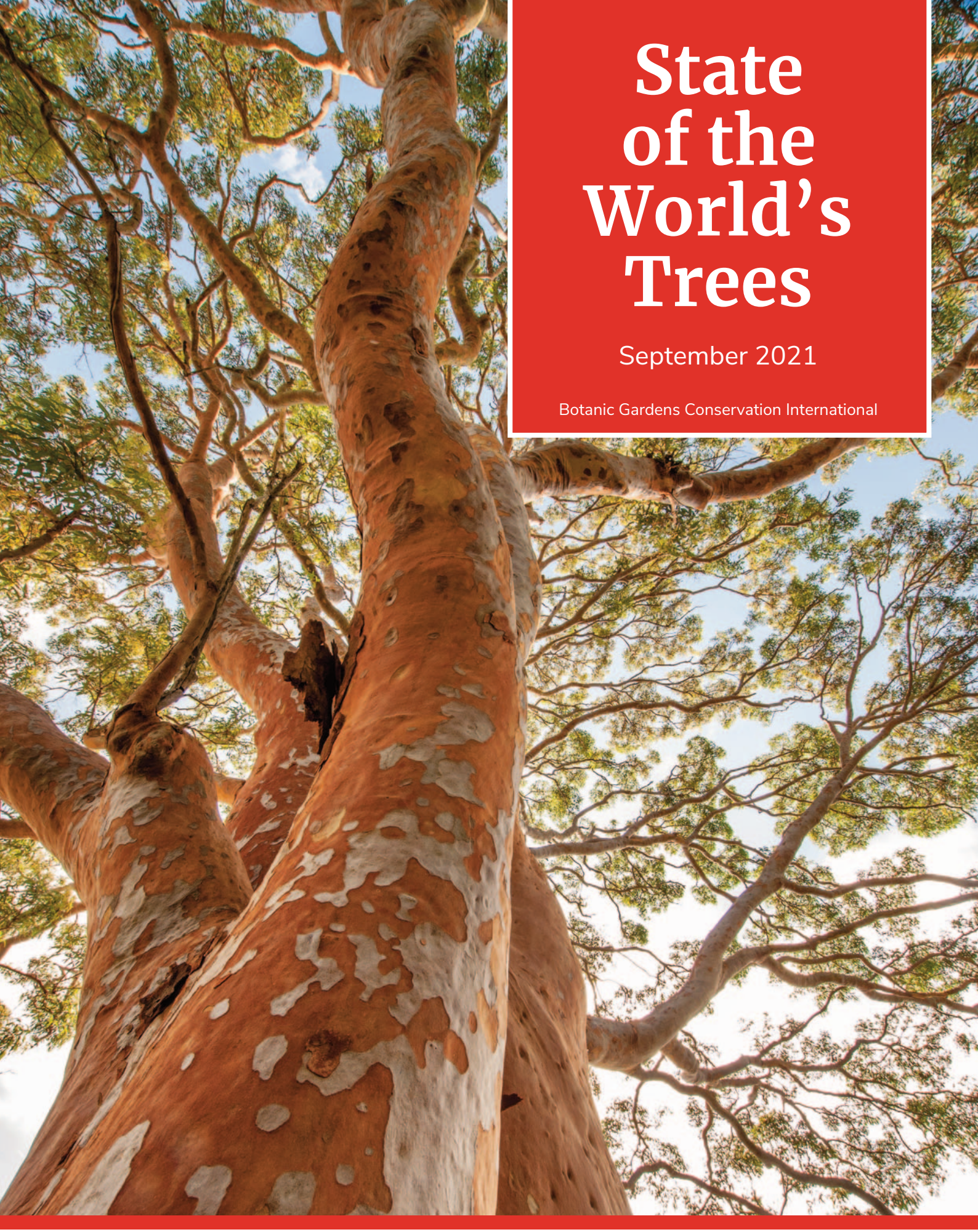

State of the World's Trees

September 2021

Botanic Gardens Conservation International

BOTANIC GARDENS CONSERVATION INTERNATIONAL

GTA Global Tree Assessment

GTSG GLOBAL TREE SPECIALIST GROUP

IUCN SSC Species Survival Commission

RED LIST

Franklinia FONDATION

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Polylepis reticulata *(Carmen Ulloa Ulloa)*

Executive summary

Trees are of vital importance ecologically, culturally and economically. Until now there have been surprising gaps in knowledge of the diversity, distribution and conservation status of trees at a global scale. Trees define forest distribution, composition and structure and thus provide habitat for half the world's known terrestrial plant and animal species. Trees are also highly significant components of biodiversity and carbon storage in many other ecosystems such as woodlands, grasslands, as well as artificial and urban environments. The interlinked biodiversity crisis and challenge of global climate change cannot be addressed without informed management of tree species.

Through the Global Tree Assessment, intensive research has been undertaken over the past five years to compile extinction risk information on the 58,497 tree species worldwide. We now know that 30% of tree species are threatened with extinction, and at least 142 tree species are recorded as extinct in the wild. The main threats to tree species are forest clearance and other forms of habitat loss, direct exploitation for timber and other products and the spread of invasive pests and diseases. Climate change is also having a clearly measurable impact.

Tree diversity is unevenly distributed across the globe. The largest number of tree species is in Central and South America, followed by the other tropical regions of Southeast Asia and Africa. The highest proportion of threatened species is found in Tropical Africa, which includes Madagascar which is one of the countries with the highest level of threatened trees. Temperate zones of Europe, Asia and North America which have relatively low tree diversity also have the lowest proportion of tree species which are threatened with extinction.

The detailed tree species information used to compile this report is now available on the GlobalTree Portal, a new major tool to support forestry, biodiversity conservation and climate change policy and action for tree species.

The Global Tree Assessment has been made possible over the past five years by a global network of over 60 institutional partners and over 500 experts.

This report summarises the conservation measures already in place for tree species: over two-thirds of tree species are recorded in at least one protected area and about a third of tree species are found in botanic gardens or seed banks. Nevertheless it calls for a new focus in planning and carrying out biodiversity conservation and ecosystem restoration, recognising the global importance of tree species. It identifies the regions where further action is needed. It provides recommendations for urgent action and calls for a new coalition to facilitate the resourcing and expertise required.

Eucalyptus pauciflora *(Courtney Whitton)*

It is crucial that we use the information now available to manage, conserve and restore threatened tree species and tree diversity. This will prevent extinction both of trees and the associated plants, animals and fungi that depend on them, sustain livelihoods and ensure the ecological health of the planet.

Foreword

Trees are one of the most familiar forms of life for all humans and represent the largest part of earth biomass. They can be found in most regions of the world. For most people trees may all look rather similar but, with nearly 60,000 species in existence, they constitute a very diverse group and form the most diverse habitats on the planet. A huge number of other species (epiphytic plants, fungi, birds, mammals, invertebrates, amphibians, reptiles, etc) depend on their presence. Their protection leads to enormous benefits to humans and wildlife alike.

It is therefore very surprising to learn that so little was known about their conservation status and shocking to know that deforestation rates remain so high. Many tree species are on the brink of extinction, some represented by one last living individual.

Unfortunately, many people continue to see trees mostly as a source of wood, which faces an unsustainable and growing demand. This, added to destructive agriculture practices, leads to the disappearance of forests all around the globe, the replacement of "non-productive" species by fast growing tree species and the impoverishment of tree diversity.

We have known for some time how many mammals, birds and amphibians, and which species in these groups, will be lost forever without conservation measures. Now, at last, we also know how many tree species face extinction, where they are located and what can be done to reverse the trend. The shocking reality is that 30% of all tree species are under threat in the wild.

Now that the state of forests and the level of greenhouse gas emissions have reached a critical state, there is fortunately a new focus on trees. Through reforestation efforts, there is a huge opportunity to change this dire picture but tree planting practices largely need to change. Forests can regenerate naturally if given a little time to rest and when tree planting is needed, in particular for threatened tree species that have reached very low numbers of individuals, the right species need to be planted in the right place.

Documenting the conservation status of a group of nearly 60,000 species is the largest initiative in the history of the IUCN Red List of Threatened Species. It represents a huge effort by hundreds of individuals under the coordination of Botanic Gardens Conservation International and the IUCN Species Survival Commission who should be thanked for this key contribution to nature conservation. This report is an important step towards the full assessment of all tree species, which will constitute a baseline against which countries will be able to report on progress towards the protection of the world's biodiversity. An entire community composed of botanists and conservationists stands ready to assist with this massive task and is already at work. They need to be associated to concrete efforts which should not be exclusively led by foresters and companies for which the number of trees planted is their sole driver.

Tree species that have evolved over millions of years, adapting to changing climates, can no longer survive the onslaught of human threats. How short-sighted are we to allow the loss of tree species on which global society is ecologically and economically dependent. If we could only learn to respect trees, undoubtedly many environmental challenges would greatly benefit.

Jean-Christophe Vié
Director General Fondation Franklinia

Carpinus insularis (Gunter Fischer)

Acknowledgements

The Global Tree Assessment (GTA) represents a new approach to assessing the conservation status of plant species. The plan from the outset was to assess all trees using the best available information from diverse sources in a pragmatic and efficient way, recognizing the urgency of the biodiversity crisis and the need for tree conservation action. The partners and individual experts involved in this massive assessment process are listed on page 36 and all are acknowledged with sincere thanks. We would especially like to thank the individuals and institutions who shared our vision for the Global Tree Assessment from the start and committed their full support. Special thanks are due to Fondation Franklinia for their belief in the project and their longterm major fundraising support. Dr Gerard Donnelly, of The Morton Arboretum, generously committed the Arboretum to supporting the GTA through the coordination of the assessment of the US trees and oak species globally.

We thank all the sponsors of the GTA: Critical Ecosystem Partnership Fund (CEPF), European Commission, Fondation Franklinia, IUCN, CBD/Japanese Biodiversity Trust, Keidanren Nature Conservation Fund, Mohamed bin Zayed Species Conservation Fund, Rufford Foundation, STFC/University of St Andrews, Toyota Foundation.

Quercus robur

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Abbreviations

A2P	Assess to Plan
AZE	Alliance for Zero Extinction
BGCI	Botanic Gardens Conservation International
FFI	Fauna & Flora International
FGR	Forest Genetic Resources
GBIF	Global Biodiversity Information Facility
GSPC	Global Strategy of Plant Conservation
GTA	Global Tree Assessment
GTC	Global Trees Campaign
GTSG	Global Tree Specialist Group
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
NDC	Nationally Determined Contributions
REDD	Reducing Emissions from Deforestation and forest Degradation
SSC	Species Survival Commission
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

The world is facing a biodiversity crisis and around 1 million animal and plant species are estimated to be threatened with extinction (IPBES, 2019). Trees are highly visible in most landscapes and are excellent biodiversity indicators. They are ecologically, culturally and economically of vital importance and yet there have been surprising gaps in knowledge of the diversity, distribution, abundance and conservation status of trees at a global scale. This report presents a summary of what we do know about tree species around the world. It presents the results of the Global Tree Assessment (GTA) which has involved five years of intensive collaborative research.

The Global Tree Assessment has developed a strategic approach to data collection on tree species involving an extensive global network of organisations and individual experts. The network coordinated by BGCI, working in partnership with the IUCN Species Survival Commission Global Tree Specialist Group, aims to complete comprehensive conservation assessments on the IUCN Red List of all tree species by 2023, building on and amplifying earlier initiatives.

WHAT IS A TREE?

Although there is no universally accepted definition of a tree, the characteristics that separates them from other plants is a woody stem or trunk that lives for many years. Global databases on plant diversity generally list species on a taxonomic basis without recording their growth form. Ecologists, temperate and tropical foresters each have their own various definitions of a tree, usually based on the size of the woody stem.

The tree definition used for the Global Tree Assessment is *"a woody plant usually with a single stem growing to a height of at least two metres, or if multi-stemmed, then at least one vertical stem five centimetres in diameter at breast height"*.

The Importance of Trees

Trees are of immense ecological importance. Trees define and form the major structural components of forest ecosystems that cover approximately 31% of the world's land surface (FAO and UNEP, 2020). Forests play a major role in the Earth's biogeochemical processes, influencing soil production, hydrological, nutrient and carbon cycles, as well as the global climate. Forests contain about 50% of the world's terrestrial carbon stocks and over 75% of the world's accessible freshwater is obtained from forested catchments (Newton, 2021). Forests provide habitat for a wide range of other species supporting at least half of the Earth's known terrestrial plant and animal species (Newton, 2021). Reports frequently state that up to 80% of terrestrial plants and animals occur in forests but this cannot yet be verified accurately (FAO and UNEP, 2020). Trees are not only found in forests, they occur in woodlands, savannahs, shrublands, grasslands, deserts, wetlands, coastal and rocky ecosystems as well as artificial and urban environments.

Wherever trees occur they support a wide range of other species from their position at the base of trophic pyramids in ecological networks. For example, 2,300 species are associated with native oak trees in the UK (Mitchell *et al*., 2019). If species at the base of trophic pyramids become extinct this might lead to an extinction cascade leading potentially to ecosystem collapse (See Box 1).

Trees are visible and measurable indicators of the health of an ecosystem. Trees alter and change the environment they are in, making them key ecosystem engineers (Lindenmayer and Laurance, 2017). In addition, trees provide many ecosystem services through water purification, erosion prevention, flood defence, carbon sequestration, air temperature control, and regulation of air quality. There is also considerable evidence and increasing acceptance that trees can play a substantial part in tackling the climate crisis (e.g. Bastin et *al*., 2019).

Trees provide a wide range of products of huge value to local livelihoods, national economies and global trade. Timber, fuelwood, wood pulp, medicinal and aromatic products, fruits and nuts are amongst the most valuable products derived from trees, many of which are predominantly sourced from the wild, poorly recorded and are under-valued. More information is given in the section on useful trees below.

BOX 1: TREES AND ECOSYSTEM COLLAPSE

Adrian Newton

Tree species individually and in species assemblages help to define ecosystems. The threatening factors impacting on trees are also impacting at the ecosystem level. Threatened tree species can act as indicators of the health of the ecosystems of which they form part.

The phenomenon of ecosystem collapse is defined as "a transformation of identity, a loss of defining features, and a replacement by a different ecosystem type" (Bland et *al*., 2017). Ecosystem collapse can be seen as an endpoint of environment degradation, which is typically anthropogenic in origin. Unlike species extinction, however, ecosystems that have collapsed do not typically disappear, but transition into some other type of ecosystem. Another key point is that collapse is persistent: while any ecosystem will change over time in response to different perturbations, it is when these changes are persistent that they might become of conservation concern. The collapse of an ecosystem is therefore often associated with an inability to recover after disturbance.

Concern about ecosystem collapse is increasing, owing to growing recognition that the process can be very abrupt, as illustrated by the bleaching and death of large parts of the Great Barrier Reef in 2016/7. With respect to forest ecosystems, there has been a series of major, large-scale disturbance events, such as the unprecedented fires in California, southern Australia, Indonesia and the Amazon in recent years. At the same time, large areas of forest are undergoing mass mortality events because of other factors, including drought and heat stress and the increased incidence of pests and diseases. Allen et *al*. (2010) provide a striking account of large-scale tree mortality occurring in many different parts of the world including the severe loss of the Endangered Atlas cedar (*Cedrus atlantica*) from Morocco to Algeria potentially leading to ecosystem collapse. The rapid decline of dominant tree species currently evaluated as Least Concern may also trigger ecosystem collapse in wide areas as with the mortality of *Pinus tabuliformis* across 0.5 million ha in east-central China, and extensive mortality of *Nothofagus dombeyi* in Patagonian South America. Many of the best-documented examples are from North America, including death of >1 million ha of multiple spruce species in Alaska, >10 million ha of *Pinus contorta* in British Columbia, 1 million ha of *Populus tremuloides* in Saskatchewan and Alberta, and >1 million ha of *Pinus edulis* in the southwestern US (Allen et *al*., 2010).

These examples illustrate that it is not only individual tree species that are declining and being lost, but entire communities of species with which they are associated, and the ecological interactions that occur between them. The ecological functioning of an ecosystem, and the benefits provided to people, are also transformed as an ecosystem collapses. Analysis of empirical evidence (Newton, 2021) shows that collapse is most likely to occur when forest ecosystems are subjected to multiple anthropogenic threats simultaneously. Different threats such as fire, logging, herbivory, and habitat fragmentation can potentially interact, creating feedbacks that can drive abrupt ecological change. However, climate change has the potential to become the principal driver of collapse in most, if not all, types of forest ecosystem. This reflects its large scale of impact, which can extend to all of the ecosystems in entire regions; its unusual ability to alter some of the abiotic components of an ecosystem, such as the availability, temperature or acidity of water; and its ability to cause the disassembly of entire ecological communities and the formation of new communities. Climate change can also interact with all other threats to drive ecosystem collapse.

The IUCN Red List of Ecosystems (RLE) (https://iucnrle.org/), focuses on the assessment of entire ecosystem. To date, around 60 assessments have been published, drawn from more than 20 countries or regions. A number of forest ecosystems have been assessed as 'Critically Endangered' such as the gnarled mossy cloud forest on Lord Howe Island of Australia, and the Gonakier forests of Senegal and Mauritania (RLE, 2021). These examples show how entire communities of trees, and other associated species, can be threatened simultaneously. Further development and implementation of the RLE would provide a valuable complement to the Red List of Threatened Species, while also affording crucial insights into the scale of the crisis facing forest ecosystems and their component tree species.

Nothofagus alpina
(Cristian Echeverria)

Tree diversity

The tree diversity we see today reflects a long history of evolution with tree species adapting to different ecological conditions around the world.

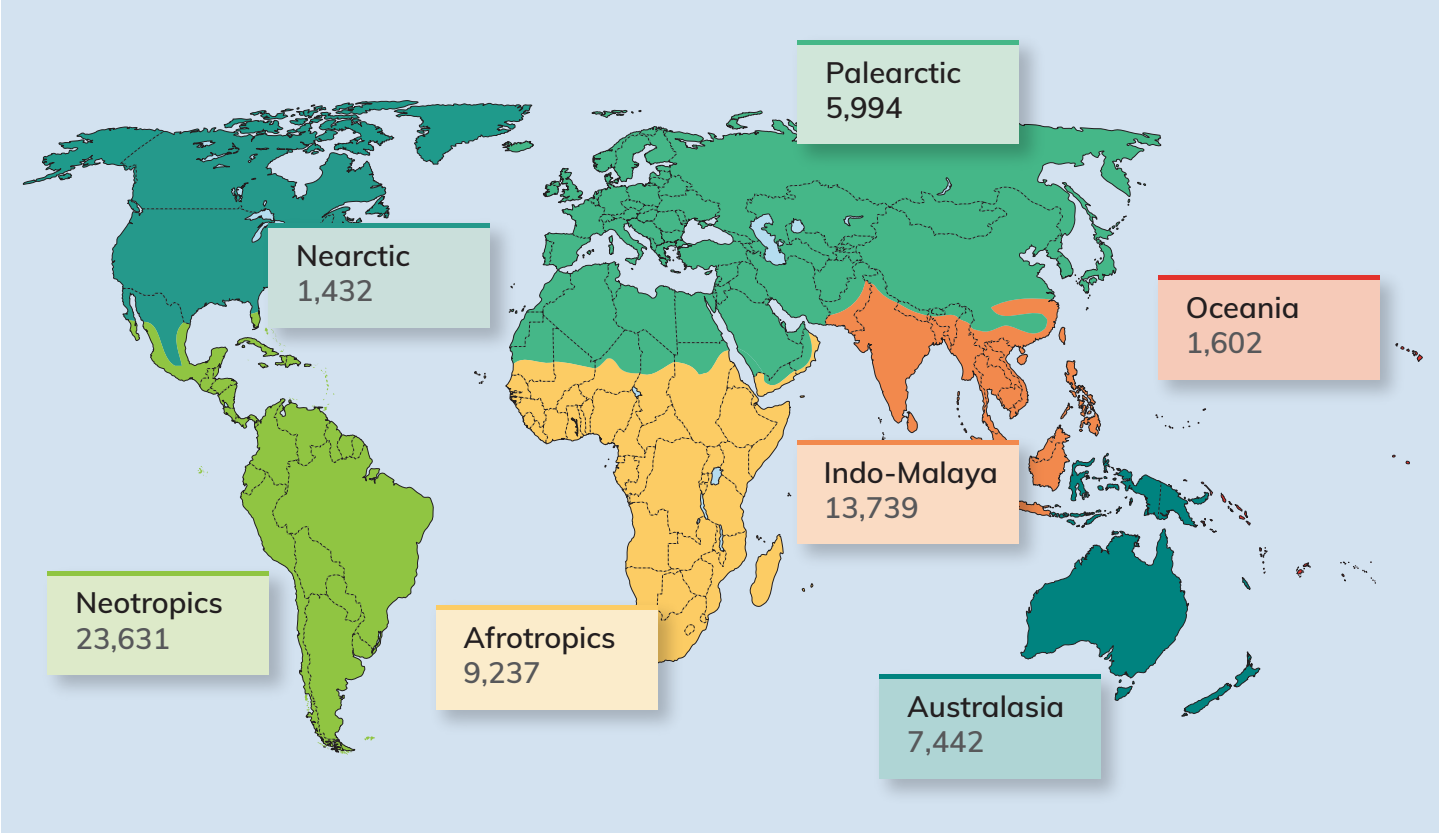
How many tree species are there?

There are 58,497 tree species globally (March 2021, Beech *et al*., 2021; BGCI, 2021a). GlobalTreeSearch (https://tools.bgci.org/global_tree_search.php), provide a complete list of the world's tree species and their country level distribution, as a tool for assessing, monitoring, and managing tree species diversity and forests on a global, regional, and national level (Beech *et al*., 2017). The information, derived from a range of plant databases, scientific references and tree experts is kept up-to-date to reflect updates in taxonomy and nomenclature as well as known distributions of the species. Plant taxonomists and botanists continue to catalogue tree species diversity and understand the relationships between species groups. Some areas of the world remain poorly known botanically, and many taxa still remain undescribed.

Which regions have the most tree species?

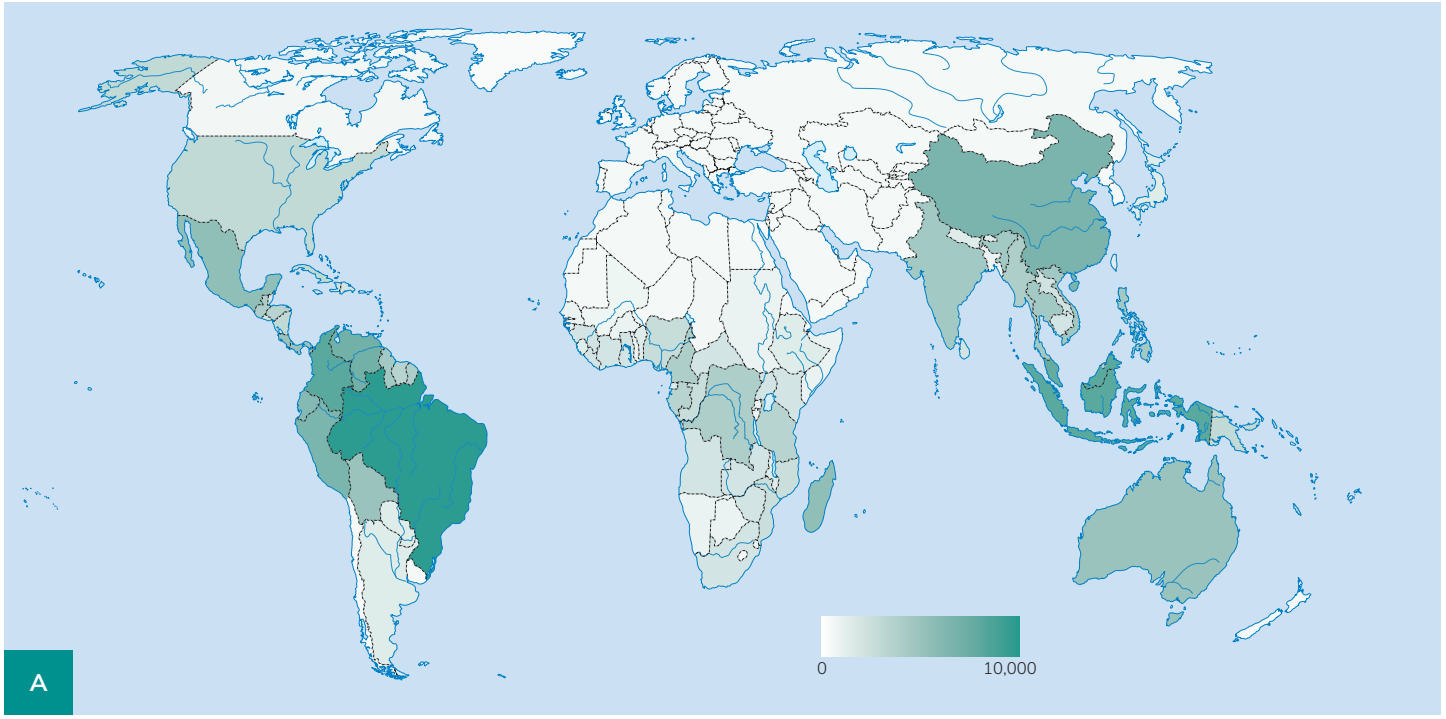
Except for the extreme polar regions and at the Earth's highest altitudes, trees are found in ecosystems in all parts of the world. The tree data compiled in the GlobalTree Portal demonstrate that tree diversity is not evenly distributed across the globe with species richness (the number of different species) varying between different regions. Tropical tree diversity contrasts sharply with that of most temperate regions. Biogeographic realms are broad divisions of Earth's land surface, based on distribution patterns of all terrestrial species. Tree species richness by biogeographic realm is shown in Figure 1. The largest number of tree species is in the Neotropics (Central and South America) with 23,631 tree species, followed by the other tropical regions: Indo-Malaya (tropical Asia) (13,739 species) and the Afrotropics (Africa south of the Sahara, including Madagascar) (9,237 species) (Figure 1). The Nearctic (North America) and Oceania are the two regions with the lowest number of tree species.

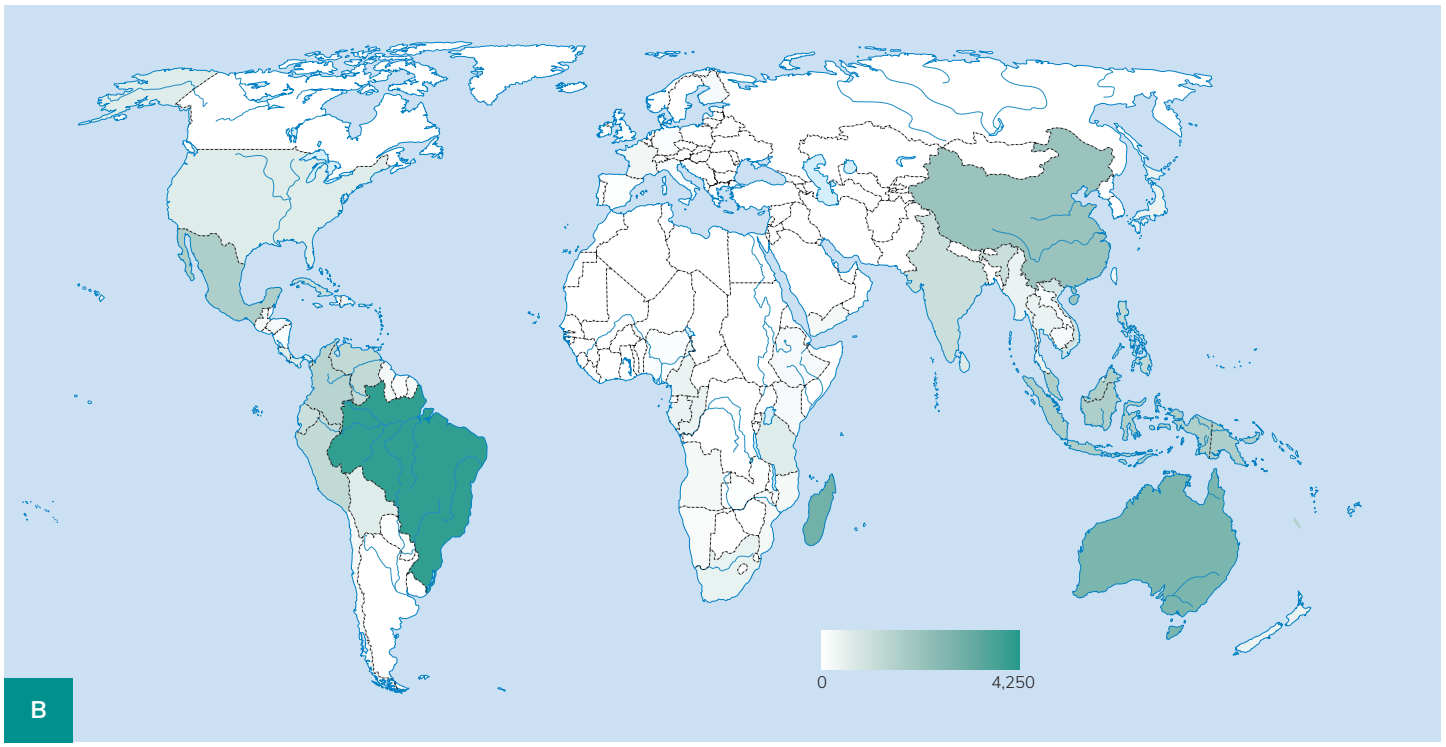
FIGURE 1. TREE SPECIES RICHNESS BY BIOGEOGRAPHIC REALM



Some tree species are naturally widespread, with for example tallowwood (*Ximenia americana)* being found in 96 countries. Most tree species are much more restricted with their distribution limited to a single region or narrow habitat type, and 58% of tree species are single country endemics. The country with the most diverse tree flora is Brazil, with 8,847 tree species, followed by Colombia (5,868 spp.) and Indonesia (5,716 spp.) (Figure 2 and Supplementary Table 1). A total of 15,748 endemic tree species are recorded in the ten countries with the highest recorded number of endemic trees. The countries with the most endemic trees are Brazil, Madagascar, Australia, China, Malaysia, Indonesia, Mexico, New Caledonia, Papua New Guinea, Colombia and Philippines. Of the most diverse countries, New Zealand, Madagascar and New Caledonia has the greatest proportion of endemic tree species, with over 90% of species being found nowhere else (Supplementary Table 1).

FIGURE 2. TREE SPECIES RICHNESS BY COUNTRY OF A) ALL TREE SPECIES AND B) ENDEMIC TREE SPECIES RICHNESS.
For information on individual countries see Supplementary Table 1.





BOX 2: MONOTYPIC TREE FAMILIES

Based on current taxonomic knowledge of tree diversity, tree species are found in 257 botanical families. Twelve of these botanical families are true monotypic families, meaning each consists of just one genus each with one tree species. These twelve monotypic tree families are scattered across the world, from Chile to Mexico, from South Africa to Yemen and from China to New Caledonia. Monotypic tree families, represented by a single genus and a single species, are of great interest taxonomically, and also in terms of phytogeography and phylogenetic studies. These species are all of special interest for conservation throughout their geographic ranges, as the extinction of these species, with no close relatives, would represent a disproportionate loss of unique evolutionary history, biodiversity and potential for future evolution. Some of the trees listed below are already at risk of extinction and need urgent protection.

THE TWELVE MONOTYPIC TREE FAMILIES

Family: Aextoxicaceae
Tree species:
Aextoxicon punctatum Ruiz & Pav.
Distribution: **Argentina, Chile**

Family: Curtisiaceae
Tree species:
Curtisia dentata (Burm.f.) C.A.Sm.
Distribution: **Southern Africa**

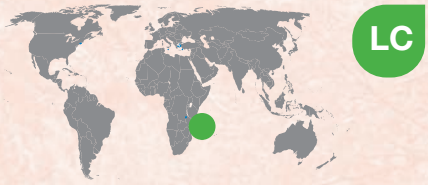
Family: Petenaeaceae
Tree species:
Petenaea cordata Lundell
Distribution: **Mexico, Belize, Guatemala**

Family: Amborellaceae
Tree species:
Amborella trichopoda Baill
Distribution: **New Caledonia**

Family: Eucommiaceae
Tree species:
Eucommia ulmoides Oliv.
Distribution: **China**

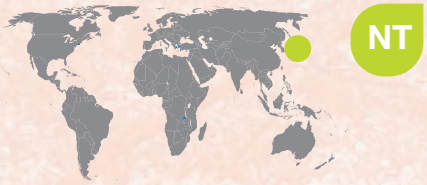
Family: Plocospermataceae
Tree species:
Plocosperma buxifolium Benth.
Distribution: **Mexico, Central America**

Family: Aphloiaceae
Tree species:
Aphloia theiformis (Vahl) Benn.
Distribution: **Madagascar, Mascarene Islands, Seychelles, Southeastern Africa**

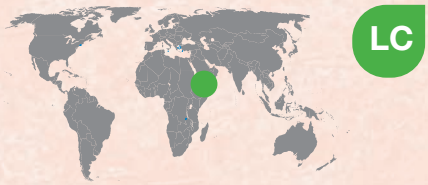


Family: Ginkgoaceae
Tree species:
Ginkgo biloba L.
Distribution: **China**

Family: Sciadopityaceae
Tree species: *Sciadopitys verticillata* (Thunb.) Siebold & Zucc.
Distribution: **Japan**



Family: Barbeyaceae
Tree species:
Barbeya oleoides Schweinf.
Distribution: **Eritrea, Ethiopia, Somalia, Arabian Peninsula**



Family: Gomortegaceae
Tree species: *Gomortega keule* (Molina) Baill.
Distribution: **Chile**

Family: Ticodendraceae
Tree species: *Ticodendron incognitum* Gómez-Laur. & L.D.Gómez
Distribution: **Mexico, Central America**

Above: Ticodendron incognitum (Nelson Zamora)
Left: Ginkgo biloba

CASE STUDY: **ANCIENT TREE SURVIVORS**
Sara Oldfield and Peter Wilf

The current diversity and distribution of trees reflects a long history of evolution and response to climate change and other environmental factors. Trees first evolved over 300 million years ago with gymnosperms being the earliest trees (excluding tree ferns). The characteristic of "woodiness" has subsequently evolved independently in many different plant families with the arrival of flowering plants in the Cretaceous period, 130 million years ago. Based on the animal fossil record, five major extinction events have occurred in the history of the planet – the "Big Five" mass extinctions. The most recent of these was in the Cretaceous period coinciding with major distribution shifts and extinctions of early flowering trees such as magnolias.

In general, taxonomic losses among plants above the rank of genus have been relatively rare at the global scale during the past mass extinctions (McElwain and Punyasena, 2007). But current pressures on trees as we face the sixth mass extinction may change this. Many of the tree families that have shown resilience, adapted and survived for millions of years, including the monotypic tree families now have species threatened with extinction.

The distribution of many tree genera reflects their ancient heritage. In the Southern Hemisphere, the breakup of Gondwana beginning in the Jurassic period, isolation of landmasses and shifts in global climate have been major influences in plant distribution at a continental scale. Recent research on fossil records and current forest plots has shown that Gondwanan rainforest lineages contribute significantly to tree community assemblages in modern rainforests. They often co-occur in widely separated assemblages far from their early fossil records (Kooyman *et al*., 2014).

The Gondwana Rainforests of eastern Australia are conserved as a World Heritage Site protecting more than 40 million years of rainforest evolutionary history. Three-quarters of the forests of New South Wales were destroyed in around 130 years leading up to the 1970s by burning and logging for valuable timber. The trees found in the remaining forests include the hoop pine (*Araucaria cunninghamii*), coachwood (*Ceratopetalum apetalum*), pinkwood (*Eucryphia moorei*) and *Nothofagus moorei*, all representatives of paleo-antarctic genera.

In total 87 current genera of plants have a paleo-antarctic fossil record from the time of the Gondwana continent. The Global Tree Assessment has made a particular effort to ensure these species are assessed and results indicate that 29% of these tree species are threatened with extinction.

The survival of Gondwanian Rainforest lineages is critically important throughout the Southern Hemisphere. The ancient tree survivors have adapted to or tracked millions of years of climate change and have survived large-scale extinction events. They continue to support the diversity and function of rich rainforest ecosystems which are essential to the future supply of ecological goods and services.

Conservation status of trees

To produce a global overview of the conservation status of trees, IUCN Red List assessments (Box 3) and other assessments (including national assessments, flora accounts or scientific papers) have been collated (for further detail, see Methods). All tree species were assigned one of six categories Extinct, Threatened, Possibly Threatened, Not Threatened, Data Deficient and Not Evaluated. Combining all the results, 17,510 tree species or 29.9% of tree species are considered threatened (Figure 3). This percentage assume that all species currently recorded as Data Deficient are not threatened. In fact, many Data Deficient species are only known from small relatively unexplored areas and may be close to extinction. Suppose all Data Deficient species are threatened, the percentage of tree species threatened with extinction increases to 51.3%. Assuming that Data Deficient species are equally likely to be threatened as all other tree species, we can estimate that 38.1% of tree species are classified as threatened. In addition, there are 142 tree species recorded as Extinct or Extinct in the Wild. At the other end of the spectrum, 41.5% of species are not considered to be at risk of extinction (Figure 3).

Fraxinus excelsior *(Chris Knapman)*

BOX 3: IUCN RED LIST

The IUCN Red List Categories and Criteria (IUCN Red List, 2021) are the most widely system to assess the probability of extinction for species. The IUCN Red List uses standardised assessment procedures to assign species to different categories of extinction risk based on five quantitative criteria, including measures of population sizes, restricted geographic distribution and rate of decline. Assessments are also complemented with a map and additional supporting information including specific threats, uses and ecology.

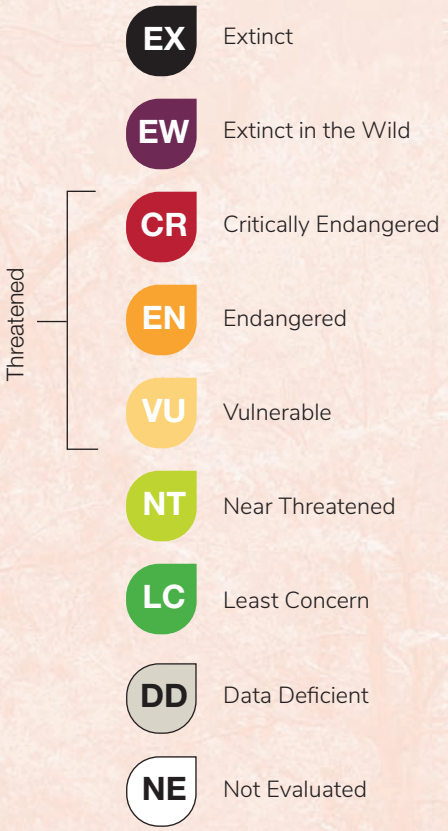


FIGURE 3. THE CONSERVATION STATUS OF THE WORLD'S 58,497 TREE SPECIES.

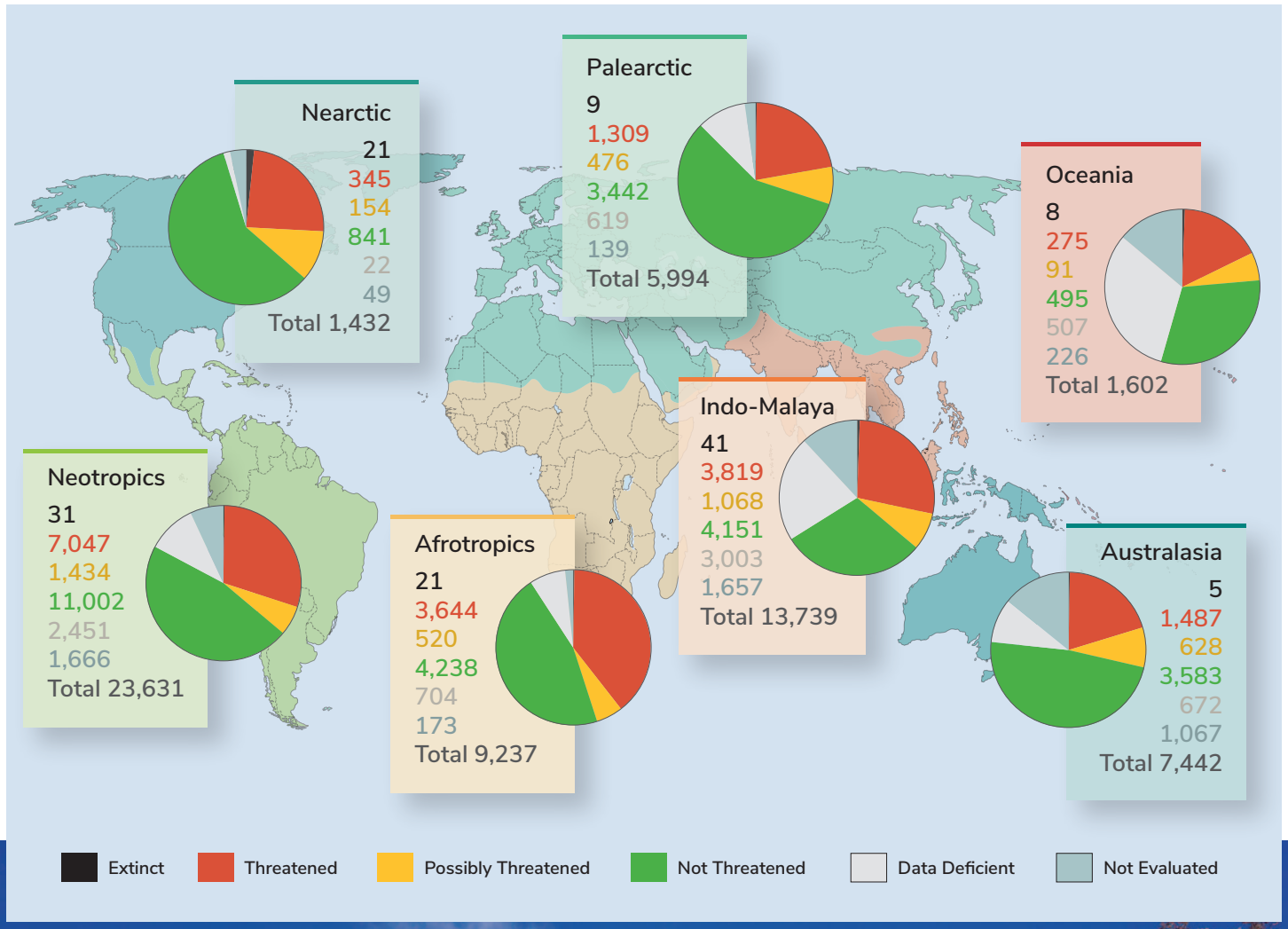
Nothofagus cunninghamii *(Sheree Parker)*

Zelkova serrata *(Marija Gajić)*

However, the numbers of threatened tree species are not evenly distributed around the globe (Figure 4 and 5).

FIGURE 4. THE CONSERVATION STATUS OF THE WORLD'S 58,497 TREE SPECIES, BY BIOGEOGRAPHIC REALM

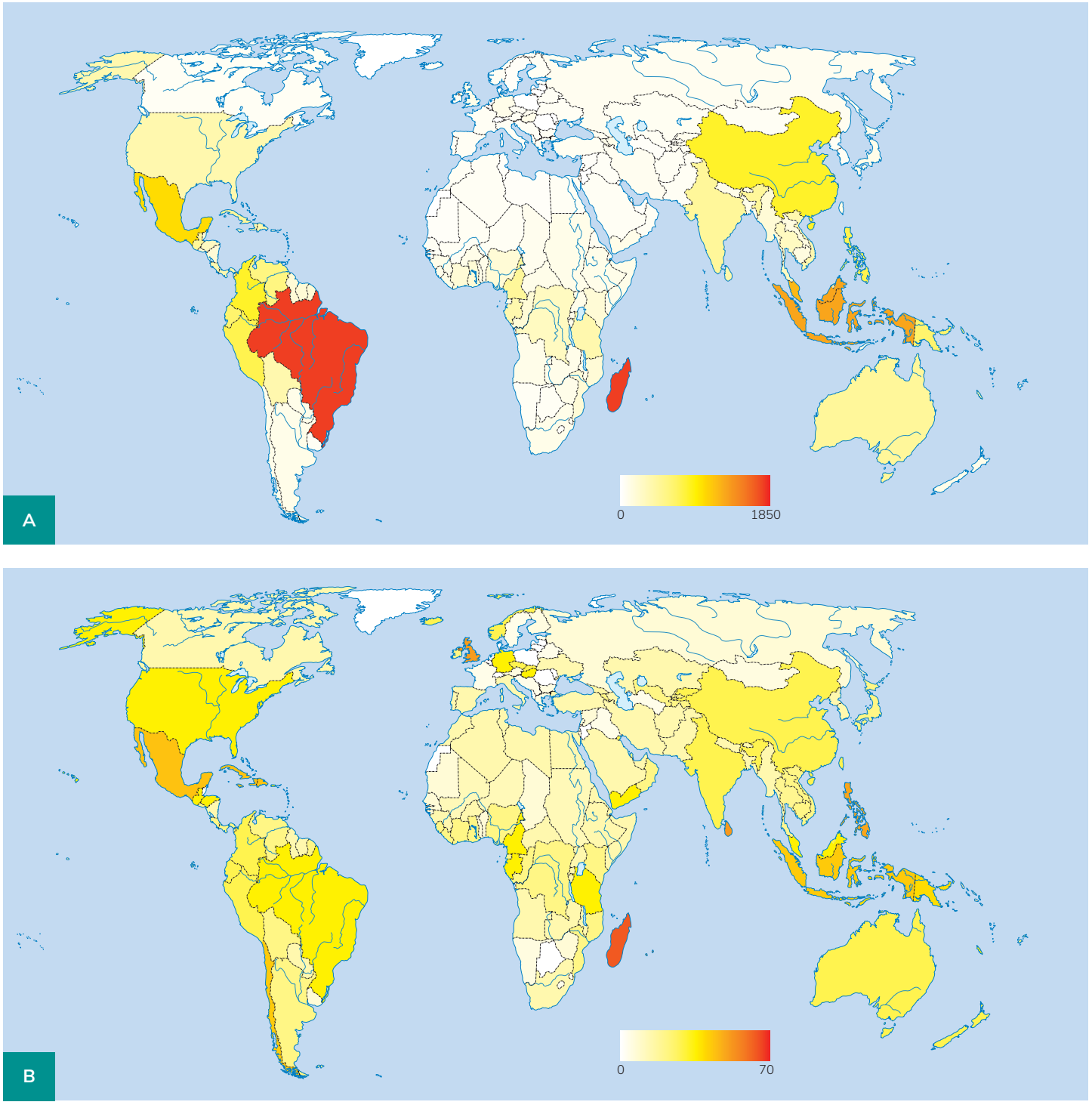
On a regional level (Figure 4), the highest proportion of threatened species is found in the Afrotropics (tropical Africa including Madagascar). The not threatened category is higher in the northern temperate zones (Palearctic and Nearctic), and the Not Evaluated and Data Deficient are highest in IndoMalaya (tropical Asia) and Oceania with over one third of species in one of those categories.



Zelkova abelicea *(Gregor Kozlowski)*

On a country level (Figure 5), the distribution of threatened species is very similar to the number of tree species around the world. The larger megadiverse countries (Brazil, China, Colombia, Indonesia, etc.) have a large number of tree species and also a large number of threatened species. Madagascar, also stands out as one of the countries with the highest level of threatened trees (Beech *et al*., 2021). However looking at the data as a percentage of threatened species (out of the total tree diversity) the pattern is altered. On average, countries have 11% threatened species in their flora. However some have much higher threat levels; St Helena (69%, n=11), Madagascar (59%, n=1,842) and Mauritius (57%, n=154) are the three most threatened countries, and of the 15 countries with the highest percentage of threatened tree species, only Chile is not an island state. At the other extreme, 27 countries have no threatened species recorded.

FIGURE 5. THREATENED TREE SPECIES RICHNESS BY COUNTRY A) NUMBER OF THREATENED TREE SPECIES AND B) PERCENTAGE THREATENED TREE SPECIES. For information on all countries see Supplementary Table 1.



Corymbia aparrerinja *(Ben Blanche)*

CASE STUDY: **ASSESSING THE CONSERVATION STATUS OF AUSTRALIAN EUCALYPTS**

Fensham et *al*., 2020

Eucalypts of three closely related genera (*Eucalytpus*, *Corymbia* and *Angophora*) define the landscape of the Australian continent and are culturally significant to its First Nations People. These trees occupy almost every habitat type in Australia and are often keystone species, supporting a huge wealth of diversity. In total, there are 822 Australian eucalypts. Working together for the Global Tree Assessment, all species were assessed using the IUCN Red List Categories and Criteria by the National Environmental Science Program (NESP) Threatened Species Recovery Hub, The Australian Government and Botanic Gardens Australia and New Zealand.

Eucalyptus macrocarpa *(Mayu Kataoka, Organic Photography)*

Overall, 193 (23%) eucalypts qualified as threatened and 36 were considered Data Deficient. Habitat conversion to crops and pastures was the cause of decline for most threatened eucalypts. The assessment process involved determining the geographic ranges of species by verifying herbarium specimen records and referring to published distribution maps. The extent of deforestation was determined by intersecting the geographic range of each species with categories of land-use based on standardised land-use maps. With this method, assuming the period of three generations for all eucalypts coincided with the period since European colonisation, 134 threatened species qualified under IUCN Red List criterion for population decline. The remainder of the threatened species were assessed due to their narrow-range with ongoing threats (mostly mining or urbanisation), or naturally rare species.

Threatened species are concentrated where deforestation and high eucalypt richness coincide, especially in Western Australia where 54% of all threatened eucalypts are found – in areas with intensive agricultural land use. An additional priority site is the 'wheat cropping' region of the Wimmera district, straddling the State border of Victoria and South Australia.

Prior to the Global Tree Assessment, 89 eucalypts were listed as threatened under Australian environmental law. The new assessment recommends that 32 of these species be downgraded to Near Threatened or Least Concern. A further 11 species were identified as Data Deficient, while an additional 147 species were proposed for listing as threatened. This systematic assessment of Australian eucalypts emphasises the importance of decline rather than rarity when compared with previous listings, with broad implications for listing long-lived plants in deforested landscapes.

Juglans cinerea *(Ed Hedborn, The Morton Arboretum)*

BOX 4: GLOBALTREE PORTAL

The detailed tree species information used to compile this report is now available on the GlobalTree Portal, a new major tool to support forestry, biodiversity conservation and climate change policy and action for tree species.

The GlobalTree Portal allows access to information on all of the world's tree species. You can explore tree species distribution, conservation status (global and others) and conservation actions. The data can be accessed on three levels – species level, country level or global level. The data underlying this portal is information gathered as part of the Global Tree Assessment and links our existing databases GlobalTreeSearch, ThreatSearch, PlantSearch and GardenSearch. In addition, conservation action is now also being tracked and can be accessed on the species pages.

BGCI GlobalTree Portal

CASE STUDY: CONSERVATION ASSESSMENTS OF US TREES

Abby Meyer

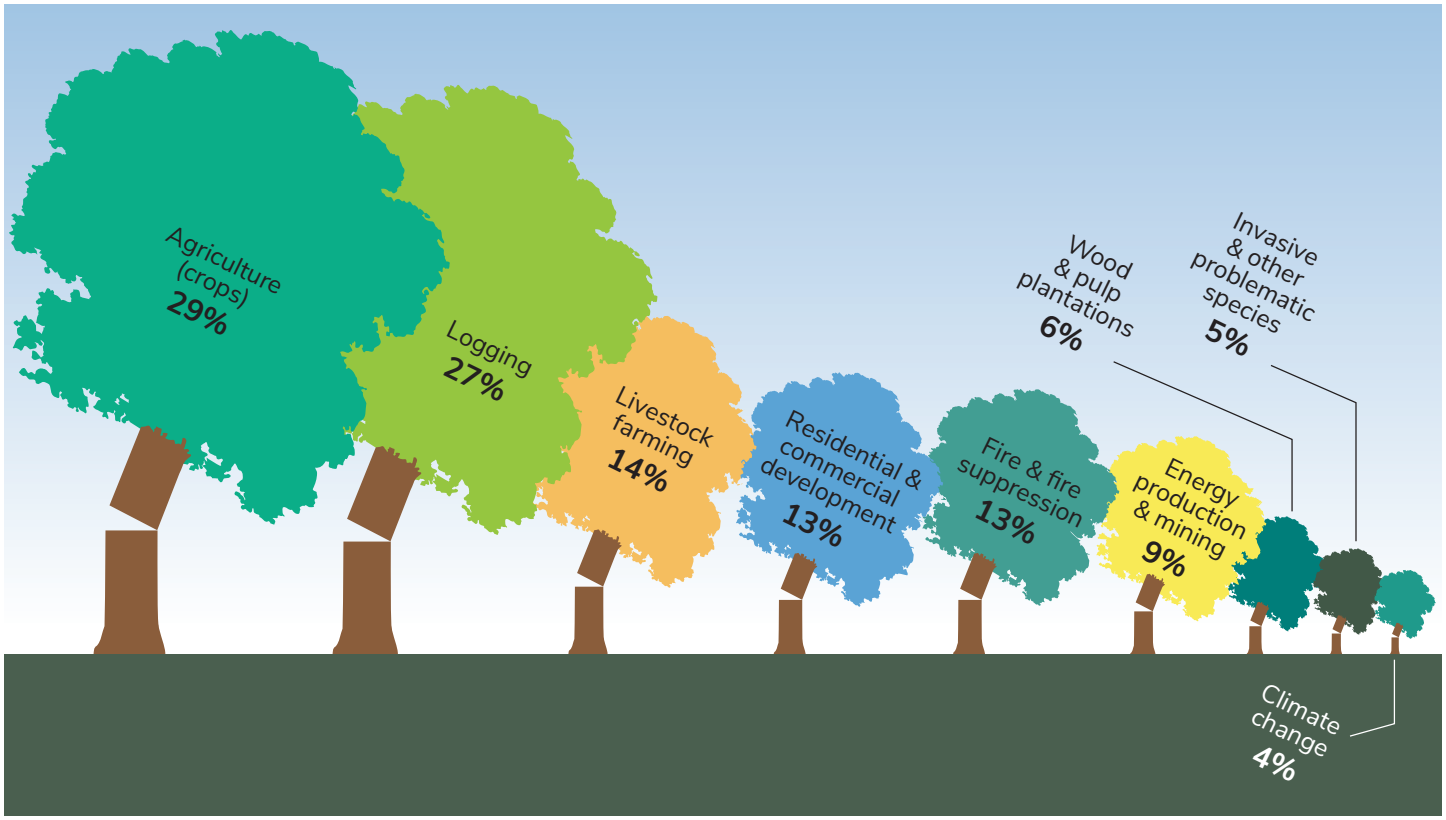
A major contribution to the Global Tree Assessment is the collaboration between BGCI-US, NatureServe, The Morton Arboretum, and the United States Botanic Garden, that has delivered the first-ever completion of conservation assessments of all 841 native, continental US tree species. Nearly all assessments have now been completed which has revealed that over 11% of US tree species have a threatened status. These assessments relied on hundreds of collaborators and species experts across the US who provided essential species information. Our team also sought to leverage as much available information as possible to support species assessments, so we created a novel crosswalk methodology between the IUCN Red List and NatureServe's global conservation status, the two complementary assessment frameworks in North America. We compared information between the two systems, identified misaligned assessments and equivalent assessment fields, and then translated priority NatureServe assessments into the required IUCN Red List format. We are now working to publish our findings, expand the geographic and taxonomic scope of the initiative, update assessment data when needed, and make the resulting tree conservation dataset more broadly available.

Tecomella undulata *(Prem Singh Bugasara)*

Main threats to trees

Information on threats to individual tree species has been collected through the Global Tree Assessment. General deforestation affects all species within a particular area whereas individual threats result from targeting of particular species for example for timber. The threats to trees act in different combinations and at different intensities in different parts of the world. Threats also change over time. The main threats identified to tree species assessed on IUCN Red List are seen in Figure 6.

FIGURE 6. THE MAIN THREATS AND PERCENTAGE OF TREES AFFECTED AS RECORDED ON THE IUCN RED LIST (2020.3).



Habitat loss

Habitat loss is currently the greatest threat to tree species. Habitat loss includes the total removal of vegetation, as well as degradation and fragmentation of persisting habitats. Over the past three hundred years, global forest area has decreased by about 40% and 29 countries have lost more than 90% of their forest cover (Newton, 2021). Conversion of land for agriculture is threatening more tree species than any other known threat. It can take place at many different scales: from small scale slash-and-burn farming, to medium-scale conversion of habitat for cash crops (such as coffee and tea), to large scale commercial crops (such as oil palm, soybean, cocoa, rubber). Research shows that seven main commodities drive more than half of deforestation worldwide (World Resources Institute, 2021). Only regions unsuited to pasture and crop plants (including deserts, boreal forest and tundra), have remained less affected by such land conversion. Other causes of habitat loss include the conversion and degradation of land from urban and industrial development (including road and other transport corridors), mining and changes in fire regimes. Fragmentation at the landscape level is a significant factor reducing plant diversity (Kettle and Koh, 2014). Fragmentation is caused both by natural causes such as storms and fires, but also more systematically via anthropogenic land use change.

Exploitation

The second major threat to tree species, is direct exploitation, especially for timber, impacting over 7,400 tree species. The harvesting of valuable tropical timbers for international trade has taken place for centuries. The forests of the Caribbean region were exploited for European timber use from the time of Columbus, with mahogany, *Swietenia mahagoni*, especially prized. Exploitation of West African timber for the European market can be traced back at least to 1672, when the Royal African Company received a charter from King Charles II of England to trade in African mahogany (*Khaya* and *Entandrophragma* spp.). By the end of the twentieth century an assessment of the extent of logging in the tropics compiled by Asner *et al.* (2009) indicated that 20 percent of the tropical forest biome was either actively logged or allocated to logging concessions between 2000 and 2005. About half of this area had already lost over 50 percent of its potential forest cover. Commercial timber extraction has now reached Central Africa, central Amazonia, the Guianas, Papua New Guinea and the Solomon Islands.

Dalbergia hirticalyx *(Roger Bernard)*

Increasing affluence in China has led to intensive exploitation of timbers used to make hongmu furniture which traditionally was only owned by royalty and elites. Madagascan species of *Diospyros* and *Dalbergia* have been ruthlessly exploited to supply the Chinese market as have *Dalbergia* species from Central America. Rosewood (*Dalbergia*) comprised 35% of the value of

Dalbergia hirticalyx *(Fortunat Rakotoarivony)*

all global wildlife and forest product-related seizures from 2005 to 2014 (United Nations and Office on Drugs and Crime, 2016). At least 76 species of *Dalbergia* and at least 164 species of *Diospyros* are assessed as threatened.

Timber extraction from natural habitats applies particularly to tropical hardwoods, of which approximately 300 million cubic metres of timber is harvested annually, equivalent to an estimated 100 million trees (Jenkins *et al.*, 2018). Exploitation of timber trees through clear felling, where whole areas of forest are cut, or selective logging, where individual species are targeted, continues under various forms of forest management. Where species are sought after for the quality and characteristics of their timber, logging can be a direct threat to that species' survival, especially when felling controls are ignored. Harvesting, transport, purchase or sale of timber in violation of national laws (commonly referred to collectively as "illegal logging") is a persistent global issue. Quantifying illegal logging is challenging and potentially controversial, but the International Criminal Police Organization (INTERPOL) estimates the value of forestry crimes including corporate crimes and illegal logging at between US$ 51 - 152 billion per year (Nellemann *et al.*, 2016). In addition to logging, trees can also be targeted for exploitation outside the timber trade. Nearly 2% of trees are at risk from other forms of harvesting – be that for medicinal, horticultural or other purposes.

Microberlinia bisulcata *logging (Xander van der Burgt)*

Lowland Mixed Dipterocarp Forest (David Bartholomew)

CASE STUDY: **BORNEAN DIPTEROCARPS**
David Bartholomew

The forests of South-East Asia are dominated by trees from the Dipterocarpaceae family. Dipterocarp species are characterised by their tall straight trunks, winged seeds and associations with ectomycorrhizal fungi (Brearley et *al*., 2016). The island of Borneo provides the centre of dipterocarp diversity (Brearley et *al*., 2016), with 273 tree species including 162 endemic species (59% endemicity). Over 20% of all trees in lowland Bornean forests are dipterocarps (Slik et *al*., 2003) and as a consequence, the forests are named after them. Bornean lowland dipterocarp forests possess many special characteristics, including the tallest known tropical forest tree species, *Shorea faguetiana* (Shenkin et *al*., 2019), mast flowering and fruiting (Ashton, 1988; Brearley et *al*., 2007), exceptionally high aboveground biomass (Slik et *al*., 2013) and wood productivity (Banin et *al*., 2014). However, lowland dipterocarp forests represent some of the most threatened forests globally, with less than half of all original South-East Asian forests remaining (Stibig et *al*., 2014).

Bornean dipterocarps were a key group assessed as part of the Global Tree Assessment, with 260 species (97%) published on the IUCN Red List. Overall, 182 species of Bornean dipterocarps (68%) qualified as threatened with extinction, with an additional 40 species (15%) classified as Possibly Threatened. A threat status could not be assigned for 3 species (1%) that were considered Data Deficient.

Under the Global Tree Assessment, logging was identified as the greatest threat to Bornean dipterocarps, threatening over 200 species. Dipterocarps possess high-quality timber, owing to their long-straight boles, high resin prevalence and dense wood. Consequently, dipterocarp timber is widely sought after and traded internationally. On Borneo, the logging industry is extremely lucrative, with over US$3.5 billion of dipterocarp timber exported each year from Kalimantan alone (Ghazoul, 2016). In fact, annual timber exports from Borneo exceed those from Amazônia and Africa combined (Curran et *al*., 2004). In addition to direct mortality of dipterocarp trees, large areas of land have been cleared and degraded by logging practices, including on concessions that deploy selective logging practices (Ghazoul, 2016). In recent decades, vast areas of land have been converted following logging with 92% of cleared forests being replaced by agricultural plantations within one year (Gaveau et *al*., 2019).

Annual forest loss on Borneo has been steadily rising in recent decades, peaking in 2016 when 0.61 Mha was lost (Gaveau et *al*., 2019). Oil palm plantations represents the largest agricultural activity on Borneo, with 88% of newly converted land planted for palm oil production (Gaveau et *al*., 2019). According to current IUCN Red List assessments, 193 Bornean dipterocarp species have agricultural production identified as a threat. Much of the remaining cleared land on Borneo has been converted to wood pulp plantations (Gaveau et *al*., 2019), which is identified as a threat to 120 Bornean dipterocarp species on the IUCN Red List. Overall, logging and land conversion in Borneo have had major impacts on Bornean dipterocarp populations, leaving almost 70% of species threatened with extinction.

Pests and diseases

Tree species are impacted by a wide range of pests and diseases that are spread by natural and artificial causes. Climate change is altering the survival opportunities for many pests and diseases in new environments. Invasive (and other problematic) species are recorded as threats for 1,356 tree species recorded on the IUCN Red List. One invasive pest species in North America and now Russia and Eastern Europe is the emerald ash borer, (*Agrilus planipennis*), which is a wood-boring beetle native to East Asia. This pest has caused major problems at the landscape level over the past two decades. Six abundant North American species of *Fraxinus* (ash) trees have become Critically Endangered as a result of predation by this beetle which was accidentally introduced through infested shipping pallets (Barstow et *al*., 2018). A further threat to ash species across Europe (including *Fraxinus excelsior* and *F. angustifolia*) is the disease Ash Dieback, which is caused by the invasive fungal pathogen *Hymenoscyphus fraxineus* which blocks the water transport systems in trees, causing crown dieback, lesions and the eventual death of the tree. The disease was first detected in Poland and Lithuania in the 1990s and has subsequently spread to most European countries (Broome et *al*., 2019).

The International Plant Sentinel Network (https://www.plantsentinel.org/) facilitate collaboration amongst institutes around the world, to work together in order to provide an early warning system of new and emerging pest and pathogen risks.

Fraxinus excelsior *affected by Ash Dieback*

CASE STUDY:

Diospyros egrettarum (George Schatz)

DIOSPYROS EGRETTARUM

A tree growing to between 3 and 5 m tall, *Diospyros egrettarum* is endemic to Mauritius. Fewer than 10 individuals remain on the mainland but a nearby coral island, Ile aux Aigrettes, boasts a larger population. The tree is considered Critically Endangered on the IUCN Red List. Ile aux Aigrettes has been a Nature Reserve since 1965 which is helping to protect this species. Undisturbed *Diospyros egrettarum* forest is resistant to invasion by exotic species, but logging and land use changes have made these forests more susceptible. However, the population on Ile aux Aigrettes is doing better, as efforts on the island have been made to eradicate exotic plants and rats, improving the survival of *Diospyros egrettarum*. Though threatened by invasive exotic plant species, it is also limited by seed dispersal, preventing the forest from expanding. This species relied on species long extinct, such as the giant tortoise, to disperse their large seeds. Recent efforts to improve the conservation status of this species include the successful introduction of Aldabran giant tortoises to replace their extinct counterparts on Ile aux Aigrettes to improve seed dispers

Diospyros egrettarum (George Schatz)

Climate change

Climate change is impacting on all forest ecosystems and is emerging as a significant recorded threat to individual tree species. In IUCN Red List assessments of tree species, climate change and severe weather is recorded as a threat in 1,080 cases. Trees of coastal, boreal and montane ecosystems are disproportionately impacted by climate change compared to other habitats. Habitat shifts and alterations is the most common recorded consequences of climate change, but also increased storm and flooding (including hurricanes and cyclones) are recorded especially for trees from tropical islands. More than 20% of tree species found in boreal ecosystems are also threatened by habitat shifts, likely driven by encroachment of temperate vegetation as boreal regions become warmer. Tree species found in intertidal zones are particularly affected by habitat shifts, likely because of rising sea levels. These coastal habitats are also threatened by storms and flooding more than any other habitats.

However, the true effect of climate change is likely to be more widespread, as climate change is also impacting the fire regime of many habitats as well as impacts of pests and diseases.

Montanoa hexagona *(Rosario Redonda-Martínez)*

CASE STUDY: **DAISY TREES AND CLIMATE CHANGE IN MEXICO**

Marie-Stéphanie Samain

Asteraceae is the most diverse family of flowering plants in Mexico, with 457 genera and 3,050 species, of which 65% are endemic. A recent study by (Redonda-Martínez *et al.*, 2021) within the framework of Global Tree Assessment research in Mexico found there are 149 arborescent species of Asteraceae in the country. Areas of high diversity and endemism for these daisy trees are mainly distributed along the Trans-Mexican Volcanic Belt and the Sierra Madre del Sur, general biodiversity hotspots for the country, fortunately where Mexico's main Biosphere Reserves and federal protected natural areas are located.

Climate suitability models show the impact of climate change on Mexican daisy trees. These indicate that an estimated 17 daisy tree species will expand their current distribution by 10%, while 33 will have distributions reduced by 50%. However, their conservation is secured because most of them occur within Biosphere Reserves and federal and community protected natural areas, being the Monarch Butterfly Biosphere Reserve, El Triunfo, the Natural Area for the Protection of Flora and Fauna "Cuenca Alimentadora del Distrito Nacional de Riego 043", State of Nayarit and the Sierra Norte de Oaxaca, the main potential areas for their conservation, as they are identified as Anthropocene refugia.

Sinclairia glabra *(Fernando Araujo-Mondragón)*

Conservation measures for trees

Using the information on the conservation status of trees around the world it is possible to assess the extent to which individual tree species are currently found in protected areas and in botanic gardens and seed banks.

Protected areas

Currently, 15.4% of the global terrestrial surface has formal protection status (UNEP-WCMC et *al*., 2021). Protected areas can take a variety of forms, from strict nature reserves where human activities are strictly controlled, to protected areas that allow human activities such as sustainable natural resource management (Dudley, 2008). *In situ* conservation of trees through protection of existing forests (and other tree habitats) is recognised as the best method for conserving tree diversity (Moomaw et *al*., 2019; Sacco et *al*., 2021). Comparing the known distribution of the world's tree species, with the Protected Area network (Protected Planet: The World Database on Protected Areas (WDPA), UNEP-WCMC and IUCN, 2020), at least 64% of all tree species are represented in at least one protected area. Not threatened species are more likely to be found in protected areas (85%) than threatened trees where only 56% of species are found *in situ*. The current global protected area network is home to a significant proportion of tree species, however, the effectiveness of this *in situ* protection is not known.

Pretoria National Botanical Garden (Paul Smith)

Seed storage at the Millennium Seed Bank, Wakehurst Place - Royal Botanic Gardens, Kew (Barney Wilczak)

Botanic gardens and seed banks

The conservation of species outside their native habitat, *ex situ* conservation, such as in botanic garden collections, field gene banks and seed banks, is also playing an essential part in preventing species extinctions. *Ex situ* conservation offers a safe place for species that are under threat in their natural environment, and in addition, it can provide plant material for restoration and species recovery programmes. Recording the *ex situ* collections of tree species is made possible by the PlantSearch database of BGCI. Currently 30% of tree species are recorded as present in at least one botanic garden or seed bank. Similar to the *in situ* analysis, a higher percentage of not threatened species are recorded in *ex situ* collections (45%) than threatened tree species (21%).

For a few species, *ex situ* conservation provides the last hope following their extinction in the wild, and such species now only persist in *ex situ* collections. Here botanic gardens and seed banks are providing the last opportunities for these species to still persist, and offers hope to be reintroduced in the wild one day. 41 species of trees only exist in *ex situ* conservation collections.

CASE STUDY:

Magnolia ekmanii (Eladio Fernandez)

MAGNOLIA EKMANII: CASE OF A RE-DISCOVERED TREE SPECIES THOUGHT TO BE EXTINCT

Joel Timyan, Conservation Director, Haiti National Trust

During the early 20th century, the famed Swedish botanist, Erik L. Ekman, discovered a magnolia new to science – *Magnolia ekmanii* – in the montane rain forests of southwestern Haiti.

For over 60 years, the species was "lost" until a small population was found again in the mid-1980s. As recently as 2014, the species was considered possibly extinct. Fortunately, in 2011, the largest known population of the species had been rediscovered in a remnant patch of primary forest. This forest was purchased by Haiti National Trust (HNT) in 2019 as the first private natural forest reserve in Haiti.

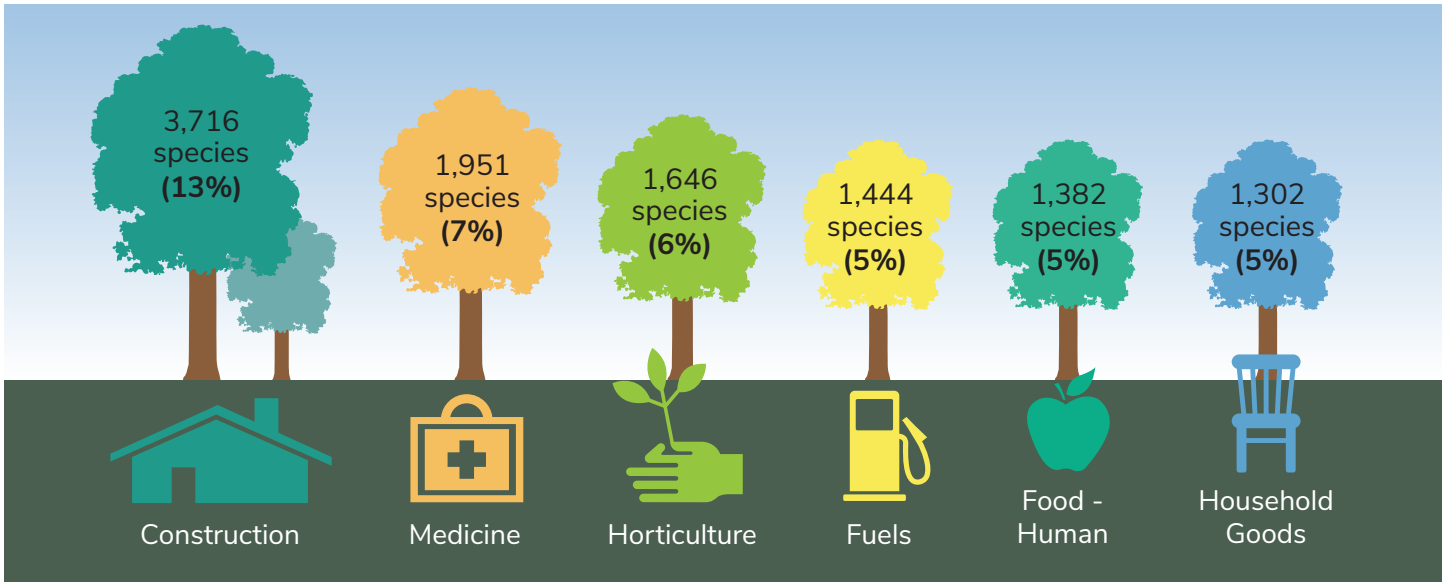
Magnolia ekmanii is considered Critically Endangered due to its restricted distribution within the western Massif de la Hotte, its small population size and ongoing threats associated with deforestation and the clearing of forests for gardens and livestock grazing. It has been selectively harvested for its hard durable wood. The moist conditions of its habitat quickly disappear with land clearing activities, further exacerbated by increased droughts and extreme weather events associated with climate change. Since 2018, HNT has initiated a program to enhance the species' long-term chances of survival. These include protecting its native habitats, restoring deforested slopes with a diversity of native species, including magnolia, and establishing ex *situ* populations elsewhere in Haiti and the Dominican Republic. An additional population of the species has been discovered in an area further east that is being established as a new national park. There is hope that this unique species of Haiti's natural heritage will continue to grace the mountain rain forests of Haiti.

Xishuangbanna Tropical Botanical Garden, Chinese Academy of Science

Useful trees

Threats to tree species impact on the essential ecosystem services they provide and also lead to the direct loss of benefits to people from the goods provided by trees. Tree species are an essential source of food, medicines, timber, fuel, fibres and ornamental materials. They are also of highly important cultural, spiritual and symbolic significance. We find that at least one in five tree species are recorded as having a specified human use and many have a variety of different uses (Figure 7).

FIGURE 7. THE MOST COMMON USES FOR TREES AS RECORDED ON THE IUCN RED LIST (2020.3)



Timber trees

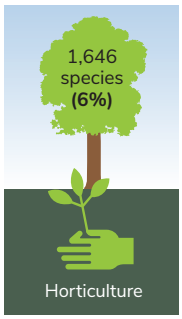
The most common use of tree species recorded during the Global Tree Assessment is use for timber (construction or structural material). Of the tree species included in the IUCN Red List, 3,716 have timber use recorded; and of these 1,254 species are recorded as threatened. Many tree species have wood characteristics which are particularly valued for their strength, resilience and appearance. Different trees species provide timber with varying strength, durability, resonance, colour and scent. As a result, certain tree species are preferred for a given purpose or end use, whether it be for building materials, veneers, furniture, musical instruments, boats and more. Timber is one of the world's most valuable natural commodities. FAO estimated the total value of global exports of timber products in 2018 to be worth US$ 270 billion. Taking into account direct, indirect and induced employment, the formal forestry sector provides an estimated 45 million jobs globally and labour income of over US$ 580 billion per year (FAO, 2018). Over 1,500 tree species are traded internationally (Mark et al., 2014). A wide range of other tree species are used locally for their wood.

The Honduras Rosewood (Dalbergia stevensonii) occurs in Belize, Guatemala and Mexico. This tree produces an incredibly dense timber making it ideal for the production of musical instruments. Recent high international demand for its timber have decimated stocks across southern Belize. It is listed as Critically Endangered and included in CITES Appendix II (Steven Brewer)

Medicinal trees

The second most common use of trees recorded during the Global Tree Assessment, is for medicinal purposes. Medicine from trees, extracted from the wood, bark, roots, leaves, flowers, fruits or seeds is fundamental to the well-being of millions of people. An estimated 10% of all trees (nearly 6,000 tree species) have medicinal or aromatic use whether in mainstream modern medicine, traditional systems of well-documented medicine developed in countries such as China or India or for local healthcare needs of indigenous people. Some of these species are of immense value in international trade. Sustainable extraction of medicine from wild trees can provide an economic value to conserve forests and the medicinal trees within them. However, without careful management, over-exploitation, driven by strong market demand, poses a significant threat to many trees. For example, Agarwood trees (from the genera *Aquilaria* and *Gonystylus*) produce a highly valuable resin used in perfumes, incense and medicines, and the huge demand for its resin has led to populations of eight *Aquilaria* and 15 *Gonystylus* species declining to a point at which they are categorised as threatened by the IUCN Red List.

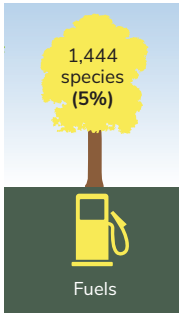
Right: The African Cherry tree (Prunus africana) occurs in montane tropical forests across central, eastern and southern Africa and Madagascar. Its bark is used locally and traded internationally to cure malaria, fever, kidney disease, urinary tract infections and prostate cancer. International trade is estimated to exceed US$ 200 million annually although there are signs that the species is now struggling to sustain the demand. Harmful extraction methods are causing the species to decline across its range. It is listed as Vulnerable on the IUCN Red List. (Kirsty Shaw)



Ornamental trees

A wide variety of trees are of ornamental importance cultivated for their attractive shape and form, flowers, cones, foliage and bark. These species are often characterised by beautiful flowers, fruits or leaves and are planted in parks and gardens worldwide. Magnolias, maples and conifers are amongst the thousands of tree species cultivated. However over-demand for some of these species, and wild collection of specimens, has led to their decline in the wild, resulting in them being threatened with extinction. Many of these popular ornamental trees are also facing the risk of extinction, with 23% of maples, 31% of oaks and half of all magnolias are threatened with extinction.

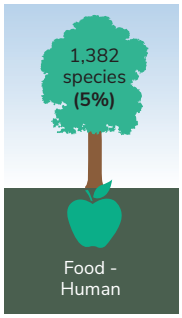
Left: Camellia azalea is an evergreen shrub or small tree restricted in Guangdong Province, China. It is of high horticultural interest, and illegal collection as demand is high while supply is small. Propagation techniques have been developed in private nurseries in an attempt to reduce illegal collection. It is listed as Critically Endangered on the IUCN Red List. (Ton Hannink)



Woodfuel trees

In developing countries, woodfuel (fuelwood and charcoal) is a particularly important product derived from trees, both for household use and for sale. Some 880 million people are estimated to spend time collecting fuelwood or producing charcoal (Jin *et al.*, 2017). More than 40 million people are engaged in commercial fuelwood and charcoal activities often to supply towns and cities. Of the tree species on the IUCN Red list, 5% are used for fuel. The widespread use of woodfuel puts significant pressure on tree species. For example in Madagascar, 244 tree species are recorded as used for fuel, and nearly half of them (117) are recorded as threatened.

Charcoal production (KMCC SE Rakotoarisoa)



Food (and drink) trees

Trees directly provide important products for food and drinks harvested from the wild for local use and commercial trade. Global Forest Goal 2 of the UN Strategic Plan for Forests, 2017-2030 calls for the contribution of forests and trees to food security to be significantly increased. Of the tree species recorded in the IUCN Red List, 5% are considered to be food trees. Tree species are also important wild relatives for major cultivated crops including avocado, coffee and oil palm. In addition to feeding humans, trees are also an important source of fodder particularly in arid areas.

Tea (Camellia sinensis) is the world's most popular drink. Tea is today cultivated in more than 40 countries worldwide, and though the origin of the species is thought to be in southwest China, its wild distribution is still unknown. Many of the very old records of the species can be traced back to the cultivation in ancient (sometimes abandoned) tea plantations. Due to its long history in cultivation, distinguishing between the wild population and naturalised plants from cultivated sources is very difficult, it may be that no wild tea plants exist today. Until more information is known, Camellia sinensis has been assessed with the conservation status Data Deficient. (Jakub Serych)

Cultural and symbolic significance

A huge variety of cultural values and symbolic functions are ascribed to the world's tree species. Particular trees have a sacred status, are used in rituals, provide ingredients for cultural dishes or have symbolic importance for ethnicity, identity and connection to a place. The contribution of forests and their biodiversity to people's identity and sense of well-being is important globally. Certain tree species and individual trees have been revered and considered sacred throughout history. Losing trees of cultural value diminish important aspects of life for different communities. However, when a tree's cultural values are enhanced or re-invigorated the survival prospects of the tree species may be greatly improved.

In Madagascar, the majestic Grandidier's baobab (Adansonia grandidieri) plays an important role, symbolising and providing a focal point for a number of village affairs. The trees are frequently the subject of local stories and legends. Individual trees were found to have strong, local legends attached to them and were often the focal point of annual ceremonies associated with local beliefs. The Grandidier's baobab is classified as Endangered, as it is threatened by fire, slash-and-burn farming, over-grazing (which inhibits regeneration) and over-exploitation of its highly valued products (such as bark and fruits). (Georgina Magin)

Taking conservation action for trees

For the first time, we now know which of the world's trees are at risk of extinction – and why. Combining this information with the knowledge on conservation actions needed to reduce threats and encourage recovering tree populations in the wild, we have the required information to take effective conservation action for trees to lead to an improved status of the tree species on the ground. Conservation action for trees requires a diverse approach and can include conservation planning, *in situ* protection, restoration, species recovery and *ex situ* conservation measures. Underpinning successful tree conservation action are education, awareness raising and increasing technical capacity. All these actions need to be considered alongside the policies and legislation supporting biodiversity conservation.

CASE STUDY: **THE GLOBAL TREES CAMPAIGN**

The Global Trees Campaign (GTC, www.globaltrees.org) aims to secure the future of the world's tree species, by taking action for threatened trees, for the benefit of people and planet. GTC was established in 1999 and is a joint initiative between Fauna & Flora International (FFI) and BGCI. GTC has worked to conserve over 400 threatened tree species in more than 50 countries.

As a result of GTC projects around the world;

- One tree species thought to be extinct was rediscovered
- 60 threatened tree species with significantly higher known populations as a result of survey work
- 200 threatened tree species with evidence of reduced or managed threats
- More than 700,000 seedlings of more than 300 threatened tree species have been planted
- 10,000 people have been trained in tree conservation skills

Recently, GTC has launched national tree conservation programmes and Global Conservation Consortia for six priority taxonomic groups of trees; Acer, Dipterocarps, Magnolia, Nothofagus, Oak and Rhododendron, to scale up conservation action for threatened trees.

Tree Conservation Planning

Effective conservation planning is needed to improve the success of conservation interventions. Conservation planning can be carried out for individual priority tree species, for multiple species (e.g. present in the same area and / or experiencing the same threats) or broader conservation action plans can be produced for larger groups of tree species.

CASE STUDY: **CONSERVATION PLANNING FOR KENYA'S THREATENED TREES**

In 2020, BGCI, the IUCN/SSC Conservation Planning Specialist Group, and the Kenya Forest Service led a series of online workshops focused on planning conservation action for Kenya's threatened trees. These workshops provided an opportunity to bring together key stakeholders to discuss and evaluate the results of an analysis for Kenya's more than 140 threatened tree species. It used the Assess to Plan (A2P) methodology, which links a single-species Red List assessment through to stakeholder-inclusive multi-species conservation action planning. The A2P process can be used to identify or confirm key biodiversity areas (KBAs), and to group threatened species together that are likely to benefit from the same conservation activities carried out by the same agencies. During the workshops, a joint vision statement and goals were developed and priority actions at national and regional levels to deliver conservation for Kenya's threatened trees were identified. A website has been set up for this initiative to help track activities and progress, a Kenya Threatened Tree Consortium has been launched, and funds have been raised to start implementing conservation actions.

Right: Native tree species for reforestation (Barney Wilczak)

Protecting trees *in situ*

The key to long-term survival for tree species is the protection and appropriate management of the tree species in their natural habitats, supporting the tree species and ensuring that associated species and ecological processes are maintained. As highlighted above, the current global protected area network is home to a majority of the world's tree species, however, the effectiveness for tree conservation within protected areas is not fully understood. More needs to be done to ensure that all species are supported in *in situ* conservation management plans. The Global Tree Assessment and associated data will ensure that this information is better incorporated into protected area planning, linking for example with the identification and protection of as Key Biodiversity Areas, Important Plant Areas and Alliance for Zero Extinction (AZE) sites.

Both within and outside of protected areas, specific management interventions are often required to protect threatened trees and allow them to regenerate. This requires a good understanding of the threats each species is facing, and identification of the best ways to manage threats.

CASE STUDY: ENSURING THE SURVIVAL OF *MAGNOLIA GRANDIS* IN VIETNAM

Critically Endangered *Magnolia grandis* is known only from small, isolated populations in southern China and three protected areas in northern Vietnam. Despite the protected status of the sites in Vietnam, limited law enforcement and management on the ground meant that *M. grandis* populations continued to decline due to illegal logging, fuelwood collection and limited recruitment of new seedlings.

Since 2013, GTC has introduced regular monitoring, patrolling and reinforcement planting across the three protected areas, with a recent focus on Tung Vai Watershed Protection Area - the home of the world's largest population of the species, at 200 individuals. Over this time, we have built strong links with local stakeholders to ensure the species' survival; establishing community patrols to protect trees from logging, planting seedlings to boost population size, and reducing the impact of cardamom cultivation - a major limiting factor on *M. grandis* regeneration.

These efforts are paying off, with no felling or damage to *M. grandis* individuals at Tung Vai since 2017. Local farmers now maintain *M. grandis* seedlings growing in their plots, where previously they would have been weeded out, and the adoption of fuel-efficient stoves has reduced pressure on the species for fuelwood. Approximately 500 *M. grandis* seedlings, ranging between 50 cm and 3 m tall, were found to have naturally regenerated at Tung Vai in 2020. Given that this regeneration has not been seen at the site previously, it indicates that our work over the last eight years to enable the species to recover has been a success and we continue to build on this to promote further natural regeneration.

Magnolia grandis (*Weibang Sun*)

Ecological restoration and tree planting

In addition to protecting remaining biodiverse areas important for tree conservation, we also need to restore degraded landscapes. Forest restoration is recognised as a global priority and 61 countries have jointly pledged to restore 170 million hectares of degraded forest lands under the Bonn Challenge. Forest restoration can boost the populations of depleted species, restore habitats and ecosystems, provide jobs and income and is an effective nature-based solution to climate change. But forest restoration must be more than tree planting for carbon credits. A huge opportunity is missed if appropriate tree species, including rare and threatened species, are not used in forest restoration. Tree-planting efforts which focus on exotic species provide limited benefit to biodiversity and can actually cause harm if planted in the wrong places (Lewis et *al*., 2019). There is a growing concern in the biodiversity conservation and ecological restoration community that not enough attention is being paid to which species are planted and where (Sacco et *al*., 2021). The Ecological Restoration Alliance of Botanic Gardens (https://www.erabg.org/) is leading some of the most biodiverse restoration projects on the planet, including forest restoration projects on five continents that incorporate threatened tree species, demonstrating that forest restoration can be achieved in a way that benefits biodiversity.

CASE STUDY: RESTORING HONG KONG'S LOST FORESTS

Kadoorie Farm and Botanic Garden (KFBG) is working to restore the natural landscape of Hong Kong. The majority of remaining forests in Hong Kong are dominated by secondary plant growth, and contain only a fraction of the species diversity of the primary forest that came before them.

All seedlings grown in KFBG nurseries are from seeds collected in Hong Kong's Country Parks. A seed collection number is assigned at the time of collection to permanently document the source of each tree. As far as possible, seeds of any one species are collected from multiple populations with the aim to maximise genetic diversity in the resulting forest.

In total, more than 60,000 seedlings have been planted, including over 300 native tree species represented, including threatened tree species such as *Quercus edithiae* (Endangered). Additional biodiversity benefits beyond trees include native animals such as bamboo pit viper (*Trimeresurus stejnegeri*), recolonising the restoration site.

Species recovery

Often conservation programmes focused on an individual threatened tree species are required to boost population numbers or reintroduce species to sites they have previously been extirpated from. Many threatened species have never been grown before, so propagation trials need to be carried out to generate a successful method for growing seedlings. It is important to address the underlying threats that meant that the species was lost or degraded in the target site, prior to and alongside planting programmes. Planting programmes should also include aftercare and monitoring to ensure the best chances of survival for the planted seedlings.

CASE STUDY: MULANJE CEDAR RESTORATION ON MOUNT MULANJE

Mulanje cedar (*Widdringtonia whytei*) is Malawi's National Tree. It is found naturally only on Mount Mulanje in the South East of the country. The tree is highly valued for its durable and fragrant timber and has been commercially exploited since the 1890s for construction, furniture and panelling. Mulanje cedar is now Critically Endangered due to illegal logging and increased manmade fires that reduce recruitment of new trees.

Eight community nurseries have been set up around the mountain with over 80 members taught to propagate Mulanje Cedar seedlings, ready to be planted back onto the mountain. Over 400,000 seedlings have been purchased from community nurseries and planted back on the mountain providing nursery workers with vital incomes. Restoration experts from the Ecological Restoration Alliance of Botanic Gardens are also helping to improve planting practices so that more trees survive and grow better.

At the same time, alternative sustainable uses of Mulanje cedar trees are being investigated. Essential oils can be produced from the tree's wood and leaves with studies into the components of this oil carried out in order to help identify what products (e.g. soaps) these oils could be used in. Communities around Mount Mulanje have planted Mulanje cedar hedges in preparation for any industry with distillation equipment and training to be provided. This could offer alternative incomes from the Mulanje cedar to local communities that don't require impact and damage to Mount Mulanje. These actions aim to ensure the planted trees on the mountain remain safe for the long-term.

Tree planting canopy closure (Gunter Fischer)

Ex situ conservation

For threatened species, it important to establish a backup collection *ex situ*, in case threats to the species in its natural habitat persist or get worse. Species that are down to dangerously small numbers, or where the threats cannot be abated in the wild, or where the natural habitat has already been lost, now rely on *ex situ* conservation for their continued survival. Without the propagation and survival of these species in botanic gardens, arboreta, seed banks and other *ex situ* conservation collections they would now have been extinct.

Chinese Hats Tree - Karomia gigas *found only in Tanzania. (Kirsty Shaw)*

CASE STUDY: KAROMIA GIGAS

Karomia gigas is one of the world's rarest trees. It is now only known to exist in southeastern Tanzania, but previously also grew within Kenya. The species is believed to be extinct in Kenya as the last known specimen was cut down in the 1970's.

Until 2011, the species was also thought to be extinct within Tanzania but in this year, botanists from the University of Dar es Salaam rediscovered the species, 28 km away from a previous collection site. A second site of the species was found in 2017. Across both locations, just 21 mature individuals of *Karomia gigas* exist and consequently the species is assessed as Critically Endangered on the IUCN Red List.

Karomia gigas is a tall tree that produces large, oval, papery seeds. Overall, little is known about the species. It is suspected that a decline in its native habitat, as forest was converted to agricultural land, caused its population to decline. Conversion of forest remains a threat to this species. Historical decline in the species is also potentially caused by wood cutting for fuel and timber. Logging still occurs locally and is a continuing threat to the species

The Tanzania Forest Service, Missouri Botanical Garden and the Global Trees Campaign are working to protect and conserve the remaining *Karomia gigas* individuals. At Missouri Botanical Garden, seedlings have been grown *ex situ* and in 2021 individuals started to flower. This is the first time that the flower of this species has been observed scientifically and it is a hopeful sign that a propagation and planting programme will be able to be carried out in future to restore population numbers and reintroduce this species back to previously known sites.

Karomia gigas *(Kirsty Shaw)*

Karomia gigas *(Kirsty Shaw)*

Education, capacity building and awareness raising

A key aspect for success of tree conservation is to equip, support and empower partners and local communities with the knowledge and skills to conserve threatened trees. Empowering more people to protect and restore threatened trees is vital to ensure that conservation projects are sustainable and have a long-term impact. In addition, education and awareness raising to schoolchildren, local communities and wider public, beyond individuals directly involved in conservation action, is also essential to motivate individuals and organisations across the world to catalyse wider action for tree species conservation and raise the next generation of conservationists.

CASE STUDY:

BINHI – COMBINING TREE CONSERVATION ACTION WITH EDUCATION

Pastor Jr Malabrigo and Ronino Gibe

In the Philippines, an innovative partnership programme combines tree red listing with species conservation action and awareness raising. Known as BINHI (Filipino term for seedling), the Energy Development Corporation (EDC), a leading renewable energy company in the Philippines, initiated this programme in 2008 Using science-based criteria, primarily considering ecological and economic importance, EDC came up with a list of 96 priority threatened tree species for conservation. Subsequently, EDC has been exploring almost every island of the Philippines to document and geo-tag remaining natural populations of some of the rarest and most threatened native trees. Through coordination and partnership with appropriate agencies, propagules were collected and propagated through a vegetative material reproduction (VMR) facility. The company's state of the art nursery and VMR facility has developed protocols for the mass propagation of the threatened species, through cuttings, with survival rates ranging from 85-100%. Some propagules produced from the VMR were donated and planted in schools and parks and some used for further research studies. To date, EDC has planted more than 9,000 threatened trees in 192 partner organisation sites across 16 regions of the country. Many of the planted saplings among EDC's partner institutions are now source of seeds even at a very young age.

To promote awareness and appreciation, all planted trees were labelled with important information about the tree, including the name of the planter/s. EDC developed a BINHI website where photos of regular monitoring per planting site are regularly uploaded allowing the planters to monitor the performance of their planted trees. More importantly, all botanical information gathered for the 13-years of the project

More than 9,000 threatened trees have been planted across the Philippines

including new distributions, phenology, and propagation techniques have been published in a book "BINHI Tree for the Future" to disseminate the project learning and experiences to a larger public.

With its years of exploration and population survey of the 96 priority species, BINHI discovered and protected several new populations of the threatened trees. This extensive field research has also enabled EDC to contribute to the assessment of the conservation status of the Philippine endemic trees. In May 2019, EDC became a Global Tree Assessment (GTA) partner working with BGCI and IUCN for the red list assessment of the Philippine endemic trees. This partnership, involving the University of the Philippines, Los Baños, has further expanded the conservation prioritisation of BINHI since results of the GTA assessment revealed more tree species that are Critically Endangered. This year, EDC launched BINHI 3.0 which targeted an additional 49 island endemic tree species recently assessed as Critically Endangered. EDC is hopeful that the same success for the first 96 priority species will be achieved by BINHI 3.0.

Policy and legislation

Action in support of tree conservation is mandated by national, regional and international policies and legislation, including forestry, agriculture, biodiversity conservation and climate change. Now that we have information on the conservation status and specific threats to tree species it will be possible to influence decision making relating to environmental policy and legislation more effectively. A review of the policy framework is outside the scope of this report, but some important examples are given below. Policies for safeguarding tree diversity in many countries need to be updated to include a specific focus on priority tree species and the identification of important sites for their conservation is required.

The Convention on Biological Diversity (CBD) provides a broad framework for all the conservation of all components of biodiversity at the ecosystem, species and genetic level. The conservation of tree species is integral to various Programmes of Work through which the CBD delivers its objectives. These programmes include the Forestry Programme, Protected Area Programme and Sustainable Use Programme. A successful cross-cutting programme has been the Global Strategy for Plant Conservation (GSPC) 2011-2020, which stimulated activities related to species identification, threat assessment and conservation, through specific targets in these areas. Post-2020 targets for plant conservation are currently under development in line with the new Global Biodiversity Framework. This Framework is presently being negotiated by CBD Parties, with the expectation that it will be adopted in 2022. The Global Biodiversity Framework will guide actions worldwide to preserve and protect nature and the essential services it provides to people.

Trees and forests play a key role in reducing greenhouse gas emissions and mitigating climate change under the United Nations Framework Convention on Climate Change (UNFCCC), which includes policies and mechanisms to reduce deforestation as a means to tackle climate change. Actions to reduce emissions derived from deforestation and forest degradation and increase forest area to sequester carbon form part of many countries' Nationally Determined Contributions (NDCs) to the Convention. The Paris Agreement, signed in 2016, sets out a framework for the conservation of carbon sinks, including forests, through schemes such as REDD+ (Reducing Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries). National REDD+ strategies and action plans include a wide range of priority actions to reduce deforestation and forest degradation, relating, for example, to agriculture, sustainable forest management in the forestry sector and governance mechanisms.

The New York Declaration on Forests, a voluntary and non-binding international declaration to take action to halt global deforestation, launched in 2014 and now has over 200 endorsers, including governments, multinational companies, groups representing indigenous communities and NGOs. This Declaration specifically includes commitments from and support to the private sector to eliminate deforestation from the supply chains of major agricultural commodities thus addressing one of the greatest threats to tree species.

The UN Strategic Plan for Forests 2017-2030, Global Forest Goal 5 calls for forest law enforcement and governance to be enhanced, including through significantly strengthening national and subnational forest authorities, and for illegal logging and associated trade to be significantly reduced worldwide. This Goal addresses the second greatest threat to tree species which is direct exploitation especially for timber.

The Global Plan of Action for the Conservation and Sustainable Use of Forest Genetic Resources identifies 27 strategic priorities for forest genetic resources (FGR) grouped into 4 areas: 1) improving the availability of, and access to, information on FGR; 2) conservation of FGR (*in situ* and *ex situ*); 3) sustainable use, development and management of FGR; 4) policies, institutions and capacity-building. Implementation of the Global Plan of Action strengthens the sustainability of the management of FGR while contributing towards the 2030 Sustainable Development Agenda, in particular Sustainable Development Goal (SDG) 15, which has a specific target on sustainable forest management.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement for the sustainable management and trade in species. Over 560 tree species are currently included in the Appendices of the Convention, either listed at species or generic level. The listings include some of the world's most precious and most threatened timbers (308 species), trees which are also of immense ecological importance. It also includes at least 54 species traded for their resin e.g. *Aquilaria* and *Gyrinops*, and trees traded for their medicinal and other desirable properties.

What next for trees

The results of the Global Tree Assessment show that we are losing trees that are vital for livelihoods and ecological services. Using the information now available on the conservation status of trees, strengthened action is urgently required to prevent further species extinctions and restore damaged and degraded ecosystems. Such action will provide responses to both the biodiversity crisis and climate change emergency. Forestry, biodiversity conservation and climate change policies and mechanisms are already in place but need to be adhered to and implemented with greater resolve and commitment. Partnerships through the Global Tree Assessment have enabled experts in the countries with the largest numbers of endemic trees to undertake assessments. Such information should be used, for example, to enhance management for threatened trees within protected areas, and support Forest Landscape Restoration, REDD+ and other sustainable forestry initiatives at a national level. The following key recommendations propose a re-think in planning and carrying out biodiversity conservation and ecosystem restoration to ensure greater recognition of the global importance of tree species. The recommendations link directly with the 2030 Agenda for Sustainable Development, which seeks to end poverty, conserve biodiversity, combat climate change and improve livelihoods for everyone, everywhere.

1. Strengthen tree conservation action globally through the formation of a new coalition that brings together existing resources and expertise, learns from the experience of the Global Trees Campaign, its network of partners and other tree conservation practitioners worldwide, and uses them to radically scale up tree conservation action

2. Use information in the GlobalTree Portal on the conservation status of tree species, their distributions and conservation action to inform conservation planning and action at local, national, and international levels, and for priority taxonomic groups. Build on this information by strengthening research on Data Deficient tree species, and collating additional information on conservation action for threatened species to avoid duplication of efforts and ensure conservation action is directed where it is needed most.

3. Ensure effective conservation of threatened trees within the protected area network by strengthening local knowledge, monitoring populations of threatened species and where necessary increasing enforcement of controls on illegal or non-sustainable harvesting of valuable species. Extend protected area coverage for threatened tree species and species assemblages that are currently not well-represented in protected areas.

4. Ensure that all globally threatened tree species are conserved in well-managed and genetically representative *ex situ* living and seed bank collections, with effective associated education programmes and material made readily available for recovery and restoration programmes.

5. Aligning with the UN Decade on Ecosystem Restoration 2021–2030, work with local communities, government forestry agencies, the business community and all other interested parties to ensure that the most appropriate tree species, including those that are threatened, are used in tree planting and restoration programmes. BGCI and the Ecological Restoration Alliance of Botanic Gardens can provide expert knowledge on propagation of indigenous tree species and restoration techniques, based on data from the hundreds of ecosystem restoration plots managed by their member organisations worldwide.

6. Improve data collection for National Forest Inventories and National Forest Monitoring Systems and use this information to reduce deforestation in areas of high tree diversity in association with REDD+ and Nationally Determined Contributions (NDCs).

7. Increase the availability of government, private and corporate funding for threatened tree species, and ensure that funding is directed to species and sites that are in greatest need of conservation. For example, BGCI's Tree Conservation Fund has been created to enable businesses, philanthropic organisations, and governments around the world to contribute to the essential effort to save the world's threatened tree species (www.treeconservationfund.org).

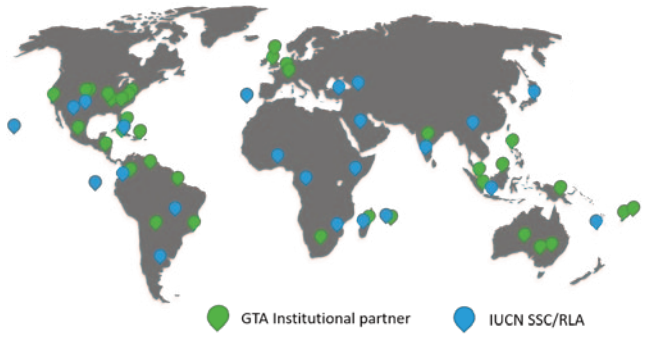
Araucaria araucana *(Cristian Echeverria)*

Partners and contributors

The Global Tree Assessment is managed and coordinated by Botanic Gardens Conservation International (BGCI) working with the IUCN Species Survival Commission Global Tree Specialist Group (GTSG). However, the Global Tree Assessment is only possible due to vast global partner network – including support and contribution of a range of institutional partners and also contributions from many individual tree experts.

Institutional partners include botanic gardens, arboreta, universities, charities, forestry institutes, research institutes, herbaria, etc.

Major institutional partners:



North America

Atlanta Botanical Garden
Field Museum
Missouri Botanical Garden
NatureServe
New York Botanical Garden
Smithsonian Institution
The Morton Arboretum
United States Botanic Garden
University of North Carolina Asheville
US Forest Service

Central America and Caribbean

Universidad Nacional Autónoma de México (UNAM), Centro Regional del Bajío, Instituto de Ecología, A.C., Mexico (INECOL)
Tecnológico de Costa Rica, Escuela de Ingeniería Forestal
Haiti National Trust
Herbario Nacional de Costa Rica, Museo Nacional de Costa Rica
Leon Levy Native Plant Preserve, Bahamas
Universidad Nacional Autónoma de Honduras
Natural History Museum of Jamaica

South America

Asociación Colombiana de Herbarios
CNCFlora/Jardim Botânico do Rio de Janeiro
Humboldt Institut
Herbario Nacional de Bolivia
Provita
The National Herbarium of Suriname

Africa

Kew Madagascar Conservation Centre
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Europe

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Royal Botanic Gardens Edinburgh
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University of Geneva
Maastricht University
Westonbirt, The National Arboretum

Asia

BINHI/Energy Development Corporation
Bogor Botanical Gardens
Department of Plant Resources, Government of Nepal
Fauna & Flora International Indonesia Office
Forest Research Institute Malaysia
Papua New Guinea National Herbarium (LAE)
Papua New Guinea Forest Research Institute
LIPI (Indonesian Institute of Sciences)
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Australasia and Oceania

Council of Heads of Australian Botanic Gardens
Australian National Environmental Science Program
BGANZ (Botanic Gardens Australia and New Zealand)
NatureFiji-MareqetiViti
Samoa Conservation Society
South Pacific Regional Herbarium
The University of Queensland

IUCN Species Survival Commission (SSC) Plant Specialist Groups and stand-alone Red List Authorities:

China Plant Specialist Group, Brazil Red List Authority, East African Plant Red List Authority, Central African Red List Authority, Madagascar Plant Specialist Group, Indonesian Plant Red List Authority, Mascarene Island Plant Specialist Group, New Caledonia Plant Red List Authority, Colombian Plant Specialist Group, Cuban Plant Specialist Group, Southern African Plant Specialist Group, West Africa Plant Red List Authority, Galapagos Plant Specialist Group, Western Ghats Plant Specialist Group, Turkey Plant Red List Authority, Caucasus Plant Specialist Group, Macaronesian Island Plant Specialist Group, North American Plant Specialist Group, Sonoran Desert Plant Specialist Group, Temperate South American Plant Specialist Group, West Asia Arabian Plant Specialist Group, Hawaii Plant Specialist Group, Korean Plant Specialist Group, Crop Wild Relatives Specialist Group, Palm Specialist Group, Conifer Specialist Group, Mangrove Specialist Group, Medicinal Plant Specialist Group, Cactus and Succulent Plant Specialist Group, Freshwater Plant Specialist Group

Acer velutinum *(Philippe de Spoelberch)*

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Alivereti Naikatini
Goginashvili Nana
Catherine Nano
Henry Ndangalasi
Csaba Németh
Adrian Newton
Ngoc Nguyen
Patrick Nimiago
Rizmoon Nurul Zulkarnaen
Martin O'Leary
Mike Oatham
Forova Oavika
Maria Fernanda Obando Picado
Sanna Olander
Sara Oldfield
Jean Michel Onana
Denise Ora
George Orel
Andrew Orme
Simone Orsenigo
Jo Osborne
Amy Palmer-Newton
Januka Pathak
Brígido Peguero
Quinter Peres
Joan Perriera
Iin Pertiwi Husaini
Antoaneta Petrova
Ei Ei Phyoe
Ruthmery Pillco Huarcaya
Nigel Pitman
David Pivorunas
Jack Plummer
Gregory Plunkett
Sarah Pocock
Caroline Pollock
Daniel Potter
Ghillean Prance
Victoria Price
Enggal Primananda
Kanchana Pruesapan
Hoo Pui Kiat
Anna Puttick
Truong Quang Cuong
Truong Quang Nguyen
Elisabeth Rabakonandrianina
Marina Rabarimanarivo
David Rabehevitra
Julian Radford-Smith
Jeannie Raharimampionona
Sri Rahayu
Eka Martha Della Rahayu
Wiguna Rahman
Domatilla Raimondo
Landy Rajaovelona
Mijoro Rakotoarinivo
Andry Rakotoarisoa
Solofo Eric Rakotoarisoa
Nantenaina Rakotomalala
Franck Rakotonasolo
Nivo Rakotonirina
Bakoly Rakouth
Hélène Ralimanana
Besoa Ramananarivo
Brigitte Ramandimbisoa
Aro Vonjy Ramarosandratana
Neptali Ramirez Marcial
Nomentsoa Randriamamonjy
Tianjanahary Randriamboavonjy
Vonona Randrianasolo
Aina Randriarisoa
Hassan Rankou
Bako Harisoa Ravaomanalina
Noro Ravololomanana
Velosoa Razafiniary
Henintsoa Razanajatovo
Jacqueline Razanatsoa
Shiny Rehel
Daniela Requena Suarez
Nilus Reuben
Carlos Reynel Rodriguez
Tim Rich
Joko Ridho Witono
Ricarda Riina
Rosniati Apriani Risna
Malin Rivers
Iyan Robiansyah
Dagoberto Rodriguez
Hernando Rodríguez Correa
Mereoni Rokocaucau
Jeanne Romero-Severson
Siti Roosita Ariati
Isaac Rounds
Christopher Russell
Terhi Ryttäri
Ikuyo Saeki
Per Harald Salvesen
Marie-Stéphanie Samain
Julia Sang
George Schatz
John Schenk
Heidi Schmidt
Janet Scott
Alexander Sennikov
Zaveri Shah-Smith
Kirsty Shaw
Shi-Kang Shen
Lulezim Shuka
Jennifer Silcock
Myknee Sirikolo
Deepu Sivadas
Sarah Skinner
Ferry Slik
Bryony Smart
Kevin Smith
Paul Smith
Jimson S. Solatre
Hoang Son
Sung-Won Son
Yi-Gang Song
Marc Sosef
Phetlasy Souladeth
Sengthong Soulinnaphou
Bec Stanley
Jean Stephan
Tariq Stévart
Randal Storey
Joeri Strijk
Larry Stritch
Mong-huai Su
Sudarmono
John Sugau
Daden Sukarta
Agnes Sumareke
Dipta Sumeru Rinandio
Brett Summerell
Weibang Sun
Terence Sunderland
Lucy Sutherland
R. Syamsul Hidayat
Sasikumar Tanggaraju
Vincent Tanguy
Wattana Tanming
Andrii Tarieiev
Vikash Tatayah
Ian Telford

Nicolas Texier
Phaxaysombath Thatsaphone
Ida Theilade
Sothearen Thi
Michael Thomas
Nunia Thomas
Philip Thomas
Lex Thomson
Mats Thulin
Mamy Tiana Rajaonah
Zou Tiancai
Siteri Tikoca
Jonathan Timberlake
Joel Timyan
Adriane B Tobias
Christian Torres-Santana
Luis Torres-Montenegro
Félicien Tosso
Amanda Treher
Liam Trethowan
Julisasi Tri Hadiah
Panagiotis Trigas
Angelo Troìa
Hong Truong Luu
Sandy Tsen
Marika Tuiwawa
Shane Turner
Dana Turonova
Ilimo Tulevu
Maman Tuvune
Arthur Glenn Umali
Krishna Upadhaya
Didi Usmadi
Winda Utami Puteri
Susana Valencia-Ávalos
Salako K. Valère
Veerle Van den Eynden
Xander van der Burgt
Luong Van Dung
Hoang Van Sam
Peter van Welzen
Grisel Velasquez
Jiří Velebil
Nadja Verspagen
Jose Luis Vivero Pol
Jeannoda Vololoniaina
Imawan Wahyu Hidayat
Prima Wahyu Kusuma Hutabarat
Neville Walsh
Kang Wang
Dick Watling
Mark Watson
Aparna Watve
Michelle Waycott
Hayley Weaver
Katherine Wenzell
Judy West
James Westrip
Murphy Westwood
Lisa Wheeler
Art Whistler
Barbara Whitlock
Didik Widyatmoko
Jan Wieringa
Martin Wigginton
Lahiru Wijedasa
Peter Wilkie
Emma Williams
Brett Wilson
Karen Wilson
Peter Wilson
Karen Winfield
Damian Wrigley
Vongsana Xayvaneng
Wei Xiao
Tomohisa Yakawa
Shixiong Yang
Low Yee Wen
Elina Nabubuniyaka-Young
Renyong Yu
Angga Yudaputra
Tan Yun Hong
Ade Yusup Yuswandi
Ana Gabriela Zacarías-Correa
Ingrid Zager
Irene Zager
Nelson Zamora
Habib Zare
Aung Zaw Moe
Freddy Santiago Zenteno Ruiz
Nyree Zerega
Dongwei Zhao

Stewartia rostrata (Arboretum Wespelaar)

Methods: How the Global Tree Assessment was carried out

Working with the global network of partners and individual experts (see above), the Global Tree Assessment (GTA) has developed a systematic approach to assessing the conservation status of all the world's tree species. The aim has been to ensure that all tree species have a published conservation assessment indicating the risk of extinction. Concerted efforts began in 2015 to list all tree species with distribution at country level and to ensure that each had a conservation category applied. The aim was to use the IUCN Red List Categories and Criteria (IUCN Red List, 2012) for all new assessments.

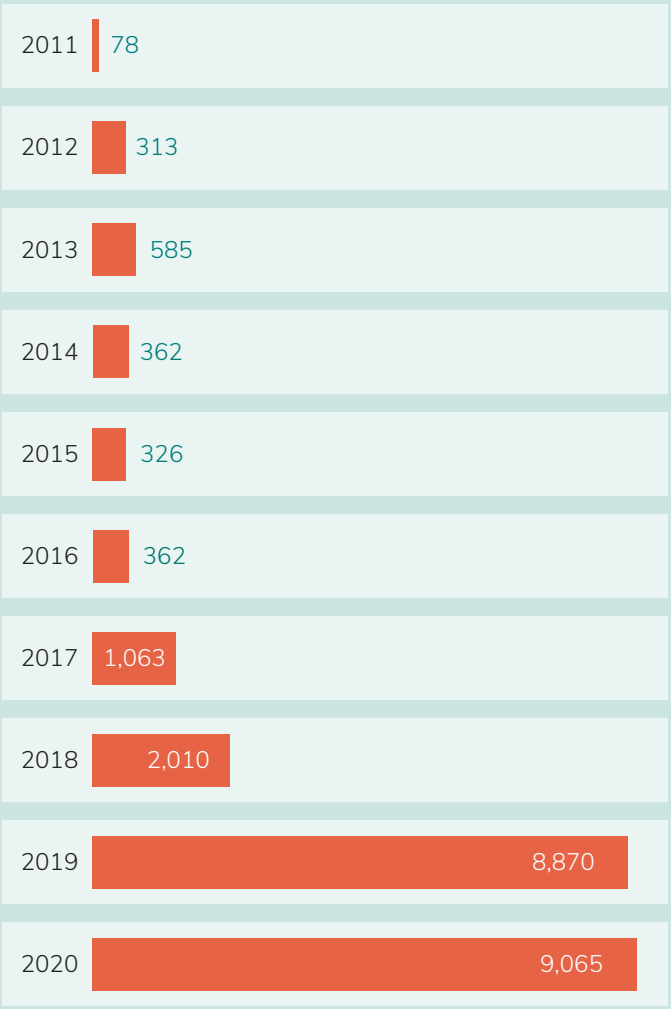
Information from the IUCN Red List is widely used to inform conservation policies and legislation, as a tool for environmental monitoring and reporting, and to prioritize areas for conservation action; it has also been used at the global scale to monitor biodiversity loss. The IUCN Red List is the leading methodology for assessing species extinction risk and 28,463 tree species had a published IUCN Red List assessment at the end of 2020 (IUCN, 2020), representing half of all known tree species.

IUCN RED LIST ASSESSMENTS FOR TREE SPECIES

The first global survey of the conservation status of trees was undertaken by UNEP-WCMC in association with the IUCN SSC and a global network of experts (the Conservation and Sustainable Management of Trees project supported by the Government of the Netherlands) from 1995–1998. This resulted in 10,091 tree conservation assessments using the 1994 IUCN Red List Categories. Around 7,000 tree taxa were assessed as threatened or Data Deficient and were subsequently published on the IUCN Red List with minimal supporting information. In 2003, the IUCN SSC Global Tree Specialist Group (GTSG) was established. The GTSG was given a broad remit to cover all trees except for conifers and palms, which were already covered by their own Specialist Groups. One of aims of the GTSG from the outset was to promote and implement IUCN Red List assessments for trees.

Additional tree assessments were produced during the period 1998–2008 (Newton and Oldfield, 2008). From 2003 to 2015, a series of tree Red List reports compiled by the GTSG was published by FFI and BGCI. These reports covered 3,101 species. In 2015 there were about 9,000 tree assessments on the IUCN Red List, the Global Tree Assessment was envisaged and work started towards it. Since then work has really taken a step change and in the last three years, the work of the Global Tree Assessment has continued to generate tree Red List reports but also ensured the assessments were added to the IUCN Red List. In the last couple of years, an order of magnitude increase in published tree red list assessments on the IUCN Red List (Figure 8) has been generated.

FIGURE 8. TREE ASSESSMENTS PUBLISHED ANNUALLY ON THE IUCN RED LIST 2011-2020



Assessment of Least Concern species

One significant new approach adopted in the Global Tree Assessment has been to rapidly and cost-effectively identify Least Concern tree species. These are species known to be abundant, widespread and not declining, i.e. not threatened with extinction. A scientific workflow was created to improve rapid assessments by combining large datasets. Baseline distribution maps were generated for tree species recorded in GlobalTreeSearch using refined Global Biodiversity Information Facility (GBIF) data. Range estimates of extent of occurrence (EOO) and area of occupancy (AOO) and number of collection events were also calculated. GBIF data provide the best readily available point locality data for many tree species. Although the data differ in age and quality, GBIF data provide an essential starting point to be checked, amended, supplemented and validated by experts. Around 48,500 maps were created through the Global Tree Assessment workflow process. There were no georeferenced GBIF data to map the remaining 11,500 tree species.

Initially over 10,000 tree species were identified out of the 48,550 as potentially Least Concern using a set of agreed criteria. The criteria are that the species should have a widespread distribution significantly over the threshold for consideration as threatened (agreed as an EOO of over 30,000 km^2, based on at least 30 unique collections (10 km apart). In addition, the species is not assessed as threatened at a national, regional or global level and is not known to be a significant medicinal or timber species. The list of approximately 10,000 species was divided geographically and taxonomically and provided to experts for validation and review. Wherever possible the species identified as potentially Least Concern were reviewed at regional workshops. Following review, Least Concern species were submitted for publication on the IUCN Red List with supporting information to meet the minimum documentation requirements.

Assessment of Data Deficient species

The category of Data Deficient (DD) indicates that there is inadequate information to determine the degree of threat faced by a taxon. In carrying out the Global Tree Assessment, the aim has been to use whatever data is currently available to assess the conservation status of each tree species, accepting that more taxonomic and fieldwork is usually desirable. DD has generally been applied where there is insufficient distribution data or where the data is too uncertain to assign a category. It is valuable to publish DD assessments on the IUCN Red List to highlight species for which further research is required. One approach to identifying DD species was based on the availability of georeferenced data. A list of tree species previously unassessed at a national, regional or global level was compiled including those for which there no GBIF data. GTSG members were involved in reviewing this list of around 1,000 species. Experts were asked for further information. In the absence of new data, the species have been preliminary assessed as DD.

Vachellia tortilis *(Teddy Kinyanjui)*

Assessment of threatened species

Adopting a rapid approach to the assessment of Least Concern and Data Deficient species, allowed more time and resources to be allocated for the assessment and documentation of tree species at risk of extinction. The approach taken in the Global Tree Assessment was to identify the countries with the greatest number of endemic species and work with national partners to produce full IUCN Red List assessments. Nearly 58% of all tree species (34,575) are single country endemics. A total of 20,300 endemic tree species are recorded as present in the ten countries with the highest recorded number of endemic trees. Global Tree Assessment partnerships were developed to undertake IUCN Red List assessments for endemic species in all these countries except for China and New Caledonia where different forms of collaboration were developed. New Global Tree Assessment partnerships were also developed for the Philippines, US and Venezuela which also have a large number of endemic trees. In some cases, existing national assessments undertaken using different methodologies were converted into the IUCN system. As well as prioritising partnerships for biodiverse countries, partnerships have been developed for specific plant families that are rich in trees, are relatively well-known taxonomically and for which expertise is available.

Consolidating threat information from additional sources

To identify the conservation status of the world's tree species, we assembled conservation assessments from BGCI's ThreatSearch database (BGCI, 2021b). The ThreatSearch database is updated regularly, and collates digitally available, evidence-based plant assessments. It contains assessments for over 139,000 accepted plant names (Nic Lughadha et *al*., 2020) compared to the 56,000 plants on the IUCN Red List (IUCN, 2020). ThreatSearch is the most comprehensive database of conservation assessments of plants, containing conservation assessments from a variety of sources: including the IUCN Red List, national red lists, and many other published sources. In total, over 275 different published sources of assessment have been collated. Species conservation assessments are carried out using a variety of methodologies, with different terminology, sometimes defined for example in national legislation. We reconciled the various assessment designations used in this study to five interpreted categories (following Bachman et *al*., 2018): 'Extinct', 'Threatened', 'Potentially Threatened', 'Not Threatened', or 'Data Deficient'.

If more than one assessment was available for a tree species, the assessments were prioritised in the following order:

i. Published global IUCN Red List assessment available on IUCN Red List (2020.3), following the IUCN Category and Criteria (IUCN, 2012)
ii. Submitted global IUCN Red List assessment, submitted to the IUCN Red List (for update 2021.1)
iii. The most recently published global assessment i.e. a national/regional red list assessment endemic to the country/region for which it was assessed (ThreatSearch - Global)
iv. The most recently published assessment of unknown or not global scope (ThreatSearch - Not Global)
v. Provisional global conservation rating (including Data Deficient), assessment made but not yet reviewed and submitted to IUCN Red List.

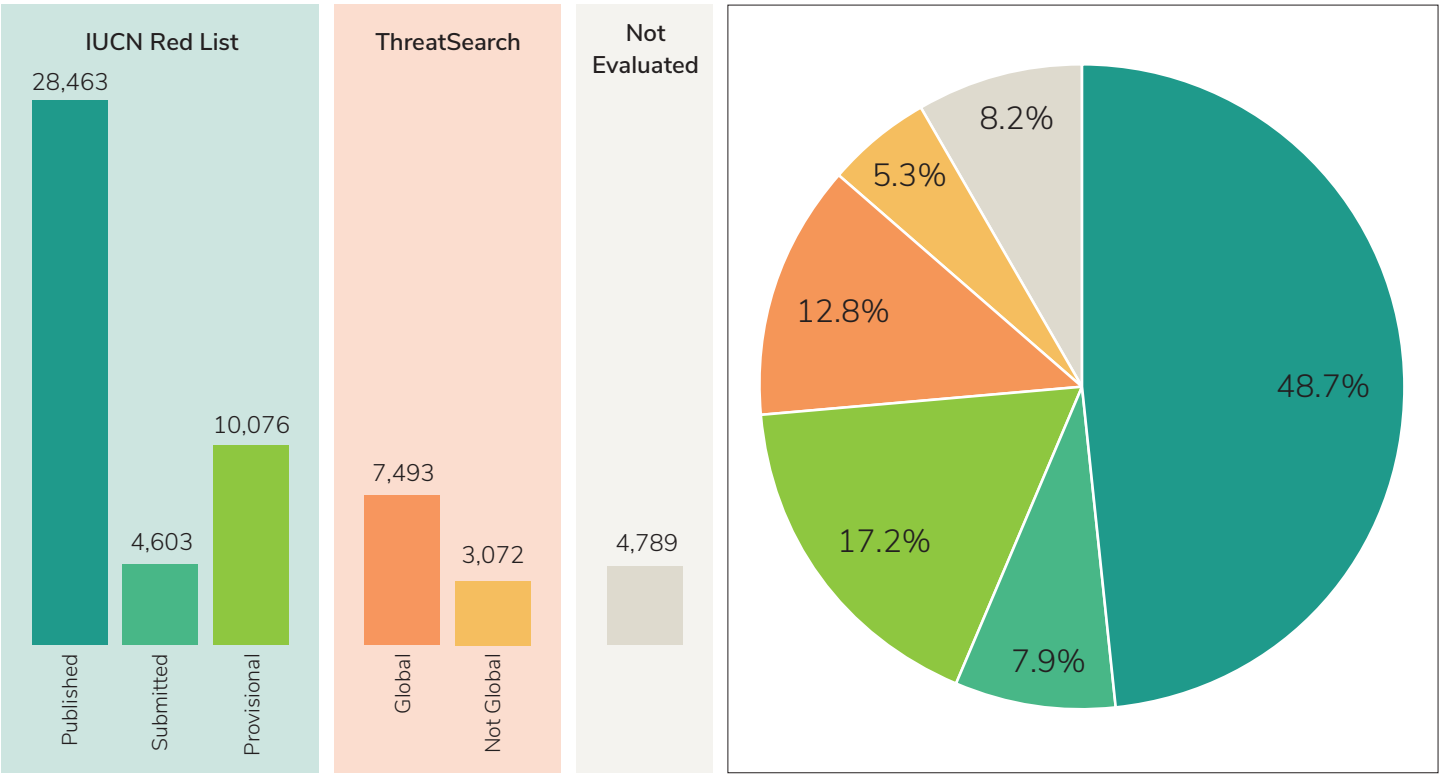
For homotypic synonyms of an accepted name, the conservation assessments were transferred to the accepted name. If the name was a heterotypic synonym, the conservation assessment was not used.

To compile the results presented in this report, assessments have been combined from a range of different sources (Figure 9). The majority (57%) of assessments are either published on the IUCN Red List (as of 2020.3) or have been submitted for publication on IUCN Red List. A further 17% of species have a provisional IUCN Red List assessment (including Data Deficient) awaiting formal review and submission. 18% of assessments were published using other sources including national Red Lists, flora accounts or scientific papers, these can all be accessed via the ThreatSearch database (Box 5). The final 8% are still not evaluated.

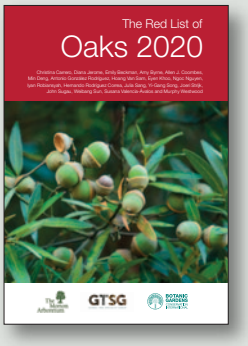
BOX 5: THREATSEARCH

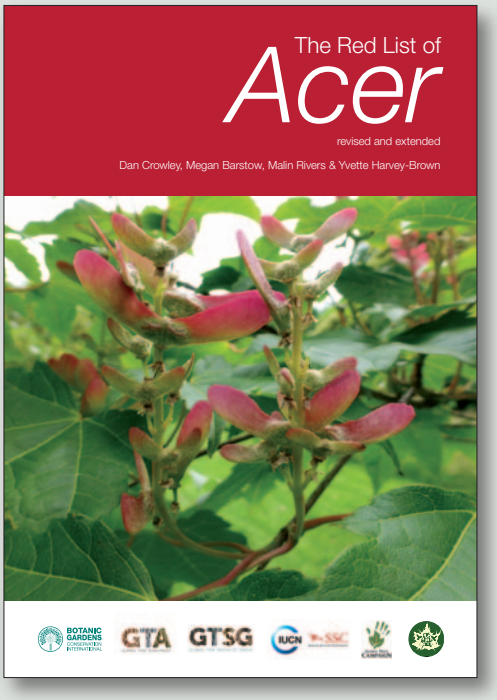
The ThreatSearch database developed by BGCI in 2017. ThreatSearch provides the most comprehensive database of conservation assessments of all plant species, listing global, regional and national red list assessments for plants derived from a variety of published sources. The main collaborators in keeping ThreatSearch up-to-date are the Royal Botanic Gardens Kew, National Red List Project managed by the Zoological Society of London, NatureServe and CNCFlora. https://tools.bgci.org/threat_search.php

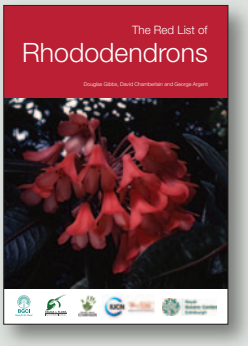
FIGURE 9. THE SOURCE OF CONSERVATION ASSESSMENTS

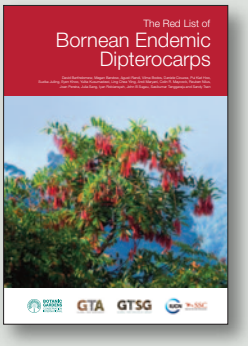


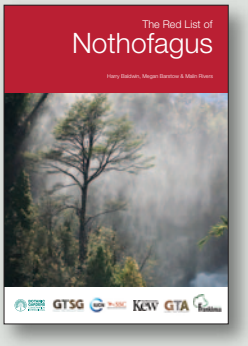
BGCI'S RED LIST PUBLICATIONS

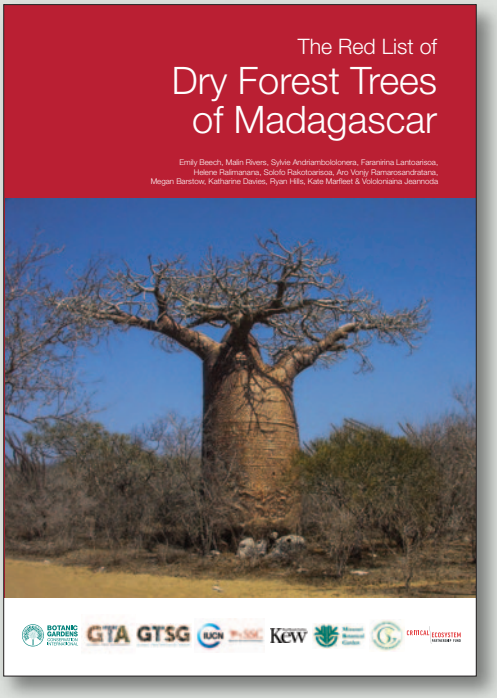


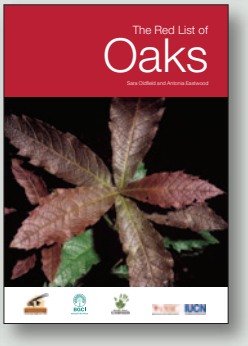


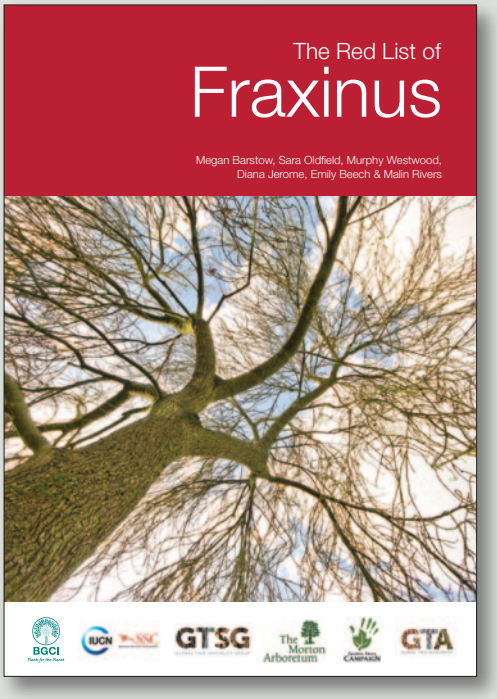


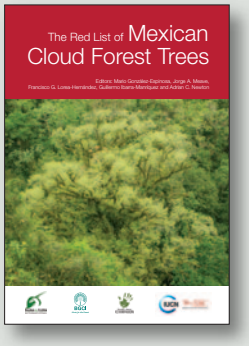


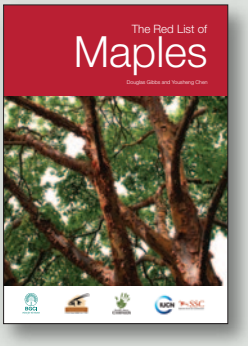


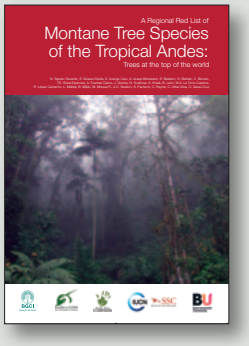


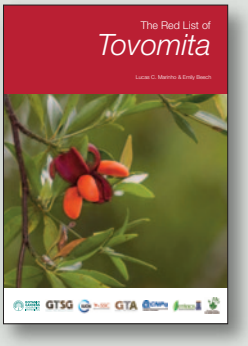


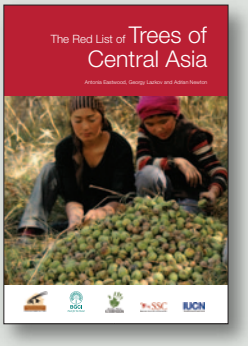












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Wollemia nobilis *(Myriam Luyckx)*

Supplementary Table

SUPPLEMENTARY TABLE 1: TREE STATISTICS PER COUNTRY

Country	Number of Species	Number of Endemic Species	Number of Threatened Species	Percentage Threatened Species
Afghanistan	115	0	6	5%
Åland Islands	2	0	0	0%
Albania	129	0	1	1%
Algeria	103	1	8	8%
American Samoa	136	2	4	3%
Andorra	34	0	0	0%
Angola	1178	73	64	5%
Anguilla	89	0	4	4%
Antigua and Barbuda	213	0	13	6%
Argentina	685	16	69	10%
Armenia	128	9	15	12%
Aruba	55	0	2	4%
Australia	3232	2730	471	15%
Austria	88	0	3	3%
Azerbaijan	133	1	7	5%
Bahamas	246	4	21	9%
Bahrain	4	0	1	25%
Bangladesh	694	10	62	9%
Barbados	153	0	7	5%
Belarus	44	0	1	2%
Belgium	51	0	0	0%
Belize	1028	13	135	13%
Benin	569	1	22	4%
Bermuda	18	3	5	28%
Bhutan	598	7	37	6%
Bolivia, Plurinational State of	3029	289	331	11%
Bonaire, Saint Eustatius and Saba	183	0	6	3%
Bosnia and Herzegovina	91	1	2	2%
Botswana	316	0	1	0%
Brazil	8847	4226	1788	20%
British Indian Ocean Territory	10	0	1	10%
Brunei Darussalam	1323	15	238	18%
Bulgaria	116	1	3	3%
Burkina Faso	334	0	18	5%
Burundi	407	1	20	5%
Cambodia	916	32	91	10%
Cameroon	1996	233	414	21%
Canada	258	7	16	6%
Cape Verde	19	2	3	16%
Cayman Islands	157	3	19	12%
Central African Republic	963	6	50	5%
Chad	254	1	10	4%
Chile	147	79	51	35%
China	4608	2144	890	19%
Christmas Island	55	5	2	4%

Country	Number of Species	Number of Endemic Species	Number of Threatened Species	Percentage Threatened Species
Cocos (Keeling) Islands	17	0	1	6%
Colombia	5868	1148	834	14%
Comoros	145	18	24	17%
Congo	1260	8	131	10%
Congo, The Democratic Republic of the	2017	188	280	14%
Cook Islands	68	5	5	7%
Costa Rica	2610	346	374	14%
Côte d'Ivoire	1058	19	139	13%
Croatia	117	1	1	1%
Cuba	1322	653	465	35%
Curaçao	87	0	4	5%
Cyprus	39	1	1	3%
Czechia	84	12	14	17%
Denmark	42	0	0	0%
Disputed Territory	10	0	2	20%
Djibouti	111	1	6	5%
Dominica	318	2	39	12%
Dominican Republic	1031	170	350	34%
Ecuador	3711	668	657	18%
Egypt	67	1	5	7%
El Salvador	850	12	122	14%
Equatorial Guinea	748	14	73	10%
Eritrea	187	1	12	6%
Estonia	44	0	1	2%
Eswatini	401	0	8	2%
Ethiopia	610	35	44	7%
Faroe Islands	4	0	0	0%
Fiji	764	536	100	13%
Finland	40	0	1	3%
France	125	3	3	2%
French Guiana	1813	73	174	10%
French Polynesia	292	223	111	38%
French Southern Territories	8	0	2	25%
Gabon	1665	138	333	20%
Gambia	190	0	9	5%
Georgia	126	1	11	9%
Germany	98	23	23	23%
Ghana	899	11	124	14%
Gibraltar	12	0	0	0%
Greece	147	4	4	3%
Greenland	4	0	0	0%
Grenada	213	1	16	8%
Guadeloupe	382	4	43	11%
Guam	64	6	6	9%
Guatemala	1850	105	422	23%
Guernsey	1	0	0	0%
Guinea	728	7	68	9%
Guinea-Bissau	321	0	16	5%
Guyana	2239	137	183	8%
Haiti	1055	209	362	34%
Honduras	1623	62	286	18%
Hong Kong	395	4	31	8%
Hungary	116	37	33	28%
Iceland	6	0	1	17%
India	2603	650	469	18%

Country	Number of Species	Number of Endemic Species	Number of Threatened Species	Percentage Threatened Species
Indonesia	5716	1483	1306	23%
Iran, Islamic Republic of	167	9	12	7%
Iraq	45	0	1	2%
Ireland	38	2	4	11%
Isle of Man	2	0	0	0%
Israel	59	2	2	3%
Italy	155	20	8	5%
Jamaica	763	335	258	34%
Japan	575	170	64	11%
Jersey	1	0	0	0%
Jordan	33	0	0	0%
Kazakhstan	84	7	7	8%
Kenya	1113	44	146	13%
Kiribati	34	0	2	6%
Korea, Democratic People's Republic of	136	1	10	7%
Korea, Republic of	205	9	15	7%
Kuwait	6	0	1	17%
Kyrgyzstan	64	5	11	17%
Lao People's Democratic Republic	1056	29	117	11%
Latvia	41	0	0	0%
Lebanon	67	1	3	4%
Lesotho	59	0	1	2%
Liberia	797	17	109	14%
Libya	46	1	3	7%
Liechtenstein	33	0	0	0%
Lithuania	38	0	0	0%
Luxembourg	38	0	0	0%
Madagascar	3129	2909	1842	59%
Malawi	730	8	49	7%
Malaysia	5422	1616	1295	24%
Maldives	35	0	1	3%
Mali	284	1	14	5%
Malta	28	0	0	0%
Marshall Islands	27	0	2	7%
Martinique	389	11	54	14%
Mauritania	76	0	3	4%
Mauritius	269	174	154	57%
Mayotte	94	18	14	15%
Mexico	3570	1453	1097	31%
Micronesia, Federated States of	155	60	8	5%
Moldova	44	0	0	0%
Monaco	13	0	0	0%
Mongolia	71	1	2	3%
Montenegro	99	0	0	0%
Montserrat	216	1	18	8%
Morocco	100	2	8	8%
Mozambique	1144	65	120	10%
Myanmar	1993	188	181	9%
Namibia	346	24	9	3%
Nauru	23	0	1	4%
Nepal	621	4	34	5%
Netherlands	44	0	0	0%
New Caledonia	1460	1325	374	26%
New Zealand	215	201	35	16%
Nicaragua	1555	25	133	9%

Country	Number of Species	Number of Endemic Species	Number of Threatened Species	Percentage Threatened Species
Niger	127	0	6	5%
Nigeria	1272	30	157	12%
Niue	63	0	4	6%
Norfolk Island	40	16	10	25%
Northern Mariana Islands	71	8	8	11%
North Macedonia	104	0	2	2%
Norway	108	16	16	15%
Oman	87	2	9	10%
Pakistan	255	4	14	5%
Palau	155	52	14	9%
Palestine	37	0	1	3%
Panama	2717	363	384	14%
Papua New Guinea	2805	1302	609	22%
Paraguay	730	19	65	9%
Peru	4501	859	786	17%
Philippines	2220	1004	756	34%
Pitcairn	29	7	10	34%
Poland	61	0	0	0%
Portugal	102	17	8	8%
Puerto Rico	633	126	141	22%
Qatar	7	0	1	14%
Réunion	140	59	54	39%
Romania	93	4	0	0%
Russian Federation	225	4	10	4%
Rwanda	390	1	24	6%
Saint Barthélemy	96	0	4	4%
Saint Helena, Ascension and Tristan da Cunha	16	14	11	69%
Saint Kitts and Nevis	155	0	10	6%
Saint Lucia	314	4	41	13%
Saint Martin	123	0	3	2%
Saint Pierre and Miquelon	20	0	0	0%
Saint Vincent and the Grenadines	299	0	27	9%
Samoa	219	59	12	5%
San Marino	4	0	0	0%
Sao Tomé and Principe	201	44	43	21%
Saudi Arabia	103	0	7	7%
Senegal	363	1	16	4%
Serbia	97	0	2	2%
Seychelles	113	45	37	33%
Sierra Leone	695	2	84	12%
Singapore	692	1	153	22%
Sint Maarten	18	0	1	6%
Slovakia	84	13	14	17%
Slovenia	96	0	0	0%
Solomon Islands	754	195	55	7%
Somalia	425	43	37	9%
South Africa	964	240	61	6%
South Sudan	512	1	19	4%
Spain	151	18	13	9%
Sri Lanka	877	380	404	46%
Sudan	261	1	17	7%
Suriname	1592	38	134	8%
Sweden	52	2	1	2%
Switzerland	76	0	0	0%

Country	Number of Species	Number of Endemic Species	Number of Threatened Species	Percentage Threatened Species
Syrian Arab Republic	81	0	3	4%
Taiwan, Province of China	653	123	99	15%
Tajikistan	68	9	9	13%
Tanzania, United Republic of	1757	322	382	22%
Thailand	2539	235	292	12%
Timor-Leste	317	5	21	7%
Togo	443	2	19	4%
Tokelau	11	0	1	9%
Tonga	168	12	14	8%
Trinidad and Tobago	576	20	37	6%
Tunisia	57	0	3	5%
Turkey	185	9	13	7%
Turkmenistan	60	3	1	2%
Turks and Caicos Islands	96	0	4	4%
Tuvalu	28	0	1	4%
Uganda	854	6	45	5%
Ukraine	101	6	5	5%
United Arab Emirates	13	0	1	8%
United Kingdom	86	34	35	41%
United States	1424	748	342	24%
United States Minor Outlying Islands	10	0	2	20%
Uruguay	195	1	8	4%
Uzbekistan	62	2	6	10%
Vanuatu	327	80	15	5%
Venezuela, Bolivarian Republic of	4812	880	614	13%
Viet Nam	2618	489	363	14%
Virgin Islands, British	225	1	15	7%
Virgin Islands, U.S.	282	4	24	9%
Wallis and Futuna	80	0	3	4%
Western Sahara	9	0	0	0%
Yemen	245	79	61	25%
Zambia	852	13	40	5%
Zimbabwe	778	10	33	4%

Eugenia fajardensis *(Fernando Figueroa Bonaparte)*

Stewartia pseudocamellia *(Rob Cubey, Royal Botanic Garden Edinburgh)*

State of the World's Trees

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