this species was Lower risk/Near Threatened, however there is little information about what this is based on. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species now meets the **Least Concern** criteria. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14))[33] and found that it met the criteria for listing in Appendix I. DBEV/WWF (2010) [180] states that this species is known to exist in 32 populations, eight (8) within protected areas and 24 external to protected areas, and were assessed as declining. Population parameters DBEV/WWF (2010) provided the information in Table 51, some of which were also reported in the CoP16 Proposal. **Table 51 –Population Parameters of *Dalbergia mollis* as provided in CoP16 Proposal 63 and DBEV/WWF (2010)** The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees, however, DBEV/WWF (2010) does not provide a percentage of seedlings or mature trees for this species, however, it is unlikely that the densities listed are for adult trees that are capable of reproducing. The health status of these populations was described as "disturbed" or "bad", with the size class distributions shown below.  **Figure 55 - Size Class Distribution in Bongolava Forest Complex [taken from** [180]**)**  **Figure 56 - Size Class Distribution in Beroroha [taken from** [180]**)**	[176, 174, 179, 242]

	Density (N/ha)	Basal Area (m^2/ha)	Bio-Volume (m^3/ha)	Regeneration Rate
Bongolava Forest Complex	210	4.77	43.97	50%
Beroroha	220	2.56	24.7	16%

Populations Studied	Population Parameters (i.e. structure, status, natural density etc.)	References
DALBERGIA MONTICOLA		
Species was surveyed in Ankeniheny-Zahamena Forest corridor, near rural commune Didy, in Tanetiniharanan forest. Latitude: 48°33'13,5''S Longitude: 18°10'29,7''E Altitude: 1111m Slope: 30%	Population Status Assessments 1998 Red List Assessment stated that mature trees were considered rare and the species was assessed as Vulnerable. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species still meets the **Vulnerable** criteria. This species was included in Appendix III of CITES at the end of 2011 due to the increase in illegal logging of this species. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14))[33] and found that it met the criteria for listing in Appendix I. DBEV/WWF (2010) [180] states that this species is known to exist in 16 populations, six (6) within protected areas and ten (10) external to protected areas, and were assessed as declining. Population parameters DBEV/WWF (2010) provided the information in Table 52, some of which were also reported in the CoP16 Proposal. **Table 52 - Population Parameters for *Dalbergia monticola* as provided in CoP16 Proposal 63 and DBEV/WWF (2010)** Ankeniheny-Zahamena Forest corridor: Density (N/ha) 200; % mature (with seeds) 13%; Basal Area (m^2/ha) 3.2; Bio-Volume (m^3/ha) 12.9; Regeneration Rate 666% The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees, as demonstrated by the fact that there was only 13% mature trees (26 N/ha). Which would be capable of reproducing. The health status of this population was described as "good". The diameter size class distribution shown in Figure 57.  **Figure 57 – Size Class Distribution for *Dalbergia monticola* [taken from [180])** Population Genetic Structure Populations in central northern region of range are more genetically diverse than populations in south and extreme north. [17]	[190, 17, 174, 179]

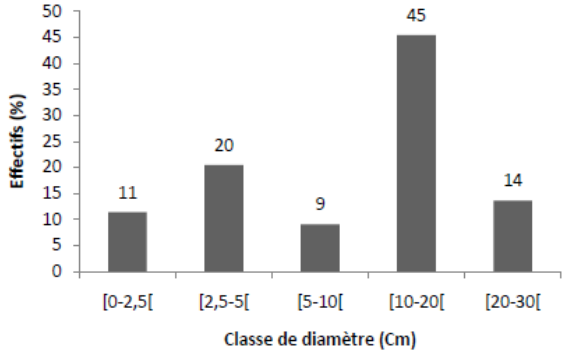
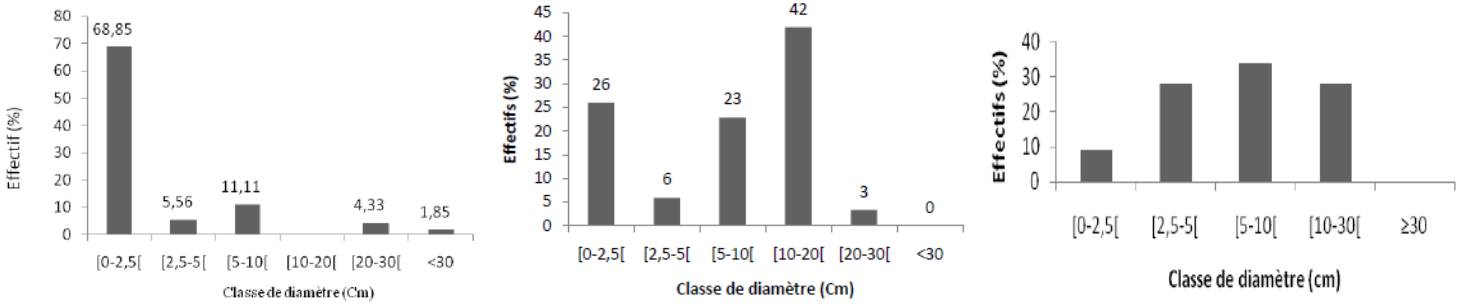
<table>
<tr><th>Populations Studied</th><th>Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td colspan="3">DALBERGIA NORMANDII</td></tr>
<tr><td>Populations surveyed in Ambodirina (Isle of St Marie)
Latitude: 16° 53' 10''
Longitude: 49° 50' 45''</td><td>
<u>Population Status Assessments</u>
1998 IUCN Red List Assessment found that this species was <u>Endangered</u>, and that its habitat was very fragmented. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species still meets the Endangered criteria. This species was included in Appendix III of CITES at the end of 2011 due to the increase in illegal logging of this species.
Barrett et al (2010) didn't have enough information to adequately assess whether this species meets the CITES Species Listing Criteria <u>(Resolution Conf 9.24 (Rev CoP14)</u>[33] for Appendix I, and simply stated it was assumed it would meet this criteria due to endangered status. However, it was recently assessed that the humid forests where this species exist have reduced by approximately 33% in Madagascar since the 1970s, which meets the Appendix I criteria of "marked decline of habitat greater than 5-30%", this in combination with the already restricted range indicates that this species meets the Appendix I criteria in its own right, and not as a "look-alike" species for those assessed as meeting the Appendix I criteria.
DBEV/WWF (2010) [180] states that this species is known to exist in two (2) populations, zero (0) within protected areas and two (2) external to protected areas, and were assessed as declining.
<u>Population parameters</u>
DBEV/WWF (2010) provided the information in Table 53, some of which were also reported in the CoP16 Proposal.
Table 53 - Population Parameters for Dalbergia normandii as provided in CoP16 Proposal 63 and DBEV/WWF (2010)
<table>
<tr><th></th><th>Density (N/ha)</th><th>% mature (with seeds)</th><th>Basal Area (m²/ha)</th><th>Bio-Volume (m³/ha)</th><th>Regeneration Rate</th></tr>
<tr><td>Ambodirina – Isle of St Marie</td><td>260</td><td>70%</td><td>4.26</td><td>11.4</td><td>20%</td></tr>
</table>
The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees. While 46 out of the 66 trees surveyed had seeds (70%), the basal area and bio-volume were still very low, due to low height of the trees surveyed. Figure 58 shows the size class distribution for this population of Dalbergia monticola. The health status of this population was described as "disturbed".


Figure 58 - Size Class Distribution for Dalbergia normandii (taken from [180])
</td><td>[192, 174, 179, 180]</td></tr>
</table>

Populations Studied	Population Parameters (i.e. structure, status, natural density etc.)	References
DALBERGIA PURPURASCENS		
Surveys were taken at three locations around Madagascar 1. Bongolava Forest Complex 2. Manombo Rainforest 3. Beroroha Forest	Population Status Assessments 1998 IUCN Red List Assessment found that this species was Vulnerable, but that populations has been "seriously reduced" due to selective felling for the precious wood. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species meets the **Least Concern** criteria. This species was included in Appendix III of CITES at the end of 2011 due to the increase in illegal logging of this species. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14))[33] and found that it met the criteria for listing in Appendix I. DBEV/WWF (2010) [180] states that this species is known to exist in 29 populations, eight (8) within protected areas and 21 external to protected areas, and were assessed as declining. Population parameters DBEV/WWF (2010) provided the information in Table 54, some of which was also reported in the CoP16 Proposal. **Table 54 - Population Parameters for *Dalbergia purpurascens* as provided in CoP16 Proposal 63 and DBEV/WWF (2010)** The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that the density values include large percentage of seedlings, saplings and small diameter trees, as indicated by the 55-70% seedling rates shown above. Figure 59 shows the size class distribution structures of the three forests where this species was surveyed.  A. B. C. **Figure 59 - Size Class Distributions for *Dalbergia purpurascens* taken from DBEV/WWF (2010). A. Bongolava Forest Complex B. Manombo Forest C. Beroroha Region** It was stated that all population of this species were considered to be in poor health due to the irregularity of the size distribution curves and health status were listed as "disrupted" or "bad".	[247, 174, 179, 244, 242]

Bongolava Forest Complex	240	70%	6%	7.07	18.72	1700%
Manombo Rainforest	100	55%	45%	7.2	37.3	122%
Beroroha Forest	320	-	-	6	50	40%

Populations Studied	Population Parameters (i.e. structure, status, natural density etc.)	References

DALBERGIA TRICHOCARPA

Populations in The Bongolava Forest Complex, specifically in the Ambohimanga forest
Latitude: 15° 57'
Longitude: 47° 27'
Altitude: 140 – 265m

Population Status Assessments

1998 IUCN Red List Assessment found that this species was Least Concern even though its habitat was declining throughout its range, because it can occur in degraded habitats.

DBEV/WWF (2010) [180] states that this species is known to exist in 53 populations, eight (8) within protected areas and 45 external to protected areas, and were assessed as declining.

Population parameters

DBEV/WWF (2010) provided the information in Table 55, some of which were also reported in the CoP16 Proposal.

Table 55 –Population Parameters of *Dalbergia trichocarpa* as provided in CoP16 Proposal 63 and DBEV/WWF (2010)

	Density (N/ha)	% mature(with seeds)	Basal Area (m^2/ha)	Bio-Volume (m^3/ha)	Regeneration Rate
Bongolava Forest Complex	300	40%	11.1	40.3	480 %

The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees, which is confirmed by DBEV/WWF (2010) which states that 40% of population was mature with seeds. Individuals with DBH between 2.5 and 10cm were rare; resulting in 480% regeneration rate. This species had almost 100 mature individuals, which resulted in the comparatively large Basal area and Bio-volume compared to other species in the same forest complex. The health status of this population was described as "disturbed".

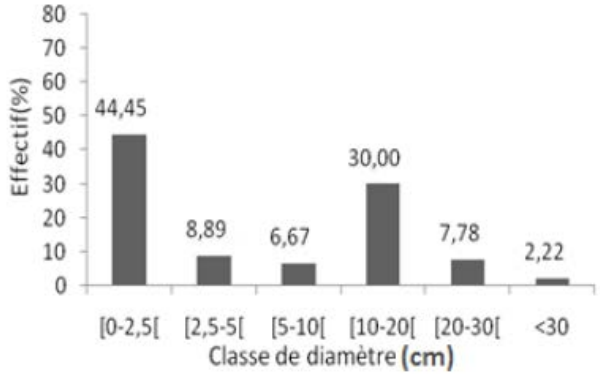


Figure 60 - Size Class Distribution of *Dalbergia trichocarpa* taken from DBEV/WWF (2010)

[248, 17, 174, 244, 180]

DALBERGIA TSIANDALANA

No populations have been surveyed.

Population Status Assessments

1998 IUCN Red List Assessment found that this species was Endangered. It had restricted range and its habitat was "very reduced and fragmented". A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species still meets the **Endangered** criteria. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14))[33] and found that it met the criteria for listing in Appendix I.

[193, 174, 244, 242]

DALBERGIA VIGUIERI

No populations have been surveyed.

Population Status Assessments

1998 IUCN Red List Assessment found that this species was Vulnerable. It had a restricted range, to only 3 sites, and had fragmented and isolated populations. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species now meets the **Endangered** criteria. Barrett et al (2010) assessed this species against the CITES Species Listing Criteria (Resolution Conf 9.24 (Rev CoP14))[33] and found that it met the criteria for listing in Appendix I.

[194, 174, 244, 242]

DALBERGIA XEROPHILA

This species was surveyed in Beroroha forest
Latitude: 22° 52' 42,6''S
Longitude: 043° 32' 26,7"E

Population Status Assessments

1998 IUCN Red List Assessment found that this species was Endangered. It had a very restricted range, on which the habitat was severely fragmented. This species was included in Appendix III of CITES at the end of 2011 due to the increase in illegal logging of this species. A new assessment carried out against the IUCN criteria in 2011 for CITES Plants Committee 19 found this species still meets the **Endangered** criteria.
DBEV/WWF (2010) [180] states that this species is known to exist in six (6) populations, zero (0) within protected areas and six (6) external to protected areas, and were assessed as declining.

Population parameters

DBEV/WWF (2010) provided the information in Table 56.

Table 56 –Population Parameters of *Dalbergia trichocarpa* as provided in CoP16 Proposal 63 and DBEV/WWF (2010)

	Density (N/ha)	% mature (with seeds)	Basal Area (m^2/ha)	Bio-Volume (m^3/ha)	Regeneration Rate
Beroroha Forest	240	29%	3.68	36.1	50%

The density per hectare is quite large, especially when compared to basal area and bio-volume, which indicates that this density includes seedlings, saplings and small diameter trees, which is confirmed because only 29% of population was mature trees. Figure 61 shows the diameter size class distribution for this species in Beroroha forest. The health status of this population was described as “disturbed”.

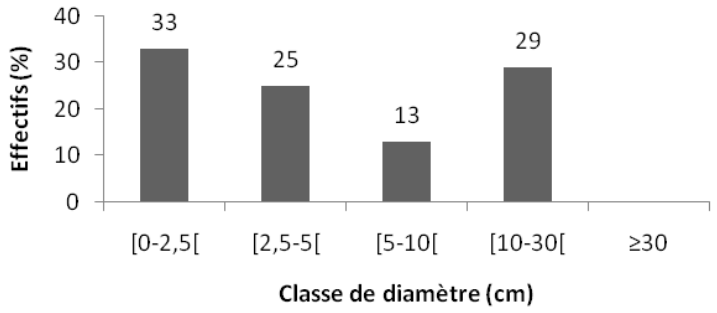


Figure 61 - Size Class Distribution for *Dalbergia xerophila* taken from DBEV/WWF (2010)

[195, 174, 244]

<table>
<tr><th colspan="3">PTEROCARPUS ERINACEUS</th></tr>
<tr><th>Populations Studied</th><th>Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td colspan="3">BENIN</td></tr>
<tr><td>The Pendjari Biosphere Reserve located in the Sudanian zone.
Latitude: 108400-11828N
Longitude: 08570-2810E
Area: 4660.42 km2

<u>Includes:</u>
Pendjari National Park (2660.4 km^2)
Pendjari hunting zone (1750 km^2)
Konkombri hunting zone (251 km^2)</td><td>Size class structure in this study conducted in 2008/2009 did not show any significant difference between the habitat types, however, the size class distributions were right skewed in unprotected areas and fallow areas. For the protected areas it was left skewed, as show in Figure 62. While protected savannas have been effective in maintaining larger individuals, populations were still found to be declining. Unprotected areas had an absence of trees with a diameter greater than 52cm. Table 57 shows the population parameter difference across different habitat types in Benin.

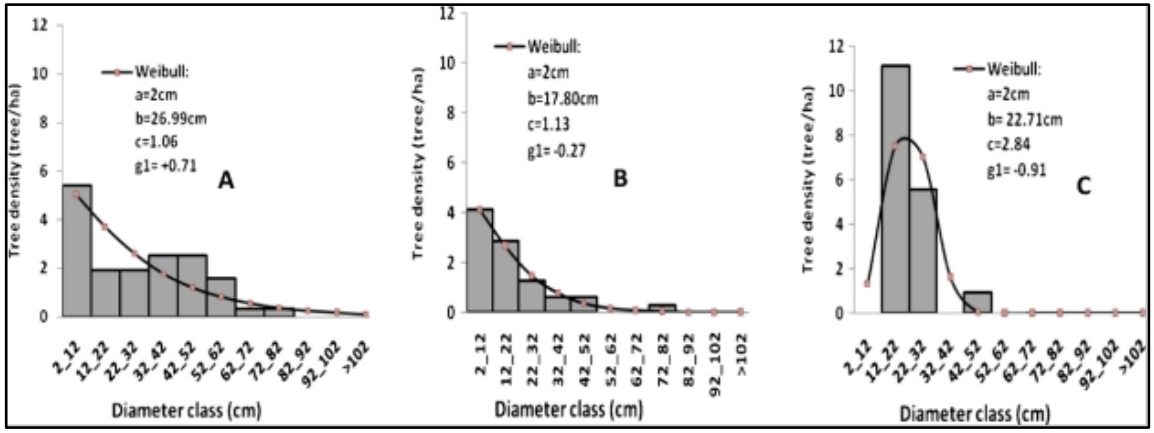
Table 57 - Population Structure and Density across Habitat Types in Benin
<table>
<tr><td>Parameter</td><td>Protected Area - Pendjari National Park</td><td>Unprotected savannas (found in the two hunting zones)</td><td>Fallow areas (two hunting zones)</td></tr>
<tr><td>Adult Density</td><td>12 ± 3.7 tree/ha</td><td>5 ± 1.9 tree/ha[34]</td><td>17 ± 2.1 tree/ha [34]</td></tr>
<tr><td>Juvenile Density</td><td>5 ± 0.9 stems/ha</td><td>3 ± 1.1 stems/ha[35]</td><td>0.00 ± 0.0 stems/ha[35]</td></tr>
<tr><td>Juvenile % in population</td><td>42%</td><td>33%</td><td>0%</td></tr>
</table>


Figure 62 - Size Class Distribution Curves (taken from Houehanou et al, 2013 - Figure 5) (A) protected savannas (B) unprotected savannas (C) in the fallows</td><td>Houehanou et al, 2013 [255]</td></tr>
</table>

34 Significantly different from protected areas
35 No significant difference

<table>
<tr><th colspan="3">PTEROCARPUS ERINACEUS</th></tr>
<tr><th>Populations Studied</th><th>Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td>Studied 400 plots in woodlands and wooded savannahs of classified forests - Higher Ouémé and Wari-Maro

Wari-Maro – 120 686 ha is located in Central Bénin
Latitude: 8 ° and 9 ° 80 10 N
Longitude: 1 ° and 55 ° 2 25 E.
This is the transition zone Sudano-Guinean

Higher Ouémé – 193 400 ha
Latitude: 9 11 9 ° 47N
Longitudes 1 ° and 2 ° 58 E. 28</td><td>Size class distribution graphs are shown Figure 63 for savannahs and woodland forests from studies conducted in 2007. While recruitment is occurring in these areas, it is not at sufficient level to suggest the populations are stable. Population parameters are provided in Table 58.

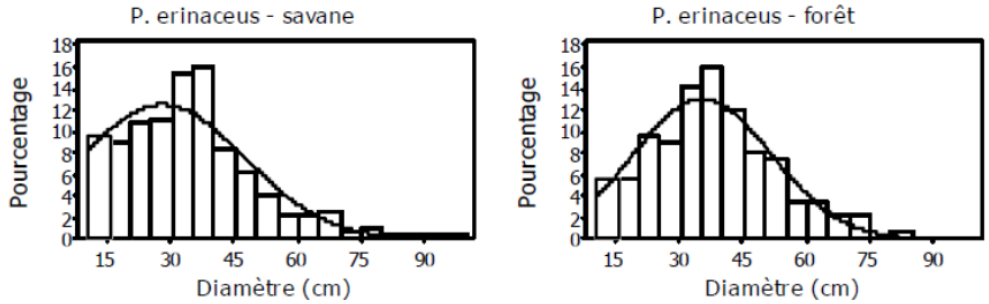
Table 58 - Population parameters of "Classified" forests in Benin
<table>
<tr><th>Parameter</th><th>Diameter (av)</th><th>Height (av)</th><th>Basal Area</th><th>Density</th></tr>
<tr><td>Savannahs</td><td>36.91cm</td><td>13.44cm</td><td>2.54 m²/ha</td><td>22.86 stems/ha</td></tr>
<tr><td>Woodland Forest</td><td>40.86cm</td><td>16.28cm</td><td>3.6 m²/ha</td><td>23.36 stems/ha</td></tr>
</table>


Figure 63 - Size Class Distribution Class Graphs (taken from Glele Kakai et al (2008)). (Left) Savannahs (Right) Forests</td><td>Glele Kakai et al, 2008 [256]</td></tr>
<tr><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td>Document stated that this species was threatened at the species level in this country.</td><td>FAO (2001) [240]</td></tr>
</table>

PTEROCARPUS ERINACEUS

Populations Studied	Population Parameters (i.e. structure, status, natural density etc.)	References
BURKINA FASO		

Five sites were studied, Table 59, which all occurred in the climatic zone defined as "Sudanian"[36]. Burkina Faso also has a large area of the Sahelian zone[37], however, all the sites in this zone were sampled in Niger. The findings should be cautiously applied to this area in Burkina Faso, as there has been no validation of transferability of results across the zone.

Table 59 - Populations Studied in Burkina Faso

Region	Area	Latitude	Longitude
1. Sapone forest	100 ha	12°7'10.41"–12°07'0.31" N	1°33'57"–1°33'48.37" E
2. Tiogo forest	30 389 ha	12°11'–12°24' N	2°39'–2°52' E
3. Laba forest (gazetted)	18 501 ha	11°48'–11°39' N	2°44'–2°36' E
4. Cassou forest (gazetted)	29 515 ha	11°44'–11°21' N	2°07'–1°44' E
5. Comoe-Leraba wildlife reserve	125 000 ha	9°39'–10°00' N	4°25'–4°59' E

NB: This study does not indicate what year the sampling was conducted.

The size class distribution curves in Figure 64 showed most classes occurred between the following:
Sudanian zone – 15-45cm Sahelian zone – 30-65cm
The distribution of height classes showed a modal distribution for all climatic zones. Full population parameters are provided in Table 60.

Table 60 - Population Parameters Across Sudanian, Sahelian and Guinean Zones in West Africa

Parameter	Sudanian Zone	Sahelian Zone	Guinean Zone[38]
Diameter (av) - tree	29.02 ± 15.44 cm	49.63 ± 19.44 cm	26.63 ± 7.89 cm
Height (av) - tree	9.51 ± 2.75m	10.18 ± 2.27m	14.16 ± 2.88m
Height (av) - merchant	3.43 ± 1.49	4.08 ± 1.35m	3.63 ± 2.63m
Tree Density	49.20 ± 63.2 N/ha	1.17 ± 0.75 trees/ha	110.9 ± 1.15 trees/ha

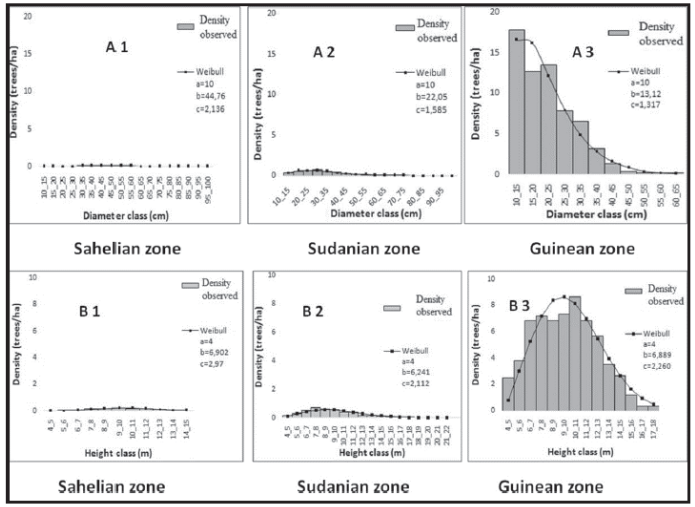


Figure 64 - Size Class Distribution in across Burkina Faso, Niger and Benin based on climatic regions (taken from Segla et al (2016) [257]

Segla et al (2016) [257]

36 Defined in Segla et al (2016) as "Total annual rainfall ranging between 900 and 1200 mm: Sudanian zone, including Tiogo, Sapone, Cassou, Laba and Comoe-Leraba forests (Burkina Faso), Oti-Keran National Park in Togo and Gaya forest (Niger)"

37 Total annual rainfall lower than 700 mm: Sahelian zone

38 Only sampled in Nigeria – also reported under that section

<table>
<tr><th colspan="4">PTEROCARPUS ERINACEUS</th></tr>
<tr><th>Populations Studied</th><th colspan="2">Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td rowspan="2">The study was conducted with 45 plots in W National Park (WNP) and the surrounding hunting grounds adjacent, covering both protected areas and “agroforestry parklands”

NB. This study does not indicate what year the sampling was conducted.</td><td>Populations in protected areas were found to be stable, due to the classic “inverse J-curve” size distribution chart (shown below) demonstrating better recruitment and regeneration conditions in the protected areas.
Conversely, populations in the hunting zones were found to have unstable and declining populations, exhibiting lower densities in all size classes and complete recruitment failure (i.e. no small diameter class individuals).

Protected Area Parklands
DBH (cm) 28.56 ± 0.94 30.76 ± 1.17
Height (m) 8.71 ± 0.25 6.11 ± 0.22
Height/DBH (m) 34.32 ± 1.06 20.68 ± 0.66

Individuals in the 5-15cm and 55-60 were only recorded in protected areas</td><td>Seedling Density (0-5cm)
Protected Area 244.44 ± 101.98
Parklands 6.67 ± 6.67

Sapling Density (5-10cm)
Protected Area 3.95 ± 1.28
Parklands 0

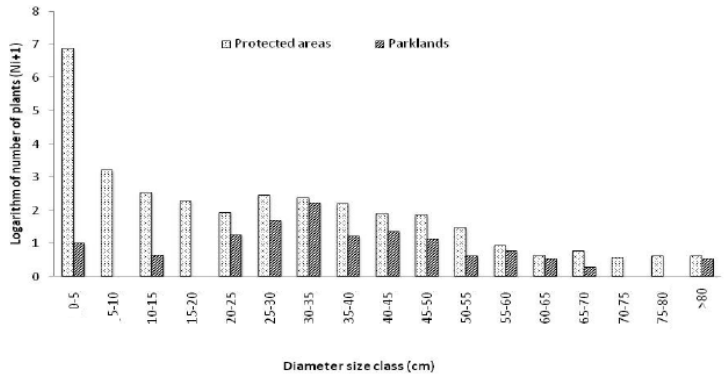
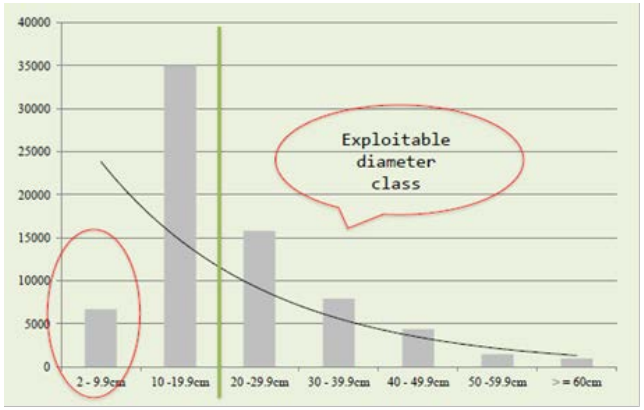
Adult Trees
Protected Area 43.46 ± 3.70
Parklands 20.25 ± 1.94</td><td rowspan="2">Nacoulma et al, 2011 [213]</td></tr>
<tr><td colspan="2"> 

Figure 65 - Size Distribution Curve (Diameter) taken from Nacoulma et al (2011) [213]</td></tr>
<tr><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td>Document stated that this species was threatened at the population level in this country.</td><td></td><td>FAO (2001) [240]</td></tr>
<tr><td colspan="3">CÔTE D'IVOIRE</td><td></td></tr>
<tr><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td>Document stated that this species was threatened at the species level in this country.</td><td></td><td>FAO (2001) [240]</td></tr>
</table>

PTEROCARPUS ERINACEUS			
Populations Studied	**Population Parameters (i.e. structure, status, natural density etc.)**		**References**
GAMBIA, THE			
In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.	Document stated that this species was threatened at the species level in this country.		FAO (2001) [240]
GHANA			
Dry semi-deciduous (DS) forest zone within Sekyere East Afram Plain District [258]. Latitude = 0° Longitude = 07° Study site is in transition between higher rainfall areas and the Guinea savannah	This species was one of 5 species considered to be the dominant species in this forest, accounting for 9.9% of all trees in the study site, with a mean DBH = 15cm. The basal area (per 40 ha) was found to be 1.45m^2, which corresponded to tree volume per 40ha of 14.70m^3. Size class distribution for this species was found to be highly left skewed, with only 3 diameter classes being represented.	Diameter (cm) No. of trees per 40ha 5-10 39 11–20 42 31–50 1 82 in total	Appiah (2013) [258]
4 distinct forest areas [259] • Kintampo • Atebubu • Dorma • Sunyani	This presentation summarises findings of a number of different papers and shows the combined size class distribution curves for the 4 separate forest areas. This shows that the populations in Ghana are declining due to slower recruitment than exploitation rates.  **Figure 66 - Size Class Distribution Curve in Ghana (taken from Dumenu & Bandoh (2014) [259])**		Dumenu & Bandoh (2014) [259]
MALI			
	"The seedlings have a slow growth rate. In Mali, seedlings were only 15cm and 42cm tall after a period of 1 and 2 years respectively (Duvall, 2008)" [259]		Dumenu & Bandoh (2014) [259]
MAURITANIA			

<table>
<tr><th colspan="4">PTEROCARPUS ERINACEUS</th></tr>
<tr><th>Populations Studied</th><th colspan="2">Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td colspan="2">Document stated that this species was threatened at the population level in this country.</td><td>FAO (2001) [240]</td></tr>
<tr><th colspan="4">NIGER</th></tr>
<tr><td>Three sites were studied, which all occurred in the climatic zone defined as Guinean[39]
<table>
<tr><td>Study site</td><td>W Regional Park</td><td>Tamou wildlife reserve</td><td>Gaya Forest (gazetted)</td></tr>
<tr><td>Area</td><td>220 000 ha</td><td>76 000 ha</td><td>9 970 ha</td></tr>
<tr><td>Latitude</td><td>11°00′–12°35′ N</td><td>12°28′–12°50′N</td><td>11°56′34″ N</td></tr>
<tr><td>Longitude</td><td>2°00–3°50′ E</td><td>2°06′–2°24′E</td><td>32°23′20″ E</td></tr>
</table></td><td colspan="2">Figure 64 (above) shows the size distribution curves for the Guinean climatic zone which was sampled in Niger.
Relevant other parameters about the population structure are:
Guinean
$D_{trees\ (av)}$ 26.63 ± 7.89 cm
$H_{tree(av)}$ 14.16 ± 2.88m
$H_{merchant}$ 3.63 ± 2.63m

Predominated by individuals in the 10-25cm size class</td><td>The third zone, only sampled in Niger, and had the following tree density.

Guinean 110.9 ± 1.15 trees/ha</td><td>Segla et al, 2015 [257]</td></tr>
<tr><th colspan="4">NIGERIA</th></tr>
<tr><td>Taraba State; conducted interviews with local people involved in the industry and the community.</td><td colspan="2">It is estimated that 30 trailers leave the Mayo Kam site weekly, leading to the following estimates of tree stands removed:
Weekly – 2250 trees
Annually – 132 600
3 yearly – not less than 400 000 trees felled.
Production has shifted from the early sites due to depletion, and are now focused on Gashaka LGA where Gashaka-Gumti National Park is located (largest in West Africa)</td><td>High densities of Pterocarpus spp, can be found between Ardo Kola, Garba Chede, Mutum Biyu, Gassol, Bali, Gashaka, Kurimi and Takum LGAs</td><td>Ahmed et al (2016) [260]</td></tr>
<tr><th colspan="4">SENEGAL</th></tr>
<tr><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td colspan="2">Document stated that this species was threatened at the population level in this country</td><td>FAO (2001) [240]</td></tr>
<tr><th colspan="4">SENEGAL AND THE GAMBIA</th></tr>
</table>

39 Defined as “Total annual rainfall higher than 1200 mm: Guinean zone including Abdoulaye and Togodo wildlife reserves in Togo.”

PTEROCARPUS ERINACEUS

Populations Studied	Population Parameters (i.e. structure, status, natural density etc.)		References
63 sites (1 km^2) across the Sahelian, Sudanian and Guinean zones were surveyed, however, exact locations are not provided. - Sites 1-30 - savanna vegetation; both grassland and woodland - Sites 36-40, 42-44, 50-51, 54-56 and 58 - forest vegetation	Sites 38-40 were classified as *Prosopis africana – P. erinaceus* woodlands, however, *P. erinaceus* is only one of several dominant species.	The following parameters are related to all dominant species not just *P. erinaceus.* Woody cover = 60% Density = 1686 N/ha	Fredericksen & Lawesson (1992) [220]

TOGO

Three sites were studied in Togo, which occurred across the Sudanian and Guinean climatic zones.

Table 61 – Study Site Information for Togo

Surveyed Area	Area	Latitude	Longitude
Oti-Keran National Park	70 660 ha	9°55'–10°2'N	0°25'–1°00'E
Abdoulaye Wildlife reserve (gazetted)	30 000 ha	8°33'–8°47'N	1°15'–1°27'E
Togodo wildlife reserves (gazetted)	25 500 ha	6°40'–6°50'N	1°20'–1°40'E

Figure 64 (above) shows the size distribution curves for the Sudanian and Guinean climatic zone which were sampled in Togo.
The size classes that predominated were:
Sudanian zone – 15-45cm
Guinean zone – 10-25cm

	Sudanian	Guinean
$D_{trees\ (av)}$	29.02 ±15.44 cm	26.63 ± 7.89 cm
$H_{tree(av)}$	9.51 ± 2.75m	14.16 ± 2.88m
$H_{merchant}$	3.43 ± 1.49	3.63 ± 2.63m

Zone Tree Density
Sudanian 49.20 ± 63.2 trees/ha
Guinean 110.9 ±- 1.15 trees/ha

Segla et al (2015) [257]

In 2013 (Oct-Dec), across 5 ecological zones of the whole country:

Zone	Description
1	Northern plains; Sudanian savannahs; 800-1000mm/year rainfall
2	Northern part of mounts of Togo, mosaics of dry forest and savannah; 1200-1300 mm/year rain
3	Central Togo; Guinean woodland savannahs, altitude: 200-400m; 1200-1500mm/year rainfall
4	Semi deciduous moist forest; altitude: 600-800m; 1300-1600mm/year rainfall
5	Coastal plain of Togo, littoral uplands, abnormal deficit of rain – 800-1200mm/year

Tree Density
Tree population density varied from 57 ± 23 to 76.5 ± 42 N/ha, but were not significantly different between zones.

Population Structure Parameters.
All zone parameters shown here were significantly different between zones.

Table 62 - Dendrometric measurements across zones

Zone	Height (av)	Diameter (av)
1	11.24 ± 3.46 m	29.93 ± 9.6 cm
2	12.40 ± 3.52 m	25.32 ± 10.92 cm
3	11.14 ± 2.74 m	25.86 ± 9.5 cm
4	10.11 ± 1.82 m	21.71 ± 8.06 cm
5	8.16 ± 2.17 m	16.06 ± 5.25 cm

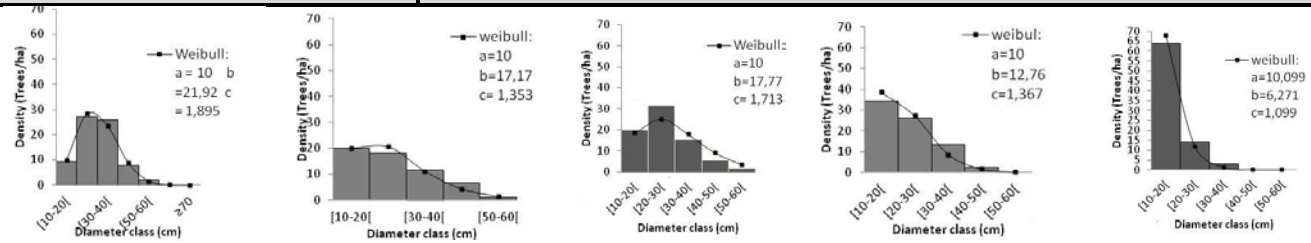
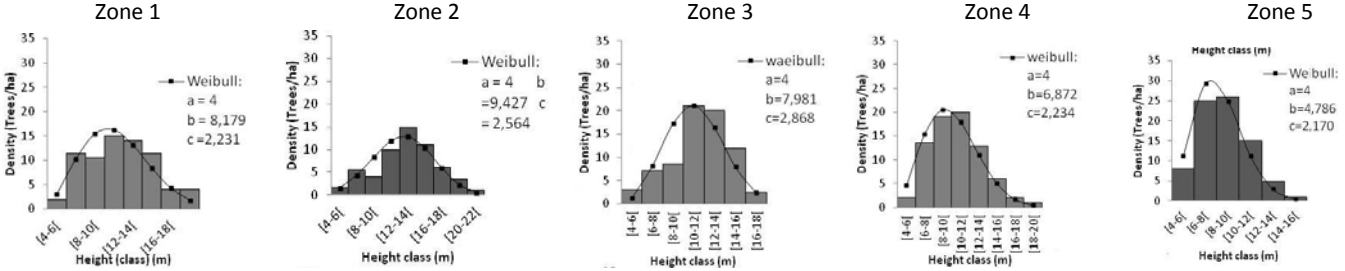
Basal Area range: 1.81 ± 0.01 m^2/ha – 5.62 ± 1.70 m^2/ha Merchantable height range: 2.38 ± 0.83 m – 3.10 ± 1.58 m

Bio Volume range: 4.68 ± 0.03 m^3/ha – 20.62 ± 0.14 m^3/ha

Zones 1 and 3 displayed modal size distributions for height and diameter indicating an older declining population, with low recruitment of juveniles. Zones 2, 4 and 5, particularly 5, showed reverse J curve size distributions indicating good regeneration and stable populations.

Segla et al (2015) [211]

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5

PTEROCARPUS ERINACEUS		
Populations Studied	**Population Parameters (i.e. structure, status, natural density etc.)**	**References**
 **Figure 67 - Diameter Size Class Distributions across Zones 1-5 (taken from [211])**  **Figure 68 - Height Size Class Distributions across Zones 1-5 (taken form [211])**		
Aledjo Protected Area; found along Atakora mounts chain in the northern part of Togo. Latitude: 1°11'E and 1°14'E Longitude: 9°14'N and 9° 17'N. Located in the Sudanian zone	*Pterocarpus* was found to be the dominant species in the reserve, making up greater than 30% of species. Relative density = 5.5 trees/ha	Wala et al, 2012 [261]
In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.	Document stated that this species was threatened at the species level in this country	FAO (2001) [240]

<table>
<tr><th colspan="4">PTEROCARPUS ANGOLENSIS</th></tr>
<tr><th>Range Country</th><th>Populations Studied</th><th>Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td rowspan="2">Tanzania</td><td>Rukwa Region

1. Katavi National Park[40] (KNP)
Latitude 6°45’–7°05’S
Longitude 30°45’–31°25’E
“The area is low elevation characterized by sandy soils and 600–1500 mm rainfall per year that falls between November and April.”

2. Msaginia Forest Reserve[41] (MFR)
North East and adjacent to KNP</td><td>Populations in both locations (i.e. even protected areas with larger trees available) were found to have been in “recruitment failure for at least 30 years, with little to no small trees <15cm DBH observed in either location”

Based on the growth rate predictions and size class distributions, only 2.1 trees per hectare are predicted to progress to exploitable size in the next 100 years. Therefore, this stand is fully exploited, as of 2002.

Loggers were found to have reduced the population in MFR from 11.4 trees per hectare to 3.7 trees per hectare, with less than 1 tree per hectare left in the harvestable size class (>45cm)

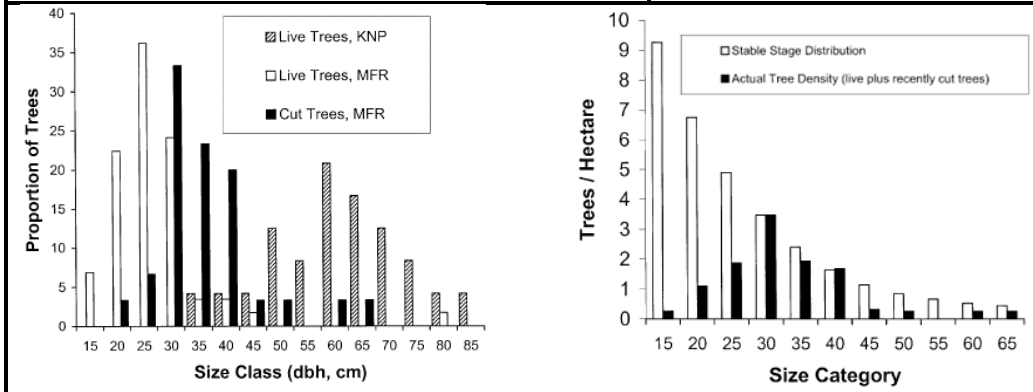
Table 63 - Estimated mean density of trees per hectare (standard deviation) [206]
<table>
<tr><td>DBH</td><td>2-5cm</td><td>5-10 cm</td><td>10-25cm</td><td>>25 cm</td></tr>
<tr><td>KNP</td><td>7.4 (7.8)</td><td>6.8 (7.3)</td><td>7.3 (7.4)</td><td>7.1 (4.6)</td></tr>
<tr><td>MFR</td><td>20.8 (9.4)</td><td>34.2 (19.4)</td><td>26.0 (11.6)</td><td>6.4 (4.6)</td></tr>
</table>


Figure 69 – (Left) Size class distributions for KNP and MFR [206] (Right) Actual MFR vs Stable population structure</td><td>Schwartz et al (2002) [206]</td></tr>
<tr><td>In 2008, 10 sites were chosen between Mikum and Ihombwe villages, Mikumi Division, Kilosa District, Morogoro Region ranging from relatively untouched to degraded.</td><td><u>Population Structure</u>
Figure 70 shows the diameter size class distribution for all sites for trees >2m, however, when including all recruits, i.e. seedlings and saplings, indicates a stable recruitment situation. However, there was only 4 individuals greater than 30cm diameter which could cause recruitment issues in the future.
However, when viewing sites individually, the size class distribution varied widely, with sites 3, 6, 8 and 10 having no trees in the smallest size class of trees.</td><td>Thunstrom (2012) [205]</td></tr>
</table>

40 *No livestock, beekeeping, hunting, fishing or timber extractions are tolerated* [201]

41 Settlements and cattle grazing are forbidden in the Forest Reserve but selective harvest of P. angolensis is carried out under license [201]

<table>
<tr><th colspan="4">PTEROCARPUS ANGOLENSIS</th></tr>
<tr><th>Range Country</th><th>Populations Studied</th><th>Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td rowspan="2"></td><td></td><td colspan="2"><u>Density</u>
Tree density (>2m) = 52.5 trees/ha
Seedling density = 113.75 seedlings/ha

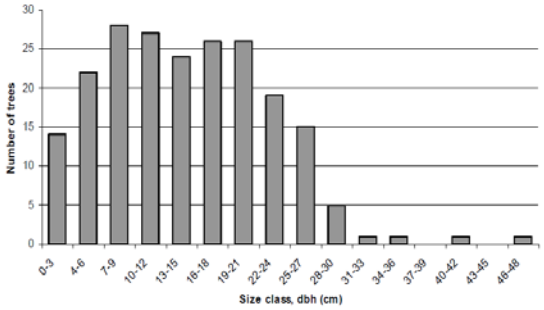
Figure 71 shows how tree and seeding density varies widely between sites.</td></tr>
<tr><td colspan="2"> 

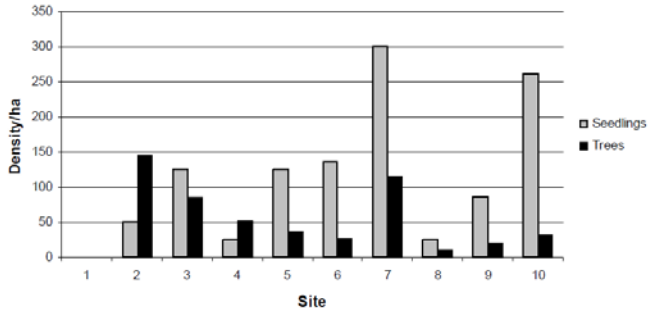
Figure 70 - Population Size Class Distribution for trees >2m (across all 10 sites) [205]
 

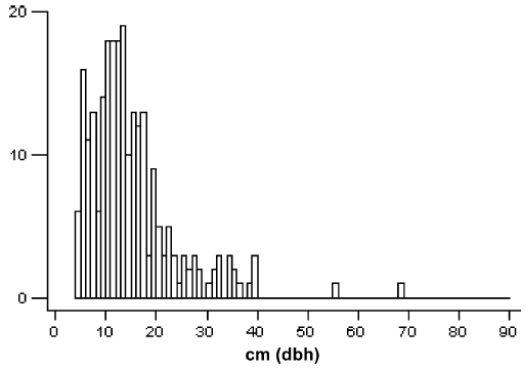
Figure 71 - Tree and Seedling Density per Site) [205]</td></tr>
<tr><td></td><td>42 sites across Miombo woodland forest were sampled in east central Tanzania – Ihombwe Village, Mikumi Division, Kilosa District
Latitude: 7°17’S
Longitude: 36°55’E
Elevation of 635m above SL</td><td>- Survey found virtually no large diameter individuals
- Regeneration was found to be good, likely because trees below allowable logging size have “good seed sets”
 

Figure 72 - DBH size class distribution for all sites (taken from [252])</td><td>Backéus et al. (2006) [252]</td></tr>
</table>

PTEROCARPUS LUCENS

Range Country: Burkina Faso

Populations Studied

In 2008/09, across region 100km north of Ouagadougou (the capital).
Latitude: 12°55'–14°05' N
Longitude: 03°40'–0°30'W

- Covering 5 or 13 administrative regions
- Plot sizes = 1000m^2

Population Structure and Status

Table 64 - Mean Diameter at Breast Height by Ethnic Region (adapted from Table I in [222])

Ethnic Area	No. of Plots	N	DBH (mean)
Fulani	13	213	17.34 ± 8.34
Gourm.	26	283	14.73 ± 7.25
Mossi	33	527	15.1 ±10.04
Samo	29	444	14.21 ± 7.41
ALL	101	1467	15.09 ± 8.59

- Despite the diameter size class distribution, shown in Figure 73 indicating a desired reverse J curve (i.e. stable population), other indicators such as the standard deviation of the quotient index indicate that the populations are unstable

- Noted that previous study Ouedraogo (2006) found the population structure varied from a reverse J shape in Tiger bush habitat to unstable populations in the steppes that had an aging population

- Reverse J shape was also not supported with the expected recruitment (refer to Table 66), with all areas showing poor recruitment of seedlings and saplings <2m in height. This is evidenced by the standard deviation of density being higher than the mean seedling density per hectare

Natural Density

Table 65 - Mean Density of Individuals by Ethnic Region (adapted from Table I in [222])

Ethnic Area	Density (/ha)
Fulani	163.85 ± 68
Gourm.	108.85 ± 59
Mossi	170 ± 79.5
Samo	153.1 ± 64.5
ALL	145.2 ± 66.4

- Gourmantché population density was significantly lower than the other regions

Table 66 - Seedling Density (Adapted from Table III in [73])

Ethnic Area	No of Plots	Seedling Density (/ha)
Fulani	65	135.4 ± 207.5
Gourm.	130	0 ± 0
Mossi	165	252.1 ± 755
Samo	145	80 ± 193.6
ALL	505	122.8 ± 456.1

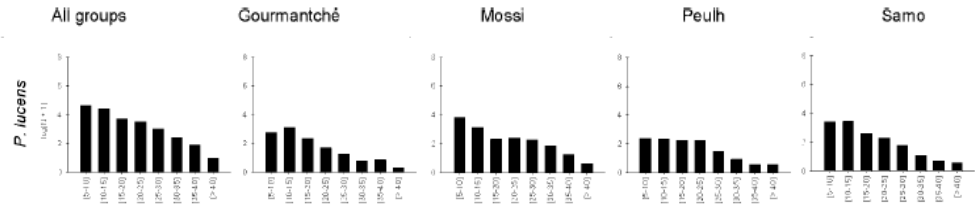


Figure 73 - Diameter Size Class Distribution (taken from [222])

References

Sop et al (2011) [222]

<table>
<tr><th colspan="4">PTEROCARPUS LUCENS</th></tr>
<tr><th>Range Country</th><th>Populations Studied</th><th>Population Structure and Status</th><th>Natural Density</th><th>References</th></tr>
<tr><td></td><td>In 2004/05, Sahelian region – Tongomayel Village in Soum Province
Latitude: 13°44’–14°50’ N
Longitude: 0°32’–2°07’W

Region is characterised by dry climate, low rainfall (June-September) and 8 month dry season from October – May.</td><td>Table 67 shows the height class structure in each habitat type, along with the density of trees. The large number of trees in the smallest size class for Tiger Bush indicates recruitment is occurring.
Table 67 - Density of Species in Height Class across different habitat types (from [218])<table><tr><td>Size class</td><td>Sparse Woody</td><td>Lowland</td><td>Tiger Bush</td></tr><tr><td><1m</td><td>9 ± 4.74</td><td>1 ± 0.1</td><td>267 ± 109</td></tr><tr><td>1-3m</td><td>2 ± 1.1</td><td>1 ± 0.3</td><td>24 ± 9.8</td></tr><tr><td>3-5m</td><td>3 ± 1.5</td><td>1 ± 0.1</td><td>37 ± 15.1</td></tr><tr><td>5-7m</td><td>2 ± 1.0</td><td>0</td><td>27 ± 10.8</td></tr><tr><td>>7m</td><td>1 ± 0.4</td><td>0</td><td>10 ± 4.0</td></tr></table></td><td></td><td>Sanon et al (2007) [218]</td></tr>
<tr><td></td><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td>Document stated that this species was threatened at the population level in this country,</td><td></td><td>FAO (2001) [240]</td></tr>
<tr><td></td><td>In 1993/94, on two 10.24 ha plots (PSP[42] and PTG) in Northern Yatenga Province
Latitude: 14°10’ and 14°13’ N
Longitude: 2 °25’ and 2°27’ W</td><td>Plot PTG Plot PSP
28.7% of total BV As above
Average tree height = 4.3 As above</td><td>Density = 64.5 N/ha
Seedling Density[43] PTG – 10 N/ha
PSP – 40 N/ha</td><td>Couteron (2001) [249]</td></tr>
<tr><td></td><td>In 1993 on 10.24 ha plot on savanna of the Gondo Plain
Latitude: 14°12’27” N
Longitude: 2°27’23” W</td><td>Biological Volume = 4863 m^3/ha
29.8% of total BV in study area
Average tree height = 5.3m
Spatial distribution was found to be highly clumped, with lots of individuals close together</td><td>Density = 35 N/ha
Density of dead individuals = 7.5 N/ha (with 39% on shallow soils)</td><td>Couteron & Kokou (1997) [199]</td></tr>
<tr><td>Ethiopia</td><td>Conducted in Metema district, North Gondar approximately 975km NW of Addis Abada.
Latitude: 12°39’ N
Longitude: 36°17’ E
Altitude range: 550-1608 m Above SL</td><td colspan="2"><u>Population Structure</u>
- P. lucens found to be one of the six most abundant species in this region
Basal Area = 8.9% or 3.78m^2/ha (total Basal Area =
Importance Value Index (IVI) = 19.55% - ranked 5th
- Size class distribution, shown in Figure 74 classed as “irregular pattern”, with absence of trees in the second two size classes
- Overall, poor regeneration potential was found in this area for this species

<u>Tree Density</u>
- The density of wooded trees decreased with increasing diameter class</td><td>Wale et al. (2012) [250]</td></tr>
</table>

42 PSP Plot was the same as used in Couteron & Kokou (1997)
43 Defined as trees with height between 0.5-1.5 meters

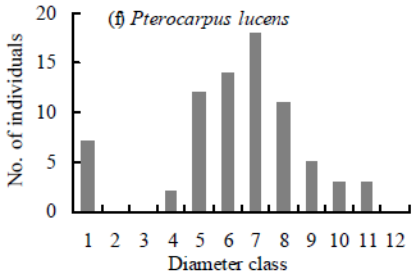
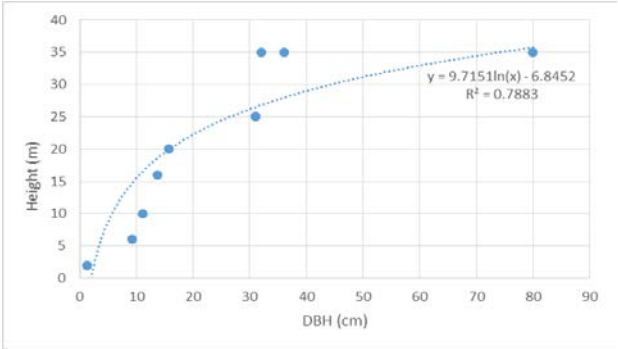
<table>
<tr><th colspan="5">PTEROCARPUS LUCENS</th></tr>
<tr><th>Range Country</th><th>Populations Studied</th><th>Population Structure and Status</th><th>Natural Density</th><th>References</th></tr>
<tr><td></td><td></td><td colspan="2">Table 68 - Species Density Parameters of Pterocarpus lucens in Ethiopia
<table>
<tr><th>Density</th><th>Relative Density</th><th>Relative Frequency</th><th>Sapling Number</th><th>Seedling Number</th></tr>
<tr><td>17.73 N/ha</td><td>4.7%</td><td>5.95%</td><td>3</td><td>3</td></tr>
</table>


Figure 74 - Diameter Size Class Distribution (taken from [250])</td><td></td></tr>
<tr><td>Senegal and The Gambia</td><td>63 sites (1 km^2) across the Sahelian, Sudanian and Guinean zones were surveyed, however, exact locations are not provided.
- Sites 1-30 - savanna vegetation; both grassland and woodland
- Sites 36-40, 42-44, 50-51, 54-56 and 58 - forest vegetation</td><td>Sites 18 and 25 were classified as P. lucens bushland, because of the high density of this species. However, two other species also feature in the dominant species, along with a shrub layer.
The following parameters are related to all dominant species of trees and shrubs not just P. lucens.
Woody cover = 50-60%
Density = 1202 N/ha</td><td>Fredericksen & Lawesson (1992) [220]</td></tr>
<tr><td>Senegal</td><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td>Document stated that this species was threatened at the population level in this country.</td><td>FAO (2001) [240]</td></tr>
<tr><td>Niger</td><td>In 2001, FAO reported on State of Forest Genetic Resources in Sahelian and North-Sudanian Africa, encompassing all countries in the region.</td><td>Document stated that this species was threatened at the population level in this country,</td><td>FAO (2001) [240]</td></tr>
</table>

<table>
<tr><th colspan="4">PTEROCARPUS SOYAUXII</th></tr>
<tr><th>Populations Studied</th><th>Population Structure and Status</th><th>Natural Density</th><th>References</th></tr>
<tr><td colspan="4">CENTRAL AFRICAN REPUBLIC</td></tr>
<tr><td>2004, in Dzanga – Sanga Dense Forest Reserve
Area: 4381 km^2- only 100 ha plot studied
Latitude: 2°14’ – 3°25’ N Longitude: 15°40’ – 16°32’ E
Studied the distribution in relation to soil fertility and topography</td><td colspan="2">Table 69 - Population Parameters of Pterocarpus lucens in Central African Republic<table><tr><td></td><td>DBH ≥ 10cm</td><td>DBH ≥ 30cm</td></tr><tr><td>Basal Area</td><td>1.29 m^2/ha</td><td>1.14 m^2/ha</td></tr><tr><td>Density</td><td>2.41N/ha</td><td>1.41 N/ha</td></tr></table>Distribution was not associated with any chemical soil properties.</td><td>Medjibe et al (2011) [225]</td></tr>
<tr><td colspan="4">CAMEROON</td></tr>
<tr><td>Takamanda Rainforest, South West Region
Area = 67599 ha</td><td>Basal Area = 0.034 m^2
IVI = 7.14
This species was not considered to be a dominant species in this forest.</td><td>- Density = 32.81 N/ha
- However, stem density for tree species was found to decrease with increasing diameter class</td><td>Ndah et al (2013) [262]</td></tr>
<tr><td>Bipindi –Akom II – Lolodorf region – 80 km east of Kribi in south Cameroon
Area = 167 000 ha
Latitude: 2°47’ - 3°14’ N Longitude: 10°24’ - 10°51’ E</td><td colspan="2">This area has been heavily logged, sometimes twice, with heavy machinery used. Logging intensity was estimated to be 10m^3/ha or 0.7 trees/ha, however, the paper states “locally much higher disturbance rates have been observed” so it is unclear where those logging intensity estimates have come from.</td><td>Van Gemerden et al (2001) [263]</td></tr>
<tr><td>1997/98, Tropenbos-Cameroon Programme (TCP) site - 80 km east of Kribi in the southern region of Cameroon.
Latitudes: 2° 4’ Longitudes: 10° 51’ E.
Area = 170 000 ha
Table 70 - Samples taken near Villages<table><tr><th>Felling Samples</th><th>Shifting cultivation plots</th></tr><tr><td>Nkoutou</td><td>Ebimimbang</td></tr><tr><td>Nyangong</td><td>Mvié</td></tr><tr><td>Minkan</td><td>Nyangong</td></tr><tr><td>Assok II</td><td></td></tr><tr><td>Ebimimbang</td><td></td></tr></table></td><td colspan="2">Table 71 - Average number of juveniles per 1000m2 (or 0.1ha)<table><tr><td></td><td>Gaps</td><td>Fields</td></tr><tr><td>Seedling</td><td>5</td><td>2</td></tr><tr><td>Sapling</td><td>2</td><td>2</td></tr></table>Seedling density of the entire tree community had dropped from 0.453 in year one to 0.182 at year six because of felling, and but had recovered somewhat by year 9 to 0.342 (unit not provided). This species had the most abundant seedling density 5 years after disturbance to fields.
Sapling density in gaps followed a similar pattern, dropping from 0.095 in year 1 to 0.074 at year six and rising to 0.107 by year 10.</td><td>Bongjoh & Nsangou (2001) [229]</td></tr>
<tr><td colspan="4">EQUATORIAL GUINEA</td></tr>
<tr><td>Nsork Rain Forest – 150 km east of Bata
Latitude: 1°14’N Longitude: 11°01’E
Date of survey is not provided.</td><td>Basal Area = 0.347 m^2/ha (rated 14th of trees survey)
Frequency – 38.8</td><td>DBH (≥ 70cm) = 0.3 N/ha
DBH (≥ 30cm) = 1.13 N/ha (over 33.5 ha surveyed)
Relative density = 1%</td><td>Senterre & Lejoly (2001) [238]</td></tr>
</table>

<table>
<tr><th colspan="4">PTEROCARPUS SOYAUXII</th></tr>
<tr><th>Populations Studied</th><th>Population Structure and Status</th><th>Natural Density</th><th>References</th></tr>
<tr><td colspan="4">NIGERIA</td></tr>
<tr><td>Oban Forest Reserve (Area = 742.55 km^2)
Latitudes 5°00′ N and 6°00′N
Longitude 8°20′ E and 8°55′ E</td><td>Reserve had high species diversity and richness, but correspondingly low abundances, as shown by low densities per hectare. Economically important species appear to be vulnerable to extinction due to extractive processes.</td><td>Population densities of trees were found to be poor.
This species only had 1 tree per hectare >10cm DBH, with a relative frequency of 0.00124%.</td><td>Aigbe & Omakhua (2015) [239]</td></tr>
<tr><td>In January 1999, in arboreta located at the International Institute of Tropical Agriculture in Southern Nigeria near
Ibadan – latitude: 7°30′N longitude: 3°54′E
Onne – latitude: 4°43′N longitude: 7°01′E</td><td>Average properties at two sites
<table><tr><td></td><td>H_{tree}</td><td>H_{bole}</td><td>DBH</td><td>D_{stump}</td><td>V_{TOT}</td></tr><tr><td>Ibadan</td><td>18.1m</td><td>9.0m</td><td>20.4cm</td><td>27.0cm</td><td>2.99m^3</td></tr><tr><td>Onne</td><td>9.2m</td><td>5.9m</td><td>13.7cm</td><td>17.7cm</td><td>1.20m^3</td></tr></table></td><td></td><td>Kang et al (1994) [264]</td></tr>
<tr><th colspan="4">PTEROCARPUS TINCTORIUS</th></tr>
<tr><th>Populations Studied</th><th colspan="2">Population Parameters (i.e. structure, status, natural density etc.)</th><th>References</th></tr>
<tr><td colspan="4">TANZANIA</td></tr>
<tr><td>Savanna Woodland, Ugalla. Was actually a chimpanzee study, but took note of the tree types used for nests, DBH and heights of each nest tree.</td><td colspan="2">This species was found to be the 5th most dominant species, making up 9.3% of the forest.
While DBH and height of each nest tree was taken, this is not reported in the paper.</td><td>Ogawa et al (2007) [265]</td></tr>
<tr><td>Various forests within a 220 km radius from Dar es Salaam.
- Species recorded at Kiwengoma forest, in Rufiji district
Area = 20.25km^2 (0.15% sampled)</td><td colspan="2">In 1991, this forest was considered to be a “moist forest with high proportion of valuable timber species….notably P. tinctorius”
In 2005, forest was found to have reduced number of large high value timber species due to logging of P. tinctorius (along with others). Lower value species were still found in large quantities. Logging of this species was considered to be more recent than some other high value species.</td><td>Ahrends et al (2010) [266]</td></tr>
<tr><td>Eastern Arc – extends from SE Kenya to southern Tanzania, Matunda forest – part of Udzungwa Mountains (Area =522 km^2)
Study was conducted in 6 areas, each of 0.2 ha each</td><td colspan="2">N (DBH 10-20cm) = 4
N (DBH > 20cm) = 18
This species was found in 5 out of the 6 study plots, only absent from West transect 3.</td><td>Marshall (2007) [267]</td></tr>
</table>

PTEROCARPUS SOYAUXII			
Populations Studied	**Population Structure and Status**	**Natural Density**	**References**
Eastern Arc Mountains - East Usambara Mountains of north-east Tanzania; 3 village landscapes: - Misalai (four plots), - Shambangeda (three plots) - Kwatango (five plots).	- This species was found in 1 forest plot (K2 – Kwatango village) - Height vs DBH curve developed from figures provided in reference for height and DBH of tree	 **Figure 75 - Height vs DBH for *Pterocarpus tinctorius* found in K2 plot of Kwatango village**	Leonard et al (2010) [268]

THREATS, DISTURBANCES AND LEVEL OF TRADE

Africa is a vast continent with an enormous range of habitats, therefore the specific threats facing those habitats are wide and varied. In general, however, they can be categorised into the same threats that face much of the natural habitats across the globe. Over-harvesting for both the local domestic and international markets is prevalent in all countries, with exponential increases in international trade of precious woods observed in the last 5 years (discussed further in the following sections). However, other threats that are facing the region include wide-scale deforestation and forest conversion for agriculture and urbanisation, and large parts of Africa are also suffering from aridification as a result of macro & micro-level climate change and over-grazing by livestock, resulting in many countries adopting specific polices to deal with aridification (refer to Management Measures section). Changing fire-regimes are also affecting the recruitment potential of many woodland species. The wide-ranging species and broader habitat level threats exacerbate the threats faced from selective felling trees of reproductive size, and wholesale deforestation [240]. Table 72 provides an overview of each of these threats. It is essential to be able to understand the true status of populations and the actual level of threats faced by these species, and therefore their ability to recover from disturbance events; whether it be selective clearing, deforestation, fire, disease outbreaks or droughts.

Table 72 - – General Overview of Threats and Disturbances for each African Species

SPECIES	THREAT AND/OR DISTURBANCE TYPE												REF.
	AC	AG	CC	D	FF	HF	HL	HD	HE	M	P	O	
Dalbergia abrahamii						✓	✓	✓	✓				[186, 17]
Dalbergia baronii						✓	✓	✓	✓				[17, 187]
Dalbergia bathiei						✓	✓	✓	✓				[17, 188]
Dalbergia chapelieri	✓					✓	✓	✓	✓				[17, 178]
Dalbergia chlorocarpa						✓	✓	✓	✓				[17, 189]
Dalbergia davidii						✓	✓		✓				[190]
Dalbergia delphinensis						✓	✓		✓	✓			[191]
Dalbergia greveana						✓	✓		✓				[17, 192]
Dalbergia hildebrandtii						✓	✓		✓				[17, 254]
Dalbergia louvelii						✓	✓		✓				[17, 193]
Dalbergia madagascarensis						✓	✓		✓				[17, 180]
Dalbergia maritima	✓					✓	✓		✓	✓			[194]
Dalbergia melanoxylon			✓	✓[44]	✓	✓		✓	✓		✓[45]		[17, 240]
Dalbergia mollis						✓	✓	✓	✓				[17, 185]
Dalbergia monticola						✓	✓		✓			✓[46]	[17, 195]
Dalbergia normandii						✓	✓		✓				[198, 185]
Dalbergia purpurascens						✓	✓		✓				[17, 255]
Dalbergia trichocarpa	✓					✓	✓		✓				[17, 256]
Dalbergia tsiandalana						✓	✓	?	✓				[199]
Dalbergia viguieri						✓	✓	?	✓				[185]
Dalbergia xerophila						✓	✓	?	✓				[201, 185]
Pterocarpus angolensis			✓	✓[47]	✓	✓	✓	✓	✓		✓[48]		[17, 239]
Pterocarpus erinaceus		✓		✓[49]			✓	✓	✓		✓[50]		[17]
Pterocarpus lucens		✓	✓				✓	✓	?		✓		[17, 182]
Pterocarpus soyauxii				✓[51]				✓	✓				[17]
Pterocarpus tinctorius								✓	✓				[17]

AC – Land Conversion for Agricultural, AG = Animal Grazing / Animal Ranching, CC = Climate Change induced Habitat Degradation (i.e. aridification) D = Diseases, FF= Forest Fires, HF= Habitat Fragmentation, HL = Habitat Loss/Deforestation or Degradation HD = Selective Logging for Domestic Markets/Use, HE – Harvest for Export, M = Mining, P = Predation (insects etc.) O = Other.

44 Heartwood can get fungal rot after fire damage
45 Sap is susceptible to powder-post beetle attack, and logs to tunnel-boring cerambycid beetles larvae. Herbivores browse on too.
46 Low genetic diversity in south and extreme north of range
47 Large individuals can be susceptible to fungal attack – "mukwa" dieback. In Zambia, this killed up to 40% of population in one outbreak. Fire damage also makes susceptible to fungus and borers.
48 Sapwood is susceptible to powder-post beetle attack. Heavily browsed by herbivores.
49 Pathogen – fungus *Phyllachora pterocarpi* produces brown spots on leaves, air dispersed
50 Seedlings attacked by rodents and crickets
51 The fungi *Coniophora cerebella, Merulius lacrymans, Polystictus versicolor* and *Poria vaporaria* have been [82]

They key for Table 72 differs to the prevous section as it is based on the information available in the supplied references. The majority of threats faced by these species are anthropogenic and are driven by either their commercial value or their usefulness to the local population living in the vicinity of their distributions. Table 73 provides a species specific summary of the uses of these species, over and above just commercial timber utilisation. Where possible we also provide estimates of a species commercial value, either historically or recently. However, for many African species data is lacking in this regard, as many are simply traded as rosewoods, "*Dalbergia* spp" or "*Pterocarpus* spp", without actually trading on the species name *per se*. This is the case with some other highly valued rosewood species, such as *Dalbergia cochinchinensis* or *Dalbergia retusa.*

Table 73 – Summary of commercial value assessments and uses of *Dalbergia* and *Pterocarpus* species in Africa

MADAGASCAR DALBERGIA SPP - GENERAL

Uses [17, 233, 15]
Madagascan rosewood or palisander is highly prized for making furniture, cabinetry, flooring, veneers, handicrafts, musical instruments, light and heavy construction, intricate carvings, a range of medicinal purposes including antibacterial and anti-malarial properties. Some species are used in dyeing and tanning processes, and some are powdered and mixed with oil in local villages for cosmetic products.

SPECIES	USES													REFs
	BB	C	Co	DC	Dy	Fo	FU	FW	MD	Mu	SD	V/F	OTHER	
Dalbergia baronii		✓		✓			✓			✓		✓		[17]
Dalbergia chapelieri		✓			✓		✓		✓					[17, 173]
Dalbergia chlorocarpa		✓					✓	✓						[17]
Dalbergia greveana[52]	✓	✓	✓	✓			✓		✓	✓		✓	sporting goods	[17]
Dalbergia hildebrandtii							✓							[17]
Dalbergia louvelii				✓			✓		✓	✓		✓	tombstones	[17]
Dalbergia madagascarensis		✓					✓					✓		[17]
Dalbergia mollis		✓					✓							[17]
Dalbergia monticola	✓			✓			✓			✓		✓	turnery/joinery	[17]
Dalbergia purpurascens				✓	✓		✓							[17]
Dalbergia trichocarpa		✓					✓	✓	✓	✓		✓	varnish	[17, 248]

BB	Boat building	FW	Use as firewood/Charcoal
C	Construction	MD	Medicinal: Antigardial, antifungal, antibacterial properties
Co	Cosmetic	Mu	Tone wood and musical instruments
DC	Decorative/handicrafts/carvings	SD	Soil and dune conservation
Dy	Tanning and Dyeing	Ti	Timber (Rough logs and Sawn Wood)
Fo	Fodder for livestock	V/F	Veneers and flooring
FU	Furniture and Cabinetry		

Commercial Value Assessments
In 2009, estimated that 1187 containers of rosewood were exported (approx. 187600 logs), at estimated value of $220 000 000 USD [243].

MAINLAND AFRICA

SPECIES	USES													REFs
	BB	C	Co	DC	Dy	Fo	FU	FW	MD	Mu	SD	V/F	OTHER	
Dalbergia melanoxylon		✓		✓		✓		✓	✓	✓	✓	✓	Fencing	[17, 233, 15]
Pterocarpus angolensis	✓	✓	✓[53]	✓		✓	✓		✓		✓	✓		[17, 206]
Pterocarpus erinaceus		✓		✓	✓	✓	✓	✓	✓	✓		✓	Insect repellent & aphrodisiac	[17, 40]
Pterocarpus lucens		✓		✓		✓	✓	✓	✓			✓	Leaves can be cooked like vegetables	[17]
Pterocarpus soyauxii	✓	✓	✓[54]	✓	✓	✓	✓	✓	✓			✓	piers/sluice gates	[17]
Pterocarpus tinctorius		✓		✓	✓	✓	✓	✓	✓			✓	Plywood, particle board, joinery	[17]

52 Considered sacred by the Mikea people.
53 Powder of this species is mixed with oil/fat to create a "cosmetic" paste that is traditionally applied to exposed skin of Ovambo and Ndembu people and in Angola.
54 Power is mixed with oil in DRC by 'ngula' people

DALBERGIA MELANOXYLON	
Commercial Value Assessments [17] • In 2002 – export value estimated to be 2-3 million USD • Total retail value in 2002 of products containing this species estimated to be 100 million USD. Average annual export from Cabo Delgado province in Mozambique, who produced 60% of exports = 720m^3.	Tanzania • Average annual export (1990-2000) was 73.5m^3, average price (2000) was 10 900 USD/m^3 • Approx. 250 000 carvings exported, value USD 970 000 • Considered "Ordinary" and mid-low value [1]
PTEROCARPUS ANGOLENSIS	
Commercial Value Assessments [17] • 1996: Mozambique exported 5500m^3 • Zambia annual export is at least 5000 m^3 • South Africa = 1 USD per 1kg wood; after carving 7 USD	• Zambia – export price $575 USD (1990s) • South Africa export value – 650 000 USD (1990s) • South Africa export price – 700 USD/m^3 (2008)
PTEROCARPUS ERINACEUS	
Commercial Value Assessments [17] • In 2008, was stated that this species did not feature in international trade, and was only used domestically [17]	• . In 2014, China alone imported 830 million m^3 of "Hongmu" logs from West Africa (HS Code 44039930[55]), of which the majority is estimated to be this species
PTEROCARPUS SOYAUXII	
Commercial Value Assessments [17] • Gabon – 1997 – export volume: 57 000 m^3; 2000-03 increased to 120 000m^3 per year [17]	• Cameroon – 1997 – export volume: 1997 m^3 [236]
PTEROCARPUS TINCTORIUS	
Commercial Value Assessments [17] • In 1990, local price was $2.40 a plank; equivalent to roughly $43.60 USD/m^2	• In 2000, local price was $4.00 a plank; or $72 USD/m^2

General Threats to Africa

As indicated in Table 72 and Table 73 there are a number of threats and uses that are general to Africa as a whole, that impact the individual species. Much of Africa is highly vulnerable to climate change [209], with many countries already affected by limited supply of water and desertification. The impacts of climate change on forest cover, water availability and drought/extreme weather patterns must be considered for all species that exist in these areas, as additional threats to any timber harvest regime. These problems are exacerbated by expanding peri-urbanization, and further exploitation of forest resources that much of the rural population relies on for their livelihoods.

Timber Harvest

Since the early 1990s, it has been well documented that these species, particularly *Dalbergia*, have been under pressure from illegal logging and trade throughout their range, primarily for the international export market [9, 240, 180, 27, 17, 243, 1, 82, 77, 105]. At CoP9, held in 1994, *Dalbergia melanoxylon* was proposed for listing in Appendix II by Kenya and Germany, as it was reported that the species had undergone significant range reductions due to severe exploitation, as far back as the 1960s. This had caused it to be rare and scattered. However, the proposal was withdrawn by proposers due to a "*need to re-examine the problems of species identification*" [269]. Given that this species is relatively easy to distinguish from other *Dalbergia* species, it is unknown what the species identification issues were being referred too. Since then the species has continued to be exploited, with little scientific effort expended in the last 22 years on clarifying the "identification issues", as evidenced by the lack of information in the Taxonomy Section for this species.

Illegal logging and trade in Madagascan rosewood species increased post 2009 following political instability, and has remained an issue ever since [2, 18, 243]. In recognition of the level of threat posed by increasing international trade, Madagascan species of *Dalbergia* were listed on Appendix II of CITES at CoP16, held in Bangkok in 2013. While an Appendix II listing does not preclude trade in listed species, due to the high level of illegal logging in national parks [2, 18, 243], the Madagascan government declared export bans on logs of rosewood species, which remains in force today [27].

More recently, *Pterocarpus* species have begun to be targeted in order to meet the increasing demand for rosewood and other precious woods on the international market, as shown in the Global Overview section. As with the *Dalbergia* species, this has been well documented over the past 5 years, with a plethora of NGO reports, government reports and

55 This customs code covers a range of species considered to be padouk, or hongmu, as listed on the Chinese Hongmu Standard.

scientific papers documenting the increasing level of logging and trade emanating from the African continent, and particularly from West African nations in the wake of logging bans in other parts of the world [270]. Figure 76, taken from Lawson (2015) [12], is representative of the analyses presented in the majority of the above-referenced papers and demonstrates the rapidly increasing trade in timber from Africa. For more detailed information refer to one of the above-referenced reports. What is apparent is that in Africa, the pattern of exports to China and the rest of the world is subject to very rapid change. Sun (2014) reported that prior to 2011, Nigeria only exported 0.1 million m^3 RWE ("Round Wood Equivalent") and that "virtually none" was exported to China. However, only 4 years later Nigeria is reported in Lawson (2015) as exporting roughly 1/3 of the approximately 1 million m^3 of logs from Africa to China. This is further supported by Treanor (2015) which indicated that Chinese imports of rosewood logs from Nigeria ranked the country second only to Lao PDR in 2014, although they only ranked 15th for sawn wood (Refer to Table 74).

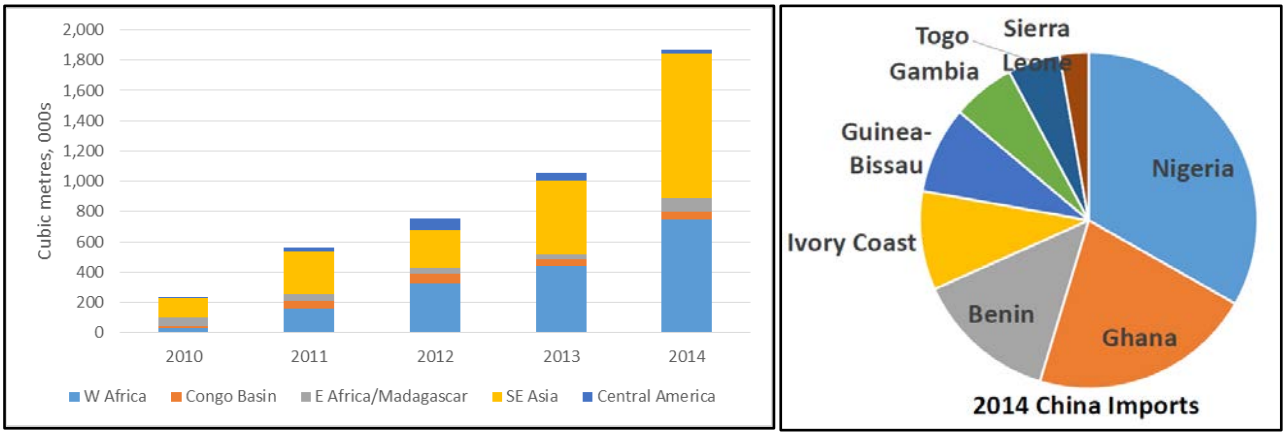


Figure 76 - Increasing International Trade of African Rosewood Species to China taken from Lawson (2015) [12]. (Left) Log imports into China (Right) Breakdown of 2014 log imports by Country into China (presumed to be by volume as not stated in Lawson (2015))

Table 74– Top Suppliers of Rosewood Logs and Sawn Wood to China in 2014 from Africa. Adapted from Table 1 in Treanor (2015) [2].

Country	Logs				Sawn Wood			
	Rank	Volume (m3)	Rank	Value (USD)	Rank	Volume (m3)	Rank	Value (USD)
Nigeria	2	221 995	4	157.6 million	15	472	19	300 000
Ghana	4	151 037	6	108.8 million	14	937	17	700 000
Benin	6	92 065	7	64.2 million	3	11,923	5	8.7 million
Mozambique	7	91,412	8	56.6	9	1,704	14	1.0 million
Guinea-Bissau	8	67,647	9	44.6	33	18	33	20 000
Côte d'Ivoire	9	61,845	10	44.6	20	242	21	200 000
Tanzania	29	282	29	0.4	7	3,068	9	2.2

While the graphs in Figure 76 are for total timber log imports into China and are not rosewood specific, it was estimated that rosewood makes up to 85% of these transactions [12]. Interestingly, Sun (2014) found that as in 2012, the percentage by volume of forest product imported from Africa only equated to 2.8% but that the *value* of imports was almost double at 5.2% [10]. This does not appear to the case by 2015. Table 74 indicates that African nations ranking by value and volume of trade in both logs and sawn wood is always higher for volume than it is for value.

One criticism often levelled at assessments carried out to date is that they primarily rely on Chinese Customs data, which use Chinese specific customs codes for "Hongmu" species that are listed on the Chinese Hongmu standard[56], as discussed in the Global Overview section. Because this standard has up to 33 different species from five different genera – *Dalbergia, Diospyros, Pterocarpus, Millettia* and *Cassia* – it is argued there is no way to know the actual level of trade for each different species. This argument is then used to justify a position that it is not possible to determine whether any of these species would meet the CITES species listing criteria, as it is difficult to ascertain direct levels of trade.

56 A Draft revision of this standard GB/T 18107-2000 – Rosewood Hongmu, was released for comment on 10 October 2014, and does not appear to have been officially published as yet.

However, the Convention and CITES Listing criteria, as described in Resolution Conf. 9.24 (Rev CoP 16) are specifically designed to take into account this type of uncertainty, such as that being able to infer or project that a species is under threat from trade is sufficient to list a species on the Appendices. However Global Eye has conducted species specific analysis of Vietnamese Customs data to gain an understanding of the species specific level of trade of rosewood species into what is the largest consumer country - China. Patterns seen in Vietnamese import and export volumes and trade routes closely resemble those for China. Vietnamese imports and exports provide important insights into which species are being exploited, and which countries are providing those species. There is considerable trade from Vietnam to China itself, thus providing important information on the species that are being imported by China, over and above the analysis of HS Code 4403 9930 10 for logs and 4407 9910 10/4407 991090 for sawn wood and 9403 5010 10/4407 6010 10 for furniture that have been conducted to date.

Species Specific Trade Data Analysis

Vietnam does appear to be an important transit country for many species, with a very high number of species being imported into the country. It appears that much of the imported timber are then exported from Vietnam broadly listed as either *Dalbergia* spp or *Pterocarpus* spp, rather than at their species level. The pattern of shifting imports of logs from Asia to Africa has already been documented in the Global Overview section. This section will outline in more detail the specifics of the trade related to Africa. As discussed in the Global Overview section, there were limited exports of African species from Vietnam, however there was considerable levels of imports, particularly of logs, so this section will focus on analysis of the species specific nature of those transactions. Figure 77 shows the range of species exported from Africa (mainland only) over a 3¼ year period (2013 – April 2016). While *P. erinaceus* dominates the trade, with *P. soyauxii* increasing in prominence over the past few years (refer to Global Overview analysis), what is unexpected is the level of trade and number of species reportedly exported from Africa but that only occur in Asia.

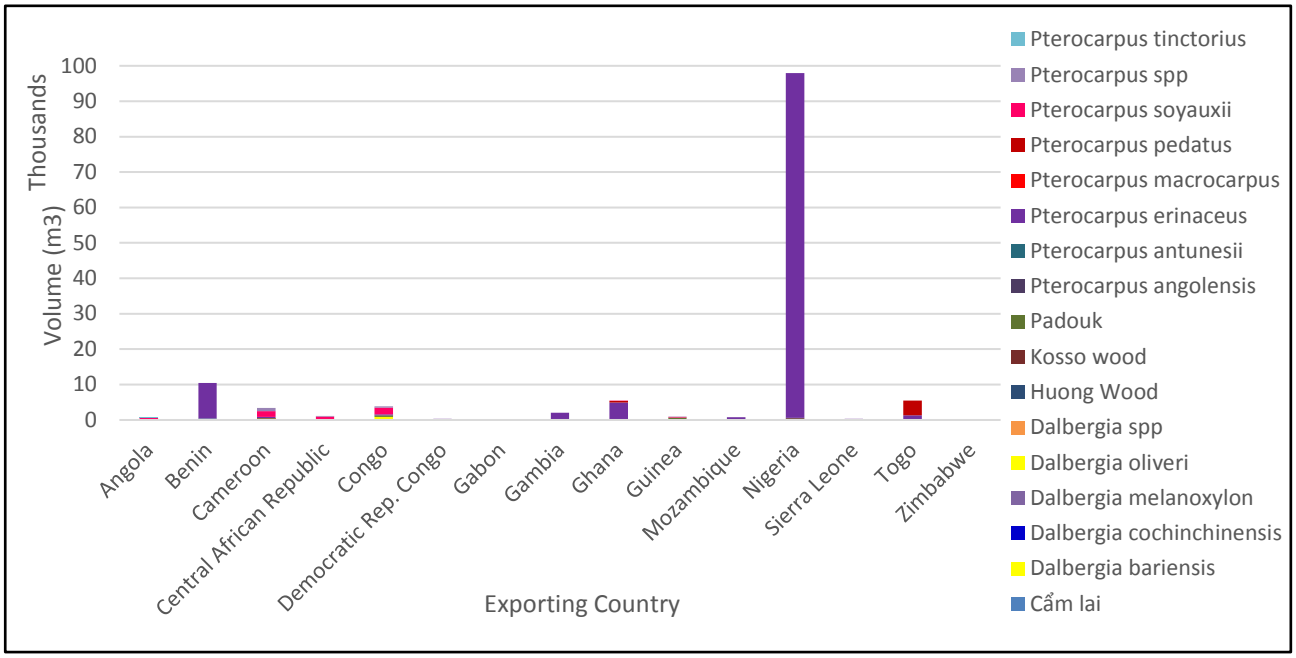


Figure 77 - Rosewood Species (Logs) Exported from Africa from 2013-April 2016

As can be seen in Figure 77, three of the most common Asian species (and their synonyms) are reportedly being exported from Africa – *D. cochinchinensis, P. macrocarpus* (and synonym *P. pedatus*) and *D. oliveri* (and synonym *D. bariensis*) in log form. Figure 79 shows the same information for sawn wood.

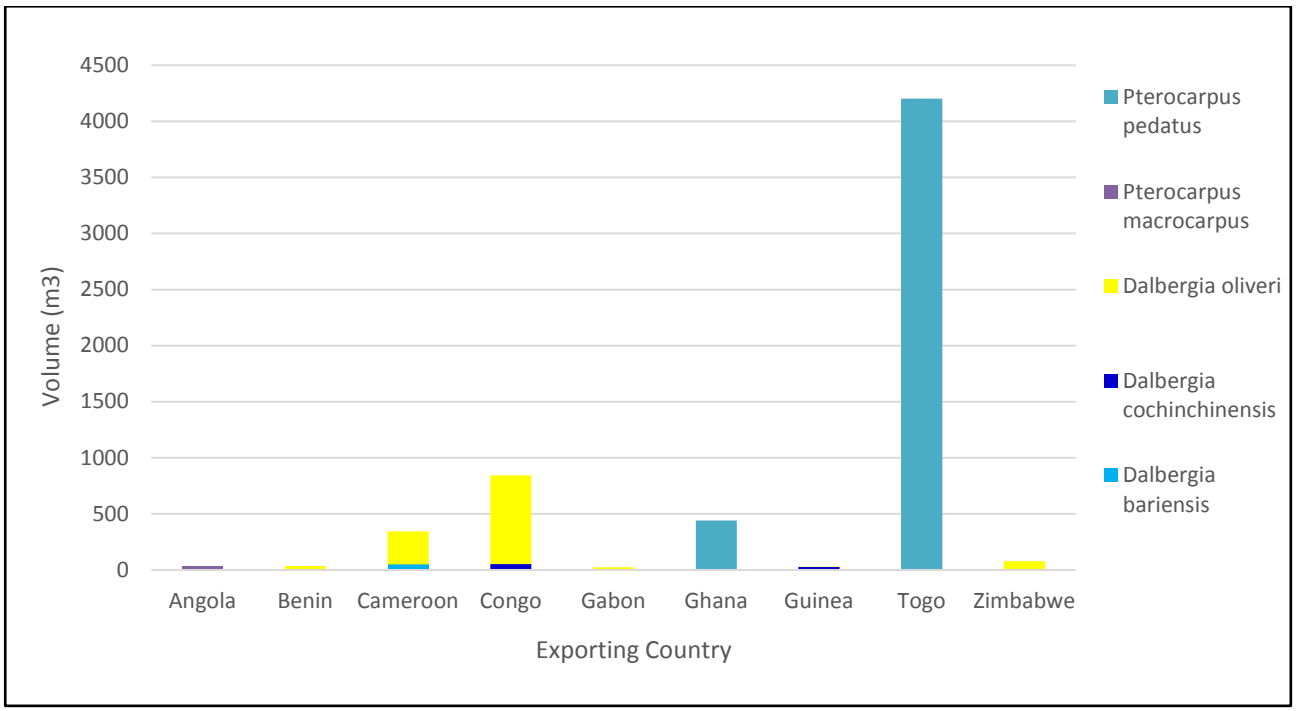


Figure 78 - Log exports from Africa to Vietnam of Asian Species

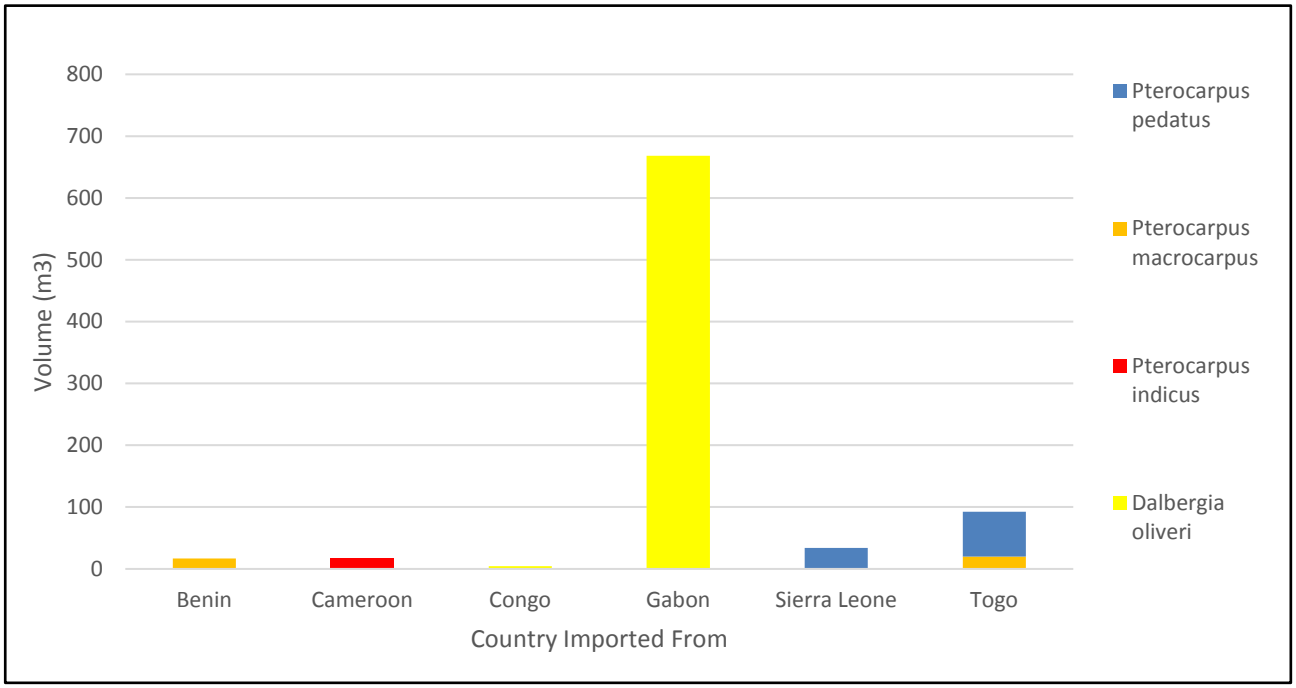


Figure 79 – Sawn Wood exports from Africa to Vietnam of Asian Species

While the overall volumes of these species being reported as exported from Africa is low, for Togo the values actually represent their entire log export harvest to Vietnam. The above graphs indicate a pattern of misreporting that may increase in coming years as more scrutiny is placed on African species. No plantations exist in Africa for these Asian species. It therefore either that traders do not know what species they are trading, which is highly unlikely, or there this is a deliberate measure to misreport species being exported to by-pass species specific log bans for species such as *P. erinaceus*.

MANAGEMENT MEASURES AND LEGAL FRAMEWORKS

Sustainable management has been on the agenda for forests for the last 20-30 years, however there remains a paucity of good examples of sustainable management of forest resources, including rosewood species. Table 75 details the various legislation, policy and management practices that have been implemented within African countries. While the majority of these countries have laws and policies that require sustainable management, implementation appears deficient. The over use of exemptions, government corruption and loopholes in legislation have made sustainable

management particularly difficult for already over-exploited species, as assessed by multiple establishments including the World Bank, FAO, UNODC and Michafutene, Maputo province in Mozambique the REDD initiative [271, 272, 273]. These sustainable management problems have been the subject of very large documents, and so we only provide an overview in this report. The intention is to outline the available information for use in determining whether non-detriment assessments can be made for these species as the mere existence of legislation is not enough to suggest species are well managed; the enforcement and implementation capacity of the State must be assessed too.

There are however isolated examples of forests in Africa that are being successfully managed by local communities through participatory community forest agreements, and that have been FSC Certified for the use of precious woods, mostly *Dalbergia melanoxylon*, as detailed in Table 75. Unfortunately due to time constraints Global Eye was unable to uncover all information on conservation management measures and *in-situ*/*ex-situ* management, so this table presents a snap shot of the situation in Africa that can be developed further where necessary.

Another important consideration with regard to moving towards sustainable management of rosewood species is the matter of seized stockpiles. There are significant volumes of rosewood, particularly Malagasy rosewood, around the world sitting dormant while CITES Standing Committee and the Malagasy government determine how to treat them. Madagascar has been under pressure for several years due to high levels of unsustainable and illegal logging throughout the country. So much so that following the CITES Listing of all Rosewood species from Madagascar in 2013, the government implemented an embargo on all exports of rosewood from the country. This issue has been closely followed within the CITES Forums of Plants Committee and Standing Committee, however there has been little resolution to date. The mere existence of these stockpiles provides opportunities to launder species out of the country. Additionally, the longer the stockpiles sit dormant, the more degraded the wood becomes, making it less useable, if/when it is determined what would be a suitable way to utilise the stockpiles. Unlike wildlife seizures, particularly ivory and rhino horn, that are routinely destroyed to reduce demand for the product, timber stockpiles are rarely treated in the same way.

Technically, under CITES, in order to issue an export certification there must first be a finding of “Legal Acquisition” and a Non-Detriment Finding. Since the timber has been illegally logged, hence why it has been seized, a finding of legal acquisition is difficult and in Madagascar’s case so is building an argument that the export would not be detrimental to the remaining forests in Madagascar, given the very poor conservation status of almost all its species. Strict management measures to control the sale or release of these stockpiles would be necessary. Additionally, in Madagascar a large proportion of the seized stockpiles in Madagascar are not owned or controlled by the government and are simply a “declared” stockpile held on private land, presumably by the persons responsible for the illegal harvest. Unfortunately, seized timber auctions have been shown throughout the Asian region to be contributing to the continued illegal logging of forests, as the seized timber is often sold back to the operator it was seized from. The operator still makes a profit even after paying the associated fine, due to the low level fines in most range countries. A seized timber auction in Madagascar would have to ensure that the profits from the timber sale directly benefitted the local people in Madagascar, as well as improved forestry management and overall conservation outcomes [2]. There are several options being discussed at the present time, with considerable effort being expended by international donors, including WRI and the World Bank to ensure the situation is managed adequately [27].

Table 75 – Domestic Legislation/Regulations and Conservation Management for Rosewood and Precious Wood Harvest and Trade by Country

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td colspan="4">ANGOLA</td></tr>
<tr><td rowspan="2">D. melanoxylon
P. angolensis
P. lucens
P. soyauxii
P. tinctorius</td><td>Prohibited
Data deficient</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
Forest policy and legislation is currently being reformed. FAO is helping the government with a National Forestry Assessment to provide current status of forests [274], however, this has been ongoing since 2008, and is yet to be published.
Land Law no. 9/04 (9 November 2004) - Forest Land Tenure
National Forest, Wildlife and Conservation Areas Policy (Resolution 1 of 14 January 2010) approved. This document lays out the strategic goals and framework for achieving sustainable management of their forestry resource, however, there are a number of issues that will limit the current ability to achieve this [231]
As at June 2016 – DRAFT Forestry and Wildlife Law discussed with Council of Ministers; awaiting debate in National Assembly [275].

Forestry Sector Management
Forestry sector is the responsibility of Minister for Agriculture; with National Forest Directorate and Forest Development Institute in support [231].
There are a number of initiatives that have been started towards reforestation in a number or area, to revitalise the wood extraction industry and combat desertification [231].
59.1 Mha of public lands are administered by the government and not designated for use by communities or indigenous people.

Challenges for Management and/or Conservation Measures
As at the World Forestry Congress meeting in late 2015, FAO assessed the following issues with achieving sustainable forestry management in Angola:
• Outdated laws - Deforestation for fuel wood and subsistence - Poor capacity within management chain and forestry inspection services
• Low production of logs</td></tr>
<tr><td colspan="4">BENIN</td></tr>
<tr><td rowspan="2">P. erinaceus</td><td>Prohibited
Export of all woody species in their raw form is prohibited - Decree No 2005-708 of 12 November 2005 – Article 21 & Inter-ministerial Decree – year 2007 – 0053/MEPN/MIC/DC/SGM /DGFRN/SEB.</td><td>Allowed Trade
Finished products only</td><td>Protection Status
Law No 93-009 of 2 July 1993 & implementing degree No 96-271 of 2 July 1996, Article 25 lists P. erinaceus (under local name Vene) as a protected species</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX.
Law No. 93-009 (2 July 1993) – Forestry Law - provides general forest plan, with 112 articles divided into five titles, covering (II) Forest area of the state (III) Woodland individual and cooperatives and (IV) Search, finding and punishment of crimes. Forests in the domain of the state are classified or protected. Implemented by:
Decree No. 96-271 (02 July 1996) - concerning the law implementing Regulation No. 93-009 of 2 July 1993 (scheme for forests in the Republic of Benin)
Interministerial Order No. 0040/MEPN/MDGLAAT/DC/SGM/DGFRN/SA (29 July 2009) - determining the types, models and conditions for issuing and control of transportation coupons or wooden</td></tr>
</table>

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">2012 – National Forest Policy of Benin (January 2012-2015) - with the advance of desertification and the general degradation of plant cover, Benin has developed this policy based on the principles of effective implementation of the participatory approach to forest resource management.
<u>Conservation Management</u>
2008 - Benin Program of Action for Adaptation to Climate Change</td></tr>
<tr><th colspan="4">BOTSWANA</th></tr>
<tr><td rowspan="2">D. melanoxylon
P. lucens
P. angolensis</td><td><u>Prohibited</u>
Data deficient</td><td><u>Allowed Trade</u>
It would appear there are no restrictions on harvest or trade of these species locally or internationally</td><td><u>Protection Status</u>
Only 1% of country cover is in protected areas, in 6 forest reserves in north east of country [231].</td></tr>
<tr><td colspan="3"><u>Legislation and Policy</u>
Agricultural Resources Conservation Act (1974) – aims to ensure sustainable utilisation by issuing harvest licenses to communities and individuals
Wildlife Conservation and National Parks Act – 1992 – aims to ensure sustainable utilisation by providing hunting licences and permits to individuals to utilise the wildlife resources.
Unable to locate any specific forestry laws prohibiting any harvest or trade in these or any other tree species.

<u>Forestry Sector Management</u>
Ongoing project “Botswana National Forest Management System” has recently published a Botswana Forest Distribution Map, which is underpinned by survey work conducted and included training of 20 staff at the Department of Forest and Range Resources on remote sensing of forests. “The Forestry Departments of Botswana, Zambia and Zimbabwe have tended to use a commercial cutting cycle of 40 years, and a minimum cutting size of 30cm diameter although these have since been reduced in a number of cases.” [209]

<u>General Forestry Conservation Programs</u>
Forest Conservation Botswana administers the “Tropical Forest Conservation Fund” which is to promote the conservation of forests in Botswana. There are a range of projects listed on their website – www.forestconservation.co.bw, however, it is difficult to ascertain the details of these projects and whether they are successful, and whether any of them are aimed at the species in question in this paper. The last annual report available for download is from 2011.

<u>Challenges for Management and/or Conservation Measures</u>
As at the World Forestry Congress meeting in late 2015, FAO assessed the following issues with achieving sustainable forestry management in Botswana:
- Weak forest department - Inadequate financing for forestry management - Lack of research output - Lack of political support
- Poorly managed forest resources - Lack of monitoring of forest resource usage</td></tr>
<tr><th colspan="4">BURKINA FASO</th></tr>
<tr><td>P. erinaceus
P. lucens
D. melanoxylon</td><td><u>Prohibited</u>
Export of logs and processed products is prohibited under Decree No 2005 - 003/MECV/MCPEA of 9 March 2005 which suspends all operations and the trade of timber at the national level.</td><td><u>Allowed Trade</u>
Nil</td><td><u>Protection Status</u>
D. melanoxylon, P. erinaceus and P. lucens is specifically protected by Order No 2004-019/MECV of 7 July 2004 (listed below)</td></tr>
</table>

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION
	Legislation and Policy These laws can be found on the FAO Legislative Database – FAOLEX. **Law No. 003-2011/AN** (5 April 2011) - Forest Code – principles for sustainable management and utilisation of forest, fish and wildlife resources. 280 articles covering (I) Forests, (II) Fauna (III) Fisheries and aquaculture (IV) Crime punishment (V) final provisions. Implemented by the following decree for forestry related aspects: **Decree 2012-090 / MEDD / CAB** (July 05 2012) – Classification of Bissiga Forest. **Decree 2012-449PRES / PM / MEDD / MEF / MATDS / MFPTSS** (24 May 2012) – detailing eco-guard recruitment and conditions of exercise of their profession. Defines an eco-guard as an individual who is committed to contribute to the territorial integrity of a wildlife protection area and / or a forest reserve in close collaboration with the forest service **Decree No. 2001-437/PRES/PM/MEE/MEF/MATD/MTT -** conversion of forests classified Diefoula and Logoniégué in reserved forest and partial wildlife reserve of Comoé-Léraba **Decree No. 2004-019 / MECV** (7 July 2004) **-** determining the list of forest species afforded special protection measures. (implements 1997 Forest Code, unknown if repealed by new version) **Order No. 001-06/PRES/PM/MEE/ -** management of the northern part of the classified forest Ouagadougou dam house a city park. **Order No. 85-47** regulating bush fires and exploitation of firewood/charcoal production. **Joint Order No. 01-47 MEF/MATD/MEE** - procedure for approving development plans of state forests & local communities. (Implements 1998 Forest Code, unknown if repealed) **Joint Order No. 01-48 MEF/MATD/MEE** instituting a forest management fund. (Implements 1998 Forest Code, unknown if repealed by new version) **Joint Order No. 02-024/MEF/MA/MRA/MEE** – established the National Planning Committee of Forests (CNAF). (Implements 1997 Forest Code, unknown if repealed) **Joint Order No. 2004-021/MECV/MFB/MATD/MEDEV** – outlines the delimitation, demarcation and signalling of the reserved forests of the state. **Specifications governing the operation of teak lumber in Burkina Faso -** relates to the definition and regulation of relations between the state, teak harvesters and owners of teak plantations, whether public or private. **Location Reserved Forests in Burkina Faso and Rehabilitation** Plan – Policy developed to help cope with declining forests. This policy is part of the Sustainable Management of Forest and Fauna Resources Framework Programme in Burkina Faso (adopted in 2006) and the Action Plan 2006-2015 Ten-Year Ministry.

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td colspan="4">CAMEROON</td></tr>
<tr><td rowspan="2">D. melanoxylon
P. erinaceus
P. lucens
P. soyauxii</td><td>Prohibited
Export of logs is prohibited [17]</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
Law No 94/01 of January 1994, with implementing decree 95-531 of 1995.
Law No 94/01 of 20 January 1994 which split forest estates into “Permanent Forest Estates” which must cover more than 30% of the country and “Non-permanent Forest Estates”, defined state forest and set out the regulations for utilising forest and wildlife resources. This law states access rights may only be granted to people or companies that are a resident of Cameroon, or have a business registered in Cameroon, whose shareholders are known to the forestry services. Rights can be subcontracted, but the original owner remains liable to meet required obligations.
Forestry Sector Management
• “Cameroon has in place a national-level independent monitor of forest law enforcement and governance” [276].
• Cameroon is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa.
• Online Iterative Forest Atlas of Cameroon tracks land use for the last 15 years and provides up to date information to allow forest monitoring and adequate management of the forestry sector.
• As at 2014, over 1 million ha of forest in Cameroon was either Forest Stewardship Council approved or PEFC (Program for the Endorsement of Forest Certification) certified. However, no details were available on the species managed under these certifications [8].
• Has 98 forest reserves, three of more than 100,000 ha. Many in the south are seriously threatened from invading by village plantations or in the north are subjected to uncontrolled cutting for fuelwood [240].
Conservation Management
There is an major program run by USAID called CARPE, which operates in six countries: the Democratic Republic of Congo (DRC), Republic of Congo, Central African Republic (CAR), Cameroon, Gabon and Equatorial Guinea, that is aimed at sustainable management of natural resources and long term planning for forest land use https://www.usaid.gov/central-africa-regional.</td></tr>
<tr><td colspan="4">CENTRAL AFRICAN REPUBLIC</td></tr>
<tr><td rowspan="2">D. melanoxylon
P. erinaceus
P. soyauxii</td><td>Prohibited
Data deficient</td><td>Allowed Trade
70% of harvested timber MUST be processed prior to export. The rest may be exported as raw logs.</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
Law No. 08.022 of 17 October 2008 – Forest Code This includes measures aimed at sustainable management of forest resources.
Forest Code Implementing Decree of April 2009
Law No 07.018 (28 December 2007) - Environmental Code
Decree No 91.018 - details procedures for granting permits, operating, and developing forests.</td></tr>
</table>

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION
	Ministerial Decree No 019 MEFCPE (5 July 2006) – preparation of management plans. **Order No 09-026** (28 July 2009) - development of the final stages of forest management plans **Ministerial Decree of May 2006** - cancelled special cutting permits Despite these seemingly extensive forestry laws, contradictions exist between them, leading to loopholes and poor governance, especially when paired with a lack of capacity and low political will [277]. There is no overriding policy as to how these measures are implemented. There is an FAO program "Technical Cooperation Programme (TCP) Project TCP/CAF/3402 to help create a national Forestry policy [278]. Forestry Sector Management • Timber companies are required to adhere to export quotas and report monthly to Ministry of Forestry species and volumes exported • Central African Republic is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa. • Online Iterative Forest Atlas of Central African Republic tracks land use for the last 15 years and provides up to date information to allow forest monitoring and adequate management of the forestry sector. Conservation Management There is an major program run by USAID called CARPE, which operates in six countries: the Democratic Republic of Congo (DRC), Republic of Congo, Central African Republic (CAR), Cameroon, Gabon and Equatorial Guinea. https://www.usaid.gov/central-africa-regional, that is aimed at sustainable management of natural resources and long term planning for forest land use
CHAD	
D. melanoxylon *P. erinaceus* *P. lucens*	Legislations and Policy These laws can be found on the FAO Legislative Database – FAOLEX. **Law No. 08/PR/14 –** covers system for conservation and sustainable management of forestry, wildlife and fisheries resources. **Law No. 014/PR/98** - define general principles of the protection of the environment, and how to sustainably manage to avoid all forms of degradation. Has 107 articles over 8 chapters including: enforcement agencies, education, heritage and environment protection, pollution, Environmental Impact Assessments, management measures. This is implemented by the following Decrees; **Decree No. 904/pr/pm/merh/2009** (06 August 2009) - regulating pollution and nuisance to the environment. **Decree No. 630/PR/PM/MERH/2010** (August 4 2010) – regarding Environmental Impact Assessments FAO is working with the government of Chad to improve their natural resource management and promote use of non-timber forest products [279]. Forestry Sector Management/Conservation Management • Chad is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa. • Signatory to Convention on Conservation of Biodiversity (ratified under Law No. 002/2006 (5 Feb 2005))

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td colspan="4">CONGO</td></tr>
<tr><td rowspan="2">P. angolensis
P. lucens
P. soyauxii
P. tinctorius</td><td>Prohibited
Law No 37-2008 – Wildlife and Protected Area; which defines an Integral Forest Reserve where no hunting, fishing, grazing, clearing or exploiting forests is allowed unless previously authorised</td><td>Allowed Trade
The majority of timber in Congo must be processed in country. Only 15% of timber is able to be exported as logs, by permit holders, after which a 35% surcharge is added to shipments.</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
Congo has a comparatively large amount of legislation for the exploitation and management of forest resources, full summaries can be found at http://www.forestlegality.org/risk-tool/country/republic-congo The following is a selection of those assessed to be the most relevant for this document.
Law No 16-2000 – Forest Code is formed by 183 articles covering provisions such as state forest, utilisation of forest, taxes and selling of wood, forest fund and establishes the different permits allowed for exploitation. This law was amended Law No 14-2009 and Law No 16-2000. Implementing decrees:
Decree No. 2002-434 (Dec 2002) – Forest Fund Decree No. 2002-437 (Dec 2002) Forest Management and Use
Law No 003/91 – Environment Protection
Law No 48/83 – defines conservation and exploitation of wildlife
Order No 8516/8516/MEFE/CAB – Dec 2005 – defines Forest Management Units and how to manage them
Order No 5279 (July 2009) – Steering Committee on Sustainable Management of Forests established
In 2013, there was issues raised with the Forest Code, relating to conversion and deforestation framework, poor definitions and the decommissioning and management of forests.
Forestry Sector Management
• Congo is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa.
• More than 40% of publically owned forests are privately managed [280]
• As at 2014, over 1.3 million ha of forest in Congo was either Forest Stewardship Council approved or PEFC certified. However, no details were available on the species managed under these certifications [8].
• Brazzaville Declaration was signed by Congo (along with several other Congo Basin countries) in an attempt to deal with illegal logging issues. The agreement aims to work towards sustainable development of a legal timber industry.
• Online Iterative Forest Atlas of Congo tracks land use for the last 15 years and provides up to date information to allow forest monitoring and adequate management of the forestry sector.
Conservation Management
The project “CAWHFI Component Project Financed by the European Commission”, for which Congo is a partner, was started in 2008, and is listed on the UNESCO website has having successfully achieved the following objectives relevant to sustainable management of forests:
Objective 3 – Strengthen the monitoring capacities so as to improve the effectiveness of the management for all the partners of the three ecological complexes</td></tr>
</table>

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<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">Objective 4 – Support the private sector and national administrations in the sustainable management of natural resources, and in particular of wildlife in protected areas.
CAWHFI stands for Central Africa World Heritage Forest Initiative – which is a transboundary network of protected areas and world heritage sites. The sites within Congo include: Nouabale-Ndoki National Park (In Sangha Tri-National Complex); Adzala-Kokoua National Park (Tri-National Dja-Odzala-Minkebe Complex) and Conkouati-Douli (Gamba-Conkouati Complex)
There is another major program run by USAID called CARPE, which operates in six countries: the Democratic Republic of Congo (DRC), Republic of Congo, Central African Republic (CAR), Cameroon, Gabon and Equatorial Guinea. https://www.usaid.gov/central-africa-regional, that is aimed at sustainable management of natural resources and long term planning for forest land use</td></tr>
<tr><th colspan="4">CÔTE D'IVOIRE</th></tr>
<tr><td>D. melanoxylon
P. erinaceus</td><td>Prohibited
2013 - Exploitation, harvest, transportation trade and export of "Vene" (P. erinaceus) timber banned (Decree No. 2013-508 of 25 July 2013)
1994 - Logging banned above 8th parallel (Decree No 94-368 – see below)
1995 - export of raw timber banned (Decree No. 95-682)</td><td>Allowed Trade
2013 - allowance of three months for existing stocks to be exported, March 2014 the ban was lifted for three further months to allow additional pre-ban stocks to be exported

Processed wood is allowed to be exported.</td><td>Protection Status
P. erinaceus is protected from exploitation under Decree No. 2013-508 of 25 July 2013</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX.

Law No. 65-425 - 1965 Forestry Code – provides definitions of forestry classifications, including access rights. Does not regulate plantations. "Forestry domain" is divided into permanent forest and private/community forests. Exploitation of forests is broadly regulated by this code.

Law No. 96-766 – Environmental Code of 1996 – protected area management and prevention of habitat degradation

1998 Rural Land Law – applies to forests in rural areas – does not include classified forests.

Law No. 2002-202 – regulates establishment, financing and management of protected areas, including police powers for enforcing laws

Decree 94-368 – (listed in Prohibited above) – also stopped industrial logging near community forests and Permanent Forest Domain, and created a legal logging rights database. Prescribed increased reforestation efforts and management which lead to an increase in reforestation.

Signatories to International Tropical Timber Agreement (1994) and Convention on Biodiversity of 1992, as well as CITES, all which promote sustainable use of natural resources.

Forestry Sector Management
• Prior to the 1998 Rural Land Law land was owned by the State, however it was generally recognised that land belonged to the lineage of people who first settled and cultivated the land. They were not able to sell the land (as it was state owned) but could grant access to the land for utilisation. Following a 1999 coup d'état, political instability in the country lasted until 2011, primarily over the issues of land rights and use [281]. Consequently the 1998 Rural Land law was not implemented effectively.
• Permanent Forest Domain – 230 classified and harvesting zone forests – covering 4.24 million ha (13% of land cover). These forests are zoned for harvest and protection.
• Companies operating in classified forests are required to submit forest management plans outlining reforestation plans, as well as social investment for local rural communities [281]. Due to scarcity of timber resources, many companies have switched effort to processing, rather than extraction [281].
• Community forests are regulated by customary law – where local people are allowed to access for subsistence.</td></tr>
</table>

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<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3"><u>Conservation Management</u>
8 National Parks and reserves account for 9% of the country's total land area [281], but are under pressure from forest conversion to agriculture by nearby farmers.
Decree No. 95-682 of 1995 requires 1 hectare for every 250 m^3 harvested to be reforested [281].</td></tr>
<tr><th colspan="4">DEMOCRATIC REPUBLIC OF CONGO</th></tr>
<tr><td rowspan="2">D. melanoxylon
P. angolensis
P. lucens
P. soyauxii
P. tinctorius</td><td><u>Prohibited</u>
Banned exchange of existing old forest concessions, and instituted a moratorium on issuing new ones (Decree No 05/116 of 24 Oct 2005)</td><td><u>Allowed Trade</u>
Companies must process 70% of wood production prior to export (Article 109 of Forest Code).</td><td><u>Protection Status</u>
No list of protected plant species</td></tr>
<tr><td colspan="3"><u>Legislation and Policy</u>
The Democratic Republic of Congo (DRC) has a comparatively large amount of legislation for the exploitation and management of forest resources, full summaries can be found at http://www.forestlegality.org/risk-tool/country/democratic-republic-congo and on DRC legal database. The following is a selection of those assessed to be the most relevant for this document.

Forestry Code No 011/2002– overriding forest management document; detailing the forest policy, protections and production rights

Law No. 11-09 (9 July 2011)– The Basic Fundamental Principles Relating to Environmental Protection

Decree No 08/08 (8 April 2008) - details procedures for classifying and declassifying forests

Decree No 08/09 (8 April 2008) – details the procedure for assigning forest concessions

Ministerial Order No 035 (5 October 2006) and supplementary Ministerial Order No 105 (17 June 2009) - Logging policies

Ministerial Order No 036 (5 November 2006) – details how to prepare, approve and implement management plans. Created forest concessions for wood production.

Ministerial Order No 001 (12 April 2007) - regulates industrial cutting of timber and purchase, sale and export of timber

While the above lists appears extensive, they have left loopholes which has allowed exploitation of permits meant for artisanal collection by large logging companies [277]

<u>Forestry Sector Management</u>
• DRC is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa.
• Companies with forest concessions are required to report on a quarterly basis the volume of timber harvested [277], and are used to calculate required taxes and duties
• Online Iterative Forest Atlas of DRC tracks land use for the last 15 years and provides up to date information to allow forest monitoring and adequate management of the forestry sector.
• The state owns all natural resources in DRC, with people or companies gaining access to use and exploit through various mechanisms (covered above).

<u>Conservation Management</u>
• 8.6% of land cover is designated as a protected area [282].
• In 2004, cancelled 91 forest concessions following an independent review, reducing forest concessions from 22 million ha to 10 million ha.</td></tr>
</table>

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">• University of Kisangani and The Centre for International Forestry Research (CIFOR) has been running capacity building programs to improve the number of trained professionals in forest related disciplines [283]
• There is an major program run by USAID called CARPE, which operates in six countries: the Democratic Republic of Congo (DRC), Republic of Congo, Central African Republic (CAR), Cameroon, Gabon and Equatorial Guinea, that is aimed at sustainable management of natural resources and long term planning for forest land use https://www.usaid.gov/central-africa-regional.</td></tr>
<tr><td colspan="4">EQUATORIAL GUINEA</td></tr>
<tr><td rowspan="2">P. soyauxii</td><td>Prohibited
Bioko Island - Banned cutting of trees and logging companies in 1990 (Decree No. 55/1991)</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX.
Law No 1/1997 – Forestry Law – governing use and management of forests, amended by Law No. 7/2003 of 27 November 2003 - Law of Environment
Decree No 121/1992 – Review and Resizing of Logging Concessions
Decree No 56/1991 – Rules of the Special Corps of Forest Rangers.
Decree No 55/1991 – Prohibits logging and export activities on a large scale on island of Bioko
Decree No 9/1991 – Modification of rates for timber exports and royalties for forest concessions
Decree No 32/1990 – Regulation of MINAGRI-GPR – which was a merger between Ministry of Agriculture, Livestock and Rural Development with Ministry of Water, Forestry and Reafforestation; outlines that it is responsible for direction, management and promotion of forestry policy (among others)
Order No. 4/1989 – Regulates cutting of trees and forestry use by logging companies
2002 – National Forestry Action Programme (NFAP) – 5 year policy regarding sustainable use of forest resources
Forestry Sector Management
• Online Iterative Forest Atlas of Equatorial Guinea tracks land use for the last 15 years and provides up to date information to allow forest monitoring and adequate management of the forestry sector. The main findings from this work were [284]:
o Protected areas have increased by 63% (392 023 ha) from 1997 to 2013, while forest concessions decreased over the same time period by 56% (930 000 ha)
o Total area of forest concessions contained within Protected Area reduced from 129 813 ha to 11 234 ha from 2002 to 2013
o Majority of large forest concessions are operated by foreign owned companies – 11 foreign companies own 48 forest concessions, with locals installed as high level partners as is required by Equatorial Guinean Law
Conservation Management
• Equatorial Guinea is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa.
• There is an major program run by USAID called CARPE, which operates in six countries: the Democratic Republic of Congo (DRC), Republic of Congo, Central African Republic (CAR), Cameroon, Gabon and Equatorial Guinea, that is aimed at sustainable management of natural resources and long term planning for forest land use https://www.usaid.gov/central-africa-regional.</td></tr>
<tr><td colspan="4">ERITREA</td></tr>
<tr><td>D. melanoxylon</td><td>Prohibited</td><td>Allowed Trade</td><td>Protection Status</td></tr>
</table>

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td>Data deficient</td><td>Data deficient</td><td>Data deficient</td></tr>
<tr><td></td><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX.
Law No 155/2006 (20 September 2006) - Forestry and Wildlife Conservation and Development Proclamation, implementing regulation for forestry:
Legal Notice 111/2006 – Regulations for the issuance of forestry permits
This Act covers the following: conservation of endangered species, afforestation and reforestation; management of protected areas; promoting forest management and conservation awareness. It also establishes a Forestry and Wildlife Advisory Board.
Environmental Proclamation 1996 – provides framework for protection of environment and sustainable development. This is act appears to have been repealed by law no 155/2006 which states "This Proclamation declares any Proclamation, Decree, Order, Legal Notice or Directive concerning matters covered by this Proclamation to be repealed."

Conservation Management
• National Action Programme for Eritrea to Combat Desertification and Mitigate the Effects of Drought (NAP) [285]
• Revised National Biodiversity Strategy and Action Plan for Eritrea (2014-2020) [286]</td></tr>
<tr><th colspan="4">ETHIOPIA</th></tr>
<tr><td>D. melanoxylon
P. lucens</td><td>Prohibited
Data deficient</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td></td><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX.
Law No. 542/2007 (4 September 2009) - Forest Development, Conservation and Utilization Proclamation
Law No 541/2007 (7 June 2007) – Development Conservation and Utilization of Wildlife Proclamation
Legal Notice 343/1968 – Regulations for Protection of Private Forests (unclear whether this has been repealed)
Regulation No. 84/2007 - Oromia Regional State Forest Enterprises Supervising Agency Establishment
Regulation No. 88/2007 - Bale Forest Enterprise Establishment – to sustainably manage forest resources, and be accountable to Oromia Regional State Forest Enterprises Supervising Agency
Regulation No 147/2009 – establishes Oromia Bureau of Land and Environment Protection</td></tr>
<tr><th colspan="4">GABON</th></tr>
<tr><td>P. soyauxii</td><td>Prohibited
- Trees < 70cm diameter are not allowed to be felled [17]
- "untitled" logging is prohibited, $21 000 USD fine or 6 months prison
2010- export ban on logs (including cut through) and sawn wood (boules in French) [287]</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td></td><td colspan="3">Legislation and Policy
Gabon has established regulations and legislation for the exploitation and management of forest resources for many years, full summaries can be found at http://www.forestlegality.org/risk-tool/country/gabon. The following is a selection of those assessed to be the most relevant for this document.</td></tr>
</table>

<table>
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<tr><td></td><td colspan="3">
Gabon Constitution – outlines provisions for managing forestry, mining and habitat as well as environmental protection as a core principle (Article 1 and 47)
Law No. 16/01 of 2001 – Forest Code – amendment to 1996 forest code to improve forest governance and improve benefits to local communities through development of social and economic opportunities. It established provisions for harvest and processing of timber including contractual arrangements, which were automatically applied to all forestry operators in 2005
Law No 16/93 – Gabon Environment Code – covers general conservation of Gabon's environment, as well as sustainable use of natural resources

Forestry Sector Management
• Forestry Management is the responsibly of the Ministry of Forestry, Environment and Protection of Natural Resources (formerly Ministry of Water and Forests)
o Directory of Inventories, Management and Forest Regeneration – monitor individual forest concessions
o Department of Forest Production – administer "small logging titles"
o Department of Industries and the Department of Research – responsible for forest control and enforcement.
o There are also several provincial units for verification and enforcement actions in local regions
• All forest concession holders are required to develop a 30 year Forest Management Plan (Article 21 of Forest Law), which subdivides the concession into annual harvest zones. Each of these zones is also required to have operation management plan prior to harvest being authorised to ensure logged areas have a rotational period of 25 years.
• Logging concessions (Article 106 of Forestry Law) can be between 50 – 200 kha, but one company can only hold concessions up to 600 kha.
• Online Iterative Forest Atlas of Gabon tracks land use for the last 15 years and provides up to date information to allow forest monitoring and adequate management of the forestry sector.
• 2010 – entered into Voluntary Partnership Agreement with EU, which have not progressed
• Government has instigated a review of Forest Code, which appears to be moving away from the previous forward steps to ensure community and social development and promote sustainable development, which is concerning

Conservation Management
• Gabon is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa.
• Forestry and Environment Sector Program (PSFE) – designed to improve sustainable management of natural resources and alleviate poverty
• National Action Plan to Fight against Illegal Forestry Exploitation – to increase the number of investigations, arrests and prosecutions of illegal loggers
• There is an major program run by USAID called CARPE, which operates in six countries: the Democratic Republic of Congo (DRC), Republic of Congo, Central African Republic (CAR), Cameroon, Gabon and Equatorial Guinea, that is aimed at sustainable management of natural resources and long term planning for forest land use https://www.usaid.gov/central-africa-regional.
</td></tr>
<tr><th colspan="4">GAMBIA, THE</th></tr>
<tr><td>P. erinaceus</td><td>Prohibited
In November 2012, The Gambia banned export of Pterocarpus erinaceus [288]</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
</table>

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<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX.
Forest Act 1998 – maintenance and development of forest resources, with view to improving socio-economic development. Act contains 121 sections with 13 Parts, including: (II) Forests (III) Forestry Funds (V) Declaration of Reserved Forests, Community Forests and State Controlled Forests (VI) Private forest (VIII) Declaration of protected Forests (IX) Forest administration (X) Forest management (XI) Offences
Forest Regulations 1998 – define activities for management, protecting and control of forest, as laid out in the Act.
Forestry Sub-Sector Policy (2010-2019) – policy is aimed at alleviating poverty through development of forest resources in a sustainable manner
The National Biodiversity Strategy and Action Plan (2015 – 2020) - the purpose is to conserve and promote the rationale use of the biological diversity</td></tr>
<tr><th colspan="4">GHANA</th></tr>
<tr><td rowspan="2">P. erinaceus
P. lucens</td><td>Prohibited
July 2014 - harvesting and export of rosewood is prohibited
1998 - Chainsaw milling outlawed
1994 – raw log export ban</td><td>Allowed Trade
Processed timber</td><td>Protection Status
P. erinaceus is protected from harvest</td></tr>
<tr><td colspan="3">Legislation and Policy
Ghana has been leading the way in Africa for forest conservation, such that Ghana has established regulations and legislation for the exploitation and management of forest resources since 1906. Full summaries can be found at http://www.forestlegality.org/risk-tool/country/ghana. Following is a selection of those assessed to be the most relevant for this document.
Forestry Commission Act 1999 Act 571 – established the Forestry Commission of Ghana, which is the subdivision of the Ministry of Lands and Natural Resources
Forest and Wildlife Policy of 2012 – revised the previous forest and wildlife policy of 1994, to include managing/improving ecological integrity of forests, savannah and other ecosystems; promoting rehab and restoration of degraded lands, sustainable development of wildlife/forest industries – especially processing resources, promoting transparent governance and community participation in natural resource management; promoting capacity building to support sustainable management.
Forest and Plantation Development Act of 2000 (Act 583) - established the Forest Plantation Development Fund to develop private commercial purpose plantations
The Forest Protection (Amendment) Act 2001 (Act 624) – creating harsher penalties for breaking forest laws to harvest, market or destroy trees
Timber Resource Management Act 1997 (Act 547) – covers resources allocation and timber access rights including Timber Utilisation Contracts (TUCs) for timber harvest
L.I. 1649 Timber Resource Management Regulations (1998) – management requirements for timber industry required under Timber Resource Management Act (1997)
L.I. 1721 Timber Resources Management (Amendment), 2003- amended previous regulations to create a competitive bidding process for timber harvesting rights
Timber Resources Management Act 617 (Amendment) Act, 2002 – amends Timber Resource Management Act to exclude private plantations from timber rights. It also includes disqualification of timber access rights for illegal loggers.
All these laws promote value adding processes in domestic industries.
Other relevant policies include:</td></tr>
</table>

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">

Forestry Development Master Plan (1996 – 2020)
Ghana: Biodiversity Conservation Strategy. MEST, 1998
Natural Resource Management Programme (NRMP I) Phase I, the World Bank, 1999–2003.The High Forest Development Component inter alia established a Forest Plantations Development Centre (FPDC) to promote and encourage private forest plantation development
Draft Forest Plantation Strategy (2016-2040)

<u>Forestry Sector Management</u>
The Ministry of Lands and Natural Resources is responsible for managing forests in Ghana.

Entered into Voluntary Partnership Agreement with EU
Ghana has trialled D. sissoo plantations since 1951
New trials are planned under the Forest Plantation Strategy (2016-2040); with D. sisso, D. retusa, D. melanoxylon and P. erinaceus listed as priority species.
In 2014, 1674 ha of forest is FSC certified [8]

</td></tr>
<tr><th colspan="4">GUINEA</th></tr>
<tr><td rowspan="2">P. erinaceus
P. lucens</td><td><u>Prohibited</u>
2006 - Export ban on coarse logs and lumber (Law No. A/2006/6634/AEF/CAB/SG)</td><td><u>Allowed Trade</u>
Data deficient</td><td><u>Protection Status</u>
Data deficient</td></tr>
<tr><td colspan="3">
<u>Legislation and Policy</u>
These laws can be found on the FAO Legislative Database – FAOLEX.
Law No. L99/013/AN (22 June 1999) - Forest Code. 132 Articles covering (I) Forest Policy (II) Forestry institutions (III) Woodlands (IV) Forest management
Law No. A/2003/7084/MAE/SGG – approval of development plan of the Forest Reserve of Sinceri-Oursa.
Law No. A/2003/7085/MAE/SGG – approval of development plan of the Forest Reserve of Balanyan-Souroumba
Law A / 2003/9537 / MAE / SGG - established a technical committee negotiation of the management contract and the specifications of N'Zérékoré Forestry Centre, for the implementation of the Convention Sino- Guinean operating industrial complex processing of wood Niampara N'Zérékoré
Joint Order A/2005/671/MAEEF - detailing rates of forest fees.
Decree D/2004/50/PRG/SGG – establishing public industrial and commercial nature called "Forest Centre N'Zérékoré to manage and ensure sustainable use of humid forests
Decree A/2001/1955/MAE/SGG - development plan of the Forest Reserve Mont Bero.
Decree D/91/105 – established the Forestry Service; who are responsible for reforestation programs, developing forest management plans, conservation of forests/protected areas and assisting forest police
Decree No. 216/PRG/SGG/89 (23 November 1989) – outlines the powers and organization of the Guinean Office of wood.
<u>Conservation Management</u>

National Action Programme to Combat Desertification (PAN / LCD) in June 2006 – framework to fight against land degradation and deforestation
National Action Plan for Adaptation to Climate Change (NAPA) of 2008.

</td></tr>
</table>

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td colspan="4">GUINEA-BISSAU</td></tr>
<tr><td rowspan="2">P. erinaceus
P. lucens</td><td>Prohibited
All exports of timber are banned [40]</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX.

Decree-Law No. 5/2011 (22 Feb 2011) - New Forestry Law – aims to promote sustainable exploitation of forestry resources, while improving socio-economic status of locals. 58 articles with 8 Chapters including (I) Forestry institutions (II) Forestry regime (III) Forest management (IV) Community forests and (V) Controls and sanctions

Decree-Law No. 5-A/2011 – established the legal framework for protected areas.

Legislative Decision No. 01/GM/97 (27 December 1996) - forestry management regulations for community forest. The regulations detail authorised activities within these protected areas (with and without a permit) and prohibited activities, such as forest fires, hunting and non-authorized honey collection.

Forestry Sector Management
Ministry of Agriculture and Rural Development is responsible for managing forests, as per Forest Law (5/2011)

Conservation Management
• Strategy and National Action Plan for Biodiversity (2000); to establish network of protected areas, restore degraded habitats, prioritise species for conservation and utilisation based on economic importance or conservation need, develop integrated plans for conservation and development of natural resources</td></tr>
<tr><td colspan="4">KENYA</td></tr>
<tr><td rowspan="2">D. melanoxylon</td><td>Prohibited
Data deficient</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy

Law Number No. 19 (26 January 2007) – Forests Act (2005) - An Act of Parliament to provide for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio-economic development of the country. Implemented by the following:

Forests (Harvesting) Rules, 2009 (Cap. 385). - 31 December 2012

Forests (Charcoal) Regulations, 2009 (Cap. 385). - 31 December 2012

Declaration of Amara Forest (L.N. 69 of 2012). - 06 June 2012

Declaration of Likia Extension Forest (L.N. 68 of 2012). - 06 June 2012

Forests (Fees and Charges) Rules, 2012 (L.N. 104 of 2012). - 22 August 2012

Vesting of Assets and Transfer of Liabilities (Cap. 385). - 31 December 2012

Forests (Participation in Sustainable Forest Management) Rules, 2009 (Cap. 385). - 31 December 2012

Law Number No. 18 of 2000 - Forest (Suspension of Timber Harvesting and Stone Quarrying) Amendment) Rules, 2000 – suspended timber harvest for a period of 1 year, which could be extended indefinitely</td></tr>
</table>

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">There are a number of separate decisions relating to individual forests and the rules around utilisation, however, they have not been included here. Further information can be obtained from FAO Legislative Database – FAOLEX

Kenya Forest Policy Strategic Plan 2013-2014 - The strategic goal is to increase the forest and tree cover to 4% over the plan period to enhance sustainable supply of forest good and services.</td></tr>
<tr><th colspan="4">LIBERIA</th></tr>
<tr><td rowspan="2">P. erinaceus</td><td>Prohibited
Data deficient</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX, along with additional rules and regulations implementing forestry management measures.

Environment Protection and Management Law (26 November 2002) - to establish a legal framework for sustainable development, management and protection of the environment by the Environment Protection Authority

National Forestry Law (6 April 2000) –management and conservation of forest resources, defining ownerships, regulates trade in forest products and wildlife. Amended by the following laws:

Act for the Establishment of A Protected Forest Area Network and Amending Chapter 1 and 9 of the new National Forestry Law, Part II of Title 23 of the Liberian Code of Laws Revised. - 10 October 2003

National Forestry Reform Law of 2006. - 19 September 2006

Wildlife and National Parks Act (21 July 1988) - primary objective of this Act is to ensure conservation and development of wildlife by controlling hunting and preserving habitat

Community Rights Law of 2009 (16 Oct 2009) – specifically regulation with regards to forest lands - determines the rules, guidelines and procedures for the establishment of forest communities and to access, manage, use and the benefits of forest resources

Forestry Development Authority Act (1 Nov 1976) – established the Forestry Development Authority (FDA). The associated regulations are all relevant as well.

Executive Order No. 1 - GoL Forest Sector Reform (2 Feb 2006)– required adoption of UN Security Council Resolution recommendations regarding Forest Concessions, cancelled all existing forest concessions, and gave power to FDA to allocate new ones.</td></tr>
</table>

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<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td colspan="4">MADAGASCAR</td></tr>
<tr><td rowspan="2">All Dalbergia species listed in Table 1, listed as being in Madagascar</td><td>Prohibited
Decree 2010-141 of 24 March 2010 prohibits the logging and trade of rosewood.</td><td>Allowed Trade
Domestic only</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX,
Law No. 97-017 (8 August 1997)- revising forest legislation, implemented by
Decree No 97-1200 (2 Oct 1997) –adopting forest policy
Inter-Ministerial Order No. 19 560-2004 (18 October 2004)- suspending the granting of mining permits and forest license in areas reserved as "conservation areas"
Decree No. 2013-785 (22 October 2013) - delegation arrangements for managing state forests for public or private persons.
Law No. 2015-056 (3 February 2016) – sets out transitional arrangements for court responsible for the prosecution and trial of offences relating to rosewood/ebony
Ordinance No. 2011-001 (August 8 2011) - regulation and punishment of rosewood offenses and ebony (Repealed by 2015-056 above)
Inter-ministerial Order No. 16.030/2006 – This order bans the exploitation of ebony and rosewood. Export of rosewood is only allowed in finished product form. (does not appear to have been repealed unlike other orders such as Decree No 2010-141 stating almost the same things)
Law No. 2015-005 (February 26 2015) - Protected Areas Management Code, implemented by Decree No 2015-769 (28 April 2015) on the establishment of the protected area called "Ampasindava" rural communes of anorontsangana and Bemaneviky West District Ambanja, Diana region
Decree No. 4667/2002 (17 Oct 2002) – established the forestry station in conservation vocation of Anjiamangirana.
Forestry Sector Management
Responsibility for local forest management and management of natural resources was decentralised in 2014 to local territories under Law No 2014-018
Conservation Management
• National Strategy for Clean Development Mechanism in Madagascar (2012) – to take advantage of benefits of sale of gas emissions and promote sustainable development</td></tr>
<tr><td colspan="4">MALAWI</td></tr>
<tr><td rowspan="2">D. melanoxylon
P. angolensis
P. lucens
P. tinctorius</td><td>Prohibited
Data deficient</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX;
Forestry Act (No. 4 of 1997) - An Act to provide for participatory forestry, forest management, forestry research, forestry education, forest industries, protection and rehabilitation of environmentally fragile areas and international co-operation in forestry and for matters incidental thereto or connected therewith.
2001 - Malawi's National Forestry Programme; sustainable management of forest goods and services for improved and equitable livelihoods.
Conservation Management</td></tr>
</table>

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">• 2005 - National Action Programme for Malawi for the United Nations Convention to Combat Desertification.
• 2015 - National Biodiversity Strategy and Action Plan II (NBSAP II) 2015-2025</td></tr>
<tr><th colspan="4">MALI</th></tr>
<tr><td>P. erinaceus
P. lucens
D. melanoxylon</td><td>Prohibited
• Felling and uprooting of P. erinaceus is prohibited (under Forest Code Law No 95-004), “unless expressly authorized” by the Director of Forest Service
• Export of unprocessed wood products are prohibited under Decree No. 00-505/P-RM (16 October 2000)
• Export of all timber is banned under the Inter-ministerial interdiction No 2014 -1856 / MC-MEF-SG-MEEA (10 July 2014)</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Forest Code (Law No. 95-004) lists P. erinaceus as protected</td></tr>
<tr><td></td><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX;
Law No. 96-016 – established the forest management unit (implemented by Decree No 96-083)
Law No. 95-004 – Forest Code - details conditions of forest resources management, implemented by:
Order No. 95-2487/MDRE.SG (14 November 1995) - determining early firing conditions in forestry of state and decentralized authorities. –
Decree No. 01-404/p-rm (17 September 2001) - outlining terms and conditions of exercise of rights conferred by the titles of exploitation of forest resources.
Law No. 95-031 establishing the conditions for management of wildlife and its habitat.
Inter-ministerial Order No. 10-2114-MAMEP-MEA-MEFP-SG (16 July 2010) - determines the agricultural business, farming, fishing, forestry.
Decree No. 04-137 (BIS) / P-RM of 27 April 2004 - distribution of income received on the occasion of the exploitation of forest and wildlife areas of the state between the development funds and protection of forests and wildlife and the budgets of local authorities.
Conservation Management
• Signatory to the convention on Biological Diversity
• 2000 - Strategy and Action Plan for Biodiversity in Mali</td></tr>
<tr><th colspan="4">MOZAMBIQUE</th></tr>
<tr><td rowspan="2">D. melanoxylon
P. angolensis
P. lucens
P. tinctorius</td><td>Prohibited
Data deficient</td><td>Allowed Trade
Quota for D. melanoxylon are laid out in Ministerial Decision (1 April 2016) by province form 10t to 400t</td><td>Protection Status
D. melanoxylon is listed as a precious wood under Min. Order 265/2005.</td></tr>
<tr><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX;</td></tr>
</table>

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<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">
Law No. 16/2014 (20 June 2014) - established the basic principles and rules on the protection, conservation and sustainable use of biological diversity within conservation areas. 63 articles, covering (II) Management of Conservation Areas (III) Protection Areas (IV) Recuperation and restoration of biological diversity (V) Endangered Flora and Fauna species (VI) Resettlement (VII) Taxes (VIII) Inspection (IX) Offences and penalties. This law –amends Law No 10/99 Forest and Wildlife Act and Act No 20/97 – Approving the Environment Act.
Law No. 10/99 on Forest and Wildlife Act (07 July 1999) This is implemented by
Ministerial Order No. 93/2005 (04 May 2005) - regulating the distribution among local communities of the 20% of tax funds collected from the use of forest and wildlife resources.
Decree No. 12/2002 approving the Regulation on Forestry and Wildlife. - 06 June 2002 Implemented by Ministerial Order No 142/2007 – Classifying the primary transformation of timber for all forestry species
Decree No. 40/2011 extending the geographical limits of the Special Reserve of Maputo.
Decree 70/2013 (20 December 2013) - regulating Approval Procedures Projects for the Reduction of Emissions causing Deforestation and Forestry Degradation.
Decree No. 30/2012 (1 August 2012) - establishing forestry exploitation requirements with an ordinary licence.
Decree No. 11/03 (25 March 2003) - amending Decree No. 12/2002 on Forestry and Wild Fauna Act.
Decree No. 38/98 (18 August 1998) - establishing fees for tree logging and fines for illegal forestry activity.
Decree No. 12/81 (25 July 1981) - establishing protective measures regarding logging of certain tree species, implemented by:
Ministerial Order No. 265/2005 (31 December 2005) - approving the list of precious timber
Ministerial Decision (1 April 2016) - establishing the table of logging quota for precious tree species
Ministerial Order No. 52-C/2003 - on forest species used for producing timber
Resolution No. 8/97 (1 April 1997) - approves the strategic policy for forestry and wildlife development
<u>Forestry Sector Management</u>
• 51 949 ha of forest were FSC certified in 2014 [8]
<u>Conservation Management</u>
• 2007 - Environmental Strategy for the Sustainable Development of Mozambique - aims to create a common vision for a wise environmental management, leading to sustainable development to contribute to the eradication of poverty afflicting the Mozambican society
<u>Ex-situ Species Management</u>
In Michafutene, Maputo province a plantation of P. angolensis was established as a 1000 hectare conservation plot between 1930-1960. This has been reduced to only 50 hectares. This species was found to be ecologically important with Importance Value Index (IVI) of 12, however, no further details are provided [289].
</td></tr>
<tr><th colspan="4">NAMIBIA</th></tr>
<tr><td rowspan="2">D. melanoxylon
P. angolensis
P. lucens</td><td><u>Prohibited</u>
Data deficient</td><td><u>Allowed Trade</u>
Data deficient</td><td><u>Protection Status</u>
Data deficient</td></tr>
<tr><td colspan="3"><u>Legislation and Policy</u></td></tr>
</table>

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<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">These laws can be found on the FAO Legislative Database – FAOLEX;

Law No. 12 of 2001 (6 December 2001) - Forest Act established the Forestry Council; as well as details management and use of forests and forest produce and protection of the environment. The Act consists of 50 sections divided into 8 Parts, including Forest management (II); Forest Management (II); Classified forests (III); Protection of the environment (IV); use of forests and forest produce (V); Control and management of fire (VI) and Offences and enforcement (VII).

Law No. 13 of 2005 (23 December 2005) – Forest Amendment Act, 2005 – changed definitions of Minister and Ministry as well as amendments to Forestry Council established

Law No. 7 of 2007 (21 December 2007) Environmental Management Act - promote the sustainable management of the environment and the use of natural resources through principles for decision making on matters affecting the environment, implemented by:

Government Notice 29 of 2012 - List of activities that may not be undertaken without Environmental Clearance Certificate: Environmental Management Act, 2007

Forestry Sector Management
• 224 335 ha of forest were FSC certified in 2014 [8]</td></tr>
<tr><th colspan="4">NIGER</th></tr>
<tr><td>P. erinaceus
P. lucens</td><td>Prohibited
Data deficient</td><td>Allowed Trade
Data deficient</td><td>Protection Status
Data deficient</td></tr>
<tr><td></td><td colspan="3">Legislation and Policy
These laws can be found on the FAO Legislative Database – FAOLEX;

National Forestry Plan NIGER (2012-2021) - to address forest degradation, desertification and poverty

Law No. 2004-040 (8 June 2004) fixing the forestry regime. To determine the management regime and implementation value of forest resources. It is formed by 90 articles covering (II) Woodland (III) Forest management (IV) Penal provisions (V) Final provisions

Law No 98/07 (29 April 1998) – establishing the rules for hunting and wildlife protection. 50 articles covering (II) hunting rights (III) protection of wildlife, protected species, wildlife reserves, the prohibited hunting methods (IV) offences and prosecution, implemented by:
Decree No. 98-295/ PRN/ MH/E (29 October 1998) establishing the rules for hunting and wildlife protection

Decree No. 2004-200/PRN/HRM/E/LCD (9 July 2004) – regarding the protection of green spaces and green belts

Decree No. 2001-202 / PRN / MHE / LCD (2 November 2001) determining the functions of the Minister of hydraulics, environment and the fight against desertification.
Implemented by: Decree No. 9/MHE/LCJD IE/ (12 February 2002) established project steering committee natural forests (FAFN)
Decree No. 2005-81/PRN/MHE/LCD organizing the Ministry of the environment and the fight against desertification

Decree No. 30/MDR/etc (13 September 1980) - established the Bureau Technique Forestier for management of water and forests for long term planning for conservation of forest resources

Conservation Management
2012 - Great Green Wall for the Sahara and Sahel Initiative - National Strategic Action Plan.</td></tr>
<tr><th colspan="4">NIGERIA</th></tr>
<tr><td>P. erinaceus
D. melanoxylon</td><td>Prohibited</td><td>Allowable Trade</td><td>Protection Status</td></tr>
</table>

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION		
P. lucens *P. soyauxii*	• Taraba State – felling and export of *P. erinaceus* is strictly prohibited • Logging in all natural forests and for all "woody species" is prohibited in Cross River State - which today accounts for 60% of Nigeria's total forests remaining • Export of all round wood banned since 1976 [290].	Unable to locate any information relating to international trade being allowed.	In Nigeria, forestry laws are under the remit of states, of which, there are 36. *P. erinaceus* is a protected species in Taraba State
	Legislation and Policy These laws can be found on the FAO Legislative Database – FAOLEX; **National Park Service Act:** Involves the management and conservation of wild fauna and flora in national parks. **Forest Law 1961:** **Forest Regulations:** **The Nigeria Forestry Act 1937:** Gives each Governor or Local Government authority, the authority to constitute its own forest reserved. **National Park Decree**: Led to the creation of the National Parks Governing Board and the creation itself of the Department of National Parks. **Endangered Species Decree of 1985** The National Forest policy was approved in June 2006 and endorsed in 2008 to be domesticated by all States in Nigeria. It is geared towards poverty reduction, promotion of food security, environmental and biodiversity conservation in addition to sustainable production of wood and non-wood products. In Nigeria, the forest industry is essentially controlled by the private sector. [1]. Forest Management Commenced with the establishment of regional forestry authorities. Their main function was the constitution of forest reserves, and the management of such was for the production of forest resources, which include both timber and non-timber products. The management and control of the forest reserves is vested in the State Governments with the Federal Department of Forestry only having monitoring functions, and holds not executive authority regarding the management of forest reserves and other forest lands. The National Parks Board has provided the Federal Government with some measure of executive powers over the protection of constituted National Parks [290].		
RWANDA			
P. tinctorius	Prohibited Article 26. Only activities authorised by the Minister can be conducted in the protected State forest [291].	Allowed Trade Article 56: Must have a license issued stating nature of good and its origin if a wholesaler of forest products in either their harvesting state or after process, wishes to sell such items Article 60: The sale of forestry products, either in harvested state or processed into other products, must	Protection Status *P. tinctorius* could not be located on the protected species list (Ministerial Order 007/2008) Article 23: The minister may suspend harvesting of forest products Article 27: The minister shall set out a list of protected trees found in state forests, district or private forests and that of isolated trees

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION		
		meet the dimensions and standards required by the market into which they are placed	
	Legislation and Policy These laws can be found on the FAO Legislative Database – FAOLEX; **National Forestry Policy:** Implemented to increase forest cover, high value additions to forest products and rational utilisation of forests, to contribute to a balanced development through economic growth and the promotion of ecological values. **Presidential Order No. 68/01 of 12/03/2014**: ratifying the accession of Rwanda to the International Union for Conservation of Nature and Natural Resources (IUCN) **Law No. 47/013 Determining the Management and Utilisation of Forests in Rwanda:** Chapter II outlines forest categories; Chapter IV Planting, conservation and protection of forests; Chapter VII Licences. This law shall apply to 1. All types of forests, 2. All tree species, 3. Persons who possess, process and utilise forest products, 4. All issues relating to sustainable forest management. **Ministerial Order 007/2008 of 15/08/2008** Establishing The List of Protected Animal and Plant Species Forestry Sector Management • Rwanda is a signatory to Treaty on the Conservation and Sustainable Management of Forest Ecosystems in Central Africa and to establish the Central African Forests Commission (COMIFAC) (2005). The goal of this treaty is to promote sustainable management of forests in central Africa.		
SIERRA LEONE			
P. erinaceus	Prohibited Cut, burn, uproot, damage or destroy a protected tree unless licensed under Section 22 (3) Forestry Act Minister may publish notice in Gazette declaring any area to be protected for purposed of conservation of soil, water, flora or fauna. Section 21(1) Forestry Act	Allowed Trade January 2010- export ban on all timber exports. Page 63 [292].	Protection Status Not Listed as protected under Forestry Act
	Legislation and policy These laws can be found on the FAO Legislative Database – FAOLEX; **The Forestry Act 1988:** Is the main law for the forestry sector in Sierra Leone and focuses on management and forests use regarding production purposes. Provides for the Minister to declare protected areas for soil, water, flora or fauna conservation and protected trees anywhere in Sierra Leone. The Act was to go under review in 2013. **The Forestry Regulation of 1989:** Developed to implement the Forestry Act 1988. Deal with concessions and licensing permits whilst providing specific directives for community forests, offences and penalties and conditions relating to the reforestation fund. **The Environment Protection Agency Act 2008:** Establishes the Environment Protection Agency of Sierra Leone, and gives if overarching responsibility for matters of environmental protection legislation, implement and ensure compliance regarding national environmental policies, regulating and monitoring waste, pollution and other environmental hazards.		
SÉNÉGAL			
P. erinaceus *D. melanoxylon* *P. lucens*	Prohibited Export of *P. erinaceus* strictly prohibited by Forest Code that the species is protected under [293].	Allowed Trade Cutting species is restricted to limited national quotas intended only for local processing (Gueye, 2015) [40]	Protection Status

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION		
		Minimum diameter of *P. erinaceus* allowable for exploitation is 60cm (use of residents only). Products acquired under right of use is strictly limited to personal and family use only	*P. erinaceus* species is protected by the current legislation; Forest Code (Law No 98-03 of 8 January 1998) and Decree No 98-164 of 20 February 1998 [40] *D. melanoxylon* is protected by law, according to Louppe et al (2008) [17]
	Legislation and policy These laws can be found on the FAO Legislative Database – FAOLEX; **Forest Code (Law No 98-03 of 8 January 1998:** Related to the management of forests, designates authority over forests and provides for the punishment of crimes, development of forests, Water and Forest Service responsibilities, and diversity provisions. **Decree No 98-164 of 20 February 1998** Relates to the operation, regulation and requirements relating to forestry resources and reserves in Senegal. Forestry Sector Management Whilst once centrally managed in Senegal, however since 1998, the management has been decentralised with nationally set quotas being divided between 120-170 enterprises that are holding professional forest producer license issued by the Forest Service. Senegal relies solely on import for wood-based panels and other wood products [294].		
SOUTH AFRICA			
D. melanoxylon *P. angolensis*	Prohibited • Can not cut, disturb, damage, destroy, remove, possess, collect, transport, export, purchase, sell, donate or otherwise acquire, dispose of any protected tree, indigenous living tree or forest product EXCEPT when licensed by the Minister. Section 7 & 15 [295].	Allowed Trade *P. angolensis* – minimum cutting diameter = 27cm (approx. 80 years of age)	Protection Status *P. angolensis* has been protected since 1967, according to Louppe et al (2008) and a special permit is required to cut. *P. angolensis* listed as Protected Species under the National Forest Act, 1998 (Act No. 84 of 1998)
	Legislation and policy These laws can be found on the FAO Legislative Database – FAOLEX; **The Forest Act 1984 -** **The National Forests Act 1998 –** Forestry Sector Management • 1 478 588 ha of forest were FSC certified in 2014 [8]		
SOUTH SUDAN			
D. melanoxylon	Prohibited • Cutting, clearing, burning, damage or remove any tree, bush, plant, vegetation, or part thereof without written authorization of Director General. Section 14 [296]	Allowed Trade Data deficient	Protection Status Data Deficient

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION		
	• No person can cut a plant or cut trees within any game or forest reserve. Section 17 [296].		
	Legislation and policy These laws can be found on the FAO Legislative Database – FAOLEX; **The Forestry Commission Act 2003:** outline rules and regulations of the forestry commission. **The Wildlife Conservation and National Parks Act, 2003**: Applies to the conservation management and protection of wildlife, forests and environmental resources, establishment of national parks, game and forest reserves and other protected areas of New Sudan.		
SUDAN			
D. melanoxylon *P. lucens*	Prohibited • Construction of any saw-mill that uses mechanical means for modulating local round wood without permit. Section 19 [297] • Prohibited in reserves: harvest/destruction/damage etc of any forest produce of a reserve. Section 6 [298]	Allowed Trade Cutting or taking from Reserves only allowed when prior permit license or permit has been issued. Section 8 [298]	Protection Status Data deficient
	Legislation and policy These laws can be found on the FAO Legislative Database – FAOLEX; **The Forests Act 1989:** Outlines acts prohibited both within and outside Reserves. **The Provincial Forest Ordinance (1932):** Outlines requirements of trade in timber and flora or Sudan.		
SWAZILAND			
P. angolensis	Prohibited • Cutting, destruction and removal of indigenous or government timber without permission from the Minister or his authorized representative. Section 3 [299] • Cross border trade- Carry, or trade in any plant listed in the Red List of Southern African Plants (1997) or IUCN (Section 20 of Flora Protection Act)	Allowed Trade Only if permit issued for specified flora species [300]	Protection Status Listed in Schedule A (Specially protected flora (Endangered)) of Flora Protection Act 2002.
	Legislation and policy These laws can be found on the FAO Legislative Database – FAOLEX; **Flora Protection Act 2002:** Provides effective protection of flora. Provides lists of protected flora in Schedules A (Specially protected flora), B (Vulnerable flora) and C (rare flora), and relevant offences **The Forest Preservation Act No 14 of 1910:** Provides for the preservation of trees and forests on Government and Swazi nation land.		

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td colspan="3">The Plant Control Act No. 8 of 1981: Provides requirements for the sale, trade, import of plants for Agricultural protection.

The Swaziland Environmental Authority Act No. 15 of 1992: Implements requirement for structure and responsibilities of the Environmental Authority.

<u>Forestry Sector Management</u>
• 111 777 ha of forest were FSC certified in 2014 [8]</td></tr>
<tr><th colspan="4">TANZANIA</th></tr>
<tr><td rowspan="2">D. melanoxylon
P. angolensis
P. tinctorius</td><td><u>Prohibited</u>
• P. angolensis: forbidden to harvest since 2002, listed as protected species on Tanzanian Forest Act (2002) [205]
• D.melanoxylon: banned for export by Ministry of Natural Resources and Tourism (unknown date). A 1994 proposal to have it listed under Appendix II of CITES was withdrawn [301].</td><td><u>Allowed Trade</u>
P. angolensis minimum cutting diameter = 25cm [17]

D. melanoxylon trees >70cm long and 22cm diameter are considered exploitable. [17]</td><td><u>Protection Status</u>
P. angolensis is listed on the Protected Wild Plants list of Tanzania Forest Act (2002) according to Thunstrom (2012), however, we were unable to find this list to confirm.

Highly vulnerable to commercial and local extinction [302].</td></tr>
<tr><td colspan="3"><u>Legislation and policy</u>
These laws can be found on the FAO Legislative Database – FAOLEX;

The Tanzanian Forest Act (2002) Part III is dedicated to Forest Management Plans, and outline the requirements for sustainable management plans across villages, private lands and full forest management.

The Forest Act No. 14 of 2002 classifies all trees with diameter over-bark at breast height (1.3 m) greater than 20 cm as saw logs. Diameters between 5 and 20 cm are suitable for poles. Diameter classes for poles are given as; Class I: 15–20 cm, Class II: 10–14.9 cm, Class III: 5–9.9 cm and Class IV: below 5 cm. These classes have different prices (URT 2002). [303]

<u>Forestry Sector Management</u>
• 131 975 ha of forest were FSC certified in 2014 [8]

<u>Ex-situ Species Management</u>
- Tanzania has a relatively large FSC certified forest area, as indicated above. There are several projects in different forest areas, working with the local communities to develop sustainably managed stands of D. melanoxylon. For example: African Blackwood Project – http://www.blackwoodconservation.org/ and http://www.mpingoconservation.org/ which has achieved Forest Stewardship Council Certification [302, 304].
• Tanzania also have seed banks which contain P. angolensis [198] at the Tanzania National Seed Centre. P. angolensis seeds cost 400 Tanzanian Shillings (TSH) per Kg. This is still referenced on the FAO website [196], however, this program has been transformed into the Tanzania Tree Seed Agency [305].</td></tr>
<tr><th colspan="4">TOGO</th></tr>
<tr><td>P. erinaceus</td><td><u>Prohibited</u>
Decree No. 2011-142/PR, article 8– requires written authorization of timber products, while article 15 states that only forest products sourced from “sustainable</td><td><u>Allowed Trade</u>
No current international controls in place on the species. Measures associated with Appendix III listing to be effective from May 9, 2016 [306]</td><td><u>Protection Status</u>
P.erinaceus is highly exploited and threatened plant species to guineo-sudanese and sudano-sahelian regions in Togo [307].</td></tr>
</table>

SPECIES AVAILABLE	PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION		
	forest management" and abiding by traceability rules may be exported [306].		Fully protected under Forest Code (2008/09)- subtracted from any sampling, except for scientific purposes. Page 12 [306].
	Legislation and Policy These laws can be found on the FAO Legislative Database – FAOLEX; **Law No 2008/09 - Forest Code:** Forestry Sector Management Ministry of Environment and Forest Resources (MEFR) is responsible for the implementation of the National Environment Policy (NEO, adopted December 3 2008), including the National Action Plan for the Environment (NAPE adopted June 6 2001). Fundamental mission of MEFR is to coordinate the development and implementation of the Government's domestic environmental, forest resources and wildlife [308].		
UGANDA			
D. melanoxylon *P. lucens*	Prohibited • All activities within Central Forest Reserve boundaries unless license issued [309].	Allowed Trade Export only upon issue of export License. Export of graded timber only with Export Permit. Section 44, Part VI [310].	Protection Status Not listed at time of report.
	Legislation and policy These laws can be found on the FAO Legislative Database – FAOLEX; **The National Forestry and Tree Planting Act 2003:** Provides for the conservation, sustainable management and development of forests for the benefit of the people of Uganda. Repeals The Forests Act, Cap 246; and The Timber (Export) Act Cap 247. Activities within the Central Forest Reserve boundaries must be approved by the National Forestry Authority by way of issuance of license for such activities. Otherwise, all activities are considered illegal, regardless of the benefit (or potential benefit) to local communities or the Ugandan public at large. Licenses should only be granted for the activities that support the objectives of the Uganda Forestry Policy, regarding protection of biodiversity and indigenous forests [309]. **National Environment Management Act 1995:** **Uganda Wildlife Act:** **Uganda Forestry Policy 2001** is implemented by **National Forest Plan 2002.**		
ZAMBIA			
D. melanoxylon *P. angolensis* *P. lucens* *P. tinctorius*	Prohibited • Export, import, tree felling, harvest or conveying of forest products unless permit or license issued by Director of Forestry Department. Sect. 50, Part VI [311]. • No person shall cut, fell, convert, process, convey or remove timber in any from, from an indigenous forest within Zambia. (Does not apply wood that is	Allowed Trade Must have export permit to export forest produce [Sec.91, Part X, The Forest Act 2015]. Must have a permit to convey, export, trade, import, harvest, or fell forest produce. Sect. 53(1), Part VI [311]..	Protection Status Not listed as protected at time of report.

<table>
<tr><th>SPECIES AVAILABLE</th><th colspan="3">PROHIBITED TRADE/SPECIES PROTECTION STATUS/CONSERVATION MANAGEMENT AREAS, POLICY AND/OR LEGISLATION</th></tr>
<tr><td></td><td>already in a factory of sawmilling site, and is being manufactured into value added finished wood products) [312]</td><td></td><td></td></tr>
<tr><td></td><td colspan="3"><u>Legislation and Policy</u>
These laws can be found on the FAO Legislative Database – FAOLEX;
The Forest Act 2015: Establishes the requirements to obtain Permit or License in relation to activities with forest products.
<u>Forestry Management</u>
“The Forestry Departments of Botswana, Zambia and Zimbabwe have tended to use a commercial cutting cycle of 40 years, and a minimum cutting size of 30cm diameter although these have since been reduced in a number of cases.” [209]</td></tr>
<tr><th colspan="4">ZIMBABWE</th></tr>
<tr><td>D. melanoxylon
P. angolensis
P. lucens</td><td><u>Prohibited</u>
Data deficient</td><td><u>Allowed Trade</u>
P. angolensis minimum cutting diameter = 25cm [17]</td><td><u>Protection Status</u>
None are listed as endangered or threatened. P.angolensis is listed as important for furniture. Page 9 [313].</td></tr>
<tr><td></td><td colspan="3"><u>Legislation and policies on Forest Resources:</u>
These laws can be found on the FAO Legislative Database – FAOLEX;
Management on forest resources in Zimbabwe is controlled by two statutes that related to State and Private Land, and Communal areas respectively. They are:
Forest Act 2015: regulates use of forest resources on state and private land, mandating the Forestry Commission to manage forest resources within the country and regulate its activities on protected forest and those on private land.;
Communal Lands Forest Produce Act (CLFPA) 1988: regulates use of resources in communal areas and gives local communities limited rights to exploit forest recourses in there are for subsistence use only [313].
Other Statutes of interest are:
Environmental Management Act 2002: creates framework for environmental management.
EIA Policy, August 1997: Requires authorities to not grant permits to projects that require an Environmental Impact Assessment.
Parks and Wildlife Conservation Act 1975: Establishes national parks, botanical reserves, gardens and sanctuaries etc. Provides for the conservation of wildlife, plants and fish and designates specially protected animals and indigenous plants.
Natural Resources Act: Outlines national strategies for the conservation and enhancement of natural resources.
<u>Forestry Management</u>
“The Forestry Departments of Botswana, Zambia and Zimbabwe have tended to use a commercial cutting cycle of 40 years, and a minimum cutting size of 30cm diameter although these have since been reduced in a number of cases.” [209]</td></tr>
</table>

CONCLUSIONS & SUMMARY

Taking into account the information contained in the above six sections, it is clear that tree species that produce precious woods in Africa are under threat from a variety of activities, including domestic and international trade, related illegal logging, deforestation, climate change induced aridification and encroachment of peri-urbanisation. While the majority of range states in Africa do appear to have legislation in place requiring good management of forests, this is not translating into associated forestry management; all range states have been losing substantial levels of forest cover over the last 15-25 years. In some countries, this rate of deforestation has rapidly increased in the last few years, which is alarming. There are a plethora of programs and donor money that has flooded into Africa over the past 30 years to improve sustainable utilisation of their resources, but it too appears to be having little affect. Perhaps greater focus should be placed on seeking robust national and transnational governance of the rosewood resources, properly resourcing government departments to perform the tasks within their legislation and management plans, and removing incentives for corruption. Based on the literature reviewed for this report there is little doubt that hardwood species in the genera *Dalbergia* and *Pterocarpus* are over-exploited, and under current conditions unlikely to be managed in a way that ensures their long-term survival.

In summary of the above information, the following key points are made:

- Current levels of trade in *P. erinaceus*, from any range state are unlikely to be considered "*compatible with the continued survival of the species in the wild"*, such that conducting a Non-Detriment Finding for this species would be difficult. This assessment is based on the high level of illegal logging reported in most range states, the fact that almost all populations of the species that have been studied show a declining or unstable population demographic, with little to no recruitment – even in protected areas where larger diameter individuals should be able to persist. While the species is noted to have "abundant natural regeneration" in the CoP17 proposal, this does not appear to translate into actual recruitment into the population. The biological traits of slow growth rates and low survivability in the first 10 years mean this species has limited ability to recover from depletion events. Altered fire regimes, due to climate and other ecological changes, is a particular threat that will exacerbate the already low survivability of seedlings.
- As *P. erinaceus* is sympatric with a number of other *Pterocarpus* species throughout much of its range, if the CITES Appendix II listing is successful there is a high likelihood that traders will simply rename shipments as an alternate species, and continue to export *P. erinaceus*. This is probably already occurring in some range states that are reporting log exports of Asian rosewood species. Range states should consider applying holistic management measures within their countries to manage this risk. An example would be to ensure all measures that are applicable to *P. erinaceus* are also applied to their replacement species i.e. rather than having a log export ban for a single species, ensure the log/sawn wood export ban is applicable to all look-alike species and that customs authorities understand which species actually exist in their countries. Until suitable timber identification measures for differentiation between species is available, the only practical way to manage risks to these species is to manage them as a block. This is precautionary and commensurate with the risks posed to serial depletion and deliberate misreporting.
- Export and trade of rosewood or other precious woods from Madagascar is unlikely to be sustainable within even one generation of these rosewood trees. There is no information on growth rates or recruitment or regeneration potential, which are essential to be able to determine a sustainable harvesting regime. There is only one species, *D. monticola*, that has any information on longevity, and it lives for up to 200 years suggesting that the species has an exceptionally long generation time, reflecting slow growth rates. When viewing the growth rates and regeneration potential for all other species in this group , it is highly likely other species in Madagascar also have slow growth rates and lower than expected recruitment potential – especially when considering that most populations in Madagascar that have been studied now extremely low density and are fragmented. There is little to no

ability for these species to recover quickly from disturbance event such as wide spread logging. The minimum time to regenerate a forest where rosewood has been depleted, to a habitat that could sustain harvesting again, is likely to be upward of 70-100 years. Unfortunately, even being able to gain sufficient information to revise these estimates (which are based on similar species' biology) is likely to take a minimum of 5-10 years, but more likely upwards of 15 years to get accurate, peer reviewed growth rate and longevity data from Madagascan forests. However, one solution could be to utilise the current stockpiles of Madagascan rosewood, spread out over the next 20-50 years to supplement and support the gathering of this scientific evidence to try to allow the forests to regenerate. The mechanisms for how this would work in practice would need to be stringent and buffered from corruption, and not encourage further felling of forests in Madagascar, a situation that itself may not be possible for several years yet.

- While international trade in replacement species in mainland Africa (namely *Pterocarpus* species other than *P. erinaceus*) is currently low compared to other precious woods, there are significant threats facing the species domestically, such that any increased risk from international trade in the future should be expected, and carefully planned for. There has already been an increase in trade over the past few years into Vietnam for *P. soyauxii*, which is likely reflective of other countries. This is a trend that can be expected to expand as protections and enforcement for *P. erinaceus* increase.
- The use of GIS distribution modelling for African species is useful to gain an understanding of the predicted suitable habitat for rosewood species, in a cost effective manner. However, much of the habitat included for most of these species is already degraded. The underlying GIS layers for "intact' forests are not well developed for Africa, and we were not able to accurately map the current predicted habitat in intact forest. Only *P. soyauxii* was in a region with sufficient information. Nonetheless, this technology is an important tool that can be utilised by forest managers in Africa to get an understanding of where their most likely suitable habitat is, and to assist to design appropriate management measures to protect those regions, or target enforcement operations to those areas.
- There is in fact a considerable amount of information available on these species in Africa that can be utilised to develop sustainable and precautionary management measures in any range states that have stable stocks of these species. However, in the absence of sustainable management practices and adequate enforcement of current laws, these species can be extirpated from regions in a very short timeframe.

SECTION IIC – REGIONAL ANALYSIS: AMERICAS

INTRODUCTION

This section of the report discusses 29 species of *Dalbergia* and one species of *Pterocarpus* (*Pterocarpus officinalis*) distributed throughout the Americas generally described as "rosewood species". For the purpose of this report, the Americas region covers countries listed in Table 76.

Table 76 - Countries within each region of the America's that have Rosewood spp

Region of the Americas	Countries with Rosewood species
North America	Mexico
Central America	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama
South America	Argentina, Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela
Caribbean	Guyana, Suriname, French Guiana, Jamaica, Hispaniola, Haiti, the Dominican Republic, Puerto Rico, the Lesser Antilles including Guadeloupe and Martinique, Dominica, the Island of Marie Galante, St Lucia, St Vincent, Trinidad and Tobago

There are a number of species of *Dalbergia* species in the Americas that are listed on the appendices of CITES. Table 77 provides details of those species, when they were listed and any associated annotation.

Table 77: *Dalbergia spp* in the Americas listed in the CITES Appendices I, II or II

TAXON	RANGE STATES	CITES LISTING	PRODUCTS COVERED (ANNOTATIONS)
Dalbergia calycina (Population of Guatemala)	Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua	II (2015)	#6: Logs, sawn wood and veneer sheets
Dalbergia cubilquitzensis (Population of Guatemala)	Belize, Guatemala, Mexico	III (2015)	#6: Logs, sawn wood, veneer sheets and plywood
Dalbergia dariensis	Colombia, Panama	III Panama (2011)	#2: All parts and derivatives except seeds, pollen, finished products packaged and ready for retail trade.
Dalbergia glomerata (Population of Guatemala)	Costa Rica, Guatemala, Mexico	III (2015)	#6: Logs, sawn wood, veneer sheets and plywood
Dalbergia granadillo	El Salvador, Mexico	II (2013)	#6: Logs, sawn wood, veneer sheets and plywood
Dalbergia nigra	Brazil	I (1992)	
Dalbergia retusa	Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Colombia (?), Belize (?)	II (2013)	#6: Logs, sawn wood, veneer sheets and plywood
Dalbergia stevensonii	Belize, Guatemala, Mexico	II (2013)	#6: Logs, sawn wood, veneer sheets and plywood
Dalbergia tucurensis (Population of Guatemala)	Guatemala, Nicaragua	III Nicaragua (2014) III Guatemala (2015)	#6: Logs, sawn wood, veneer sheets and plywood

Source: Adapted from Vaglica (2015).

Of the Rosewood species in the Americas, Mexico has 18 of the 30 species that are the subject of this report and 13 of those species are listed in Proposal 54 put forward by Mexico for CoP 17 for listing on Appendix II [314]. Another proposal to list all species in the *Dalbergia* genus on Appendix II (with the exception of *Dalbergia nigra* which is already listed on Appendix I) has been put forward by Guatemala for consideration at CoP 17 [6].

SPECIES TAXONOMY

As with other regions, clarification of species taxonomy is a problem with establishing species distribution and thus level of threat and/or protection. In the America's, *Dalbergia retusa* is believed to be present in Belize [64] but according to TRAFFIC the species found in Belize is actually *D. granadillo*, not *D. retusa* as reported [315]. Rudd (1995) argues that most of the species of *Dalbergia* from Mesoamerica were originally described from limited specimens. "*As more material has become available gradation of characters has become evident. Many of the differences between taxa are*

subtle, and there is considerable intergradation" [316]. As a result Rudd (1995) suggested *Dalbergia calderonii var calderonii* (Standley) to be a different species to *Dalbergia calderonii var molinae* (Rudd). Rudd also suggested the subordinate taxa be adopted for *D. retusa var. cuscatlanica*; *D. retusa var. hypoleuca*; *D. retusa var. lineata* and *D. retusa var. pacifica* [316]. At a recent workshop in Mexico, scientists have suggested that *D. retusa* in not a native species in Mexico [317]. Whilst *D. retusa* is reported as a traded species, the belief is that this species is actually *D. granadillo*, rather than *D. retusa* [314].

Taxonomic uncertainty, and therefore confusions over levels of trade in species, can lead to delays in species receiving required protection, particularly CITES protection, as it is argued that there is insufficient scientific information to judge whether a species meets the listing criteria and for a Non Detriment Finding to be conducted [318]. However, CITES as a convention, is written to take factors such as taxonomic uncertainty into consideration during the listing process and when conducting Non Detriment Findings. As such Parties can and should act in the best interests of the species, and if there is sufficient evidence to suggest that a species is under threat from trade, then the protocols are there for it to be listed, with any taxonomic uncertainties listed as look-alike species. This affords all species adequate protection and should ensure that all trade that is conducted is appropriately non-detrimental.

Table 78 below shows the species taxonomy for those species that are the subject of this report for the America's region. It shows the accepted name, any synonyms recorded for that species and a recommendation of whether a taxonomic revision may be required. The table also includes common names. Sources consulted for taxonomic information include The Plant List [59], Linares [319], Rudd [316], the IUCN Red List of Threatened Species [320], the International Legume Database and Information Service (ILDIS) [321] and Vaglica [23]. The list also contains common names, variations and contradictions where they occur.

Table 78 - Species Taxonomy in the Americas region. A = Accepted Name S = Synonym RR = Taxonomic Revision Required

A	S	RR	TAXONOMY DISCUSSION	COMMON NAMES
DALBERGIA BRASILIENSIS				
✓			Accepted name (Vogel). Synonym – *Amerimnon brasiliense* (Vogel) Kuntze [59].	Brazil rosewood, palissandre du Bresil, caraboa-brava, caviuna jacaranda [23].
DALBERGIA CALDERONII				
✓			Accepted name (Standley). Synonyms include: *Dalbergia funera* [60]. Subordinate taxa includes *Dalbergia calderonii var. calderonii* and *Dalbergia calderonii var. molinae* [316].	Ebony or Marimba (Guatemala), Funera, granadillo, belly frog, panza de rana [319].
DALBERGIA CALYCINA				
✓		✓	Accepted name (Bentham). Synonyms include *Amerimmon calycinum* (Benth), *Dalbergia intibucana* and *Dalbergia calderonii var. Monlinae* [316, 314].	Cahuirica, buzzard, sangualica, nambar, niambaro, zopilote, black granadillo or granadillo negro [314].
DALBERGIA CEARENSIS				
✓			Accepted name (Ducke). Synonym *Dalbergia variabilis var. bahienis* [320].	Brazilian kingswood, kingwood, violetta, violet wood, Jacarand violeta, Jacarand-Cega-Machado, Ceara-rosewood, voiletwood, brazilianishes Violettholz, jacaranda-cega-machado [23, 77].
DALBERGIA CONGESTIFLORA				
✓			Accepted name (Pittier). Synonym – *Amerimnon congestiflora* (Pittier) (Standley) [314, 60].	Campinceran [317].
DALBERGIA CUBILQUITZENSIS				
✓			Accepted name (Donn Sm) Pittier. Synonyms – *Dalbergia variabilis var. cubilquitzensis* [319].	Rosewood, granadillo, hormiguillo, hormiguillo o palo de cuero, leather; Guatemalan rosewood [314, 317, 322].
DALBERGIA CUSCATLANICA				
✓		✓	Accepted name (Standley). Synonyms include *Amerimnon cuscatlanicum* (Standley) and *Dalbergia pacifica* (Standley & Steyerm), *Dalbergia retusa* and *Dalbergia retusa var. cuscatlanica* [60].	Pacific reture rosewood; palissandre reus du pacifique, granadillo, nogal [23].

A	S	RR	TAXONOMY DISCUSSION	COMMON NAMES
DALBERGIA DARIENENSIS				
✓			Accepted name (Rudd). Synonyms include *Dalbergia frutescens* [59]. No synonyms recorded for this species [59].	Black rosewood, Panamanian rosewood [323].
DALBERGIA DECIPULARIS				
✓			Accepted name (Rizzini & Mattos). No synonyms recorded for this species [321, 23].	No registered common names for this species [321]. Vaglica reports the common names of Brazilian tulipwood, pink wood, palissandre du Bahia, bois de rose, bahia roseholz, bastia-de-arruda, cegomachado, pau-cravo and pau-de-fuso [23].
DALBERGIA FOLIOLOSA				
✓			Accepted name (Benth). Synonyms include *Amerimnon polphyllum* (Kuntze) and *Miscolobium polpyllum* [321, 59]. Some specimens of this species found in Brazil have different flower colour to those from other localities may suggest a new taxon distinct from *D. foliolosa* but current evidence is insufficient to make this determination at present [324].	Leafleted rosewood, palissandre foliole and jacaranda-rosa [23].
DALBERGIA FRUTESCENS				
✓			Accepted name (Vell) Britton. Synonyms include *Dalbergia frutescens var. frutescens* and *Dalbergia frutescens var. tomentosa* (Vogel) Benth [321] Vaglica and Tropicos also suggests that *Dalbergia variabilis* (Vogel), *Pterocarpus frutescens* (Vell), *Triptolemea glabra* (Benth), *T. latifolia* (Benth), *T. montana* (Benth), *T. montana* (Mart), *T. ovata* (Benth), *T. pauciflora* (Mart) and *T. platicarpa* (Benth) as also synonyms of *D. frutescens* [23, 60]. Taxonomic clarification is needed to determine if trees referred to as *Dalbergia* spp and/or rosewood in the Chiquibul Forest Reserve in Belize are in fact *D. retusa*). *D. granadillo* is a similar species, occurring in El Salvador and Mexico [315].	Frutescens rosewood, Brazilian pinkwood, Brazilian tulipwood, palisandre frutescent, kingwood, bois de rose, bahia rosehout, violet wood, pinkwood, pauros, bejuco negro, caranda, cipo-preto, jacaranda-rosa, pau-de-fuso, pau-rosa, sangrito [325].
DALBERGIA FUNERA				
✓			Accepted name (Standley). No synonyms recorded [321, 59].	Funera rosewood, palissandre funera, ebano, funera [23].
DALBERGIA GLOMERATA				
✓		✓	Accepted name (Hemsley). Synonyms include *Amerimnon glomeratum*, *Dalbergia cubilquitzensis* and *Dalbergia tucurensis* [60]. Mexico and Vaglica both report only *Amerimnon glomeratum* as a synonym for this species [314, 23].	Hormiguillo, palo de marimba, sinaca, balsamo marimba stick, gateado, balm [314].
DALBERGIA GRANADILLO				
✓		✓	Accepted name (Pittier). Synonyms – *Amerimnon granadillo* [59, 321].	Zangalicua, granadillo, Mexican cocolobo, Tigerwood Rosewood [323].
DALBERGIA HORTENSIS				
✓			Accepted name (Heringer & al) [321].	Gardens rosewood, jacaranda, sebastiao-de-arruda [23].
DALBERGIA LONGEPEDUNCULATA				
✓			Accepted name (Linares and Sousa). No registered synonyms for this species name [314, 60].	No registered common names for this species name [314].
DALBERGIA LUTEOLA				
✓			Accepted name (Linares and Sousa). No synonyms for this species name [59, 314, 60].	No registered common names for this species name [59, 314, 60].

A	S	RR	TAXONOMY DISCUSSION	COMMON NAMES
DALBERGIA MELANOCARDIUM				
✓			Accepted name (Pittier). Synonym – *Amerimnon melanocardium* [314, 60].	Chapulaltapa (El Salvador), ebony or ebano, rosewood blackheart, rosewood, palissandre Coeur noit, granadillo [319, 314].
DALBERGIA MISCOLOBIUM				
✓			Accepted name (Benth). Synonyms include *Dalbergia violacea* (Vogel) Marme; *Dalbergia nigrum* (Mart) and *Dalbergia violaceum* (Vogel) [321, 23].	Miscolobium rosewood, palissandre miscolobium, carbinna, carbiuna-do-campo, Canela-de-burro, Caviuna-do-cerrado, Jacaranda caviuna-do-cerrado, Jacaranda-do-campo, Jacaranda-do-cerrado [321, 23].
DALBERGIA MODESTA				
✓			Accepted name (Linares and Sousa). Some confusion over whether species is modesta or modesti. No synonyms for this species name are known [60]	No common names are recorded for this species name.
DALBERGIA NIGRA				
✓			Accepted name (Allemao. ex Bentham). Synonyms include *Drepanocarpus microphyllus* Wawra, *Miscolobium nigrum* Allemao and *Pterocarpus niger* Vell [59, 60].	Brazilian Rosewood, Bahia Rosewood, Rio Rosewood, Palo santo de Brasil, Jacaranda de Brasil (Varty, 1998), Jacaranda caviuna, Jacaranda preto, Jacaranda roxo, Palisander, Palissandre du Bresil [320].
DALBERGIA PALO-ESCRITO				
✓			Accepted name (Rzed & Guridi-Gomez). No synonyms for this species are known [59, 314, 60].	Palo-escrito, escrito, tlajuilocuáhuitl, tzipil, tzipilín tlacuilo y tlanchinol [326, 314].
DALBERGIA RETUSA				
✓		✓	Accepted name (Hemsl). [59] Synonyms include *Amerimnon lineatum* (Pittier) Standley; *Amerimnon retusum* (Hemsl) Standley; *Dalbergia hypoleuca* (Pittier); *Dalbergia lineata* (Pittier); *Dalbergia retusa var. lineata* (Pittier) Rudd; *Dalbergia retusa var. retusa* [59] There appears to be some taxonomic confusion over whether some species are *D. retusa* or *D. granadillo*, particularly in trade [315].	Coco-bolo [59].
DALBERGIA RHACHIFLEXA				
✓			Accepted name (Linares and Sousa). No synonyms for this species are known [59, 60].	No registered common names for this species.
DALBERGIA RUDDIAE				
✓			Previously described as ruddae. Named for Velva E. Rudd. Now known as ruddiae. Neither version of the spelling appears in The Red List or ILDIS database. No synonyms registered for this name [327, 59]. Mexico refers to this particular species as *D. ruddae* [314].	Tepenahuastle, pretty heart [327].
DALBERGIA SPRUCEANA				
✓			Accepted name (Benth). Synonym listed as *Miscolobium spruceanum* (Benth) [321]. Vaglica (2014) also suggests *Amerimnon spruceanum* as being recorded as a synonym [23].	Jacaranda, Jacaranda-do-Para, Subuarana, villous rosewood, palissandre villeux, canafistul-brava, caviuna, jacaranda [321, 23].
DALBERGIA STEVENSONII				
✓			Accepted name (Standley). No synonyms registered for this name [321].	Honduras rosewood, Rosewood, Nogaed, Nagaed, Palissandre du Honduras, rosewood Honduras, Rosul [321, 328].
DALBERGIA TUCURENSIS				
✓			Accepted name (Donn. Sm). No synonyms for this name [321].	Knoblauch (2001) suggests granadillo as a common name for tucurensis [317] [314].
DALBERGIA VILLOSA				
✓			Accepted name (Benth). Synonyms include *Dalbergia villosa var. barretoana* (Hoehne) Carvalho and *Dalbergia villosa var. villosa* [321]. Vaglica (2014) also suggests that *Amerimnon villosum*, *Dalbergia villosa var. divaricate, Dalbergia villova var. villosa*, and	Heliotropio, Jacaranda [321].

A	S	RR	TAXONOMY DISCUSSION	COMMON NAMES
			Miscolobium villosum as synonyms [23]. Tropicos also mentions *Machaerium sordidum* [60].	
PTEROCARPUS OFFICINALIS				
✓			Accepted name (Jacq). Synonyms include *Ligoum officinale* (Jacq) Kuntze; *Moutouchi crispate* (DC) Benth; *Moutouchi suberosa* (Aubl).; *Pterocarpus belizensis* (Standley); *Pterocarpus crispatus* DC; *Pterocarpus draco* L; *Pterocarpus hemipterus* (Gaertn); *Pterocarpus moutoichi* (Poir); *Pterocarpus officinalis subs. Officinalis*; *Pterocarpus suberosus* (Aubl). Pers [59].	

SPECIES BIOLOGY

There has been relatively little scientific effort expended to understand the species specific biological attributes of the different *Dalbergia* and *Pterocarpus* species throughout the Americas, potentially due to the difficulty in identifying individual species in the field [23]. While there has been limited species specific information gathered, some general rosewood traits are known from various sources. Rosewood species can be found across a wide range of tropical habitats from temperate and coastal areas through to cloud forests found 3000m above sea level. Figure 80 shows the species richness for *Dalbergia* across the different habitat types in the Americas. Very few species are found in only one habitat type with some seven species being found across six or more habitat types [23, 314]. The highest species richness is found in the moist semi-deciduous forest with nine different species found in this particular habitat type. Montane or cloud forest, coniferous forests, moist evergreen forests, coastal forests and semi-deciduous forest also have high species richness. Only sertao vegetation and shrubland habitat types featured as suitable habitat for a single species each. Some species are adapted to a variety of different habitat types [329, 324, 319, 316].

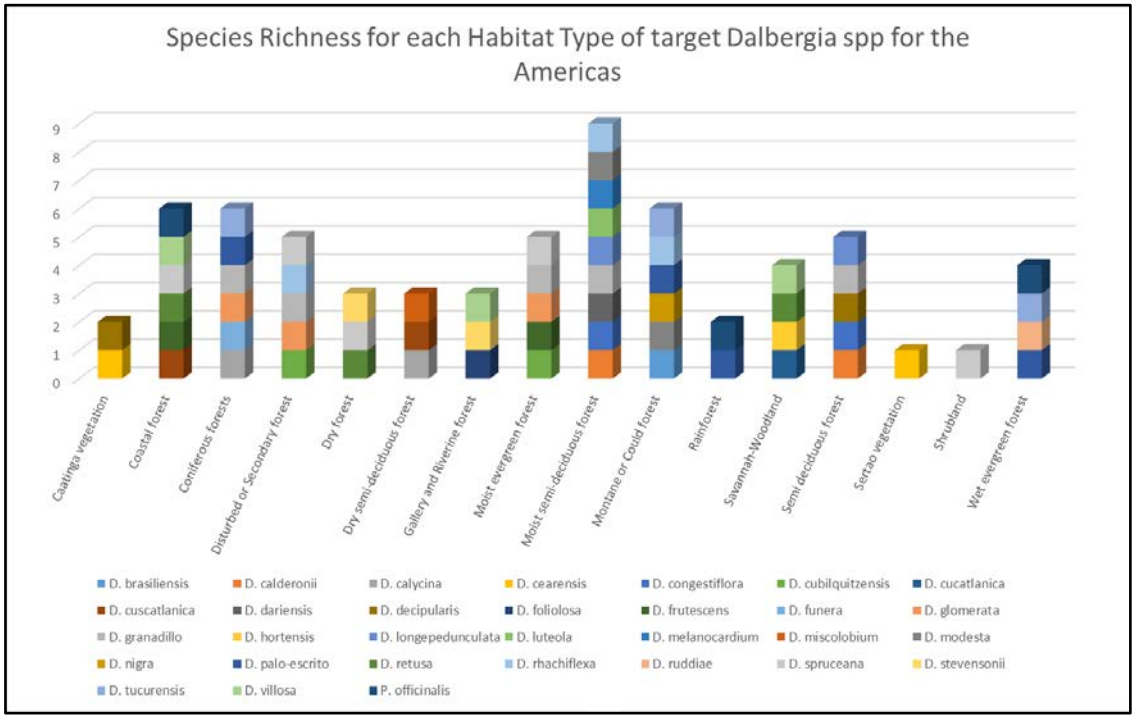

Figure 80 - Species richness for Rosewood species in the Americas

Note: Figure 80 highlights the variety of habitat types where rosewood species are found. Several species are found across a number of different habitat types. Note: Figure 10 shows the species richness for the rosewood species in the Americas. In order to try and compare the different habitat types, we have regrouped all of the voluminous categories of habitat. While reducing the overall number of categories some information may have been lost and inevitably some errors will have been made, but a reduced number of categories makes it easier to compare habitat types [330].

The Mexican CoP17 proposal states that mature trees in the Americas take 70-100 years to produce a sufficient heartwood to be commercial viable [314]. Literature reviews suggest that many of the rosewood species share a number

of common features. Gibbs and Sassaki (1998) have found that *Dalbergia spp* have been observed to exhibit mass flowering events in comparison to the numbers of fruits they produce. They have also observed that *D. miscolobium* trees only flower biannually and that the species has a high level of seed abortion or self-incompatibility, as does *D. retusa* and *D. nigra*. It is noted that the characteristic of self-incompatibility is a feature common to many species of neo-tropical trees whom primarily rely on bees, insects or animal interactions for pollination [331, 332].

Honeybees appear to be the major distributor of pollen for *D. glomerata*, *D. stevensonii* and *D. retusa* though wasps, beetles and butterflies have also been observed [333]. Seed dispersal can occur by wind and also by water, particularly in the case of *D. restusa* [334] and *Pterocarpus officinalis* [335]. Bush and Rivera (1998) have reported pollen being dispersed up to 40 metres by wind in a tropical rain forest [336]. Regeneration appears to be problematic and exacerbated by slow growth rates. Madrigal (1993)[57] and Marin and Flores (2003) both suggest however that species such as *D. retusa* respond well in areas exposed to fire [334, 6].

Another reported regeneration strategy for *Dalbergia* species is sprouting or coppicing. Coppicing is where new growth occurs from the stump or root system of felled trees. This is a particularly important management strategy for plantations or areas planned areas of regrowth. Coppicing has been noted with *D. stevensonii* [6].

Table 79 provides details of the species specific biological information distributed in the America's. It only covers those species that are subject to this report and has omitted any species where there was insufficient biological information available, such as *D. hortensis* for example. It should be noted that acquiring consistent and comparable information on the biology of these species has been difficult with some species having very little scientific information available. The first part of the table contains species where there was limited information available. The second part of the table contains those species where there was a greater degree of scientific biological information available.

57 As cited in CITES 2016

Table 79 - Biological information on Rosewood species of the America's

ROSEWOOD SPECIES OF THE AMERICAS				
Species	**Species Description**	**Habitat Type**	**Reproduction and Growth, Development and other Biology factors**	**Wood Properties**
Dalbergia calderonii	Average sized tree Height: 12m [23]	Tropical deciduous and medium deciduous forests [329]. Soils - Fertile soils required [329]. Altitude -500-2000m [317, 329].		
Dalbergia congestiflora		Tropical evergreen forests and secondary forests [317]. Altitude Range: 40-950m [337].	Mexico – flowering season November to December [338]. Reported to be monostylous hermaphrodite [339].	Heartwood dark violet-brown in colour with no odour when dry [340]. Heartwood is said to have a natural resistance to fungal attack [341]. Reported to be a hard and heavy timber particularly in comparison with species such as *D. funera* [340].
Dalbergia cubilquitzensis	Large tree of up to 30m in height.	Species occurs in both tropical evergreen forests and pine-oak forests [329]. . Altitude Range - 40-950m [329]	Flowering season - Brazil November to January (Sao Paolo) November to April (Parana) Fruiting Season - Brazil April to August (Parana) April to October (Sao Paolo) -nitrogen fixing symbiosis with rhizobia, thus playing an important role in enhancing soil fertility and biodiversity [329, 201].	Timber reported to be very heavy varying from 0.94 g/cm³ for early formed wood to 1.12-1.23 g/cm³ for mature wood [340].
Dalbergia decipularis	Height: 8-12 [329] Diameter: 15-40 [337]	Located in the semi-deciduous forests of Bahia and Minas Gerais in Brazil. Also said to occur in Caatinga vegetation. Only described in 1973 its precise geographical location is still to be defined [77].	High germination rate in a nursery setting with seeds sprouting in a little over one week [337].	Growth rate for *D. decipularis* is said to be medium [337].
Dalbergia foliolosa	Large tree with a height of up to 32m.	Greater stature in trees is recorded at lower altitudes and smaller trees at higher altitude. Especially abundant in the Atlantic Forest [324]. Altitude Range: sea level to 1000m [324]. Soil Requirements: Organically rich soils and sandy soils [324].	Fruiting/Flowering behavior Fruits tend to develop on branches that overhang water [324]. Specimens located in transitional vegetation between the Atlantic forest and restinga[58] vegetation are said to produce deep purple flowers in contrast to the pale yellow flowers found in the Atlantic Forest [324]. This occurrence	

[58] Restinga vegetation is a coastal forest vegetation found in Brazil.

ROSEWOOD SPECIES OF THE AMERICAS				
Species	**Species Description**	**Habitat Type**	**Reproduction and Growth, Development and other Biology factors**	**Wood Properties**
			may suggest a new taxon distinct from *D. foliolosa* but there is currently insufficient evidence to confirm this at present [324]. Seed dispersal Dispersed by water [324].	
Dalbergia frutescens		Found along the coast of Brazil in restinga vegetation and along the border of the Atlantic evergreen forest. Also found in the high forests of Serra do Mar [324]. Altitude Range: up to 1200m [324].	Flowering season – October to November Fruiting season - unknown [342]	
Dalbergia funera	Small tree with height of 6-12m	Pine-oak forest [343] Altitude Range: 500-2000m Soil Requirements: Fertile, loam soils [329].	Species said to have a symbiotic relationship with nitrogen forming bacteria, similar to other *Dalbergia* species [337, 201].	Heartwood yellow-brown in colour with no known odour when dry. Timber density (g/cm³) is ± 1.10 [340].
Dalbergia glomerata	Tree with a height of 18m	Tropical evergreen forests and secondary vegetation. Species is also found in tropical evergreen swamp forests [329]. Altitude Range:- 600-1000m [337] Soils are generally ill drained and waterlogged and calcium poor [329].	Reported to show an initial growth rate of 2m in height then slowing to an average of 2cm/annual diameter thereafter [329]. In common with many other *Dalbergia* species, *D. glomerata* is said to produce the nitrogen fixing bacteria, rhizobia [337]. Species also provide suitable habitat for epiphytes such as lichens, fungi, bromeliads and ferns who live on the trunk and branches [329, 201].	
Dalbergia granadillo	Tree of up to 20m [327]	Deciduous forests, pine, oak and mixed pine-oak forests, wet forests with pronounced seasonality [340]. Altitude Range: 750-1200m [340]. Soils - well-drained soils [327]. Rainfall range: less than 700m annually [340].	*D. granadillo* blooms in May [327] Fruiting is generally unknown but possibly in May to June prior to the rainy season [327]. Species also has a symbiotic relationship with nitrogen-fixing bacteria [337].	Heartwood yellow to orange with dark brown with dark streaks. Odour believed to be fragrant. Density of 0.90-1.35 g/cm³ [340].
Dalbergia longepedunculata	Small tree of between 6-10m [327].	Occurring in tropical deciduous forests and medium semi-deciduous forests [327]. Altitude Range: 600 – 1000m [327].	Flowering season is July with fruiting between December and March [327].	
Dalbergia luteola	Small tree of up to 8m in height [327].	Exclusively found in deciduous tropical forests [70]. Altitude Range: 800m [327]	Flowering season –November with fruiting season unknown [327].	

ROSEWOOD SPECIES OF THE AMERICAS				
Species	**Species Description**	**Habitat Type**	**Reproduction and Growth, Development and other Biology factors**	**Wood Properties**
		Soils: found in soils where there is limestone [327].		
Dalbergia melanocardium	Medium sized tree growing between 12-15m.	Tropical deciduous forests [70]. Found in both in primary and secondary forests [102]. Altitude Range: 600m		
Dalbergia palo-escrito	Large tree growing up to 35m in height with a diameter of 80cm	Cloud forests, coniferous, deciduous and medium evergreen rainforests [70]. Endemic to Mexico [95].		Heartwood is said to be yellow brown to brown with or without dark streaks. Density is between 0.65-0.82 g/cm³ [340].
Dalbergia rhachiflexa	Medium sized tree between 5-15m [327]	Lowland and mountainous deciduous forests or in open, disturbed vegetation [327].	Flowering season is in May with fruiting probably occurring from October to December before the rainy season [327].	
Dalbergia ruddiae	Large tree up to 25m in height and up to 40cm in diameter [327].	High evergreen forests and riparian vegetation [70]. Soils: Sandy and wet soils.	Flowering season – January to February with fruiting between October to December in Mexico [327].	
Dalbergia spruceana		Grows in dry forest habitats usually at low elevations. Also found in secondary vegetation within semi-deciduous forests [324]. Altitude Range: 200-1200m [329]. Soil Requirements: Sandy and degraded soils [324].		
Dalbergia villosa		Found within mixed areas of cerrado vegetation and moist gallery forests, often found in scattered pockets of moister vegetation [324].		

DALBERGIA BRASILIENSIS			
Height (m)	**Diameter (cm)**	**Flowering Season**	**Fruiting Season**
4-20 [328] [344]	20-50 [345]	*Brazil*	
		November to January (Sao Paolo) [337] November to April (Parana) [337]	April to August (Parana) April to October (Sao Paolo)

Habitat Type/natural density	**Reproduction strategy and germination potential**	
Semi-deciduous and deciduous secondary forests, humid slopes and more dense primary formations [345]. Recorded as being abundant in the montane forests of southeastern Brazil [344].	Hermaphroditic plant. Pollination by bees and other insects. In a nursery setting germination rates of 50% can be experienced [337]. The reproductive process is said to occur at 3 years of age in controlled situations such as plantations [345]. Seed dispersal is generally by wind [345].	
	Growth rates and heartwood development information	**Ecological Significance**

Soil Requirements: Occurs in soils with low fertility, has also grown in plantations with clayey soils and good drainage [345]. Altitude Range: 10m (Parana) and 1300m (Minas Gerais) [345]. Latitude: 19°50'S in Minas Gerais to 29°40'S in Rio Grande do Sul [345]. Rainfall range: 1200mm Parana and 2,100mm in Minas Gerais [346]. Average temperature - winter: 12.2-16.6°C [345]. Average temperatures – summer: 19.9-24.9°C [345].	Growth rate: Reported to have a moderate rate of growth, considered suitable for plantations and reforestation [337]. Average annual increase of up to 1.39-1.69m after six years growth [345]. Density: Reported to be 12/ha in the Atlantic Forest in the State of Sao Paolo [345]. Timber density: Moderately thick timber between 0.60 – 0.91 g/cm³ [345].	As noted in other *Dalbergia* species, *D. brasiliensis* has a symbiotic relationship with certain soil bacteria with bacteria forming rood nodules and fixing nitrogen. Nitrogen is not only beneficial to the tree itself during growth but to other species within the surrounding ecosystem [337, 347, 201].

DALBERGIA CEARENSIS

Height (m)	Diameter (cm)	Flowering Season		Fruiting Season
5-10 [337]	10-25 [337]	Brazil	Peak flowering occurs at the beginning of the rainy season [348].	Beginning of the dry season but can produce fruit throughout the year including into the next season, bearing fruits from both seasons at the same time [348].
Wood Structural Properties		Venezuela		Fruiting occurs throughout the year but mature fruits only present during the dry season of the onset of the rainy season [348].
Wood density: 1.01g/cm³.		Panama		Fruiting early in the wet season, dispersion of fruit in the dry season [348].

Habitat Type/natural density	Reproduction strategy and germination potential	Growth rates and heartwood development information
Endemic deciduous species [348]. Also found in dense arboreal caatinga [324]. Soil Requirements: Deep rich soils [324].	Germination Rates In the wild, Reproduction and germination generally follows the seasons [348]. In a nursery setting seeds can attain a 50% germination rate, with sprouting occurring within one week [337]. In Panama seed germination and early seedling development takes place at the beginning of the rainy season [348]. Defoliation Leaf shedding in Brazil was observed to correspond with the dry season of July to December when rainfall was scarce and there was limited water storage in the soil. It was further observed that *D. cearensis* buds appeared at the onset of the rainy season [348].	Growth rate for this species is said to be fast but reported to slow should the roots be disturbed [347].
Flowering and Fruiting Behaviour		**Ecological Significance**
- Buds appear at the onset of the rainy season [348]. - short flowering cycle - attributed to the balance between the demands of reproduction and the physiological demands associated with the energy exerted to maintain the flowers [348]. - maintains fruit throughout the year, mature fruit is only available at the end of the season [348].		Endemic deciduous species known to store water in its root system at the beginning of the dry season [348]. Also has a symbiotic relationship with certain soil bacteria known to fix nitrogen, a process beneficial to the tree as well as nearby plants and trees [337, 347, 201].

DALBERGIA CALYCINA

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
Up to 18m [329]	20-100 [329]	*Guatemala*	
		December to April [349]	May to September [349]
Habitat Type/natural density			**Growth rates and heartwood development information**

Found in dry and deciduous forests. In Guatemala the species is found in sub-tropical humid forests and volcanic areas [350]. Soil Requirements: Deep soils with loamy or clay loam. Well drained soils with a slope of 0-7% [329]. Altitude Range: 600-1700m [329].	In a study reported by FAUSAC-FNPV (2015) on growth rates of *D. calycina*, results suggest that the majority of trees surveyed belonged to the class diameter of 20-40cms. Smaller populations were found in both the 80-100 cm diameter and the 40-80cm diameter classes respectively [349]. The surveyed population consisted of scattered trees and included road side vegetation [349, 329].
Reproduction strategy and germination potential	**Ecological Significance**
Seed dispersal: September to November [349]. Vegetative growth: February to November [349]. Defoliation: December to March [349].	Nitrogen fixing symbiosis also occurs with this species which is known to enhance soil fertility and be of benefit not only to the tree itself but other nearby species [337, 347, 201]. Epiphytes are known to live on the trunk and branches of the tree [329].

DALBERGIA MISCOLOBIUM

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
12 [324]		*Sao Paulo, Brazil*	
		January	Legumes dispersed by wind at the beginning of the dry season (May and June) [351].

Habitat Type/natural density	Reproduction strategy and germination potential
Found in open Cerrado[59] vegetation and dry Cerrado in the mountain ranges of central east Brazil [324]. Soil Requirements: Rocky and sandy soils [324]. Altitude Range: above 900m [324]. Rainfall range:	Fruiting/Flowering behaviour Trees do not flower each year, tending to flower biennially. Mass flowering with low fruiting success has been observed with this species [352]. • Most of the fruits are single-seeded despite *D. miscolobium* having the ovary containing two ovules. • Sassaki and Felippe (1999) observed in their research that despite the ovary having two ovules, in 88.3 percent of fruits, only the apical seed developed, with the percentage of double seeded fruits diminishing as the fruit grew. The high percentage of apical-seeded fruits may be attributed to fertilization failure and high levels of seed abortion as experienced in other species of *Dalbergia*. • It was also noted that as double seeded pods did not tend to disperse as widely as the single seeded pods, possibly due to their weight when being dispersed by the wind [351].

DALBERGIA NIGRA

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
15-38 [353] *12.7-18* [354].	*80-121* [353]	*Brazil*	
		November to December	January to September

Habitat Type/natural density	Reproduction strategy and germination potential
D. nigra is of scattered occurrence in the eastern forests of Bahia and southward toward Espirito Santo and Rio de Janeiro and inland through to Minas Gerais. Also a component of the Atlantic forest from southern Bahia to Sao Paulo in Brazil. Known to be	Pollinated by bees and seeds dispersed by wind. Likely to outcross with a possible self-incompatibility system similar to that observed with *D. miscolobium* [331].
	Growth rates and heartwood development information

59 Cerrado vegetation is tropical savannah vegetation found in Brazil.

scarce due to earlier exploitation of the species [324, 353]. Soil Requirements: Rich, undulating clay and loam soils with good drainage	Tree development: It has been noted that old defective tree stems seem to produce the most attractive wood. Trees that have had unwanted sap removed are often hollow and lose volume [353]. Costa et al (2015) in their study on tree growth observed that *D. nigra* has distinct growth rings which were marked by thickened fiber walls. Growth rates: *D. nigra* was observed to show little variation in growth until around 15 years of age with growth rates increasing for a short period then decreasing again from around 24 years of age [354]. The estimated time span to reach the minimum logging diameter (MLD) of 50 cm was 61 years [354]. DBH (cm) = 14.5 – 30.7 Diameter Annual Increase(DAI) = 8.1 (±1.8)

DALBERGIA RETUSA

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
		General	
15-30 [353, 337]	*50-91 d.b.h.* [353, 337]	January to May (first flowering) August to September (second flowering)	March to May Dry season with irregular fruit drop [355]

Habitat Type/natural density	Reproduction strategy and germination potential	Growth rates and heartwood development information
Found on flatlands or moderate slopes in tropical dry forests with an annual rainfall less than 2000mm and a temperature range of between 24 to 30 °C [81]. Soil Requirements: Requires deep sandy or rocky soil [334]. Altitude Range: 350-500 [349]. Rainfall range: Less than 2000mm [329]. Temperature range: 24 to 30°C [329].	Pollination Bees and other insects, seeds dispersed by both wind and water. [334] *D. retusa* has been known to come into partial bloom out of season attracting large numbers of bees, even recorded as attracting bees away from other flowering species in the same area [356]. Mass flowering followed by low fruit set has been observed for this species [337]. Flowering occurs after 4 or 5 years [357]. Seed dispersal: September to February [329]. Vegetative growth: January to November [329]. Defoliation: November to March [329]. Demonstrated to exhibit self-rejection [358]. Seeds can remain viable for up to 5 years although reportedly have a high rate of unviability [334]. Reported as an evergreen species with soft wood, it uses soil water as a reservoir. Flowers can appear rapidly as old leaves are shed [359]. Biennial fruiting has been observed in this species. *D. retusa* is believed to drop its leaves in January to March, flush in April, flower in March or April and have mature fruit at some point in the dry season [355]. Reported to respond well to fire with regeneration of young trees observed in areas that have been periodically exposed to fire [337]. Germination rate Germination rates of up to 80% observed in a nursery setting [337].	As with many *Dalbergia* species a slow growth rate is recorded for this species [337]. Trees may reach heights of 8 m and 13 d.b.h. when grown in controlled situations [334]. Heartwood shows remarkable resistance to termites, even when buried for 13 years in the jungle with part exposure to the elements [360]. Natural regeneration is scarce although young trees up to 4m have been observed in areas that have been periodically exposed to fire [337]. Regeneration is abundant [315]. Heartwood colour is yellow to orange or dark brown with dark streaks. Density is between 0.90-1.35 g/cm [340].
		Ecological Significance
		Provides suitable habitat for a range of epiphytes including orchids, ferns, bromeliads, fungi and lichens which can be found living on both the trunk and branches [329]. Also exhibits symbiosis of root nodules with nitrogen-fixing rhizobia, which is beneficial to soil fertility and forest biodiversity in general [329].

DALBERGIA STEVENSONII

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
15-30 [329]	91 [328]	*General*	
		May to July [328]	July [329]

Habitat Type/natural density	Reproduction strategy and germination potential	Growth rates and heartwood development information
Endemic to Belize and restricted to the south of the country. In Guatemala it is found along rivers and in wetlands and in tropical humid forests [329]. Soil Requirements: Calcareous [329]. Altitude Range: 50-600m [349]. Latitude Range: 16-17°N [328].	Little is known of the reproduction strategy of *D. stevensonii*. It is thought that some of the known characteristics of other species such as *D. miscolobium*, *D. nigra*, *D. sissoo*, *D. retusa* and *D. tucurensis* may be applicable also to *D. stevensonii*. These include outbreeding, mass flowering and low fruiting rates and high levels of seed abortion. Pollination is by bees [328]. Seed dispersal: April to May [329] Vegetative Growth: August to May [329] Defoliation: April to June [329] Unripe fruit can be subject to predation, particularly by caterpillars or pupae [328].	Heartwood is medium to dark pinkish brown with dark streaks. Density is between 0.93-1.17 g/cm³ [340, 361]. Timber is heavy and durable with an average of 960kg/m³ when dry [328]. **Ecological Significance** *D. stevensonii* forms nitrogen-fixing nodules like many other *Dalbergia* and neotropical legume species [328].

DALBERGIA TUCURENSIS

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
25-35m [362]			
		May to July [329]	February to May [329]

Habitat Type/natural density	Reproduction strategy and germination potential	Growth rates and heartwood development information
Coniferous and broadleaf forest and cloud mountain [72] [70]. Also appears to be a canopy species [101]. Soil Requirements: Associated with Limestone [329]. Altitude Range: 150-1500m [362]. Rainfall range:	Described as being hermaphrodite with bi-sexual flowers [362]. Similar features to that exhibited by the *Dalbergia* genus including mass flowering with limited production of fruit and high levels of seed abortion [329]. Seed dispersal: May to June [329] Vegetative growth: March – January [329] Defoliation: December to February [329]	Heartwood is yellow-brown to brown and may or may not have streaks. Density is between 0.65-082 g/cm³ [340]. It is also reported that *D. tucurensis* has a lower density rate in comparison to other Central American species of *Dalbergia* [340]. **Ecological Significance** Suitable habitat for epiphytes [349]. As with many other *Dalbergia* species exhibits a nitrogen-fixing root symbiosis with rhizobia which is beneficial to soil fertility and forest biodiversity [347].

PTEROCARPUS OFFICINALIS

Height (m)	Diameter (cm)	Flowering Season	Fruiting Season
11-23 [363]	30	*Puerto Rico*	
		February to September [335]	March to November [335]
Habitat Type/natural density		*Jamaica*	

<table>
<tr><td></td><td>July and August [335]</td><td>July to September [335]</td></tr>
<tr><td rowspan="6">Found in coastal wetlands, swamps with both fresh and brackish water [335].

<u>Soil Requirements:</u> Swamps with clay or sandy soil, often containing organic matter. Areas can contain coral and shell. [335] In areas of the Caribbean the species can be found in areas of varying salinity [335].

<u>Altitude Range:</u>
Puerto Rico: 350m [335]
Jamaica: up to 175m [335]
Dominica: up to 60m [335]

<u>Latitude:</u> 20°N (46) to 2°S latitude (54) [335]

<u>Rainfall range:</u> 1600-4000mm/y [335]

<u>Temperature:</u> 20-24°C [335]</td><td colspan="2">Trinidad</td></tr>
<tr><td></td><td>May [335]</td></tr>
<tr><td colspan="2">Dominica</td></tr>
<tr><td></td><td>April to November [335]</td></tr>
<tr><td>Reproduction strategy and germination potential</td><td>Growth rates and heartwood development information</td></tr>
<tr><td rowspan="2"><u>Germination</u>

Pterocarpus seeds can germinate when afloat but do not root when water depth exceeds 3 or 4 cm [335].

<u>Seed establishment</u>

Vegetation in tropical swamp forests effect seed stranding and establishment. Standing trees help to raise ground level by trapping litter between buttresses. This pattern of seed establishment generates clumps of trees with some individuals growing so close to each other making it difficult to identify individuals [363].

<u>Fruit and flower production</u>

It has also been reported by Eusee and Aide (1999) that flower and fruit production are considerably greater for this species in areas with low salinity [364]. This species has been identified as hermaphrodite [362].

Low levels of reproduction which tend to occur in sites with high levels of salinity appear to correlate with low recruitment. Land clearance and changed environmental conditions mean that there is a risk that P. officinalis may be at risk of extinction in many areas where it was previously present [364].</td><td>Puerto Rico recorded the largest individual of the species which measures 274mc in d.b.h and 20.5m in height. P. officinalis is a soft and very light wood, particularly in relation to other precious woods utilised for their heartwood. P. officinalis is said to be fast growing and this may be linked to the light weight of the timber [335].</td></tr>
<tr><td>Survivability</td><td>Ecological Significance</td></tr>
<tr><td>Saur et al (1998) report that P. officinalis has exhibited morphological and physiological adaptations, particularly in relation to root structure, in order to survive in waterlogged environments [79].

- The large buttresses may provide a broad platform that appears to minimize toppling. It has also been noted that P. officinalis may recover quickly from hurricane damage in relation to other species that suffer a high mortality rate after such events [363].</td><td><u>Nitrogen symbiosis</u>

P. officinalis is also known to be a nodulating species. It has also been noted that this symbiotic fixation constitutes significantly to nitrogen uptake. This process is possibly responsible for the success of the species in flooded areas of the neotropics [363].

<u>Adaptation to the environment</u>

Floating seeds, fast growth rates, capacity to sprout, buttressed tree trunks and tolerance to mild brackish water are all adaptations of bloodwoods that may account to their ability to survive in harsh environments [335]</td></tr>
</table>

DISTRIBUTION AND RANGES

Scientific information regarding species distribution and ranges is limited. Fragmentation, deforestation and general overexploitation of many of these species and their habitats is well known anecdotally but has not been documented, particularly in recent times, in much of the scientific literature [318, 329]. Much of the scientific literature and research available describing *Dalbergia* and the distribution of the genus have been undertaken some time ago or can only be found in reference books that are no longer available or frequently published in Spanish. This is to be acknowledged as a limitation of this report. In other cases, political unrest or illegal forest activities do not make field work and associated research safe to undertake, particularly in areas where organised crime and/or corruption is a factor [317, 365].

Table 80 outlines the distribution, range and habitat reduction of those countries located in the America's region that are the subject of this report. Where available, the amount of tropical forest present, the reported rate of deforestation (%) from 2005 to 2010 and the amount of primary forest remaining in those countries is provided. In relation to primary forests both Brazil and Peru still have large percentages of primary forest intact in relation to their total forest area available [318]. With regards to the rates of deforestation both the Dominican Republic and Guyana have halted the rate of deforestation. For countries such as Honduras, Ecuador, El Salvador and Nicaragua, deforestation increased between 1-2% per year.

Table 80 - Species Distributions and Habitat Range Reduction

SPECIES AVAILABLE	DISTRIBUTION	HABITAT REDUCTION
ARGENTINA		
Dalbergia frutescens	*D. frutescens* is found in the northern part of Argentina along the Atlantic coast [321].	Argentina recorded the 9th largest annual net loss of forest area between 2010 and 2015 losing some 297 000 000 hectares or 1% of its forest [124].
BELIZE		
Dalbergia calderonii	Recorded as present in Belize according to Tropicos [60].	Forest coverage in Belize has been reduced from 87% of the total area in 1927 to between 61 and 79% of the total area [328]. In the Toledo District alone, it is estimated that 90% of Belize's historical rosewood has been decimated [3] and that some 5,000 acres of forest per year is logged or lost to land clearing [3]. Belize's annual deforestation rate between 2005 and 2010 was -0.68%. The total forest area remaining is 1 393 000 hectares with 599 000 hectares of this being recorded as primary forest [318].
Dalbergia calycina	Reported as occurring in Belize according to the IUCN Red List of Threatened Species [320].	
Dalbergia cubilquitzensis	Recorded as occurring in Belize according to Tropicos [60].	
Dalbergia melanocardium	Reported as occurring in Belize according to Tropicos [60].	
Dalbergia retusa	Reported as occurring in Belize according to the IUCN Red List of Threatened Species [320].	
Dalbergia stevensonii	Exists in patches with the remaining areas said to be in the Toledo District	
Dalbergia tucurensis	Reported to occur in Belize according to Tropicos [60].	
BOLIVIA		
Dalbergia frutescens	Species present in Bolivia according to Tropicos [60]. Areas include Beni, La Paz and Santa Cruz [366].	The total forest area of Bolivia is 57 196 000 hectares with some 37 164 000 hectares being primary forest. The deforestation rate between 2005-2010 was -0.53% [318].
Dalbergia foliolosa	Species present in Bolivia according to Tropicos [60] Districts include Beni, La Paz and Santa Cruz [366].	
Dalbergia miscolobium	Recorded as occurring in La Paz and Santa Cruz by the Bolivian government [366].	
Dalbergia spruceana	*D. spruceana* has been recorded in Bolivar state and in the extreme north east of the country [324].	
Dalbergia villosa	*D. villosa* is said to occur in Santa Cruz in Bolivia [23].	
BRAZIL		
Dalbergia brasiliensis	*D. brasiliensis* occurs only in southern and eastern Brazil [23]. It is known to extend from the Atlantic forests near Rio de Janeiro and Sao	Brazil lost an estimated 2.19 million hectares of forest per year in the period 2005-2010. This is an annual rate of deforestation of 0.42%, which

	Paulo through to the Acaucaria forest of Parana and Santa Catarina [324, 6].	is lower than the estimated annual rate of deforestation in the period 2000-2005 (0.57%) (FAO 2010b). Brazil has an estimated 477 million hectares of primary forests. [318]. In the southern Bahia extraction of valuable timbers, particularly *D. nigra* has drastically reduced unprotected forests [367]. Table 81 provides details of the annual deforestation area for different periods of time. In general Brazil has experienced considerable deforestation in recent decades, over 3.4 million hectares per year from 2003-2007. However since 2008 there has been a marked decline in deforestation rates in general, but particularly in the Amazon and Cerrado biomes with rates falling by well over 50%. Overall the total level deforestation in Brazil has reduced from 3,025, 853 hectares around 1990 to 1,775, 265 hectares in 2010 – a period of 20 years. Several of these biomes, namely Caatinga, Cerrado and Atlantic Forest provide valuable habitat for *Dalbergia* species [324, 368].
Dalbergia cearensis	*D. cearensis* occurs in north eastern Brazil including the states of Bahia, Ceara, Paraiba, Pernambuco and Piaui [321, 23].	
Dalbergia decipularis	*D. decipularis* occurs in eastern Brazil in the states of Bahia and in the north of Minas Gerais [321, 23].	
Dalbergia foliolosa	*D. foliolosa* is also distributed throughout Brazil in the states of Bahia, Distrito Federal, Minas Gerais and Rio De Janeiro [321, 23].	
Dalbergia frutescens	*D. frutescens* grows along the coast of Brazil predominantly in restinga vegetation and along the border of the Atlantic evergreen forest. In the south east of the country is can be found from retinga vegetation near the coat to the high forests of the Serra do Mar. It has also been located in gallery forests and in the Aracucaria forest in southern Brazil [324].	
Dalbergia hortensis	*D. hortensis* only occurs in Brazil. It can be found in the states of Brasilia, Distrito Federals and is native to the state of Minas Gerias [23, 324].	
Dalbergia miscolobium	*D. miscolobium* is native to Brazil and found in the following states: Bahia, Ceara, Distrito Federal, Goias, Maranhoa, Mato Grosso, Minas Gerais, Parana, Piaui and Sau Paulo. [321, 23] This species is also reported to be found at altitudes above 900m in the mountain ranges of east-central Brazil [324].	
Dalbergia nigra	*D. nigra* is typical of the Atlantic forest found from southern Bahia to northern Sao Paulo. *D. nigra* is also said to extend inland to eastern Minas Gerais [324].	
Dalbergia spruceana	Species present in Brazil according to Tropicos [60].	
Dalbergia villosa	*D. villosa* occurs in Minas Gerais and Sao Paulo [23, 324].	

Table 81: Brazil – Average annual deforestation area (hectares) from 1998 - 2012

Brazil – annual deforestation area (ha)				
	1988-1992	**1998-2002**	**2003-2007**	**2008-2012**
Biomes	**1990 (average)**	**2000 (average)**	**2005 (average)**	**2010 (average)**
Amazon	1 178 353	1 429 358	1 559 493	649 945
Caatinga	276 300	276 300	276 300	276 300
Cerrado (Savanna)	1 417 900	1 417 900	1 417 900	824 460
Atlantic Forest	45 700	45 700	45 700	28 980
Pampa	36 300	36 300	36 300	33 740
Pantanal	71 300	71 300	71 300	29 300
Total	**3 025 853**	**3 276 858**	**3 406 993**	**1 775 365**

Source: FRA, Country Report, Brazil (2015) [368]

COLOMBIA		
Dalbergia darienensis	Reported to be found in the Bolivar district of Colombia [369].	Colombia's 60,728,000 hectares of natural forest cover 50% of the country. Colombia's wood product exports totalled nearly US$43 million in 2013. India was the largest export market with 31%, followed by Panama, China and Venezuela, but regional markets also account for a significant share of exports. Colombia has 132,249 hectares of FSC certified forest
Dalbergia frutescens	Species is recorded as being present in Amazonas, Antioquia, Casueta, Cordoba and Cundimarca districts [366, 60].	
Dalbergia retusa	*D. retusa* – there are conflicting reports of whether *D. retusa* occurs in north-western	

	Colombia, although many reports suggest the species does not occur at all in Colombia [315]	(November 2014) [370]. The deforestation rate from 2005-2010 was -0.17% [318].
Pterocarpus officinalis	*P. officinalis* is found in the Lower Magdalena River floodplain and the Narino region of Colombia [335].	
COSTA RICA		
Dalbergia calycina	*D. calycina* is native to Costa Rica [371]	*Dalbergia calycina* – within Costa Rica the forests have declined due to land clearing and cattle ranching [371].
Dalbergia cubilquitzensis	Reported as occurring in Costa Rica according to ILDIS and Vaglica [321, 329].	The total forest area for Costa Rica is believed to be 2 605 000 hectares with 623 000 hectares being primary forests. The deforestation rate from 2005-2010 was 0.90% [318].
Dalbergia cuscatlanica	Reported to occur in Costa Rica according to Tropicos [60].	
Dalbergia frutescens	Reported as occurring in Costa Rica according to Tropicos [60].	
Dalbergia glomerata	Reported to occur in Costa Rica according to Tropicos [60].	
Dalbergia melanocardium	Reported to occur in Costa Rica according to Tropicos [60]	
Dalbergia ruddiae	Reported to occur in Costa Rica according to Tropicos [60].	
Dalbergia tucurensis	Reported to occur in Costa Rica according to Tropicos [60].	
Pterocarpus officinalis	*P. officinalis* occurs in the Talamanca region [335].	
Dalbergia retusa	Reported as occurring in Costa Rica according to the IUCN Red List of Threatened Species [320].	*Dalbergia retusa* has been the subject of heavy exploitation in the past particularly in Costa Rica and Panama, and consequently its available habitat has been reduced by 61.5% [315]. Exploitation of *Dalbergia retusa* as a timber is intense and areas where the species was formerly widespread are almost completely exhausted; this is most notable in Costa Rica [372].
DOMINICAN REPUBLIC		
Pterocarpus officinalis	Occurring in coastal and interior wetlands throughout its range, predominantly on the northern coast [335].	The total forest area is approximately 1 972 000 hectares. The amount of primary forest is not known however the recorded deforestation rate for the period 2005-2010 was 0% [318].
ECUADOR		
Dalbergia frutescens	Reported as occurring in Ecuador according to Tropicos [60].	The total forest area for Ecuador was 9 865 000 hectares with primary forest totalling 4 805 000 hectares. The deforestation rate between 2005 and 2010 was -1.89% [318]. The principal drivers of deforestation are ever-increasing areas of subsistence and commercial agriculture and cattle ranching, illegal logging and the exploitation of non-renewable resources such as oil, gold and other minerals, accompanied by road construction and subsequent colonization. ITTO (2011) estimated total officially sanctioned harvest of natural forests under the licensing systems above at around 400 000 m3 to 500 000 m3 per year [323].
Pterocarpus officinalis	Reported to occur in Esmeraldis and Manabi according to Tropicos [60].	
EL SALVADOR		
Dalbergia calderonii	Reported to occur in the regions of Chalatenango, Morazan and Santa Ana [60].	The total forest area for El Salvador is 287 000 hectares of which 5 000 hectares is made up of primary forest. For the period 2005-2010 the deforestation rate was recorded as -1.47% [318].
Dalbergia calycina	Reported to occur in El Salvador according to Tropicos [60]	
Dalbergia congestiflora	Reported to occur in El Salvador according to Tropicos [60]	
Dalbergia cuscatlanica	Reported to occur in El Salvador according to Tropicos [60]	

Dalbergia funera	Reported to occur in El Salvador according to Tropicos [60]	
Dalbergia granadillo	Reported to occur in El Salvador according to Tropicos [60]	
Dalbergia melanocardium	Reported to occur in El Salvador according to Tropicos [60]	
Dalbergia retusa	Distribution of *D. retusa* is restricted to the north-western region, no data is available on size, cover, and density, vertical or horizontal structure or regeneration status. Reported as vulnerable [315].	
Dalbergia tucurensis	Reported to occur in El Salvador in the Ahuachapan and Santa Ana regions according to Tropicos [60].	
FRENCH GUIANA		
Pterocarpus officinalis	Reported to occur in French Guiana according to Tropicos [60].	The total forest area for French Guiana is 8 080 000 hectares of which 7 690 000 hectares is primary forest. The deforestation rate for the period 2005-2010 was -0.04% [318].
GUATEMALA		
Dalbergia spp.	The distribution of *Dalbergia* is highly fragmented in Guatemala and restricted to specific regions, such as Alltoa Verapaz, Baja Verapaz, Izabal, Huehuetenango, Quiche and Peten. Fourteen species occur in Guatemala, seven of which are known to be used for their timber [350].	*Dalbergia* spp have declined in Guatemala during the period 1991 to 2012 from an estimated 1 012 800 ha in 1991 to around 648 000 ha in 2012. This results in a net loss of 364 400 ha over a 12 year period [349]. The total forest area of Guatemala is around 3 657 000 hectares with 1 619 000 hectares of primary forest. The deforestation rate between the years of 2005 and 2010 was -1.47% [318]. The reduction in the quantity, quality, and connectivity of natural habitat is the greatest direct cause of biodiversity and tropical forest loss in Guatemala, as well as in the world. Habitat damage, especially the conversion of forested land to agriculture land, has a long history in Guatemala, beginning with the Spanish colonization after 1500 in the lowland and mid-elevation forested regions most easily converted to agriculture. The second major wave of assault on the Guatemalan forests began in the 20th century, driven by a combination of factors, including population growth, inequitable land and income distribution, and development policies. Deforestation is commonly cited as the main cause of global habitat loss, and, this model is also consistent in Guatemala In 2010 forest area was reported to cover 26.3% of the land area of the country with an estimated annual rate of change of forest cover of -1.7%. [328].
Dalbergia calderonii	Occurs in Chiquimula, Huehuetenango and Jalapa [366].	
Dalbergia calycina	Reported to occur in Sacatepequez and Santa Rosa [366].	
Dalbergia cubilquitzensis	*D. cubilquitzensis* is said to occur in Guatemala according to Rudd [373]. However according to the Tropicos website, *D. cubilquitzensis* is reported to only be found in Belize and Mexico [60]. Reported by the Government of Guatemala as occurring in Alta Verapaz [366].	
Dalbergia cuscatlanica	Reported as occurring in Guatemala according to Tropicos, however the Government of Guatemala has not recorded the species as being present in CITES PC22 Doc. 17.2 [366, 60].	
Dalbergia funera	Reported as occurring in Chiquimula, Huehuetenango and Jalapa by Tropicos but not by the Government of Guatemala in CITES PC22 Doc. 17.2 [366, 60].	
Dalbergia glomerata	Reported to occur in Alta Verapz, Izabal and Quiche [366].	
Dalbergia luteola	Occuring in the district of Huehuetenango [366].	
Dalbergia melanocardium	Reported as occurring in the district of Santa Rosa [366, 60].	
Dalbergia retusa	For *D. retusa* - included in Category 2 of the List of Threatened Species of Guatemala (which refers to species that are restricted to only one habitat type) [315]. FAUSAC-FNPV (2015) reports however that over an 11 year period from 1991 through to 2012 the distribution of areas of *D. tucurensis* and *D. retusa* declined from 1 789 012 ha to 1 031 234 ha. This shows	

	a net loss of some 757 778 ha during this time [349]. Reported to occur in Alta Verapaz, Escuintla, Santa Rosa and Suchitepequez [366].	
Dalbergia stevensonii	Guatemala exports sawn wood from this species, but there is no information concerning its ecology or distribution in the country or the extent of logging. An assessment of the species in the wild is urgently needed [374]. FAUSAC-FNPV (2015) reports a decline is the distribution of areas with *D. stevensonii* from 1991 to 2012 from 2 100 210 ha to 1 306 449 ha resulting in a net loss of some 793 761 ha [349].	
Dalbergia tucurensis	As reported above under D. retusa, areas where this species exist have declined from from 1 789 012 ha to 1 031 234 ha over a 12 year period - net loss of some 757 778 ha during this time [349]	
GUYANA		
Dalbergia frutescens	Reported as occurring in Guyana according to Tropicos [60].	The total forest area is 15 205 000 hectares with an estimated primary forest area of 6 790 000 hectares. The deforestation rate between 2005 and 2010 was recorded as 0% [318].
Pterocarpus officinalis	*P. officinalis* can be found on the Mora forest floodplain and in the north coast Mora forest [335].	
HAITI		
Pterocarpus officinalis	Reported to occur in Haiti according to Tropicos [60].	The total forest area in Haiti is recorded as being 101 000 hectares with none of that area recorded as being primary forest. The deforestation rate between the years of 2005 and 2010 was -0.77% [318].
HONDURAS		
Dalbergia calderonii	Recorded as a species of Honduras in CITES PC22 Doc. 17.2 [366].	The total forest area for Honduras is recorded as 5 192 000 hectares with some 457 000 hectares believed to be primary forest. The deforestation rate from 2005-2010 was -2.16% [318].
Dalbergia calycina	Recorded as a species of Honduras in CITES PC22 Doc. 17.2 [366].	
Dalbergia cubilquitzensis	*D. cubilquitzensis* is reported by Rudd (1995) to be found in Honduras, however it is not said to be in Honduras according to the Tropicos website [314, 373, 60]. CITES PC22 Doc. 17.2 reports that the species is found in Honduras [366].	
Dalbergia glomerata	*D. glomerata* is found in the following regions of Honduras: Colon, Atlántida, Cortes, Yoro, Comayagua, Gracias A Dios and Olancho [23].	
Dalbergia longepedunculata	Reported as a species by Tropicos [60] however not recorded by the Government of Honduras in CITES PC22 Doc. 17.2 as currently existing in Honduras [366].	
Dalbergia melanocardium	Recorded as a species of Honduras in CITES PC22 Doc. 17.2 [366].	
Dalbergia retusa	*D. retusa* is reported from the western areas of Honduras. It is included in the list of Species of Special Concern in Honduras in the category vulnerable A1 cd + 2cd according to the IUCN [315].	
Dalbergia stevensonii	Recorded as a species of Honduras in CITES PC22 Doc. 17.2 [366].	
Dalbergia tucurensis	Recorded as a species of Honduras in CITES PC22 Doc. 17.2 [366].	
JAMAICA		
Pterocarpus officinalis	Reported to occur in Jamaica according to Tropicos [60].	The total forest area of Jamaica is 337 000 hectares with 88 000 of these designated as primary forest. Between 2005 and 2010 the

		deforestation rate was recorded as being -0.12% annually [318].
MEXICO		
Dalbergia calderonii	*D. calderonii* is found in the states of Chiapas, Oaxaca and Sousa-Sanchez [60]	The total forest area in Mexico is said to be around 64 802 000 hectares with some 34 310 000 hectares recorded as being primary forests. The deforestation rate between 2005 and 2010 was -0.24 % annually [318]. The loss of primary and secondary vegetation is currently estimated by CONAFOR[60] to be 400 000 ha per year, although deforestation rates are reported to be falling. Vegetation disturbance is estimated to affect about 550 000 ha/year, which indicates a rapid degradation process. There is also a rehabilitation process going on because a total area of 278 000 ha per year (70% of the deforestation) is subject to some form of rehabilitation. The change of forest resources is highly focused on the tropical and subtropical regions, where land-use change dynamics has been greater than in other parts of the country [375].
Dalbergia calycina	*D. calycina* is found in dry semi-deciduous forests and forest in volcanic areas. It is present in the states of Michoacan, Oaxaca and Chiapas [371, 314].	
Dalbergia cuscatlanica	Reported by Tropicos as occurring in the Chiapas district of Mexico. Not recorded by Mexico as occurring there in CITES PC22 Doc. 17.2 [366, 60].	
Dalbergia congestiflora	*D. congestiflora* is located within the states of Chiapas, Colima, Guerrero, Jalisco, Michoacan, Morelos, Oaxaca and Puebla [314, 60].	
Dalbergia cubilquitzensis	Located in the states of Chiapas and Oaxaca [314, 60].	
Dalbergia glomerata	*D. glomerata* is distributed within Mexico and Central America but the IUCN notes that species found outside of Mexico actually related to other species (such as *D. glabra, D. cubilquitzensis or D. tucurensis)* [314, 371, 327]. CITES reports that *D. glomerata* is endemic to Mexico [314].	
Dalbergia granadillo	The timber of *D. retusa* is said to be almost indistinguishable from that of *D. granadillo* [314]. *D. retusa* occurs in southwest and southeast Mexico with records of the species in Chiapas and Oaxaca, but no data on population status [315]. Recent research suggests that *D. retusa* is not native to Mexico and that species used in trade may actually be *D. granadillo* instead [314].	
Dalbergia longepedunculata	*D. longepedunculata* is found in the state of Oaxaca [327, 314].	
Dalbergia luteola	*D. luteola* is distributed in the state of Chiapas [327, 314].	
Dalbergia melanocardium	*D. melanocardium* is distributed in the state of Chiapas [314].	
Dalbergia modesta	*D. modesta* is said to be endemic to Mexico and is found in the states of Chiapas and Oaxaca [327, 314].	
Dalbergia palo-escrito	*D. palo-escrito* is said to be endemic to Mexico and can be found in the states of: Hidalgo (rare cloud forest), Queretaro, San Luis Potosi, Guerrero, Oaxaca and Morelos [326, 314, 376]	
Dalbergia rhachiflexa	*D. rhachiflexa* is also endemic to Mexico and is located in the states of Michoacan and Guerrero [327, 314].	
Dalbergia ruddiae	*D. ruddiae* is found in both Mexico and Costa Rica and is distributed in the Mexican state of Chiapas [327, 314].	
Dalbergia stevensonii	Reported as occurring in the Chiapas district of Mexico [366, 60].	
Dalbergia tucurensis	*D. tucurensis* is native to Brazil and is found in the state of Chiapas [314].	
Pterocarpus officinalis	Reported by Tropicos as occurring in the Yucatan region of Mexico [60].	

[60] National Forestry Commission of Mexico

NICARAGUA		
Dalbergia calycina	Reported to be rare in Nicaragua, despite being listed as Least Concern by the IUCN List of Threatened Species [371].	The total forest area of Nicaragua is 3 114 000 ha with 1 179 000 ha of primary forests. The deforestation rate between 2005 and 2010 was -2.11% per year [318].
Dalbergia calderonii	Reported to occur in Nicaragua according to Tropicos [60].	
Dalbergia cubilquitzensis	*D. cubilquitzensis* is said to occur in Nicaragua according to Rudd (1995) [373, 314]. However, according to the Tropicos website, it is only distributed in Belize and Mexico [60].	
Dalbergia retusa	Reported as occurring in Nicaragua according to the IUCN Red List of Threatened Species [320].	
Dalbergia tucurensis	Reported to occur in Nicaragua according to Tropicos [60].	
PANAMA		
Dalbergia cuscatlanica	Reported to occur in Panama according to Tropicos [60].	The total forest area of Panama is 3 251 000 ha with none recorded as primary forests. The deforestation rate between 2005 and 2005 was -0.36% annually [318]. There are recent unconfirmed reports of uncontrolled harvest in *Dalbergia retusa* in the Darien region of Panama [315].
Dalbergia darienensis	Listed on Appendix II by Panama [377, 60].	
Dalbergia retusa	*D. retusa* is only found in the drier, southern parts of the isthmus. Commercial harvest and a restricted distribution has reduced populations in Panama [315]	
Pterocarpus officinalis	*P. officinalis* is found in the localities of Changuinola and the Darien swamp [335].	
PERU		
Dalbergia frutescens	Reported to occur in the regions of Loreto and San Martin according to Tropicos [60]	The total forest area of Peru is estimated to be 67 992 000 ha with primary forests of some 60 178 000 ha. The deforestation rate between 2005 and 2010 was -0.22% [318].
SURINAME		
Pterocarpus officinalis	Reported to occur in Suriname according to Tropicos [60].	The total forest area of Suriname is 14 758 000 ha with some 14 001 ha recorded as primary forests. The deforestation rate from 2005 to 2010 was -0.02% [318].
TRINIDAD AND TOBAGO		
Pterocarpus officinalis	Reported to occur in Trinidad and Tobago according to Tropicos [60].	The total forest area of Trinidad and Tobago is 226 000 ha with some 62 000 ha of primary forests. The deforestation rate is -0.32% per annum [318].
VENEZUELA		
Dalbergia frutescens	Reported to occur in the region of Boliva according to Tropicos [60].	Venezuela does have significant conservation zones, with the Law on Forests and Forest Management requiring that 10% of the managed production forest be protected as a preservation zone. The estimated total area contained in reserves compatible with IUCN categories I-IV is 17.9 million hectares. This amounts to nearly 20% of the national territory. However, many of these areas exist only on paper. Protected areas are used for logging and mining - both illegal and government-sanctioned - and other forms of development, while some protected areas have been designated despite being cleared long ago [318].
Dalbergia spruceana	Reported as occurring in Amazonas and Bolivar [60].	
Pterocarpus officinalis	*P. officinalis* is found in the Orinocco delta in Venezuela [335].	

As stated above, there is a lack of up-to-date distribution and range information for each species in the Americas, limiting the overall picture provided in the above table. As such country-wide assessments of habitat lost are provided as a proxy for the reduction in available habitat for these species. In an attempt to overcome this limitation, Global Eye conducted a Geographic Information System (GIS) modelling exercise using known localities and bioclimatic parameters to predict and map the possible range extent, overlaid with known forest loss data up to 2014 (see Annex A for further details on the methods used). This allows for a justifiable prediction of the current possible distributions for the selected

rosewood species in the Americas. Figure 81 to Figure 83 show the maps for *D. frutescens, D. retusa, D. stevensonii and P. officinalis*. The species distribution modelling showed a wide area of potentially suitable habitat and environmental variables for several species, due to the forest loss layer including degraded forest habitats. In order to understand the most likely current habitat for these species, an additional data layer was added, showing forest areas that are considered "intact". These maps are the second map provided in Figure 81 to Figure 83 (with black oceans) which displays the extent of reduction in available suitable habitat for these species. Modelling was conducted for a range of other species as well, that have not been presented here. Ideally these types of exercises would be verified by field surveys to check the accuracy of the GIS modeling, but this was outside of the scope of this report. Nonetheless the GIS models provide important analysis on the pressures to these species. They can also be developed further with a sample of on-ground surveys in order to validate/refine the modeling techniques. Overall it is cost effective and important exercise to undertake.

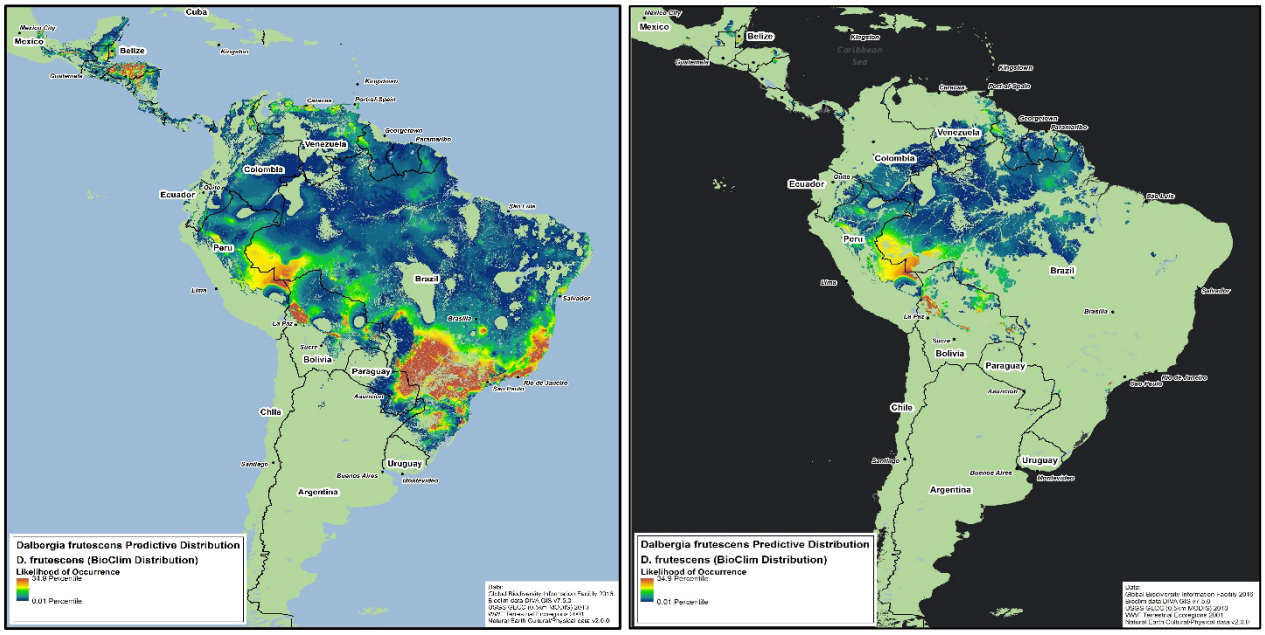

Figure 81 - *Dalbergia frutescens. (*Left*)* Predicted Suitable Habitat Range. (Right) Suitable habitat contained within "intact forests". Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

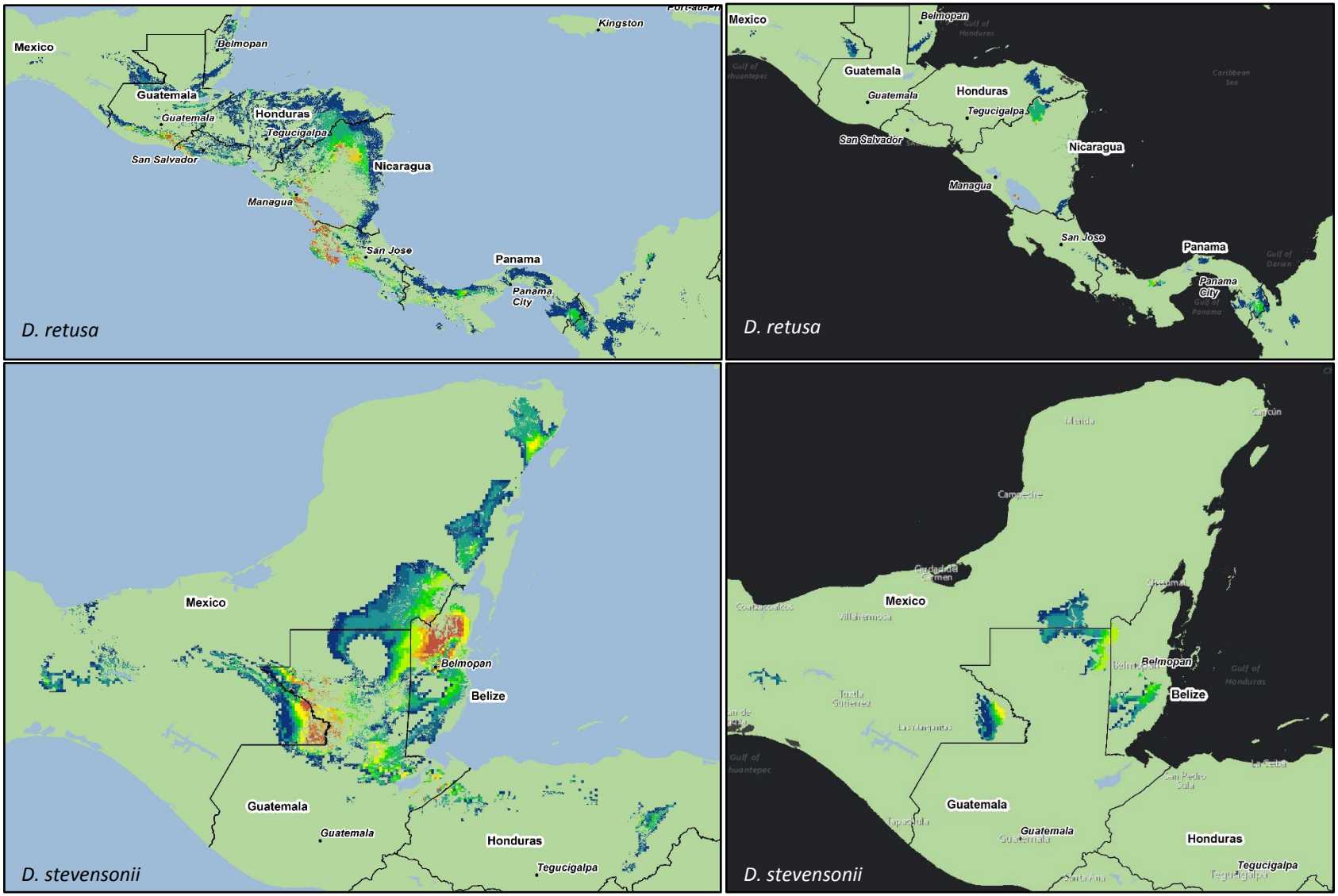

Figure 82 – Central American Species – *D. retusa and D. stevensonii* (Left) Predicted Suitable Habitat Range. **(Right) Suitable habitat contained within "intact forests".** Red indicates most suitable/favourable environmental variables for the species; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

Predicted habitat was also modelled for *D. granadillo*, which is often considered synonymously with *D. retusa,* however the intact forests model showed that there is no suitable habitat for this species left in pristine forest, so this hasn't been included here. Interestingly, this modelling exercise backs up the recent findings from the Mexico Workshop [317] where scientists suggested that *D. retusa* was not considered to be a native species to Mexico. Only very small region of suitable habitat is indicated in Mexico which is considered

to be a low likelihood of being found (indicated by the blue shading). All these maps show the extent to which suitable habitat for rosewood species in Central American countries such as Guatemala, Mexico, Honduras, Costa Rica and Panama have all lost. There only exists very small pockets of suitable habitat that have a high likelihood of containing rosewood species (indicated as red/orange shading).

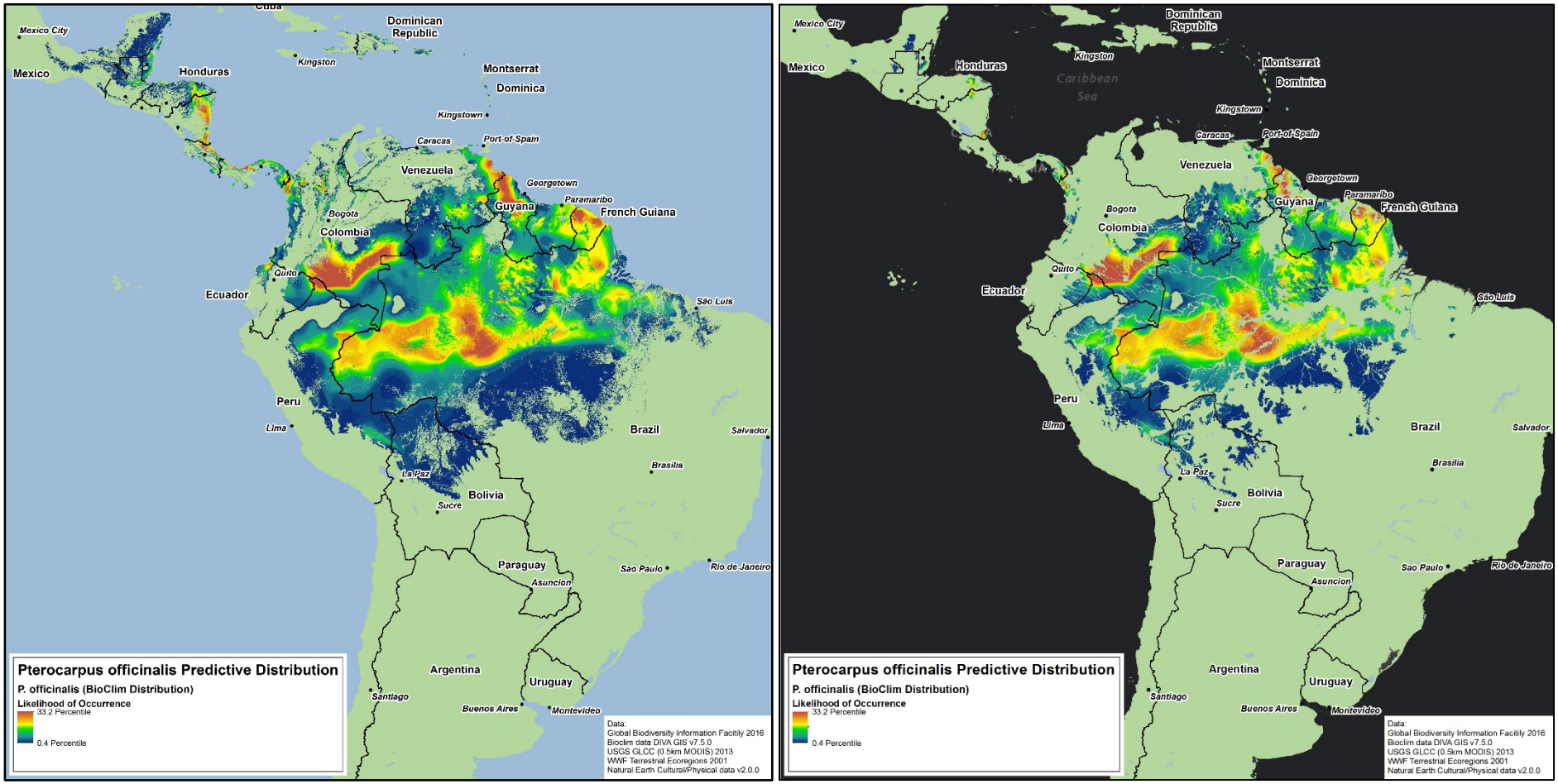

Figure 83 – *P. officinalis* (Left) Predicted Suitable Habitat Range. (Right) Suitable habitat contained within "intact forests". Red indicates most suitable/favourable environmental variables for the species ; Blue indicates least suitable/favourable environmental variables within known environmental parameter range for the species.

POPULATION STRUCTURE AND STATUS

Information on population structure and status in the Americas is limited. It is known that the forests throughout the region have been widely affected by logging and deforestation, as reported in the Distribution and Ranges Section above, thus it is likely that many of the species reported here occur in fragmented forest. The modelling exercise conducted in

the previous section shows there does still remain suitable habitat, although highly restricted. Table 82 provides the species specific populations status information that has been reviewed for this document. It should be noted however, that Global Eye was only able to access English language papers on these species and may therefore limit the range of scientific papers available.

Table 82 - Population Status and Structure in Americas

<table>
<tr><th>POPULATION STUDIED</th><th>POPULATION PARAMETERS – STATUS, STRUCTURE and DENSITY</th><th>REFERENCES</th></tr>
<tr><td colspan="3">DALBERGIA SPP</td></tr>
<tr><td colspan="3">GUATEMALA</td></tr>
<tr><td>Alta Verapaz and Peten regions of Guatemala</td><td>Vaglica (2015) reports that the population of the genus Dalbergia in Guatemala was surveyed in 2012 [329]. The research was undertaken by FAUSAC-FNPV[61] (2015) and clearly reported an absence of certain diameter classes of Dalbergia spp. In the two regions studied in Guatemala, class diameters of between 20 and 60cm were the only recorded diameter of Dalbergia spp found in the wild (refer to Table 83) [329, 349]. This lack of trees with a diameter above 70-90 cm in diameter and low land area and bio-volume all suggest that the genus is in decline throughout the studied areas [349, 329].

Table 83: Diameter classes of Dalbergia spp. found in Alta Verapaz and Peten regions of Guatemala
<table>
<tr><th></th><th>10-19.9</th><th>20-29.9</th><th>30-39.9</th><th>40-49.9</th><th>50-59.9</th><th>60-69.9</th><th>70-90</th><th>Total</th></tr>
<tr><td>Density N/ha</td><td>0.653</td><td>0.787</td><td>0.533</td><td>0.333</td><td>0.033</td><td>0.013</td><td>-</td><td>3.448</td></tr>
<tr><td>Land area (m²)/ha</td><td>0.013</td><td>0.036</td><td>0.047</td><td>0.005</td><td>0.003</td><td>0.004</td><td>-</td><td>0.707</td></tr>
<tr><td>Biovolume (m³)/ha</td><td>-</td><td>00.7</td><td>0.025</td><td>0.008</td><td>0.042</td><td>0.033</td><td>-</td><td>0.115</td></tr>
</table>
Source: FAUSAC-FNPV, 2015 taken from Vaglica, 2015 [329, 349].</td><td>FAUSAC-FNPV (2015) [349]; Vaglica (2015) [329].</td></tr>
<tr><td colspan="3">DALBERGIA MISCOLOBIUM</td></tr>
<tr><td colspan="3">Brazil</td></tr>
<tr><td>Jatobas biological reserve in Bahia</td><td><u>Tree Density</u>
- Studied tree mortality, recruitment and changes in density of woody species.
- A density of 10.77 stems/ha was recorded in 1991 and 13.08 in 2004. A dominance of 13.60 was recorded in 1991 and 16.56 in 2004 [378].
- Of 14 trees surveyed, they recorded 2 deaths, 5 recruits. Over the 13 year study period, the density and dominance of D. miscolobium remained stable [378].</td><td>Roitman et al (2008) [378]</td></tr>
<tr><td colspan="3">DALBERGIA STEVENSONII</td></tr>
<tr><td colspan="3">Guatemala</td></tr>
<tr><td>Franja Trasversal del Norte, (FTN) (Alta Verapaz and Izabal)</td><td>This study in Franja Trasveral del Norte, located four populations of Dalbergia stevensonii, ranging from 44 to 800 trees.
Table 84: % of Trees found in diameter classes in FTN study area
<table>
<tr><th>DBH (cm)</th><th>0-20</th><th>20-40</th><th>60-100</th></tr>
<tr><td>Density (%)</td><td>22%</td><td>57%</td><td>5%</td></tr>
</table>
Source: FAUSAC-FNPV (2015) and Vaglica (2015) [349, 329]
This particular study indicated that there were very few (5%) mature trees found within the study site [349, 329].</td><td>FAUSAC-FNPV (2015) [349]; Vaglica (2015) [329].</td></tr>
</table>

[61] FAUSAC-FNPV - Faculty of Agronomy of the University of San Carlos-Nature for Life Foundation.

<table>
<tr><th>POPULATION STUDIED</th><th>POPULATION PARAMETERS – STATUS, STRUCTURE and DENSITY</th><th>REFERENCES</th></tr>
<tr><td colspan="3">DALBERGIA CALYCINA</td></tr>
<tr><td colspan="3">Guatemala</td></tr>
<tr><td><u>Santa rosa region:</u>
This is the same study as listed above for D. stevensonii.</td><td>One population of approximately 100 trees were found in Santa Rosa.
Table 85: % of trees found in diameter classes (cm) in Santa Rosa region<table><tr><th>DBH (cm)</th><th>20-40</th><th>40-80</th><th>80-100</th></tr><tr><td>Density (%)</td><td>64%</td><td>18%</td><td>18%</td></tr></table>Source: FAUSAC-FNPV (2015) and Vaglica (2015) [349, 329]
The majority of the trees fell into the 20-40cm diameter class although this species was found to hold a moderate level of trees in the larger class diameter of 80-100cm. The number of individual trees found in this class diameter were greater than those found for D. stevensonii but were still limited in number [349, 329].</td><td>FAUSAC-FNPV (2015) [349]; Vaglica (2015) [329].</td></tr>
<tr><td colspan="3">Nicaragua</td></tr>
<tr><td>No specific studies found on this species in this country</td><td>D. calycina currently classified as of being of least concern by the IUCN Red List of Threatened species, this is despite being considered rare in Nicaragua [371]. According to Groom (2012) the taxon is known to occur in a number of protected areas and although there are threats to the habitat this is not thought to have had an effect on the population of this particular species at this stage [371].</td><td>Groom (2012) (add ref)</td></tr>
<tr><td colspan="3">DALBERGIA RETUSA</td></tr>
<tr><td colspan="3">Little information is available on abundance of Dalbergia retusa. There are conflicting accounts on the conservation of the species reported even within countries. D. retusa is described as threatened in Costa Rica, Guatemala, Mexico, Nicaragua and Panama but its conservation status has also been described as good in both Costa Rica and Nicaragua [315].</td></tr>
<tr><td colspan="3">Guatemala</td></tr>
<tr><td><u>Suchitepéquez area</u></td><td>One population of 48 trees of D. retusa was found in Suchitepéquez. A few scattered trees were also located in Santa Rosa and Escuintla.
Table 86: % of trees found in diameter classes (cm) in Suchitepéquez region<table><tr><th>DBH (cm)</th><th>0-20</th><th>40-80</th></tr><tr><td>Density (%)</td><td>69%</td><td>21%</td></tr></table>Source: FAUSAC-FNPV (2015) and Vaglica (2015) [349, 329]
The above results show that whilst there is good initial recruitment, the percentage reduces significantly when the in the availability of mature trees. This may indicate a high level of exploitation [349, 329].</td><td>FAUSAC-FNPV (2015) [349]; Vaglica (2015) [329]</td></tr>
<tr><td colspan="3">Nicaragua</td></tr>
<tr><td></td><td>D. retusa is frequent from the Pacific to the Atlantic coasts, with a good presence in open areas the species is distributed across the country mainly outside of forests at a density of 0.064 trees per hectare.</td><td>Groom (2012)</td></tr>
<tr><td colspan="3">DALBERGIA TUCURENSIS</td></tr>
<tr><td colspan="3">Guatemala</td></tr>
<tr><td><u>Alta Verapaz and Quiche</u></td><td>Only scattered trees were located in both Alta Verapaz and Quiche. Whilst growth appears across all of the class diameters, the small number of trees surveyed shows that suitable, if not highly fragmented habitat, does exist but the population numbers reflect only scattered populations.
Table 87: % of trees found in diameter classes (cm) in the Alta Verapaz and Quiche regions<table><tr><th>DBH (cm)</th><th>0-20 cm</th><th>20-40 cm</th><th>40-60 cm</th><th>60-100 cm</th></tr><tr><td>Density (%)</td><td>30%</td><td>22%</td><td>36%</td><td>12%</td></tr></table>Source: FAUSAC-FNPV (2015) and Vaglica (2015) [349, 329]</td><td>FAUSAC-FNPV (2015) [349]; Vaglica (2015) [329]</td></tr>
</table>

In a study on Atlantic forest fragmentation and the comparison of disturbed and undisturbed remnants, Carvalho et al (2015) suggest that species richness in disturbed forests was well below that found in preserved forest fragments. Loss of tree species, increased anthropogenic activity, changes in community composition, reduced genetic diversity and changed dynamics in animal and plant interactions particularly with regard to pollination & seed dispersal are all negative effects reported in forests that have experienced fragmentation [346, 332].

Figure 84 shows the species rarefaction or density curves of tree species sampled in three locations. Two of these locations looked at tree growth in disturbed forest fragmentations (a – BESP; b – VEND) with a third sample looking at an undisturbed forest fragment (c – RBU). The diameter distribution of the trees sampled in the disturbed forest fragments was also compared with the undisturbed forest fragment. The location of the study site was in the municipality of Silva Jardim in the State of Rio de Janeiro, Brazil [346]. The study found that the density curves as well as the diameter distribution was greater in the trees sampled from the undisturbed forest fragment in comparison to the disturbed sites, where the density and tree diameter was less [346].

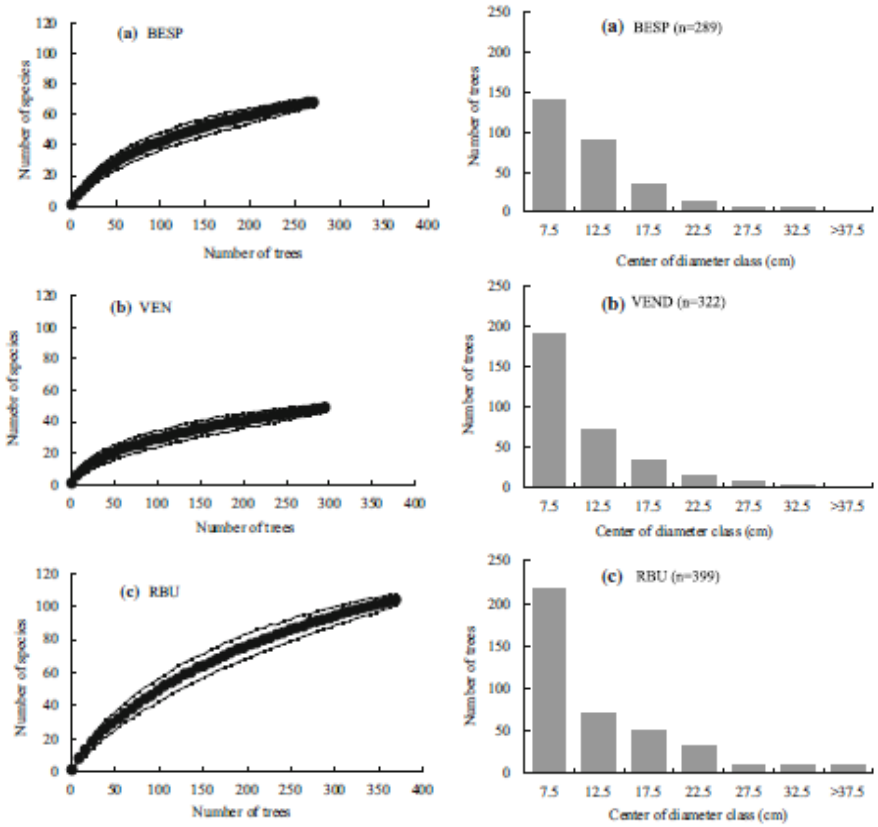

Figure 84: Comparison of species rarefaction curves between fragmented and undisturbed forest and comparison of diameter size class distribution of forest fragments and undisturbed forests (BESP is Fazenda Boa Esperanca; VEND is Fazenda Vendaval – both disturbed forest fragments and RBU is Uniao Biological Reserve, which is the preserved forest fragment).

THREATS, DISTURBANCES AND LEVEL OF TRADE

Rosewood species in the Americas are increasingly threatened from a number of anthropogenic factors. Table 88 shows the major threats and uses for each of the rosewood producing species. The primary use of all rosewood producing species is as a valuable precious wood harvested for its rich colour and durability. Commercially it is used for the manufacture of luxury furniture, musical instruments, specialty wood carvings and intricate crafts, chess boards, jewellery boxes, tool handles, construction, cabinetry and flooring amongst a wide range of other uses [23, 314, 315]. and while sustainable harvest and trade is not a threat *per se*, it is near-impossible to differentiate a finished product as originating from a legal or an illegal transaction, or indeed if the harvest of a species is actually sustainable. In order to understand the sustainable level of harvest that can be achieved, it important to understand the external other threats. These include encroachment by agriculture, pastoralism and cattle ranching, road construction, clearance for housing including burning and use for firewood, predation by insects and the effects of climate change. The main concern is that the level of recruitment and reproduction will not be be sufficient to restock forests with the rate of clearance, putting populations at risk of further decline [23, 314].

The variety of threats and uses shown in Table 88 highlights the diversity of rosewood species [329]. Some more unusual uses include food colouring pigment and as a dye for clothing or timber products. The heartwood for *D. congestiflora* is even used for the colouring in candy [379].

Table 88: Rosewood species threats and uses in the America's

SPECIES	THREATS							USES						REFs
	P	HL	FR	DF	HD	RC	FF	C	FU	Mu	DC	MD	FW	
Dalbergia brasiliensis	✓				✓			✓	✓		✓	✓	✓	[23, 345, 328]
Dalbergia. calderonii			✓	✓							✓	✓		[328, 317, 314]
Dalbergia. calycina		✓	✓					✓	✓	✓		✓		[329, 328, 317]
Dalbergia cearensis									✓	✓	✓	✓		[23, 317]
Dalbergia. congestiflora			✓						✓	✓		✓		[317, 314]
Dalbergia. cubilquitzensis			✓					✓	✓	✓	✓	✓		[23, 329, 317, 314]
Dalbergia. cuscatlanica											✓	✓		[23, 317]
Dalbergia dariensis												✓		[23]
Dalbergia decipularis					✓				✓	✓		✓		[23]
Dalbergia foliolosa			✓	✓	✓	✓				✓		✓	✓	[23]
Dalbergia frutescens		✓							✓			✓		[23]
Dalbergia funera			✓		✓	✓		✓	✓			✓		[23]
Dalbergia glomerata		✓	✓	✓		✓		✓	✓	✓		✓		[23, 329, 314]
Dalbergia granadillo									✓	✓	✓	✓		[317]
Dalbergia hortensis									✓			✓		[23, 317]
Dalbergia longepedunculata		✓	✓					✓				[62]✓		[317, 314]
Dalbergia luteola		✓						✓				✓		[317, 314]
Dalbergia melanocardium			✓	✓				✓				✓		[317, 314]
Dalbergia miscolobium											✓	✓		[23, 317, 314]
Dalbergia modesta			✓				✓					✓		[317, 314]
Dalbergia nigra	✓			✓								✓		[380]
Dalbergia palo-escrito	✓		✓		✓			✓	✓	✓		✓		[317, 314]
Dalbergia retusa				✓	✓	✓	✓		✓	✓	✓	✓	✓	[329, 317]
Dalbergia rhachiflexa			✓	✓								✓		[317, 314]
Dalbergia ruddiae			✓					✓	✓			✓		[317, 314]
Dalbergia spruceana									✓		✓	✓		[23, 317]

62 *D. Longepedunculata* has also been identified as being threatened by illegal trafficking and social conflict. [326, 322]

SPECIES	THREATS							USES						REFs
	P	HL	FR	DF	HD	RC	FF	C	FU	Mu	DC	MD	FW	
Dalbergia stevensonii				✓			✓		✓	✓	✓	✓		[329, 317]
Dalbergia tucurensis	✓			✓	✓	✓		✓	✓			✓	✓	[329, 317, 314]
Dalbergia villosa											✓	✓		[317]
Pterocarpus officinalis	✓				✓									[314]

Key			
Note: This key is different to previous sections, as it is based on the references provided in this region	P	Rodent and/or insect predation	C Construction
	HL	Habitat loss, unspecified or general	FU Furniture and Cabinetwork
	FR	Habitat destruction and fragmentation	Mu Tonewood and musical instruments
	DF	Deforestation	DC Decorative craft
	HD	Wood extraction, selective logging	MD Medicinal: Antigardial, antifungal, antibacterial properties,
	RC	Road construction	
	FF	Forest fires	FW Use as firewood/Charcoal

Many of the *Dalbergia* species traded are of significant commercial value. Table 89 provides some examples of the varying value of *Dalbergia* timber species on the international market. This value can dictate how their risk level for unsustainable harvesting can change over time dependent on market value, with reducing availability driving a rise in commercial value, and a corresponding increase in harvest which is often hard to determine legality of at market.

Table 89 - Comparison of value of Dalbergia spp on the international market [77]

Timber species	US$ cost per m³ for instrument blanks	US$ cost per m³ for sawn wood
Dalbergia cearensis	79 368	13 985
Dalbergia frutescens	79 190	15 256
Dalbergia nigra	211 029	Not known
Dalbergia palo-escrito	85 851	Not known
Dalbergia retusa	93 766	13 116
Dalbergia stevensonii	77 471	11 004
Dalbergia tucurensis	62 756	Not known

Habitat loss and destruction remain one of the most important factors threatening tropical forests outside of illegal logging of timber for their rosewood. As shown in the Distribution and Ranges section, habitat loss is a major issue for much of the Americas. What habitat that does remain is fragmented and as reported in the Population Structure and Status section, Carvalho *et al* [346] attribute fragmentation to a reduction in species richness, composition, reduced genetic diversity, growth rates, predation and pollination. As many of the remaining populations of *Dalbergia* within the Americas exist within disturbed and fragmented populations, this process of fragmentation is a significant threat [329, 381, 382].

Summary of CITES Listed Species Trade

Compared to the trade data available for Asia and Africa, there is limited information available for the Americas, as shown by the analysis conducted in the Global Overview Section which showed less than 2% trade in Vietnam. However, unlike the other regions, several species from the Americas have been listed on CITES for a number of years. *D. nigra* has been lited on Appendix I since 1992, while *D. retusa, D. stevensonii* and *D. granadillo* have all been listed on Appendix II since in 2013. Several other species have been listed on Appendix III as well, including *D. calycina, D. cubilquitzensis, D. dariensis, D. glomerata and D. tucurensis*. As such there is species specific information available worldwide for some of these species that isn't reliant on country customs data. As reported for the other regions, the Americas have also experienced an increase in trade in recent years, as shown in Figure 85 and Figure 86. These graphs clearly show a general increasing trend since 2005, with a peak in 2013 – one from a global source (CITES) and one from a regional source (Guatemala).

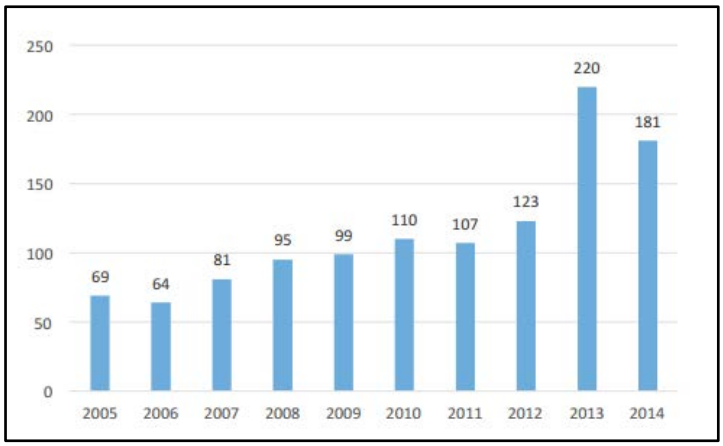

Figure 85 Annual transactions of Dalbergia spp. products: year range 2005-2014 (Source [6])

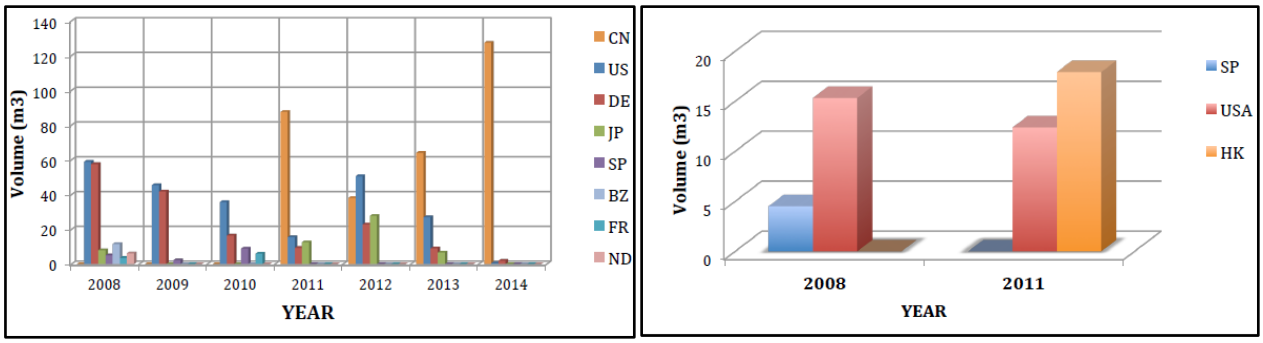

Figure 86 – Importing countries from Guatemala 2008-2014 (Left) *Dalbergia stevensonii* (Right) *Dalbergia retusa* (taken from Vaglica, 2015 [329])

The peak in export transactions displayed in both figures mirrors the patterns seen in both Asia and Africa following the listing of a range of *Dalbergia* species on CITES Appendix II in 2013, thus reiterating the risk of serial depletion of these species discussed in the Global Overview Section.

Given that *D. nigra* is listed on Appendix I, it is surprising that there is 1490 commercial trade transactions recorded in the CITES Trade Database since its listing, which is banned under the Convention. Interestingly, the top 3 exporting countries are not range countries, namely the USA (393 transactions) and Great Britain (303), while, Japan is the number one importing country of this species according to the CITES Trade Database. There are also transactions listed in the trade database that indicate the source was "artificially propagated", however, the IUCN Red list Assessment completed in 2008, stated that there was an absense of "replacement plantations" [380] suggesting that these may be fraudulent transactions. Ferris (2014) reports several other commercial shipments of wild or unknown sourced specimens of *Dalbergia nigra* that provides indications that the CITES listing may not be effectively implemented for this species [64].

Similarly, there are number of similar inconsistencies noticed in the CITES Trade database records for several other species in this region. Specifically for *D. stevensonii* which was listed on Appendix III in 1998, there is a large discrepancy between the reported export level from countries world wide versus the reported imported level of receiving countries. Exporting parties only reported 162 558 m^3 of sawn wood, logs and veneer, while importing parties have reported 821 305 m^3, which is over 5 times more exports reported than imports. For example, there are two transactions in the CITES Trade Database, from Guatemala to the USA equating to 780 000 m^3 of sawn wood for this species, which are not reported by Guatemala, in any of the available resources [383]. Where as for *D. tucurensis*, the exporting partoes are reporting highe values than the importing parties. These discrepancys highlights a potential issue with the management and traceability of these species and exports. The transactions recorded for these CITES Listed species are all primarily commercial transactions of wild sourced timber. This is allowed under an Appendix II and III listing, however, are meant to backed by CITES Non Detriment Findings[63] and Findings of Legal Acquisition. The existence of such assessments is unknown.

63 NDFs for Appendix III species are only required by the Party that lists the species on Appendix III, all other Parties are required to provide "Country of Origin" certificates

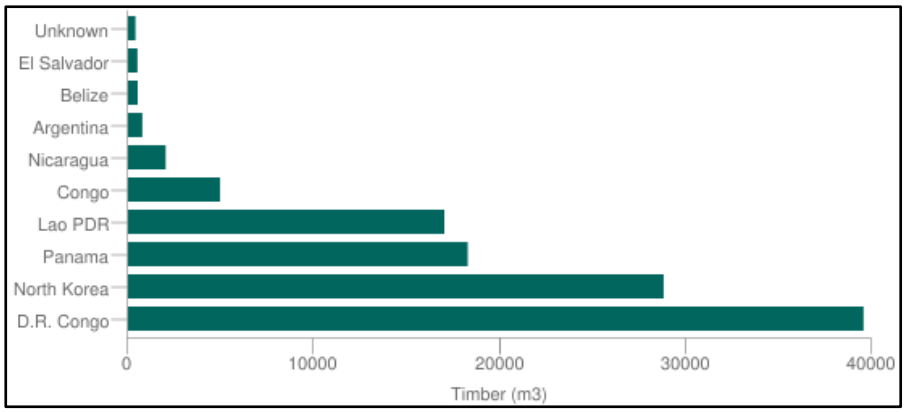

Figure 87 Top 10 countries that exported CITES listed timber to China (Source: Timber (m3) Years: 2010-2014 (all data displayed were reported by China) CITES Trade Dashboard 2016 [383].

The CITES Trade dashboard indicates that countries from the Americas are in the Top 10 Exporting Parties for CITES isted Timber species to China over the period 2010-2014. In order of volume (m^3) of exports those countries are Panama, Nicaragua, Argentina, Belize and El Salvador (Figure 87).

D. retusa and *D. stevensonii* both feature in the Top 10 tree species in trade according to the CITES Trade Dashboard (Figure 88) [383]. *D. retusa* (also shown on Figure 88) is the most prominent species in trade from this region, and the second most traded CITES Listed *Dalbergia* species after *D. cochinchinensis*. *D. retusa* was only listed on Appendix II in 2013 and however, subsequently showed a more than four fold increase in trade in 2014, a pattern observed for *D. cochinchinensis* and several replacement species. Interestingly, over the same time period, *D. stevensonii* which was also listed on Appendix II in 2013 but reported a reduction in trade in 2014 following a significant increase in trade in 2013 [383]. It would appear that listing species is a catalyst for traders to export their stocks of the species before authorites have the ability to fully implement the listing.

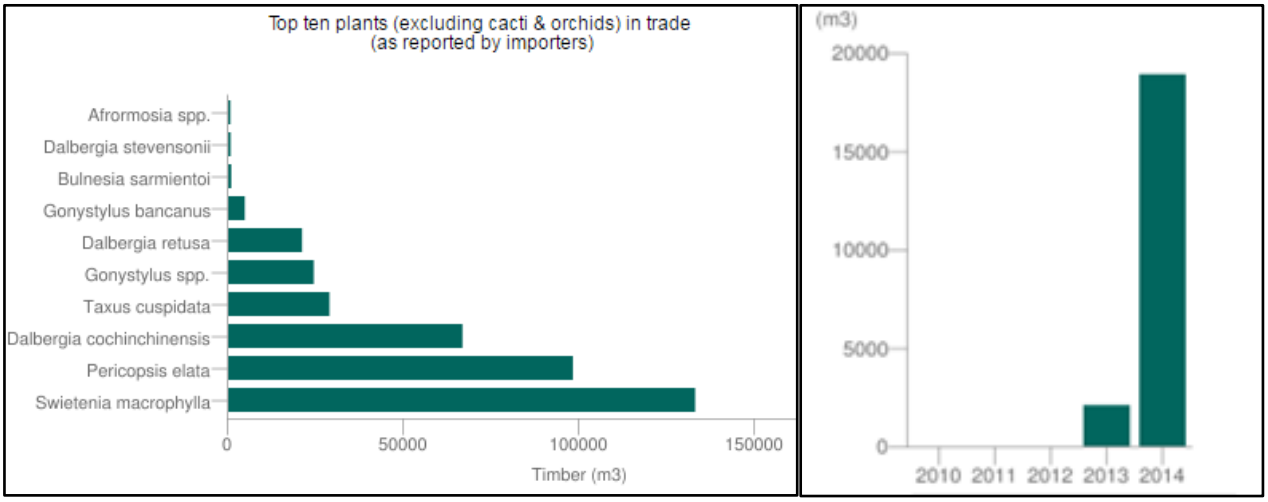

Figure 88 CITES Trade Dashboard Outputs (left)Top 10 timber species in trade 2010-2014 (Right) Trade exports of D. retusa (2010-2014) [383].

As discussed above, reliance on the Chinese Customs commodity codes or other world customs codes is problematic, especially when trying to quantify level of trade due to the misreporting of species under HS Codes. However, when there is a lack of species specific information available from regional sources, this is all that is available, and appropriate precaution in assumptions is required. A search of online databases using UN COMTRADE data under the HS codes of 4403 and 4407 has revealed high levels of trade for hardwood species (such as *Dalbergia* and *Pterocarpus*). Looking at the range states of *Dalbergia or Pterocarpus*, trade analysis of HS codes 4403 revealed that the top 3 importers for logs were India, China and Vietnam, with only sporadic trade reported for other importing countries, while for 4407 (sawn wood) the two biggest importing were the United States, followed by China.

Seizure Data

While trade data in *Dalbergia* species for the Americas may be limited by comparison to the other regions, there have been reports of increased trade in recent years [77], which is evidenced by the increasing number of rosewood seizures throughout the region. In the past 14 years, there have only been 21 seizures reported to CITES for *D. nigra* (CITES Appendix I), almost half of which have occurred since 2013 [383]. There has been a further six seizures reported to CITES for other Dalbergia species since the group of listings at CoP16 in 2013. That's 16 seizures since 2013 when there has only been 21 overall for *D. nigra* since 2003. There was also a highly significant seizure of 92 tons of Honduran rosewood (*Dalbergia stevensonii)* in 2014 bound for China [384], which is not reflected in the CITES Trade Database. To compound the issue further, Guatemalan authorities report even more seizures than what is recorded in the CITES Trade Database as shown in Table 90.

Table 90 - Illegal trade volume of *Dalbergia* exports confiscated by Guatemalan Authorities between 2011 and 2014 [329]

Year	Species	Volume m^3	Value USD	Destination
2011	Rosul (*Dalbergia* spp)	32	135680	China
2011	Rosul (*Dalbergia* spp)	64	271360	China
2011	*Dalbergia spp*	14.442	340539	China
2011	*D. retusa*	43.8	869127	China
2012	Rosul (*Dalbergia* spp)	200	848000	China
2012	*D. stevensonii*	163.24	3839928	China
2012	*D. stevensonii*	24.776	585145	China
2012	*D. stevensonii*	36.18	-	China
2013	Rosul (*Dalbergia* spp)	25.57	108416	China
2013	Rosul (*Dalbergia* spp)	32.14	582917	China
2013	*Rosul (Dalbergia spp)*	66.22	371620	El Salvador
2013	*Rosul (Dalbergia spp)*	39.57	222062	Honduras
2013	*D. stevensonii*	18.28	-	China
2014	*Rosul (Dalbergia spp)*	9.77	41424	China
2014	*Rosul (Dalbergia spp)*	5.86	24864	China
2014	*Rosul (Dalbergia spp)*	0.92	3858	China
2014	*Rosul (Dalbergia spp)*	1.65	16618	China
2014	*Rosul (Dalbergia spp)*	69.324	255091	China
2014	*Rosul (Dalbergia spp)*	2.59	21963	China
2014	*Rosul (Dalbergia spp)*	11.7	99216	China
2014	*Rosul (Dalbergia spp)*	10.08	85478	China
2014	*Rosul (Dalbergia spp)*	8.63	73182	China
2014	*Rosul (Dalbergia spp)*	10.53	89294	China
2014	*D. retusa*	14.93	-	China

While species specific data is harder to come by in this region, all the data that is available suggest an increasing level of trade that is in opposition to management measures beign implemented by range countries, particularly CITES measures in this region. While the Americas have a paucity of data on these factors when compared to other regions, range countries in this region have been reasonably proactive in seeking further protections and international sanctions to help manage the risks to these species.

MANAGEMENT MEASURES AND LEGAL FRAMEWORKS

Unsustainable trade in timber is now an issue of global significance with the world seeking to implement a number of law enforcement and protection mechanisms to address this important issue [365]. As increasing numbers of valuable timber species are listed by environmental conventions such as CITES, there is increased pressure on individual countries to ensure that they have sufficient legislation, regulation and environmental policies in place to assist in both addressing protection of populations of species within their borders and the regulation of trade in protected species.

Table 91 shows which of the selected countries in the America's have forestry policy, legislation and regulations in place. All countries have a national forestry or equivalent policy in place with the exception of El Salvador and all countries have national legislation. Information is not available for regional, provincial or local legislation for Costa Rica, the Dominican Republic, French Guiana, Nicaragua and Panama. Peru and Venezuela only have national legislation. Whilst not all countries have legislation in place against all jurisdictions the provision of a national policy and legislation is promising. It is also important to note that nine countries have legislation across nearly all jurisdictions showing that forestry and environmental legislation is critical across all areas of government and in particular in areas where forests are located and managed locally [237].

Table 91: Forest Policy and Regulatory Framework in place to support implementation of Sustainable Forest Management in the America's region. Source: Adapted from FAO (2015) [237]

Policy		Legislation/Regulations			
		National	Regional	Provincial/State	Local
	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Argentina	✓	✓	✓	✓	✓
Bolivia	✓	✓	✓	✓	✓
Brazil	✓	✓	✓	✓	✓
Colombia	✓	✓	✓	✓	✓
Costa Rica	✓	✓	?	?	?
Dominican Republic	✓	✓	✓	?	?
Ecuador	✓	✓	✓	✓	✓
El Salvador	×	✓	✓	✓	✓
French Guiana	✓	✓	✓	?	?
Guatemala	✓	✓	✓	?	?
Guyana	✓	✓	✓	✓	✓
Honduras	✓	✓	✓	✓	✓
Mexico	✓	✓	×	✓	✓
Nicaragua	✓	✓	?	?	?
Panama	✓	✓	?	?	?
Peru	✓	✓	×	×	×
Venezuela	✓	✓	×	×	×

Of particular reference to *Dalbergia* species in this region, both Mexico and Guatemala have proposals to list *Dalbergia* species at CoP17 [6, 314]. Mexico's proposal is to list 13 species of *Dalbergia* on Appendix II, while Guatemala's is to list the entire genus of *Dalbergia* on Appendix II. Mexico's proposal was put forward after local workshops found all the species eligible for protection in Mexico were in need of protection from international trade [314, 317]. The Guatemalan proposal was put forward after considerable work by Vaglia [350] through the ITTO program which suggested their species were also in need of protection from international trade. The proposal for the full genus of *Dalbergia* was considered the most appropriate by Guatemala due to the difficulty in distinguishing between *Dalbergia* species. The proposal states that the genus *Dalbergia* can be distinguished from other genus of rosewood producing timber species [6], which is not necessarily the case. *Pterocarpus* species particularly are difficult to distinguish from Dalbergia, especially when in log or sawn wood form, and particularly as a finished product.

Table 92 provides the details of management arrangements throughout the Americas whether species specific or at a forestry management level.

Table 92 – Assessment of domestic legislation for rosewood harvest and trade per range country

SPECIES AVAILABLE	PROHIBITED TRADE, POLICY AND LEGISLATION
BELIZE	
Dalbergia calderonii *Dalbergia calycina* *Dalbergia cubilquitzensis* *Dalbergia stevensonii* *Dalbergia tucurensis* *Possibly:-* *Dalbergia retusa* *Dalbergia granadillo.* *Dalbergia melanocardium*	Prohibited Trade Belize prohibited all raw rosewood exports in 1992, but lifted the ban in 1996. A moratorium on the harvesting and export of rosewood was enacted in 2013 [3]. Legislation Forest Act, Chapter 213 (1981) [385]
BOLIVIA	
Dalbergia frutescens *Dalbergia foliolosa* *Dalbergia spruceana* *Dalbergia villosa*	Legislation Bolivia adopted a new Constitution in 2009 of which Article 386 affirms the importance of forests in Bolivia. Bolivia has the following legislation in place:- Forest Law 1770 (1996, Constitution articles 38 and 299); Law 3525 of November 2006; National Forest Development Fund (2008); Supreme Decree 29643 (2008) and various development plans designed to recognise the importance of natural resources in the economic development of Bolivia [318, 24].
BRAZIL	
Dalbergia cearensis *Dalbergia decipularis* *Dalbergia frutescens* *Dalbergia nigra* *Dalbergia spruceana*	Prohibited Trade No commercial international trade in *Dalbergia nigra* is allowed due to its Appendix I listing on CITES following a decision by the Eighth Meeting of the CoP in 1992 [380]. This species is listed as threatened according to IBAMA and the FAO and appears of the official list of threatened Brazilian plants [82]. As a threatened species, federal and state legislation prohibits the cutting of *D. nigra* trees [82]. Legal trade Products reported in legal trade via the WCMC CITES Trade Database include plywood and veneer (USA and Portugal), plywood (Greece), logs (Portugal). Products generally reported in trade include carvings, timber, timber pieces and veneer with only one shipment recorded as live plants [82]. Most of these were pre-Convention specimens. Since 2006, forest management (timber harvesting) has been permitted in Brazil's public forests through forest concession contracts that can span up to 40 years. Concessions are granted through a transparent tendering and/or bidding process for the production of timber and/or non-timber products or services. Each year the Brazilian Forest Service prepares an Annual Forest Concessions Plan, which is a major instrument of policy planning for forest concessions in public forests [318]. Legislation Brazil adopted a new Constitution in 1998 giving local government more autonomy over natural resource management. Relevant legislation includes:- Law 4771 (1965) Forest Code; Law 5197 (1967) Protection of Fauna; Law 6937 (1981) National Environmental Policy; Law 9433 (1997)Water Resources Policy Law 9605 (1998)Environmental Crimes; Decree 3179 (1999) Penalties for Forest Crimes; Decree 3420 (2000) National Forest Programme; Decree 4340 (2002) Regulates articles of Law 4771; Law 11 284 (2006) Public Forest Management Law; Resolution 378 (2006) Allows permits to be issued by the Brazilian Institute of Environment and Renewable Resources; Resolution 379 (2006) Regulates the National Environmental System forest database; Decree 6063 (2007) Regulates provision of Law 11 284; Resolution 406 (2009) Establishes technical standards for the implementation of PMFSs for logging. Policy: In 2004 Brazil announced its Action Plan to Prevent and Control Deforestation in the Amazon [318].
COLOMBIA	
Dalbergia darienensis *Dalbergia frutescens*	Policy Forest policy is defined in the *National Forestry Development Plan 2000*.

SPECIES AVAILABLE	PROHIBITED TRADE, POLICY AND LEGISLATION
Dalbergia retusa (?). *Pterocarpus officinalis*	Legislation *General Forest Law* (Ley General Forestal, Ley 1021) *Law on a National Development Plan for 2006-10* (Ley 1151, 2007) to take into account indigenous interests; *Forest Law (1959)* which established seven national forest reserves *1974 Decree (*Decreto 2811) adopted the National Code of Renewable Natural Resources; *1993 General Environment Law* (Ley General Ambiental, Ley 99); *1996 Decree* (Decreto 1791) which relates to forest harvesting; *Law 1377 (2010)* permits use of planted forests [318].
COSTA RICA	
Dalbergia calycina *Dalbergia glomerata* *Dalbergia melanocardium* *Dalbergia ruddiae* *Dalbergia retusa* *Pterocarpus officinalis*	Legislation Forestry Law 7575 (1996) [385]
DOMINICAN REPUBLIC	
Pterocarpus officinalis	Legislation In 2000 the Dominican Republic approved the Environmental and Natural Resources General Law No. 64-00. This law sets out the regulations for the protection of the environment and natural resources with the aim of ensuring sustainable use. Article 17 sets out some of the basic principles including the precautionary principle, the principle of "Whoever pollutes, pays", the Tort Principle, the Participation Principle, the Principle "In dubio pro natura", the ab initio Prohibition Principle and the Public Order Principle to name a few. This law also created the Department of Environment and Natural Resources [291]. Law 118-99 is the Dominican Republic's forestry law. Defines positions within the National Forestry Resources Institute and lists the regulations for forest protection, use, commercial rules, investment and education [386]
ECUADOR	
Pterocarpus officinalis	Legislation The 20th Constitution of Ecuador was approved in 2008. Conservation is recognised in the constitution in Article 406 and Article 407 prohibits extractive activities in protected areas which include timber harvesting. Forest Law (L.74 PCL. RO 64) (1981) assigns ownership of all forestry assets to the government of Ecuador. This law is currently under revision and will be based on the National Strategy for Sustainable Forest Development 2007-1011 [318].
EL SALVADOR	
Dalbergia calderonii *Dalbergia calycina* *Dalbergia congestiflora* *Dalbergia granadillo* *Dalbergia melanocardium* *Dalbergia retusa* *Dalbergia tucurensis*	Legislation *D. calderonii* listed on the official list of threatened plants in El Salvador. Decreto numero 268 Ley Forestal El Salvador (2012) [385]
GUATEMALA	
Dalbergia calderonii *Dalbergia calycina* *Dalbergia congestiflora* *Dalbergia cubilquitzensis* *Dalbergia glomerata* *Dalbergia luteola* *Dalbergia melanocardium* *Dalbergia retusa* *Dalbergia stevensonii* *Dalbergia tucurensis*	Legislation Forest Law (Decreto 101-96, Ley Forestal, 1996); Resolution 01/43 (2005); Law on Protected Areas (Ley de Areas Protegidas, Decreto 4-89, 1989) amended in 1996 and 1997 regulates the Guatemalan System of Protected Areas [318]. *D. retusa* listed in official list of threatened species for Guatemala. Policy A National Strategy for Conservation and Sustainable Use of Biodiversity was approved in 1999 [318]. Guatemala also has regulations on harvesting *D. retusa* within the management categories of the national system of protected wild areas [315].

<table>
<tr><th>SPECIES AVAILABLE</th><th>PROHIBITED TRADE, POLICY AND LEGISLATION</th></tr>
<tr><td colspan="2">GUYANA</td></tr>
<tr><td>Dalbergia foliolosa
Dalbergia frutescens
Pterocarpus officinalis</td><td><u>Policy</u>
Guyana established a National Forest Policy Statement in 1997 to safeguard the conservation and productivity of its natural forest resources.

<u>Legislation</u>
The Forest Act – Chapter 67.01 was in place from 1953 to 2009 when the Forest Bill (2009) was passed, however this Bill is still awaiting assent. When it comes into effect it will appeal Law 67.01 [318].</td></tr>
<tr><td colspan="2">HONDURAS</td></tr>
<tr><td>Dalbergia calderonii
Dalbergia calycina
Dalbergia glomerata
Dalbergia longepedunculata
Dalbergia melanocardium
Dalbergia retusa
Dalbergia spruceana
Dalbergia stevensonii
Pterocarpus officinalis</td><td><u>Trade</u>
All trade in D. retusa is banned in Honduras under Resolution GG-MP-104-2007 [315].

<u>Legislation</u>
Forest Law 98 (Ley Forestal, Areas Protegida y Vida Silvestre) 2007.
Ley Forestal de Honduras, Decreto 85-71 (1971) [318]

<u>Policy</u>
Honduras also has a National Forest Policy 2002-2025 which acknowledges the economic importance of forestry and the balance required to conserve these resources. Local governments also have a mandate for forests and protected areas under the 2007 Forest Law [318].</td></tr>
<tr><td colspan="2">MEXICO</td></tr>
<tr><td>Dalbergia calderonii
Dalbergia calycina
Dalbergia congestiflora
Dalbergia cubilquitzensis
Dalbergia glomerata
Dalbergia granadillo
Dalbergia longepedunculata
Dalbergia luteola
Dalbergia melanocardium
Dalbergia modesta
Dalbergia palo-escrito
Dalbergia retusa
Dalbergia rhachiflexa
Dalbergia ruddiae
Dalbergia spruceana
Dalbergia stevensonii
Dalbergia tucurensis
Pterocarpus officinalis</td><td><u>National legislation</u>
Mexico has a national forest program which incorporates the National Strategic Forestry Plan 2025 prepared in 2003 and regulations in 2005. The General Law for Sustainable Forest Development incorporates eight instruments. These are:-
Forest Development Planning; National Forest Information System; National Forest and Soil Inventory; Forest Zoning;
National Forest Registry; Official Forest Regulations; National System of Forest Management; and Annual Satellite Assessment of Forest-cover change [318].

The General Wildlife Act which regulates species listed under NOM-059-SEMARNAT-2010.
General Sustainable Forest Development Act and associated regulations.

<u>NOM-059-SEMARNAT – 2010</u>
NOM-059-SEMARNAT – 2010 is Mexico’s official list of endangered species. Listings, or proposals to change listings, need to obtain an evaluation using the MER criteria (Method for Evaluating the Risk of Extinction of Plants in Mexico). Proposals along with the MER assessment are submitted to CONABIO (the CITES Scientific Authority of Mexico) for presentation to SEMARNAT (the Ministry of Environment and Natural Resources) for consideration [385].

Currently the protection status of Dalbergia species listed on NOM-059-SEMARNAT-2010 only lists D. congestiflora [314]nd D. granadillo as being in danger of extinction (thus regulated under the General Wildlife Act). The remainder of the thirteen species listed in CoP 17 Proposal 54 are currently not protected under NOM-059-SEMARNAT-2010 however, utilisation of these species is regulated by the General Sustainable Forest Development Act [314]. This Act requires an Environment Impact Assessment for species found within natural protected areas. There are 17 natural protected areas within Mexico where the 13 species proposed for listing in CoP 17 Proposal 54 can be found [314].

Currently in the most recent assessment outlined in CITES PC22 Doc 22.4 the thirteen species do qualify for a listing recommendation in NON-059-SEMARNAT-2010. The recommendation is as follows:-

<table>
<tr><td>In danger of extinction</td><td>D. calderonii</td><td>D. cubilquitzensis</td></tr>
<tr><td></td><td>D. longepedunculata</td><td>D. luteola</td></tr>
<tr><td></td><td>D. melanocardium</td><td>D. ruddiae</td></tr>
<tr><td></td><td>D. stevensonii</td><td>D. tucurensis</td></tr>
<tr><td>Threatened</td><td>D. calycina</td><td>D. modesta</td></tr>
<tr><td></td><td>D. palo-escrito</td><td>D. rhachiflexa</td></tr>
<tr><td>Subject to special protection</td><td>D. glomerata</td><td></td></tr>
</table>
</td></tr>
</table>

SPECIES AVAILABLE	PROHIBITED TRADE, POLICY AND LEGISLATION
	NICARAGUA
Dalbergia calderonii *Dalbergia calycina* *Dalbergia retusa* *Dalbergia tucurensis*	Legislation Ley No. 462 Ley de Conservacion, Fomento, y Desarrollo Sostenible del sector Forestal [385]. Policy *D. retusa* considered a low priority in Forest Action Plan of Nicaragua.
	PANAMA
Dalbergia darienensis *Dalbergia retusa (?)* *Pterocarpus officinalis*	Legislation Ley Forestal de la Republica de Panama (Ley No. 1 del 3 de febrero de 1994) [385]. Law 24/1992 – reforestation; Article 43 of Law 1/94; Wildlife Law 24 (1995); General Law on the Environment (1998) (Ley General de Ambiente, 41/98); Decree Law No. 2 (2003) relating to forest management guidelines; Law 5 (2005) (Ley sobre Delito contra el Medio Ambiente, 2005) outlines penalties for illegal logging and other environmental crimes [318].
	PERU
Dalbergia frutescens	Policy Peru has a National Forest Strategy (2002) which was adopted by the Government in 2004 becoming Decreto Supremo 031-2004-AG). Legislation National Forest Strategy Implemented through the Forestry and Wildlife Law (Ley Forestal y de Fauna Slvestre – Ley 27308) 2000. The law covers a range of issues such as indigenous rights, forest conservation, concessions for commercial timber, tourism and the management of resources by local governments [318].
	VENEZUELA
Dalbergia frutescens *Pterocarpus officinalis*	Legislation Venezuela's 1999 Constitution sets out the framework for forest management in Articles 127-129. Other relevant legislation includes: Organic Law for the Environment (2006); Organic Law of Land Management (1983) – Article 15; The Penal Law of the Environment (Ley Penal del Ambiente) 1992; Ley de Gestion de la Diversidad Biologica (2008); Decree 6070 Law on Forests and Forest Management (2008); Trade Domestic timber trade within Venezuela is regulated by the 1966 Forest Law for Soil and Water and international trade by the Fiscal Law which regulates the import and export and states that logs harvested in natural forests cannot be exported. Policy New forest policy and legislation is currently being prepared [318].

Several countries in the America's also have management measures in place in relation to permanent forest estate (PFE), protection of primary forest, forest ownership, biodiversity, soil, water and carbon storage. As such, PFE is an important component of forestry conservation. However, Honduras, Mexico, Panama and Trinidad & Tobago all allow the total area of PFE to be harvested, which seriously undermines the purpose of this designation. Colombia is the only country in this region that does not allow any harvesting of their natural forest PFE [318]. Table 93 shows how PFE has changed in countries from this region from 2005 to 2010. The most interesting trend was that Brazil had a significant increase in PFE, while both Ecuador and Peru reduced their PFE available while also allowing more area for harvest. Brazil and Peru both increased their planted PFE over the same period [318].

Table 93: Production of PFE ('000 hectares) in the Americas region

	NATURAL-FOREST PFE										PLANTED-FOREST PFE			
COUNTRY	AREA		AVAILABLE FOR HARVEST		WITH MANAGEMENT PLANS		CERTIFIED		SUSTAINABLY MANAGED		AREA		WITH MGT PLAN	
YEAR	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Bolivia	17000	25100	5470	9680	5470	9680	2210	1720	2210	1720	60	73	-	-
Brazil	98100	135000	-	15340	5250	15340	1160	2700	1360	2700	3810	6650	1350	3380

	NATURAL-FOREST PFE										PLANTED-FOREST PFE			
COUNTRY	AREA		AVAILABLE FOR HARVEST		WITH MANAGEMENT PLANS		CERTIFIED		SUSTAINABLY MANAGED		AREA		WITH MGT PLAN	
YEAR	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Colombia	5500	5500	2150	-	-	-	0	9	200	315	148	405	80	150
Ecuador	3100	1964	-	115	65	86	0	0	101	176	164	175	65	90
Guatemala	1140	1140	540	540	697	697	520	481	672	630	71	85	27	27
Guyana	5450	11090	3800	6710	3730	4053	0	184.5	520	520	12	12	0	0
Honduras	1590	1096	1070	1096	671	1096	37	111	187	276	48	48	28	31
Mexico	7880	8400	8600	8400	8600	750	163	12	163	750	100	171	34	84
Panama	350	350	86	86	63	72	0	0	0	44	56	71	32	47
Peru	24600	18700	8000	8431	5000	7563	59	713	560	1603	250	820	8	-
Suriname	6890	5319	1740	2000	73	899	0	89	0	247	7	13	7	-
Trinidad and Tobago	128	127	75	75	75	75	0	0	15	15	15.4	15.4	15.4	15.4
Venezuela	13000	12920	3120	4379	1480	4379	0	0	480	510	863	845	727	845

Source: Taken from Blaser et al (2012) [318]

CONCLUSIONS AND SUMMARY

Rosewood producing species in the Americas are traded commercially across the region and the rest of the world. However they are also at risk from a variety of threats, including illegal trade, deforestation and overexploitation for a wide range of uses. As in the rest of the world the threats compound the overall level of exploitation., leading to what the data suggests is serious overexploitation when the numerous legal and illegal harvesting regimes are combined. Other threats to precious wood species in the region include habitat loss, human settlements, cattle ranching, agriculture, road construction and land clearing for firewood and charcoal. While all the range states have national legislation and to a lesser extent state, regional or local legislation and environmental policies in place, there appears to be significant room for improvement to manage the species sustainably.

Overall the following observations can be made:-

- Taxonomic uncertainty with some species is an issue in establishing species distribution. Confusion over which countries *D. retusa* is believed to be present in as well as frequently being reported as *D. granadillo* is problematic. Confusion of species identification can provide loopholes allowing one species to be traded or disguised as another through deliberate misreporting, as observed for the other regions.
- Like other rosewood producing species of *Dalbergia* and *Pterocarpus*, the species present in the Americas share a number of biological similarities. These include slow growth rates, sprouting and coppicing, the symbiotic relationship with rhizobia found in root system nodules which can enhance soil fertility, mass flowering and low fruiting, pollination primarily by bees;
- Current scientific data is missing on for several species in relation to biology, population structure and status and trade, however, some of this information can be inferred from other similar species, allowing the ability to apply precautionary management measures until such information can be gathered to refine the management measures accordingly
- While there is limited scientific information available on the distribution and ranges of species, the GIS modelling and mapping exercise conducted here clearly demonstrates the severely restricted ranges of suitable habitat existing in intact forests. Modelling exercises such as this are relatively inexpensive compared to conducting actual surveys and can provide robust assessments that can be utilised to inform NDF assessments in the absese of on ground survey work. Survey work can conducted if/when funding is available, and on small poertion of the modelled area so as to validate the findings of the model. This can reduce the overall costs associated with determining current distribution and ranges of these species.
- Illegal logging and export is continuing to increase – as evidenced by the increased number of seizures in the last few years. International pressure on rosewood species within the Americas is considered likely to continue

to increase as the trade from other source countries reduces due to increased protections (i.e. log export bans from supplier countries such as Madagasacar and West Africa;

- Trade in *Dalbergia* species from within the Americas is reported as low in comparison to that recorded in both Asia and Africa. However the pattern of trade over recent years shows similar increasing trend to the other regions, with a peak in 2013 following the multiple listings of Dalbergia species on CITES Appendix II at CoP16.

Increased and targeted support within range states to address all of these issues is required. In the case of the Americas region, further scientific research is required to provide much needed biological and distribution data, so that suitable habitat can be preserved. Legislative frameworks need to be more effective and this will require support of governments across all levels within countries.

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SECTION III – NON DETRIMENT FINDING REQUIREMENT GAP ANALYSIS

Table 102 is an assessment of how much information is available in order to conduct a Non Detriment Finding (NDFs) for a particular *Dalbergia* or *Pterocarpus* species. The assessment categories are as follows:

- ✓✓✓ There is a good level of species specific information available to inform an assessment against the NDF criteria. Having a good level of information does not however indicate that the species is being managed sustainably, it suggests there is enough information to determine that to a good degree of accuracy, such that less iterative management measures could be designed.
- ✓✓ There is a fair level of information available, either at species specific level, or genus level to inform an assessment against the NDF criteria. A higher degree of conservatism is required in making an NDF with a lower level of information available.
- ✓ There is a limited species specific information available however, there is information available on similar species or at genus level that could be used to inform an assessment against the NDF criteria. A high level of risk would be associated with authorising trade in NDFs created for species with this level of information, suitably precautionary and adaptive management arrangements should be implemented while gathering more scientific information on the species.
- ✖ There is insufficient information available to make an assessment against NDF criteria for this species. Extremely precautionary measures should be implemented prior to authorising any future trade in species with this level of information available.

It is noted however, that NDFs can be local, regional or trans-national if a species has a wide distribution. While there may be limited information for a particular region or country, this assessment is based on the global picture. Due to the precautionary principle, and the principle of acting in the best interests of species, as laid out in the CITES convention, while there may be limited information for a particular forest area, information can be utilised from other similar regions, and used in conjunction with the range of information in this document to make an informed assessement, and implement appropriate management measures as a result of the risk level determined.

Table 94 - Assessment of Information Available to Conduct a Non Detriment Finding for *Dalbergia* or *Pterocarpus* species

Species	Taxonomic uncertainty	Biology	Distribution	Population status/structure	Threats	Trade	Legislation	Conservation & Management Measures
Dalbergia annamensis	Y	✓✓	✓✓✓	✓	✓✓	✓	✓✓	✓
Dalbergia assamica	Y	✓✓	✓✓	✓	✓✓	✓	✓	✓
Dalbergia balansae	Y	✓✓	✓	✓	✓✓	✓	✓✓	✓
Dalbergia bariensis	Y	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓
Dalbergia cochinchinensis	N	✓✓✓	✓✓✓	✓✓✓	✓	✓✓✓	✓✓✓	✓✓
Dalbergia cultrata	Y	✓✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓
Dalbergia fusca	Y	✓✓✓	✓	✓✓	✓✓	✓✓	✓	✓
Dalbergia latifolia	N	✓✓✓	✓	✓	✓✓✓	✓✓	✓✓	✓✓
Dalbergia mammosa	Y	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓

Species	Taxonomic uncertainty	Biology	Distribution	Population status/structure	Threats	Trade	Legislation	Conservation & Management Measures
Dalbergia oliveri	N	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Dalbergia odorifera	N	✓	✓	×	✓✓	✓✓	✓	✓
Dalbergia sissoo	N	✓✓	✓	×	✓✓✓	✓✓	✓	✓✓✓
Dalbergia tonkinensis	Y	✓	✓	✓	✓✓	✓	✓✓	✓✓
Pterocarpus dalbergiodes	Y	✓✓	✓	✓	✓	✓	✓	✓
Pterocarpus indicus	N	✓✓✓	✓	×	✓✓✓	✓✓	✓✓	✓✓
Pterocarpus marsupium	N	✓✓✓	✓	×	✓✓	✓	✓✓	✓✓
Pterocarpus macrocarpus	N	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Pterocarpus santalinus	N	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Dalbergia abrahamii	Y	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Dalbergia baronii	Y	✓	✓✓	✓	✓✓	✓	✓✓	✓✓
Dalbergia bathiei	Y	✓	✓✓	✓	✓✓	✓	✓✓	✓✓
Dalbergia chapelieri	N	✓	✓✓	✓	✓✓	✓	✓✓	✓✓
Dalbergia chlorocarpa	N	✓	✓✓	✓	✓✓	✓	✓✓	✓✓
Dalbergia davidii	N	✓	✓✓	✓	✓	✓	✓✓	✓✓
Dalbergia delphinensis	N	✓	✓	✓	✓	✓	✓✓	✓✓
Dalbergia greveana	Y	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Dalbergia hildebrandtii	Y	✓	✓	✓	✓✓	✓	✓✓	✓✓
Dalbergia louvelii	N	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Dalbergia madagascarensis	Y	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Dalbergia maritima	N	✓	✓	✓	✓	✓	✓✓	✓✓
Dalbergia melanoxylon	N	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Dalbergia mollis	Y	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Dalbergia monticola	Y	✓✓	✓✓	✓✓✓	✓✓✓	✓✓	✓✓	✓✓
Dalbergia normandii	N	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Dalbergia purpurascens	N	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Dalbergia trichocarpa	Y	✓✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓

Species	Taxonomic uncertainty	Biology	Distribution	Population status/structure	Threats	Trade	Legislation	Conservation & Management Measures
Dalbergia tsiandalana	N	✓	✓	✓✓	✓	✓	✓✓	✓✓
Dalbergia viguieri	N	✓	✓	✓✓	✓	✓	✓✓	✓✓
Dalbergia xerophila	N	✓	✓✓	✓✓✓	✓✓	✓	✓✓	✓✓
Pterocarpus angolensis	N	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Pterocarpus erinaceus	N	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Pterocarpus lucens	N	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓	✓	✓✓✓
Pterocarpus soyauxii	N	✓✓✓	✓✓	✓✓	✓	✓✓	✓	✓✓✓
Pterocarpus tinctorius	N	✓✓	✓✓	✓✓	✓	✓✓	✓	✓✓✓
Dalbergia brasiliensis	N	✓✓✓	✓✓	✓	✓✓✓	×	✓	✓
Dalbergia calderonii	N	✓	✓✓	✓	✓✓✓	×	✓✓✓	✓✓
Dalbergia calycina	Y	✓✓✓	✓✓	✓	✓✓✓	×	✓✓	✓✓
Dalbergia cearensis	N	✓✓✓	✓	✓	✓✓	×	✓	✓
Dalbergia congestiflora	N	✓	✓	✓	✓✓	×	✓	✓
Dalbergia cubilquitzensis	N	✓	✓✓	✓	✓✓✓	×	✓✓	✓✓
Dalbergia cuscatlanica	Y	✓	✓	✓	✓	×	✓	✓
Dalbergia darienensis	N	✓	✓	✓	✓	×	✓	✓
Dalbergia decipularis	N	✓	✓	✓	✓	×	✓	✓
Dalbergia foliolosa	N	✓✓	✓	✓	✓	×	✓	✓
Dalbergia frutescens	N	✓	✓✓	✓	✓	×	✓	✓
Dalbergia funera	N	✓	✓	✓	✓	×	✓	✓
Dalbergia glomerata	Y	✓✓	✓	✓	✓✓✓	×	✓✓	✓✓
Dalbergia grandadillo	Y	✓	✓	✓	✓	✓✓	✓	✓
Dalbergia hortensis	N	✓	✓	✓	✓	×	✓	✓
Dalbergia longepedunculata	N	✓	✓	✓	✓✓	×	✓✓	✓✓
Dalbergia luteola	N	✓	✓	✓	✓✓	×	✓✓	✓✓
Dalbergia melanocardium	N	✓	✓	✓	✓✓	×	✓✓	✓✓
Dalbergia miscolobium	N	✓✓✓	✓✓	✓	✓✓	×	✓	✓

Species	Taxonomic uncertainty	Biology	Distribution	Population status/structure	Threats	Trade	Legislation	Conservation & Management Measures
Dalbergia modesta	N	✓	✓	✓	✓✓	×	✓✓	✓✓
Dalbergia nigra	N	✓✓✓	✓	✓	✓	✓✓✓	✓✓✓	✓✓✓
Dalbergia palo-escrito	N	✓	✓✓	✓	✓✓	×	✓✓	✓✓
Dalbergia retusa	Y	✓✓✓	✓✓	✓	✓✓	✓✓	✓✓✓	✓✓
Dalbergia rhachiflexa	N	✓	✓	✓	✓✓	×	✓✓	✓✓
Dalbergia ruddiae	N	✓	✓	✓	✓✓	×	✓✓	✓✓
Dalbergia spruceana	N	✓	✓	✓	✓✓	×	✓	✓
Dalbergia stevensonii	N	✓✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓
Dalbergia tucurensis	N	✓✓✓	✓✓	✓	✓	✓✓	✓	✓
Dalbergia villosa	N	✓	✓	✓	✓✓	×	✓	✓
Pterocarpus officinalis	N	✓✓✓	✓✓	✓	✓✓	×	✓	✓

ANNEXES

ANNEX A – GEOGRAPHIC INFORMATION SYSTEMS (GIS) MODELLING AND MAPPING METHODS

The baseline maps were produced using Species Distribution Modelling (SDM) based on point locations for each species, and their associated environmental variable to predict suitable habitat regions. The species location data utilised was obtained from a variety of open sources, the major sources being the Global Biodiversity Information Facility (GBIF) and the Discover Life Global Mapper

GBIF was the primary source for *Dalbergia* and *Pterocarpus* species locations (http://www.gbif.org/species). This website is able to access numerous international open data sources concerning animal and plant life around the world. A search for each species produces a detailed report listing (where known) of species name(s), common name(s), taxonomy, habitat, search links and location. Location descriptions range from the most basic (i.e. country) to the most detailed (i.e. latitude/longitude) termed georeferenced data. Georeferenced data for all available species were downloaded as a csv file and imported into ArcGIS v10.4.1. GBIF however did not have suitable level of occurrence or location data for some of the species of interest. In such cases other plant/species databases were searched, in particular the Discover Life (http://www.discoverlife.org/mp/20m?act=make_map).and RiBioMas web databases for locations. These locations were then combined with GBIF locations in Excel and imported into ArcGIS. Location data was then cleaned for incorrect locations such as those falling into ocean/seas, introduced species locations and university/botanical garden collections. Location data was then examined for further irregularities such as in the case of d. brasiliensis. Of the 436 locations, 268 had 0.00N 0.00E given as the coordinate, which were removed. Where suitable point locations were not available, species associations were utilized instead, such as for *D. oliveri* and *P. macrocarpus*, which is known to grow in association with teak. This was required for Myanmar where there is little point location available.

Species Distribution Niche Modelling

There are many different species distribution models used to produce species distributions at various scales. Algorithms are based either on presence, presence/absence or qualitative data for the species of interest to produce occurrence predictions based on geographically referenced climate, topographical and biological data [400]. This has the advantage of being able to predict the occurrence of species in regions inaccessible either due to remoteness or political instability.

Two modelling methods were used for determining Dalbergia and Pterocarpus species distributions. Bioclim species distribution modelling was carried out for most species, as the resulting distribution was a measure of the likelihood of occurrence for the species. However, in circumstances where there were few or clustered locations, Max Ent species distribution modelling was carried out as this is a better method for dealing with such datasets. The Bioclim models were then cleaned with the removal of 0 data values, while Max Ent models were cleaned with the removal of data values less than 0.03. To validate the result of the species distribution models and the assumptions for the maximum possible extent, a comparison between both was then conducted and the maximum possible extent modified accordingly, and the land cover re-extracted.

The land cover type (discussed below) extracted for each species was then converted into a mask and used to extract the Bioclim or Max Ent species distribution model (retaining the predictive model values), and used for the first set of maps. The Global Forest Change data was then added to account for clearing post 2010, which was not accounted for in the Global Land Cover Type dataset.

However, this still showed significant regions of suitable habitat for species in regions known to no longer contain any rosewood, thefore, to more accurately present the current situation an further data layer was add to show the suitable habitat occurring within “pristine” forests, or non degraded forests that have had little impact from any form of logging.

Species Distribution Modelling Software Packages

MaxEnt

Maximum Entropy (MaxEnt) modelling predicts species occurrence by finding the distribution that is most spread out or closest to uniform, by taking the environmental limits of known locations into account. That is, a probability distribution subject to the constraint that the predicted mean matches the empirical average. Comparison studies between BioClim and MaxEnt algorithms show that BioClim modelling has a tendency to produce species ranges larger than observed on the ground. It also only deals with climate data. Hence, MaxEnt algorithms are the preferred SDM technique as it allows a number of other ecological factors to be taken into consideration, such as elevation, vegetation and soils if required. MaxEnt generally shows a good predictive performance [388] and like the BioClim algorithm, it requires only species presence data. However, it is difficult to compare with other SDM algorithms as it provides an indication of environmental suitability, rather than a likelihood of occurrence.

BioClim

TBioClim has been used extensively for species distribution mapping. It is a climate envelope model which uses only occurrence data to define the envelope for each environmental variable considered.

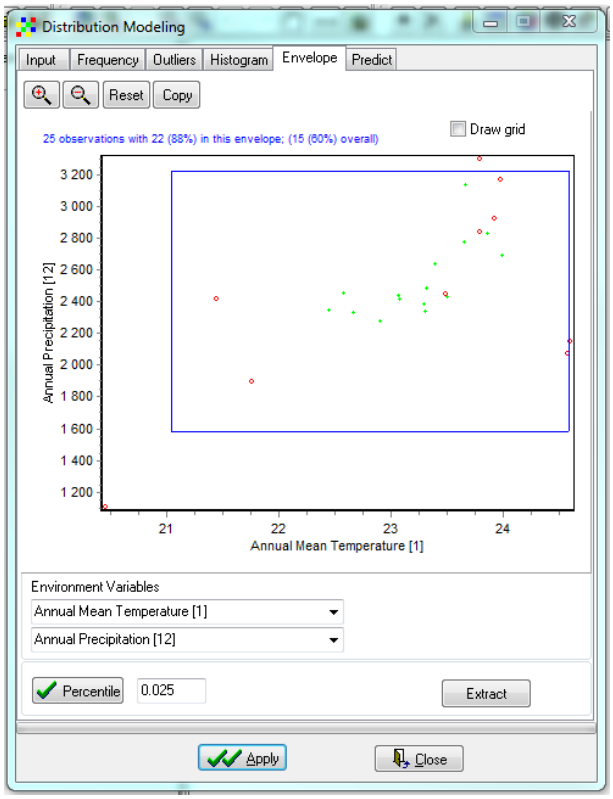

Figure 1 -BioClim n-dimensional bounding box or envelope (DIVA-GIS)

The algorithm computes the similarity of different locations (species) by comparing the climatic/environmental values at all locations, to generate a percentile distribution at known species locations (or training sites). As a result, the closer to the 50th percentile (median value) a given location is, the greater the likelihood is for finding that species present. However, there is no distinction between the 10th and 90th percentiles [389].

BioClim modelling was conducted using the DIVA-GIS v7.5.0 freeware package. Although it has been shown that it does not perform as well as some other modelling algorithms, such as MaxEnt it is still widely used because it is simple, provides a ranking of environmental variables and does not require absence data.

Climate Variables for MaxEnt and BioClim Modelling

The Worldclim (v1.3) climate dataset at 2.5 minute (5km) resolution was used for the BioClim modelling, while, the current WorldClim v1.4 30sec (1km) resolution dataset was used for the For Maximum Entropy modelling. This included the following bioclimatic variables listed :

- BIO1 - Annual Mean Temperature;
- BIO2 - Mean Diurnal Range (Mean of monthly (max temp - min temp));
- BIO3 - Isothermality (BIO2/BIO7) (* 100);
- BIO4 - Temperature Seasonality (standard deviation *100);
- BIO5 - Max Temperature of Warmest Month;
- BIO6 - Min Temperature of Coldest Month;
- BIO7 - Temperature Annual Range (BIO5-BIO6);
- BIO8 - Mean Temperature of Wettest Quarter;
- BIO9 - Mean Temperature of Driest Quarter;
- BIO10 - Mean Temperature of Warmest Quarter;
- BIO11 - Mean Temperature of Coldest Quarter;
- BIO12 - Annual Precipitation;
- BIO13 - Precipitation of Wettest Month;
- BIO14 - Precipitation of Driest Month;
- BIO15 - Precipitation Seasonality (Coefficient of Variation);
- BIO16 - Precipitation of Wettest Quarter;
- BIO17 - Precipitation of Driest Quarter;
- BIO18 - Precipitation of Warmest Quarter;
- BIO19 - Precipitation of Coldest Quarter

Other data layers

Ecoregion

An “Ecoregions” layer was utilized to further confine the species distribution models to the known habitat types that different *Dalbergia* and *Pterocarpus* species are known to occur in. Ecoregions are ecologically and geographically defined areas which contain distinct assemblages of communities and species. That is, each ecoregion has a particular biodiversity of flora, fauna and ecosystems (including soil and landforms) that define each ecoregion. However, these are not sharply defined boundaries, being best described as a fuzzy boundary. For this exercise, the WWF defined eco-regions were utilized. The WWF have synthesised previous efforts to determine 8 ecozones consisting of 867 terrestrial ecoregions. The WWF ecoregions were defined by species, climate and ecosystems, which when considered as a whole, define the maximum possible extent of a species distribution based on the known locations. However, this also includes regions within these ecoregions which would be unsuitable for the given *Dalbergia/Pterocarpus* species to exist.

Land Cover

To further refine the extent of a given *Dalbergia/Pterocarpus* species, the land cover associated with each species location was analysed. These were then extracted from the United States Geological Survey (USGS) Land Cover Institute (LCI) “land type dataset”. Imagery was processed as described by Broxton et al (2014) [390]. During processing, the imagery was found to have substantial interannual variability, with half of the land pixels showing a land cover change over the 10 year period (seasonality and variation within seasons). Therefore, the change in global land cover is dependent on the temporal aspect of the imagery. To overcome this variance, they developed a value added global land cover map by weighting each land cover type by a corresponding confidence score for each year and determining the cover type by the highest weighted land cover for each pixel. Climatology was validated by comparing it with the System for Terrestrial Ecosystem Parameterization database as well as from the Google Earth proprietary software database. The final dataset produced was a global dataset consisting of 17 different land cover categories.

0: Water
1: Evergreen Needle Leaf Forest
2: Evergreen Broadleaf Forest

3: Deciduous Needle Leaf Forest
4: Deciduous Broadleaf Forest
5: Mixed Forest
6: Closed Scrubland
7: Open Scrubland
8: Woody Savannas
9: Savannas
10: Grassland
11: Permanent Wetland
12: Croplands
13: Urban and Built-up
14: Cropland/Natural Vegetation Mosaic
15 Snow and Ice
16: Barren/Sparsely Vegetated

Forest Change

To account for vegetation loss via clearing post 2010 (USGS Global Land Cover dataset), the Global Forest Change 2000-2014 (v1.2) data was acquired from the University of Maryland over the 3 regions of interest. The Global Forest Cover Loss 2000-14 per year was download as 100 x 100 tiff tiles, and merged together regionally to form the forest loss data layer.

Pixel cell values were encoded either as 0 (no loss) or as a range from 01 to 14 representing 2001 -2014 respectfully. Again, due to the high resolution of the data and time constraints for the modelling work, the data was overlayed on the final distribution modelling results to capture areas cleared since 2010.USCS LCI within the maximum possible extent either as non-degraded environments or degraded environments (cropland/national vegetation mosaic).

Intact Forest Layer

Finally, to produce the second lot of maps to compare with, a final data layer showing intact or natural forets was utilized to show how restricted the ranges of these species could be, if only restricted to forest areas that have yet to be logged. This data set was obtained from http://data.globalforestwatch.org/datasets/63f9425c45404c36a23495ed7bef1314.

Limitations

The absence of data from part of a given species range is problematical. Such a case is in Asia where information from countries such as Myanmar (politically restrictive regime) means that little if any data is available, such as in the case of D. oliveri, D. cochinchinensis and P. macrocarpus where no location data exists in plant/biodiversity databases.

However, some work indicates that in the case of these three species, *D. oliveri* for example, has symbiotic interactions with other species such as *Tectona grandis, Albizia chinensis, Dipterocarpus alatu*s and *Sindora siamensis*. Locations were obtained for *T. grandis, A. chinensis* and *S. siamensis* from GBIF and the Discover Life Global Atlas. In the Myanmar region, *T. grandis* location points were added to the *D. oliveri* location dataset and the SDM (Max Ent) was run again. This appeared to improve the distribution modelling, as when locations for *A. chinensis* and *S. siam*ensis where overlayed on the distribution prediction, 85% of the locations correlated to high habitat suitability.

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