The Red List of Fraxinus

Megan Barstow, Sara Oldfield, Murphy Westwood,
Diana Jerome, Emily Beech & Malin Rivers

BGCI
Plants for the Planet

IUCN SSC
Species Survival Commission

GTSG
GLOBAL TREE SPECIALIST GROUP

The Morton Arboretum

Global Trees Campaign

GTA
GLOBAL TREE ASSESSMENT

BOTANIC GARDENS CONSERVATION INTERNATIONAL (BGCI) is the world's largest plant conservation network, comprising more than 500 botanic gardens in over 100 countries, and provides the secretariat to the IUCN/SSC Global Tree Specialist Group. BGCI was established in 1987 and is a registered charity with offices in the UK, US, China and Kenya.

THE IUCN/SSC GLOBAL TREE SPECIALIST GROUP (GTSG) forms part of the Species Survival Commission's network of over 7,000 volunteers working to stop the loss of plants, animals and their habitats. SSC is the largest of the six Commissions of IUCN – The International Union for Conservation of Nature. It serves as the main source of advice to the Union and its members on the technical aspects of species conservation. The aims of the IUCN/SSC Global Tree Specialist Group are to promote and implement global red listing for trees and to act in an advisory capacity to the Global Trees Campaign.

THE MORTON ARBORETUM is an internationally recognized outdoor tree museum and tree research center located in Lisle, Illinois. As the champion of trees, the Arboretum is committed to scientifically informed action, both locally and globally, and encouraging the planting and conservation of trees for a greener, healthier, more beautiful world. Learn more at mortonarb.org.

THE GLOBAL TREES CAMPAIGN (GTC) is undertaken through a partnership between BGCI and FFI. GTC's mission is to prevent all tree species extinctions in the wild, ensuring their benefits for people, wildlife and the wider environment. GTC does this through provision of information, delivery of conservation action and support of sustainable use, working with partner organisations around the world.

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Foreword

Fraxinus quadrangulata *(The Morton Arboretum)*

Over the past decade BGCI, in partnership with the IUCN Global Tree Specialist Group, has been leading the way in evaluating the threat status of the world's tree species. This monumental task - to assess all 60,065 tree species by 2020 - is known as the Global Tree Assessment (GTA), and it is urgently needed. As *The Red List of* Fraxinus illustrates so well, tree species are disappearing around the world at an alarming rate. As of the end of 2017, 10,237 tree species have been assessed globally for the IUCN Red List, 63% of which are threatened with extinction. The efforts of the Global Tree Specialist Group to complete the GTA are therefore timely and a critical first step toward prioritizing tree species for conservation action, to reverse the trend of species decline around the world.

The Red List of Fraxinus has great personal relevance for me, as it reveals the stark truth of the state of ash trees in eastern North America. As a native of the state of Michigan - the epicenter of the emerald ash borer (EAB) invasion - I have seen firsthand the rapid disappearance of ash trees from forests and urban green spaces. We have lost more than 100 million ash trees in 31 states since EAB arrived in the 1990s. At The Morton Arboretum near Chicago, Illinois, we have lost 160 accessioned *Fraxinus* trees from our living collection, and 2,000 ash trees from managed natural areas. More than half of the threatened *Fraxinus* species in this Red List report are native to eastern North America. These are common trees – found in native woodlands and planted widely as urban street trees – that many took for granted until now. This report shows that even widespread, presumably secure species are potential victims of invasive pests and diseases. It illustrates how important it is for even apparently secure species to be thoroughly evaluated for the Red List, so that baseline information on population size and trends can be documented and time stamped, to compare with future monitoring efforts. In the case of ash trees in the USA, all six of the eastern species entered the Red List for the first time in a threatened category, five of the six as Critically Endangered. If this is the case for well-known, thoroughly studied, keystone species in the USA, imagine how many species are slipping away undocumented and undescribed in places like the Amazon rainforest, subtropical Africa, and southeast Asia.

In a time of unprecedented globalization and climate change, it is of critical importance that we gather the baseline data on the state of the world's tree species. The information captured in Red List assessments provides guidance for much needed *ex situ* and *in situ* conservation efforts. As *The Red List of* Fraxinus exemplifies, the assessments can also form the foundation for an early warning system for emerging invasive pests and diseases.

Botanical gardens and arboreta have an important role to play in the Global Tree Assessment. As world leaders in botanical knowledge, well curated tree collections, and conservation expertise, we are positioned to have the highest impact on the success of the GTA. I urge my colleagues from gardens around the world to join the efforts in supporting the GTA, to help advance knowledge of trees so that governments, scientists, and conservation practitioners have the tools needed to prevent future disasters like that of the eastern North American *Fraxinus* species.

Gerard T. Donnelly, PhD
President and CEO
The Morton Arboretum

Acknowledgements

The Red List of Fraxinus was achieved through consultation with a wide range of experts and specialists who shared expertise on this well known, important group of species. Without their contributions this publication could not have been produced and the conservation status of many *Fraxinus* species would remain unknown. Everyone's work on these species is gratefully appreciated.

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All the gardens that shared their collection information and published data on BGCI's PlantSearch database are gratefully acknowledged.

The provision of photographs is also gratefully acknowledged with credits given alongside each image.

IUCN Red List Categories

- **EX** Extinct
- **EW** Extinct in the Wild
- **CR** Critically Endangered
- **EN** Endangered
- **VU** Vulnerable
- **NT** Near Threatened
- **LC** Least Concern
- **DD** Data Deficient
- **NE** Not Evaluated

List of acronyms

BGCI	Botanic Gardens Conservation International
CBD	Convention on Biological Diversity
EAB	Emerald ash borer
FFI	Fauna & Flora International
GSPC	Global Strategy for Plant Conservation
GTA	Global Tree Assessment
GTC	Global Trees Campaign
GTSG	Global Tree Specialist Group
IUCN	International Union for Conservation of Nature
SSC	Species Survival Commission

Fraxinus paxiana *(Arboretum Wespelaar)*

Executive summary

Fraxinus chinensis *(Ian Harvey-Brown)*

Fraxinus is an iconic genus of trees within the Oleaceae family, known for its horticultural significance and the key ecosystem functions it provides in temperate woodland. However, the genus is becoming increasingly associated with the bleak news of the devastating impact that pests and diseases are having on populations of many *Fraxinus* species.

The Red List of Fraxinus contains IUCN Red List Assessments for 53 species of *Fraxinus*, including 11 species threatened with extinction in the wild. The six threatened North American species are facing serious population decline as a result of infestation by the invasive emerald ash borer (EAB). Threats to the remaining five species include restricted geographic range, logging and habitat loss. A further seven species are assessed as Data Deficient as a conservation category could not be assigned due to insufficient information. The majority of species within *Fraxinus* (66%) were considered to not be of conservation concern, a consequence of many species having wide native geographical ranges.

Alongside EAB, which is threatening widespread species in North America, in Europe native species are threatened by the pathogen *Hymenoscyphus fraxineus* which causes ash dieback. The impact of this pathogen causes the currently common *Fraxinus excelsior* to be assessed as Near Threatened in *The Red List of* Fraxinus.

As a genus, *Fraxinus* has a wide geographic range with species occurring across North America, Europe, China and parts of Indochina, the Indian subcontinent and North Africa. Due to the impact of EAB in North America this region contains the greatest number of threatened *Fraxinus*. Other threatened species are found in Algeria, China, Cuba, Morocco and Mexico.

Fraxinus species have substantial economic and livelihood value, often being used as fodder for livestock or being traded nationally and internationally for timber. They are also frequently used as garden and roadside plants and are common in botanic gardens. An *ex situ* survey of the genus found 85% of species were present in collections and only one threatened species was not found in a single *ex situ* collection.

The Red List of Fraxinus highlights the scale of threat faced by the group and the importance of greater monitoring and protection against invasive pests and diseases. This publication aims to engage and promote a more concerted effort towards addressing these global issues for *Fraxinus* and also other important plant groups that may be affected by similar invasions. It also identifies the species in need of global conservation action with small ranges and population size.

Fraxinus angustifolia *(Arboretum Wespelaar)*

PART 1

Background

The ash genus, *Fraxinus*, is one of the largest in the Oleaceae family. This family contains 27 genera and 687 accepted species names (WCSP, 2017). Within *Fraxinus* itself there are 53 species. It also contains hybrids and many infraspecific names. Plants of this genus grow as deciduous trees and shrubs. They are mostly found in temperate woodland and forest in the Northern Hemisphere, ranging from North America, across Europe and the Middle East to China and Japan. A few species can be found in tropical sites in Central America, India and parts of Indochina and two species are found in North Africa (WCSP, 2017). *Fraxinus* species have a range of uses. They have ornamental value and are often planted as street trees and some species are prized for their strong timber. *Fraxinus* is also a source of livestock fodder in various countries. Within North America they have a particular ecological role, often being dominant in woodland in their northern range.

Although *Fraxinus* species are often widespread and can be weedy, some species are at risk in the wild due to small geographic ranges. Even those that currently have extensive ranges are susceptible to invasive pests and diseases such as the emerald ash borer (EAB), *Agrilus planipennis*, in North America and the fungal pathogen *Hymenoscyphus fraxineus* in Europe which causes ash dieback. These threats are causing rapid population decline predicted to continue into the future. There is a need for conservation assessment of *Fraxinus* to understand how many species are threatened by these factors and to raise awareness for the plight of these valuable trees.

The evaluation of the conservation status of trees facilitates the prioritisation of tree conservation action, enabling the direction

Red List	Year published
The Red List of Endemic Trees and Shrubs of Ethiopia and Eritrea	2005
The Red List of Trees of Guatemala	2006
The Red List of Magnoliaceae	2007
The Red List of Oaks	2007
The Red List of Maples	2009
The Red List of Trees of Central Asia	2009
The Red List of Mexican Cloud Forest Trees	2011
The Red List of Rhododendrons	2011
A Regional Red List of Montane Tree Species of the Tropical Andes	2014
The Red List of Betulaceae	2014
The Red List of Magnoliaceae – revised and extended	2016
The Red List of US Oaks	2017
The Red List of Theaceae	2017
The Red List of *Fraxinus*	2018

Table 1. Summary of Red Lists produced by Botanic Gardens Conservation International in partnership with Fauna & Flora International and the Global Tree Specialist Group

Fraxinus floribunda *(Arboretum Wespelaar)*

Fraxinus ornus *(Ian Harvey-Brown)*

of effort to species that are most in need. The process is identified as a global conservation priority and Botanic Gardens Conservation International (BGCI) in partnership with the IUCN/SCC Global Tree Specialist Group is undertaking an ambitious initiative to assess all the worlds trees by 2020, the Global Tree Assessment (see box). This initiative directly contributes to Target 2 of the Global Strategy for Plant Conservation.

Also, BGCI in partnership with Fauna & Flora International coordinates the Global Trees Campaign. A key component of the Global Trees Campaign is the assessment of the extinction risk of trees as the first step towards safeguarding species from extinction. The Global Trees Campaign has been producing red list publications for over a decade, generating 14 taxonomically or regionally focused publications (Table 1). *The Red List of* Fraxinus is the first in depth assessment of a genus within the Oleaceae family.

Global Tree Assessment (GTA)

There are about 60,000 tree species globally, but two thirds of species have not had their conservation status assessed. An ambitious initiative, the Global Tree Assessment, aims to provide conservation assessments of the world's tree species by 2020.

Despite the importance of trees, many are threatened by over-exploitation and habitat destruction, as well as by pests, diseases, drought and their interaction with global climate change. In order to estimate the impact of such threats to trees there is an urgent need to conduct a complete assessment of the conservation status of the world's tree species – the Global Tree Assessment.

The Global Tree Assessment, led by BGCI and the IUCN SSC Global Tree Specialist Group, is identifying those tree species that are at greatest risk of extinction. The goal of the Global Tree Assessment is to provide prioritised information to ensure that conservation efforts are directed at the right species so that no tree species becomes extinct.

www.globaltreeassessment.org

Method

Taxonomic scope and concepts

The taxonomic concept used for *The Red List of* Fraxinus followed the World Checklist of Selected Plant Families (WCSP, 2017). Another key reference is Wallander (2008) which lists 43 species, noting that since *Fraxinus* was described by Linnaeus in 1753 over 450 taxa have been described, most of which are regarded as synonyms today. More recent species-specific taxonomic publications on *Fraxinus* species have also been consulted.

For this Red List report, we focused on species level assessments, as the IUCN Red List of Threatened Species only accepts infraspecific conservation assessments if a species level assessment has also been carried out.

Plant authority names follow those from The International Plant Names Index (IPNI, 2017).

Fraxinus chinensis *(Arboretum Wespelaar)*

Conservation assessment method

Information was gathered on species' geographic distribution, population data, population trends, habitat, ecology, threats, use and trade, and conservation measures (in place and required). A wide range of resources was consulted to gather all the required information. This included published and unpublished sources such as national and regional floras, scientific papers, reports, herbarium records, and expert opinion. Where available, National Red List information was used, using BGCI's database ThreatSearch (www.bgci.org/threat_search.php). For a full list of references used for each species see the individual species red list assessment available online at the IUCN Red List Website (www.iucnredlist.org). Maps were produced for species using occurrence records downloaded from the Global Biodiversity Information Facility (GBIF.org, 2017) as well as other data sources where available. Using all the available information, a conservation category and criteria were assigned using the 2001 IUCN Red List Categories and Criteria Version 3.1 (IUCN, 2012).

Species are assigned one of eight categories (Figure 1): Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) and Data Deficient (DD) (Figure 1). CR, EN and VU are considered the three threatened categories. Taxa that do not qualify for a threatened category, but are close to qualifying for or are likely to qualify for a threatened category in the near future, can be assigned to the category NT. LC is used for species that are assessed but are not considered to have major threats including widespread species and rare but stable species. The use of the category DD may be assigned to poorly known taxa. Species not yet evaluated are classified as NE. In this report NT, LC and DD are grouped as "not threatened".

In order to assess whether a species belongs to a threatened category (CR, EN, VU) the species should be evaluated in relation to five criteria: A) Population reduction, B) Geographic range, C) Small population size and decline, D) Very small or restricted population, and

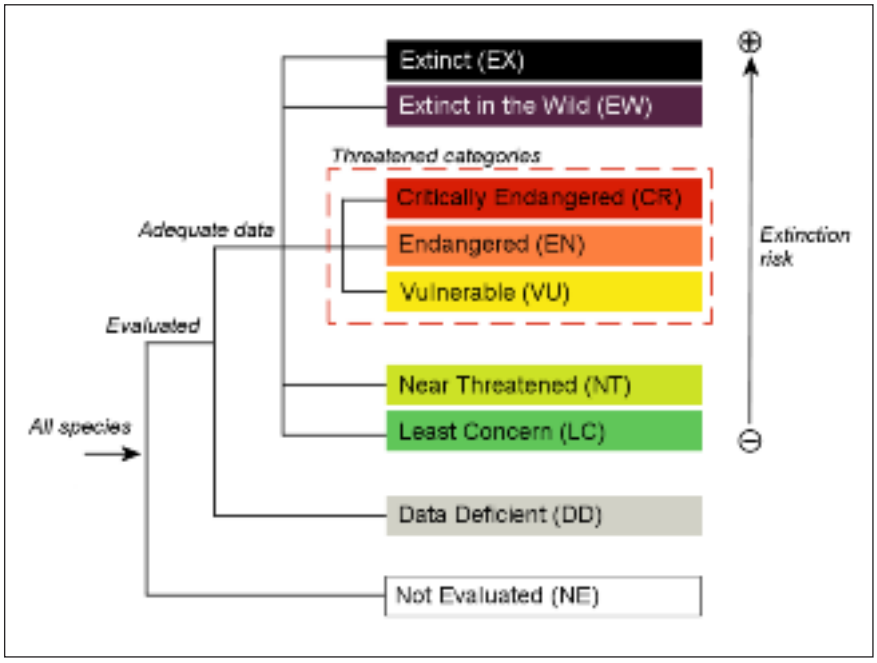

Figure 1. Structure of the IUCN Categories (version 3.1) (Credit: IUCN)

Fraxinus paxiana *(Arboretum Wespelaar)*

E) Quantitative analysis. The criteria are based on a set of thresholds and subcriteria. Extensive guidelines are available to facilitate the process for the conservation assessors (IUCN Standards and Petitions Subcommittee, 2017).

Assessors evaluate taxa using all five criteria, but a taxon needs only to fulfil one of the five criteria to qualify for a threatened category. When several criteria are met resulting in different status assessments, the precautionary principle is applied and the most threatened category should be assigned (IUCN, 2012). Once completed and reviewed the assessments are sent to the IUCN, Red List for publication on the IUCN, Red List of Threatened Species (IUCN, 2017). It is recommended that species on the list are revaluated every 5-10 years (IUCN, 2012).

All species in this report were assessed on a global scale.

Review and evaluation

Wherever possible, expert opinions were sought for all species assessed. Sometimes experts carried out the conservation assessment for their own species (assessors), and sometimes they contributed data for the conservation assessment to be carried out (contributors). In accordance with IUCN Red List regulations, all assessments were also reviewed, often by a member of the Global Tree Specialist Group (reviewer).

In this report, assessors are only specified for the threatened species, and when the assessors were not the authors of this report, BGCI staff or interns. For full details of the assessors, contributors and reviewers see the IUCN Red List of Threatened Species website (www.iucnredlist.org).

Red list report format

This report lists all species with their authors, country distribution and the conservation assessment ratings. The threatened species are also listed with a condensed rationale for the conservation assessment. All other information (including full rationale, synonyms, information on distribution, population, habitat and ecology, conservation measures, threats and uses) will be listed on the website for the IUCN Red List of Threatened Species (IUCN 2017, www.iucnredlist.org).

The threatened (Critically Endangered, Endangered and Vulnerable) species are listed alphabetically in Part 2A.

The Near Threatened species are listed alphabetically in Part 2B.

The Data Deficient species are listed alphabetically in Part 2C.

The Least Concern species are listed alphabetically in Part 2D.

Case studies

Case study 1: The emerald ash borer - a major threat to ash species

Invasive species are one of the five main threats to global biodiversity. In the US, the damage caused by the emerald ash borer (EAB), *Agrilus planipennis,* is a potent example. The larvae of this species feeds on the vascular tissue of trees, creating extensive galleries under the bark, which disrupt the flow of water and nutrients to the tree leading to rapid death. Widespread native ash species have suffered dramatic declines over the past two decades following the accidental introduction of the beetle. Six abundant ash species occurring in the Eastern US and Canada are now listed as Critically Endangered or Endangered as a consequence. These are White Ash (*Fraxinus americana*), Carolina Ash (*Fraxinus caroliniana*), Black Ash (*Fraxinus nigra*), Green Ash (*Fraxinus pennsylvanica*), Pumpkin Ash (*Fraxinus profunda*), and Blue Ash (*Fraxinus quadrangulata*).

The emerald ash borer is native to the Russian Far East, China, Japan and The Republic of Korea. Host species for this beetle, within its natural range, include *Fraxinus chinensis, Fraxinus lanuginosa* and *Fraxinus mandshurica*, as well as other species in Oleaceae and some tree species outside of this family. The emerald ash borer weakens individual trees of these host species but does not have a significant impact on native forests.

The emerald ash borer was accidentally introduced from Asia to Detroit, Michigan in the 1990s likely through infested shipping pallets. Since then the beetle has spread rapidly throughout the central and eastern US. It has been recorded in 30 US states and two Canadian Provinces. The introduced pest is having a severely detrimental impact on widespread North American ash species, which do not have natural resilience. Studies have shown that EAB infests both healthy and stressed trees of all ages. Within six years from infestation virtually all ash trees within a forest can be lost.

There is currently no evidence to suggest that the rate of spread of EAB, or its impact on ash mortality, will decrease significantly. As yet there is no treatment or remediation available for large wild populations. Research and management efforts to better understand the spread and impact of the pest are underway in multiple sectors, including government agencies, local municipalities, universities, horticulture, and botanical gardens including The Morton Arboretum. The emerald ash borer has not yet reached the species in western parts of North America, although there is no reason to believe it will not eventually spread here. There is the possibility that the southern-most populations of the ash species of the US and Mexico will not be impacted as EAB needs a period of cold to complete its lifecycle.

Scraping for EAB (The Morton Arboretum)

Case study 2: Fighting back against ash dieback

The increasing globalisation of trade in plants and plant material, together with the impacts of climate change, has led to an increase in the introduction and spread of new and damaging plant pests and pathogens.

BGCI's International Plant Sentinel Network (IPSN, http://www.plantsentinel.org) works to facilitate collaboration amongst institutes around the world, with a focus on linking botanic gardens and arboreta, National Plant Protection Organisations (NPPOs) and plant health scientists. These institutions are working to provide an early warning system of new and emerging pest and pathogen risks.

A recent major threat is ash dieback (*Hymenoscyphus fraxineus*). First observed in Poland and Lithuania in the 1990s it has subsequently spread to most European countries. European ash, *Fraxinus excelsior*, is a key and abundant native species in many countries throughout Europe. The species is an environmentally, economically and socio-culturally important species. The loss of ash in Europe would have a major impact including a negative cascading effect on the biodiversity and habitats it supports (Pautasso *et al*., 2013).

BGCI manages two unique databases that contribute to IPSN activities, PlantSearch (see box on page 17) and GardenSearch. GardenSearch is a global database of all known gardens listing key information such as significant collections, research and conservation programmes, location (country, region, GPS coordinates) and contact details, all of which can be used to identify gardens in areas of interest.

Fraxinus excelsior *with ash dieback* *(Arboretum Wespelaar)*

The living collections in botanic gardens represent a unique resource to facilitate research on invasive plant pests and pathogens, although in general, living plant collections are underutilised for this kind of research. An excellent example of collaboration between plant health scientists and botanic gardens is being led by The Forestry Commission in the UK. They are currently working with several UK botanic gardens to determine the level of tolerance of a range of ash species in their collections for tolerance to ash dieback. Research involves sourcing as many different species as possible of ash growing in arboreta and botanic gardens in the UK. Individuals of each species will be grown on using native ash root stock. The species will be monitored for disease development and species survival. The possibility of introducing ash dieback resistance into native ash by hybridising with species that demonstrate high levels of resistance can then be considered.

References

Pautasso, M., Aas, G., Queloz, V. and Holdenrieder, O., 2013. European ash (*Fraxinus excelsior*) dieback–a conservation biology challenge. Biological Conservation, 158: 37-4

Fraxinus mandshurica *(Arboretum Wespelaar)*

CASE STUDY 3: THE DECLINE OF *FRAXINUS MANDSHURICA*

Manchurian ash*, Fraxinus mandshurica,* is a popular ornamental plant and is grown in many botanic gardens. In its natural habitat this species occurs in the Russian Far East, Central China, the Korean Peninsula and in North and Central Japan. Logging and deforestation, to meet the increasing need for timber in China over the past 50 years, has led to the species becoming increasingly threatened in the country. *Fraxinus mandshurica* is considered to be Vulnerable on the China Plant Red List and is a nationally protected species. It occurs in some Chinese protected areas and is now grown in commercial plantations in Northeast China. Exploitation for international trade is currently the major threat to *F. mandshurica* in the Russian Far East. Illegal logging and uncontrolled trade have been reported in Primorsky and Khabarovsky Provinces. Small-sized enterprises in Suifenhe City in the southeast of Heilongjiang Province, China are engaged in the import of *F. mandshurica* from Russia for use in flooring and furniture manufacture. Concern about the rate of illegal logging and loss of old-growth forests led to the species being added to CITES Appendix III by the Russian Federation in 2013. This enables monitoring of levels of international trade and checks on the legality of consignments. Manchurian ash is currently considered to be globally Least Concern because it is not under threat in a significant portion of its range, in Japan, The Republic of Korea and The Democratic People's Republic of Korea. However, conservation measures are very important in China and Russia and monitoring of the species is required to ensure that it does not become threatened in the future. A significant decline in *F. mandshurica* and its habitat has already been attributed to climate change in parts of its range.

Fraxinus mandshurica *(Arboretum Wespelaar)*

Red list results

Fraxinus sogdiana *(Arboretum Wespelaar)*

Threat status of *Fraxinus*

Fifty three species of *Fraxinus* are assessed in *The Red List of* Fraxinus. Of these species, 11 (21%) are considered globally threatened (CR, EN, VU), 35 (66%) were assessed as not threatened (NT, LC) and the remaining seven species (13%) were listed as Data Deficient (Figure 2). Due to the number of Data Deficient species it is recommended that a range of 'threat' is given. Therefore the proportion of threatened species of *Fraxinus* is between 21 and 34%.

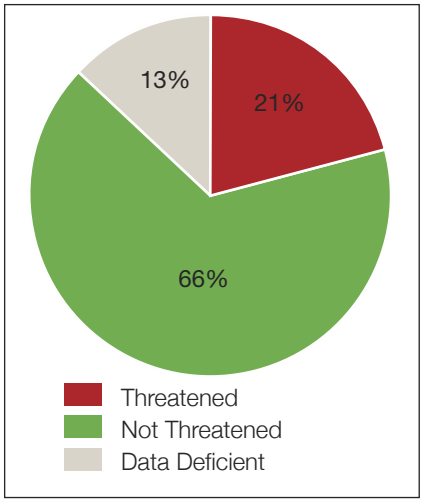

Figure 2. Summary of threat status of Fraxinus

IUCN Red List category	Number of species
Extinct	0
Extinct in the Wild	0
Critically Endangered	5
Endangered	5
Vulnerable	1
Near Threatened	3
Least Concern	32
Data Deficient	7
TOTAL	53

Table 2. The number of Fraxinus *species in each IUCN Red List category*

No species of *Fraxinus* are considered extinct, but five species were assessed as Critically Endangered – with an extremely high risk of going extinct. A further five species were assessed as Endangered (Table 2). A single species (*F. baroniana*) was assessed as Vulnerable and three species were assessed as Near Threatened. These species were *Fraxinus excelsior, F. latifolia* and *F. texensis*. All three are listed as such due to the impending threat from invasive pests, which could cause significant population decline in the future.

Criteria used in *The Red List of* Fraxinus

Although species can be assessed using up to five criteria, only one criterion needs to be met for a species to be assessed as threatened. Within this publication, a single species (*F. dimorpha*) was assessed using more than one criterion. This species was assessed under both criterion A (population reduction) and B (restricted geographic range) (Table 3).

Six species were assessed using criterion A, which is used when species are experiencing rapid population decline. The use of criterion A for these assessments, reflects the catastrophic population declines currently being observed as a consequence of the invasive EAB. Criterion B was used to assess the remaining threatened species. The other criteria (C, D and E) were not utilised for any of the *Fraxinus* assessments.

IUCN Red List category	Number of species
Criterion A	7
Criterion B	5
Criterion C	0
Criterion D	0
Criterion E	0

Table 3. The number of threatened Fraxinus *conservation assessments using the five different Red List criteria.*

Fraxinus excelsior *(Ian Harvey-Brown)*

Country analysis

Fraxinus species are distributed across 76 countries. China has the most species (19), followed by Mexico (16) and the United States (15) (Figure 3). The remaining 73 countries each have fewer than ten *Fraxinus* species. The majority of countries contain just one species of *Fraxinus*, often *F. excelsior*. This species is native to 39 countries. The only other species found in over 30 countries is *F. angustifolia*. In contrast 16 species of *Fraxinus* are single country endemics.

The majority of threatened ash species are found in North America. These species are commonly widespread but threatened. *Fraxinus potosina* is the only threatened North American species endemic to Mexico and is at risk of extinction due to its rarity within a restricted area. The Republic of Korea contains one threatened endemic, *F. chiisanensis*. Two further threatened species can be found in China (*F. hubeiensis* and *F. baroniana*). The only species restricted to North Africa (Algeria and Morocco), *F. dimorpha* is also threatened.

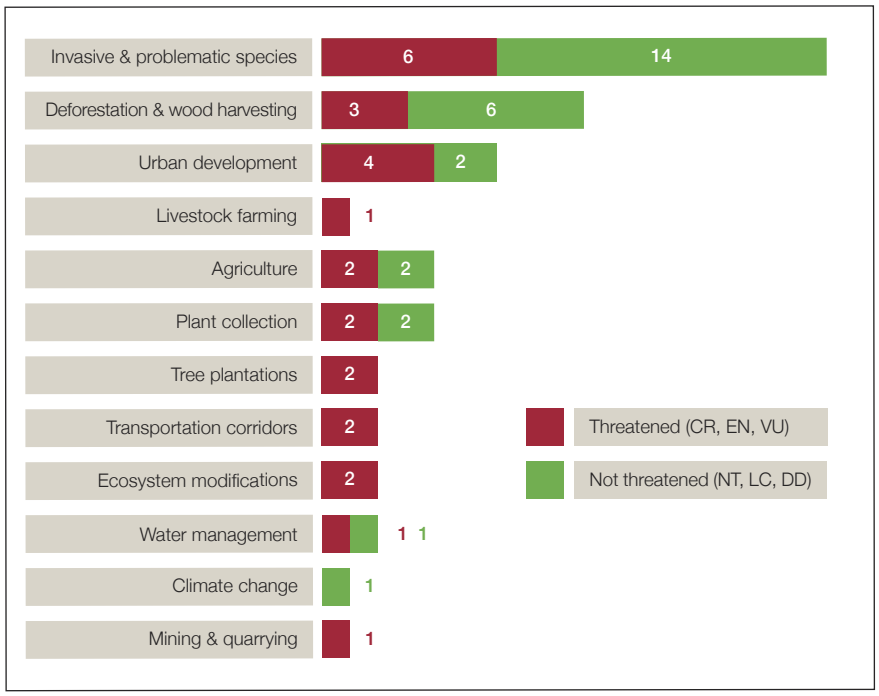

Figure 4. Threats to threatened and not threatened Fraxinus *species*

Major threats to *Fraxinus*

Considering both threatened and non-threatened *Fraxinus* species, the most commonly recorded threat to the genus is invasive and problematic species. The worst of these are EAB in North America (Case study 1) and the fungal pathogen *Hymenoscyphus fraxineus* in Europe which causes ash dieback (Case study 2).

The impact of invasive pests and diseases is followed by the exploitation of *Fraxinus* trees and shrubs for timber (Figure 4). Threats to species habitats such as the expansion of agriculture (crops and livestock), urban centres, and infrastructure development are also recorded as posing risk to a number of species.

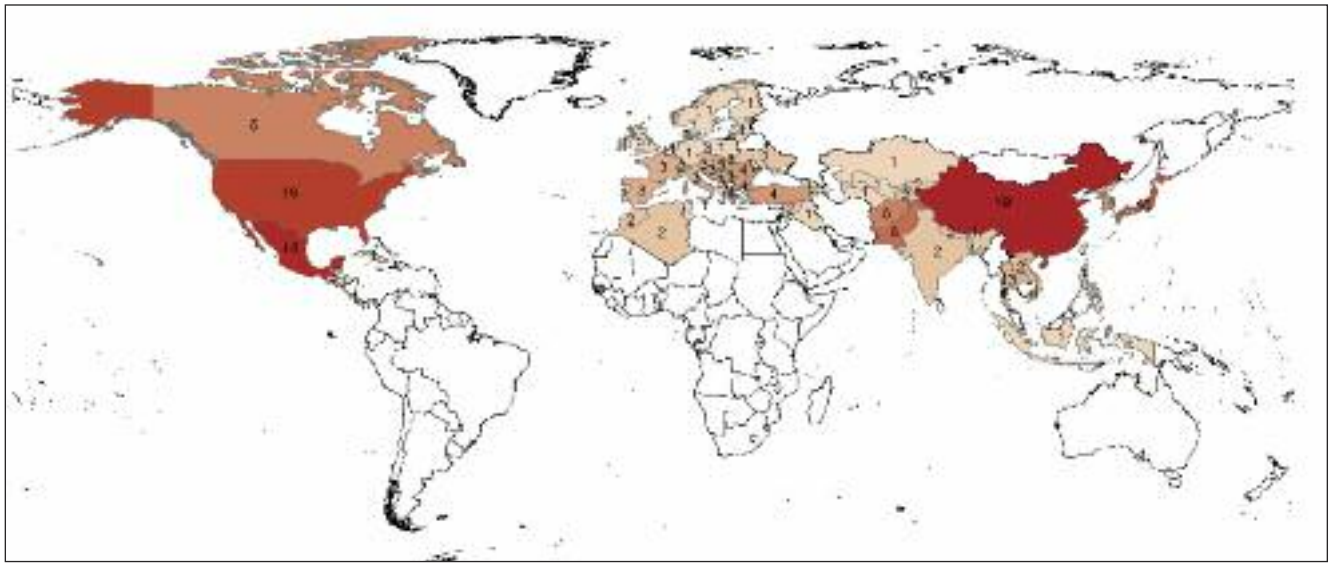

Figure 3. Fraxinus *species richness per country*

Fraxinus texensis *(Ian Harvey-Brown)*

Population trends

There is very limited population information available for most species of *Fraxinus*. As such, the population trend for the majority of species (39) is unknown (Figure 5). Only four species are considered to have increasing or stable populations while ten species are known to be experiencing population decline. It is recommended that more research is undertaken to understand the population trends of *Fraxinus* species.

Uses

Two thirds (35 species) of *Fraxinus* have an identified use. Across the assessments for utilised species ten different uses were recorded (Figure 6). Use in horticulture is the most common application of this popular ornamental group. This is closely followed by its use for timber for construction and also to produce 'household goods'. Some *Fraxinus* species are also used to generate medicines and are an important source of fodder for livestock in various countries.

One of the most widely traded ashes is *Fraxinus mandshurica*. This species is an important source of timber and used in the production of boats, musical instruments, furniture, sports equipment and speciality items. This species is extensively logged in Russia and China, where its harvest is not considered to be sustainable. Due to the pressure on the species in the Russian Federation, in 2014 it was added to CITES appendix III for this country (Case study 3).

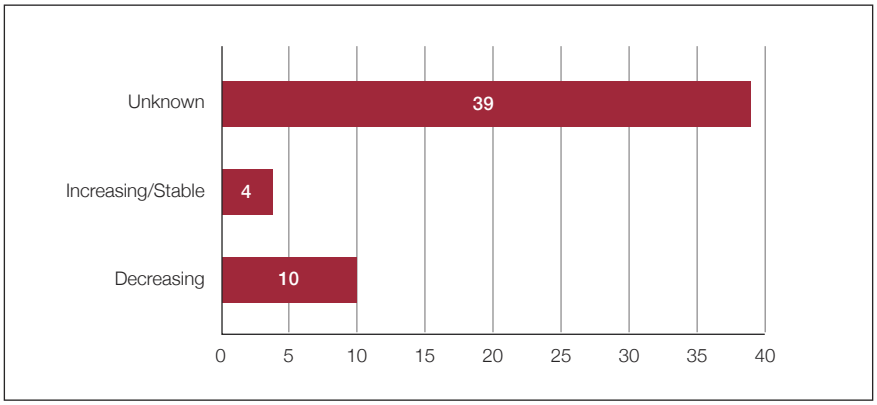

Figure 5. Population trends of Fraxinus *species.*

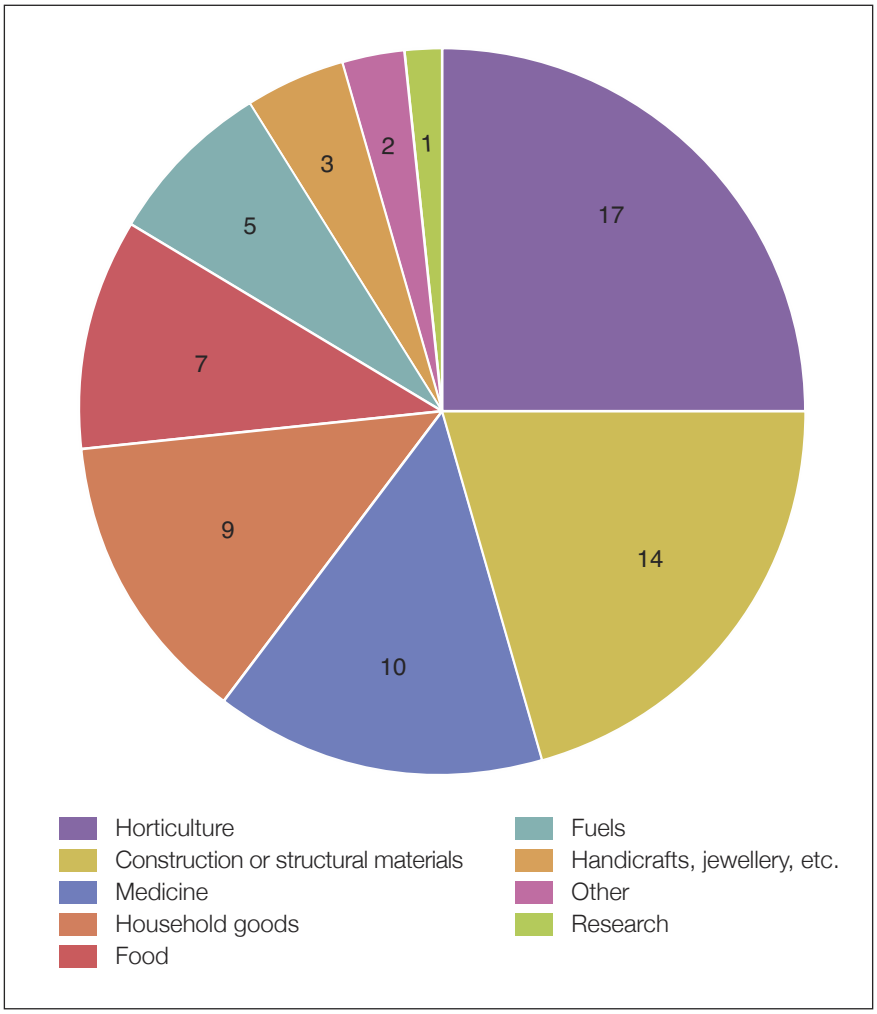

Figure 6. The recorded uses of Fraxinus *species*

Ex situ survey of *Fraxinus*

Fraxinus ornus *(Arboretum Wespelaar)*

An *ex situ* survey enables the assessment of species coverage within botanic gardens, arboreta and seed banks. *Ex situ* collections provide an important backup to prevent species extinctions. Using BGCI's PlantSearch database (see box opposite), we analysed the presence of *Fraxinus* species in collections of botanic gardens, arboreta and seed banks across the world. This identified 1,980 records from 394 institutions (Appendix 2). For this *ex situ* survey to inform conservation action, cultivar and hybrid records were excluded, infraspecific records were included and assigned to their appropriate species.

Species in *ex situ* collections

Eighty-five percent (45 species) of *Fraxinus* species are found in *ex situ* collections (Figure 7). Those not recorded in collections are listed in Table 4. Of the 11 threatened species, one species is not found in collections, *Fraxinus hubeiensis* (EN). This species should be brought into collections as a priority. Overall, Target 8 of the Global Strategy for Plant Conservation calls for 75% of threatened plants to be held in *ex situ* collections (CBD, 2012), therefore *Fraxinus* (with 90%) meets this target. Thirty two species are present in collections held in country of origin, equivalent to 60% of the genus.

Species	IUCN Red List Category
Fraxinus ferruginea	LC
Fraxinus hubeiensis	EN
Fraxinus petenensis	DD
Fraxinus pringlei	LC
Fraxinus punctata	DD
Fraxinus purpusii	LC
Fraxinus reflexiflora	DD
Fraxinus rufescens	LC

Table 4. Fraxinus *species not recorded in* ex situ *collections*

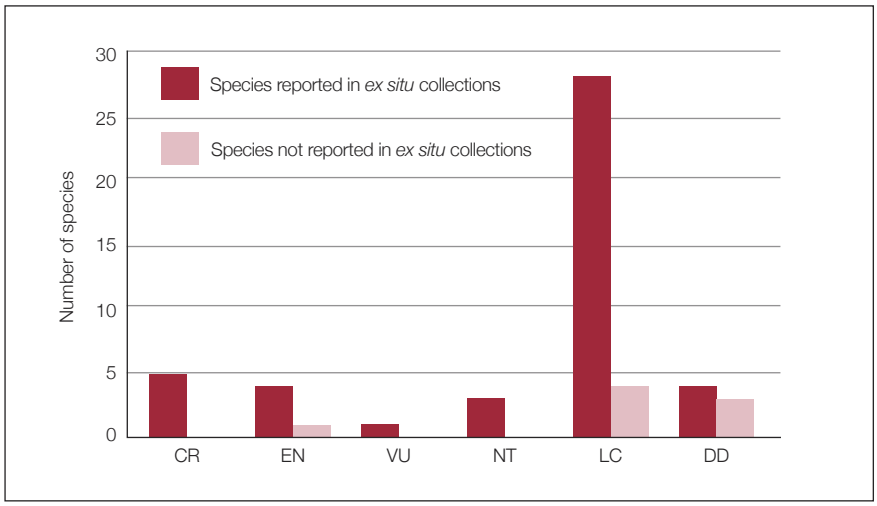

Figure 7. Presence and absence of Fraxinus *species in* ex situ *collections per IUCN Red List Category*

Fraxinus caroliniana *(Jan De Langhe/Arboretum Wespelaar)*

Fraxinus platypoda *(Arboretum Wespelaar)*

Number of *ex situ* collections

Seven species of *Fraxinus* are found in five or fewer *ex situ* collections, including one Endangered species, *F. potosina*. Small numbers of collections are unlikely to provide adequate insurance in case of stochastic events that may destroy wild populations or *ex situ* collections themselves. For restoration or reintroduction purposes, it is doubtful that small numbers of *ex situ* collections will hold sufficient genetic diversity.

Many of the threatened species of *Fraxinus* are those found in the largest number of collections. For example *F. americana* (CR) is reported from the most collections (197) (Table 5). It will be important to evaluate the genetic diversity of these collections, to ensure a sufficient and representative level of genetic diversity is being maintained *ex situ*. The susceptibility of these individuals to EAB should also be considered and plans put in place to treat susceptible trees with suitable pesticides.

Species	Number of *ex situ* collections	Red List Category
Fraxinus americana	197	CR
Fraxinus excelsior	184	NT
Fraxinus pennsylvanica	180	CR
Fraxinus ornus	167	LC
Fraxinus angustifolia	126	LC
Fraxinus chinensis	104	LC

Table 5. Fraxinus *species in the largest numbers of* ex situ *collections.*

PlantSearch

BGCI's PlantSearch database is the only global database of plants in cultivation. It is available online, and it is free to contribute to and access. PlantSearch connects around 2,000 researchers and horticulturists to collections every year. Locations and gardens are not publicly revealed and requests can be made via blind email messages. PlantSearch is an easy way for *ex situ* collection holders to contribute to broader *ex situ* assessments, such as this survey. By uploading a taxa list to PlantSearch, collection holders can connect their collections to the global botanical community and find out the conservation value of their taxa, including the number of locations each taxon is known from globally and its current global conservation status. It is important for institutions with *ex situ* collections to share accurate data and keep it updated, and PlantSearch relies on collection holders to upload up-to-date taxa lists on an annual basis to ensure accuracy and enhance usability of the data.

www.bgci.org/plant_search.php

Fraxinus potosina *(Michael Moore)*

Conclusions and recommendations

Policy relevance

The Red List of Fraxinus contributes to Target 2 of the Global Strategy for Plant Conservation (GSPC) of the Convention on Biological Diversity, which calls for 'an assessment of the conservation status of all known plant species, as far as possible, to guide conservation action' to be produced by 2020 (CBD, 2012). The production of these assessments also informs action for other targets of the GSPC including Target 8 which calls for 'at least 75% of threatened species in *ex situ* collections, preferably in the country of origin, and at least 20% available for recovery and restoration programmes' (CBD, 2012).

Fraxinus is an important woody genus, ecologically, economically and culturally. The decline in widespread and familiar species in North America and Europe has been a cause of significant public concern. Botanic gardens have a major role to play in supporting the conservation of this valuable genus.

Fraxinus latifolia *(Arboretum Wespelaar)*

Fraxinus chinensis *(Arboretum Wespelaar)*

Recommendations

Greater *in situ* and *ex situ* conservation of threatened *Fraxinus*

- Those species not found in *ex situ* collections should be brought into collections. Priorities include the Endangered *F. hubeiensis*, a Chinese species which is not recorded in PlantSearch despite its use in horticulture.
- The genetic diversity of current *ex situ* collections should be assessed to ensure they are representative of the diversity of the species or genus as a whole. Preserving genetic diversity is particularly relevant for ongoing research to improve resistance to pests and diseases across the genus.
- Those threatened species in *ex situ* collections that are at risk from EAB or ash dieback should be identified and protective measures put in place.
- *In situ* conservation is a priority for threatened species, notably for the Endangered *F. potosina* which occurs only on gypsum in the area of Guaxcamá, Mexico. It grows with many other narrow endemics and the flora is worthy of monitoring and protection.

Awareness of pests and diseases and their transmission

- There should be continued research into the control and mitigation of the impact of EAB and ash dieback
- There is a need to research and develop breeding programmes to assess the potential of introducing EAB and ash dieback resistance into wild populations.
- Quarantine processes should be extended to prevent/reduce movement of infected wood between locations, nationally and internationally.
- Increase the use of the International Plant Sentinel Network in the fight against plant pests and diseases.

Enhancement of knowledge about *Fraxinus* species

- More information should be gathered on the species assessed as Data Deficient, particularly by engaging local experts.
- In general, more information on the status of *Fraxinus* populations would be beneficial, including those that are currently Least Concern. This is very important, for example, for *F. mandshurica* which is widespread but heavily exploited in parts of its range.

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Fraxinus floribunda *(Arboretum Wespelaar)*

Fraxinus latifolia *(Ian Harvey-Brown)*

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PART 2

A. *FRAXINUS* SPECIES EVALUATED AS THREATENED

Fraxinus americana L.
CR A3e+4ae
United States, Canada, Mexico
White Ash (*Fraxinus americana*) is the most common and useful native ash of the US but is never a dominant species in the forest. *Fraxinus americana* is suffering the devastating impact of introduced invasive pest, the emerald ash borer (EAB), that has rapidly spread across much of the native range of White Ash and shows no sign of stopping. Emerald ash borer infestation girdles trees as small as 2.5 cm dbh and leads to death within five years; this can cause up to 100% mortality in White Ash populations. White Ash is unable to persist for very long through vegetative reproduction and seeds only remain viable in the seed bank for 2-3 (rarely 7-8) years, so regeneration after EAB infestation is minimal or nonexistent. Furthermore, EAB persists in forests in low population densities after major ash population crashes, so the orphaned cohort of White Ash seedlings that remains is quickly infested as they reach a suitable size for EAB infestation. Although niche, dispersal and climate change modelling studies for EAB in North America have been conducted, results have been conflicting and subject to model uncertainties. Overall all, authors agree that the overwhelming majority of ash populations will very quickly be overcome by EAB infestation. As such, a population decline of at least 80% over the next 100 years (and likely much faster than that) is assumed. Therefore, *F. americana* is assessed as Critically Endangered under criteria A3e+4ae.
Assessors: Jerome, D., Westwood, M., Oldfield, S. & Romero-Severson, J.

Fraxinus americana *(Kris Bachtell/The Morton Arboretum)*

Fraxinus baroniana *(Arboretum Wespelaar)*

Fraxinus baroniana Diels
VU B1ab(iii)
China

Fraxinus baroniana is a small tree that is endemic to China occurring in Gansu, Shaanxi and Sichuan. *Fraxinus baroniana* has a very small and narrow distribution only occurring along the Jialing River. The extent of occurrence is 12,994 km². This species is threatened by flooding, river bank construction and road construction which leads to loss and fragmentation of the habitat. There are fewer than 10 locations. Further research and surveys are needed. Given its small distribution and threats *F. baroniana* meets the criteria for Vulnerable.

Fraxinus caroliniana Mill.
EN A3e+4ae
Cuba, United States

Fraxinus caroliniana (Carolina Ash) is suffering the devastating impact of introduced invasive pest, the emerald ash borer (EAB), that has rapidly spread across much of the native range of Carolina Ash. The infestation can infect trees as small as 2.5 cm dbh and lead to death within five years. Based on the behaviour of other ash species it is assumed this species does not persist well via vegetative reproduction and has a short lived seed bank. It is therefore likely that for Carolina Ash regeneration after EAB infestation is minimal or nonexistent. Furthermore, EAB persists in forests in low population densities after major ash population crashes, so the orphaned cohort of ash seedlings that remains is quickly infested as they reach a suitable size for EAB infestation. Although niche, dispersal and climate change modeling studies for EAB in North America have been conducted, results have been conflicting and subject to model uncertainties. The general consensus is that EAB will spread across much, if not all, of the eastern, central, and southern US. It is possible that up to half of Carolina Ash's native range may fall outside the suitable habitat for EAB, being too tropical for the insect to survive and undergo an overwintering phase of its life cycle. As such, a population decline of at least 50% over the next 100 years (and likely much faster than that) due to EAB infestation is a conservative estimate of threat. Therefore, *F. caroliniana* is assessed as Endangered under criteria A3e+4ae.

Assessors: Jerome, D., Westwood, M., Oldfield, S. & Romero-Severson, J.

Fraxinus chiisanensis* Nakai
EN B2ab(ii,iii)
China

Fraxinus chiisanensis has an estimated area of occupancy (AOO) of about 84 km². It occurs in nine locations. The distances between each subpopulation range from 5-100 km, making the population severely fragmented (i.e., distances between subpopulations are likely to be too great to allow for effective gene flow). There is clear and documented evidence of a continuing decline in quality and quantity of habitat due to a number of factors which include the effects of deforestation. For these reasons *F. chiisanensis* has been assessed as Endangered.

Assessors: Kim, Y.-S., Kim, H. & Son, S.-W.

**This species was assessed in 2015 and as such was not reassessed for this publication.*

Fraxinus caroliniana *(Ian Harvey-Brown)*

Fraxinus dimorpha Coss. Durieu
EN A2cd+3cd+4cd, B2ab(i,ii,iii,v)
Algeria, Morocco
Fraxinus dimorpha is a western Mediterranean species, endemic to North Africa with a restricted distribution in Morocco and Algeria. *Fraxinus dimorpha* is very local, uncommon and fairly rare in most of its stations and the abundance of the species varies from rare to occasional and the populations are severely fragmented. The population trend of *Fraxinus dimorpha* is decreasing, the number of mature individuals and the population density are significantly reduced during last decades and the species occurs often in small subpopulations. The population reduction is inferred to be very high at 70 % over the last three generation and is projected to continue declining by 50% in the future due to many threats. The estimated area of occupancy (AOO) is less than 500 km^2 and the species is under numerous medium to high impact threats, especially: ruthless collection for domestic uses and for trade, collection practices, overgrazing, deforestation, human activities, management activities and climate change with an estimated continuing decline in the population size and the habitats quality on all the locations. Therefore, *Fraxinus dimorpha* is assessed globally as Endangered.
Assessors: Rankou, H., M'Sou, S., Alifriqui, M. & Martin, G

Fraxinus hubeiensis S.Z.Qu, C.B.Shang & P.L.Su
EN B1ab(v)
China
Fraxinus hubeiensis, a large ash tree, is endemic to Hubei where it has a small distribution. The extent of occurrence is estimated to be less than 100 km^2 and it is known from fewer than five locations. The species has been overexploited for Penjing design, a form of ornamental plant use. Further research is required to ascertain the extent of ongoing threats and decline. Given the small extent of occurrence, limited number of locations, one of which is a nature reserve, and continuing decline in mature individuals due to the gathering of plants *F. hubeiensis* is assessed as Endangered.

Fraxinus nigra Marshall
CR A3e+4ae
United States, Canada
Fraxinus nigra (Black Ash) is suffering the devastating impact of introduced invasive pest, the emerald ash borer (EAB) that has rapidly spread across much of the native range of Black Ash. The infestation can begin in trees as small as 2.5 cm dbh and cause death within five years. EAB therefore causes virtually 100% mortality of Black Ash populations. Black Ash is unable to persist for very long through vegetative reproduction and seeds only remain viable in the seed bank for at most 7-8 years, so regeneration after EAB infestation is minimal or nonexistent. Furthermore, EAB persists in forests in low population densities after major ash population crashes, so the orphaned cohort of Black Ash seedlings that remains is quickly infested as they reach a suitable size for EAB infestation. As such, a population decline of at least 80% over the next 100 years (and likely much faster than that) is assumed. Therefore, *F. nigra* is assessed as Critically Endangered under criteria A3e+4ae.
Assessors: Jerome, D., Westwood, M., Oldfield, S. & Romero-Severson, J.

Fraxinus pennsylvanica Marshall
CR A3e+4ae
United States, Canada, Mexico
Fraxinus pennsylvanica (Green Ash) is suffering the devastating impact of introduced invasive pest, the emerald ash borer (EAB) that has rapidly spread across much of the native range of Green Ash. EAB infests and feeds on all North American ash species it has so far encountered, but has a strong preference for Green Ash. Trees as small as 2.5 cm dbh are infected and become girdled leading to death within five years of infestation. EAB therefore causes virtually 100% mortality of Green Ash populations. Green Ash is unable to persist for very long through vegetative reproduction and seeds only remain viable in the seed bank for 2-3 (rarely 7-8) years, so regeneration after EAB infestation is minimal or nonexistent. Furthermore, EAB persists in forests in low population densities after major ash population crashes, so the orphaned cohort of Green Ash seedlings that remains is quickly infested as they reach a suitable size for EAB infestation. Although niche, dispersal and climate change modelling studies for EAB in North America have been conducted, results have been conflicting and subject to model uncertainties. While some studies have indicated that a very small portion of Green Ash's native range may fall outside the suitable habitat for EAB a population decline of at least 80% over the next 100 years (and likely much faster than that) is assumed. Therefore, F. pennsylvanica is assessed as Critically Endangered under criteria A3e+4ae.
Assessors: Jerome, D., Westwood, M., Oldfield, S. & Romero-Severson, J.

Fraxinus potosina Brandegee
EN B1ab(i,iii)
Mexico
Fraxinus potosina is a small shrub or tree endemic to Mexico. It is restricted to a small area with gypsum soils in the centre of the state of San Luis Potosi, Mexico. It has an estimated extent of occurrence of 1,541 km^2, has a severely fragmented distribution in its desert scrub environment and it is threatened by the potential expansion of mining. The species is assessed as Endangered.
Assesors: Martínez Salas, E., Oldfield, S. & Samain, M.-S.

Fraxinus potosina *(Michael Moore)*

Fraxinus profunda (Bush) Bush
CR A3e+4ae
United States, Canada, Mexico
Fraxinus profunda (Pumpkin Ash) has experienced range contractions as it has been extirpated from Florida and the Carolinas probably due to habitat destruction. It is suffering the devastating impact of introduced invasive pest, the emerald ash borer (EAB) that has rapidly spread across much of the native range of Pumpkin Ash. Infestation effectively girdles trees as small as 2.5 cm diameter at breast height (dbh) (many years before reproductive maturity), leading to death within five years of infestation. EAB therefore causes virtually 100% mortality of Pumpkin Ash populations. Pumpkin Ash is unable to persist for very long through vegetative reproduction and seeds only remain viable in the seed bank for 2-3 (rarely 7-8) years, so regeneration after EAB infestation is minimal or nonexistent. Furthermore, EAB persists in forests in low population densities after major ash population crashes, so the orphaned cohort of Pumpkin Ash seedlings that remains is quickly infested as they reach a suitable size for EAB infestation. Although niche, dispersal and climate change modelling studies for EAB in North America have been conducted, results have been conflicting and subject to model uncertainties. As such, a population decline of at least 80% over the next 100 years (and likely much faster than that) is assumed. Therefore, *F. profunda* is assessed as Critically Endangered under criteria A3e+4ae.
Assessors: Jerome, D., Westwood, M., Oldfield, S. & Romero-Severson, J.

Fraxinus quadrangulata *(Arboretum Wespelaar)*

Fraxinus quadrangulata Michx.
CR A3e+4ae
United States
Fraxinus quadrangulata (Blue Ash) is suffering the devastating impact of introduced invasive pest, the emerald ash borer (EAB), that has rapidly spread across much of the native range of Blue Ash. Infestation can occur in trees as small as 2.5 cm diameter at breast height (dbh) and lead to their death within five years. EAB therefore causes virtually 100% mortality of Blue Ash populations. Blue Ash is unable to persist for very long through vegetative reproduction and seeds only remain viable in the seed bank for 2-3 (rarely 7-8) years, so regeneration after EAB infestation is minimal or nonexistent. Furthermore, EAB persists in forests in low population densities after major ash population crashes, so the orphaned cohort of Blue Ash seedlings that remains is quickly infested as they reach a suitable size for EAB infestation. As such, a population decline of at least 80% over the next 100 years (and likely much faster than that) is assumed. Therefore, *F. quadrangulata* is assessed as Critically Endangered under criteria A3e+4ae.
Assessors: Jerome, D., Westwood, M., Oldfield, S. & Romero-Severson, J.

B. FRAXINUS SPECIES EVALUATED AS NEAR THREATENED

Fraxinus excelsior L.
Albania, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Islamic Republic of Iran, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia FYR, Moldova, Montenegro, Netherlands, Norway, Poland, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Fraxinus latifolia Benth.
Canada, United States

Fraxinus texensis (A.Gray) Sarg.
Mexico, United States

Fraxinus excelsior *(Ian Harvey-Brown)*

C. FRAXINUS SPECIES EVALUATED AS DATA DEFICIENT

Fraxinus micrantha Lingelsh.
Nepal, Pakistan, India

Fraxinus pallisiae Wilmott
Bulgaria, Greece, Macedonia FYR, Moldova, Romania, Russian Federation, Turkey, Ukraine

Fraxinus petensis Lundell
Mexico, Guatemala

Fraxinus punctata S.Y.Hu
China

Fraxinus reflexiflora Lundell
Mexico

Fraxinus trifolioata W.W.Sm.
China

D. FRAXINUS SPECIES EVALUATED AS LEAST CONCERN

Fraxinus angustifolia Vahl
Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Italy, Macedonia, the former Yugoslav Republic of, Malta, Montenegro, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Turkey, Ukraine, Russian Federation, Georgia, Armenia, Azerbaijan, Iraq, Algeria, Morocco, Tunisia, Turkmenistan, Iran, Islamic Republic of, Afghanistan, Pakistan, Palestine, State of, Lebanon, Israel, Syrian Arab Republic

Fraxinus anomala Torr. ex S.Watson
United States

Fraxinus apertisquamifera H.Hara
Japan

Fraxinus berlandieriana A.DC.
Mexico, United States

Fraxinus bungeana A.DC.
China

Fraxinus chinensis Roxb.
Russian Federation, Japan, China, Korea, Republic of, Lao People's Democratic Republic, Thailand, Viet Nam, Korea, Democratic People's Republic of

Fraxinus cuspidata Torr.
Mexico, United States

Fraxinus dipetala Hook. & Arn.
Mexico, United States

Fraxinus ferruginea Lingelsh.
China, Myanmar

Fraxinus floribunda Wall.
Afghanistan, China, Japan, India, Bhutan, Nepal, Pakistan, Lao People's Democratic Republic, Myanmar, Thailand, Viet Nam

Fraxinus gooddingii Little
Mexico, United States

Fraxinus greggii A.Gray
Mexico, United States

Fraxinus griffithii C.B.Clarke
China, Bangladesh, India, Indonesia, Japan, Myanmar, Philippines, Viet Nam

Fraxinus hookeri Wenz.
China, India, Pakistan

Fraxinus insularis Hemsl.
China, Japan

Fraxinus lanuginosa Koidz.
Japan, Russian Federation

Fraxinus longicuspis Siebold & Zucc.
Japan

Fraxinus malacophylla Hemsl.
China, Thailand

Fraxinus mandshurica Rupr.
Russian Federation, China, Japan, Korea, Republic of, Korea, Democratic People's Republic of

Fraxinus odontocalyx Hand.-Mazz. ex E.Peter
China

Fraxinus ornus L.
Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Italy, Lebanon, Macedonia, the former Yugoslav Republic of, Montenegro, Romania, Serbia, Slovakia, Slovenia, Spain, Switzerland, Syrian Arab Republic, Turkey

Fraxinus paxiana Lingelsh.
China

Fraxinus platypoda Oliv.
China, Japan

Fraxinus pringlei Lingelsh.
Mexico

Fraxinus purpusii Brandegee
Guatemala, Mexico

Fraxinus raibocarpa Regel
Afghanistan, Tajikistan

Fraxinus rufescens Lingelsh.
Mexico

Fraxinus sieboldiana Blume
China, Japan

Fraxinus sogdiana Bunge
China, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan

Fraxinus stylosa Lingelsh.
China

Fraxinus uhdei (Wenz.) Lingelsh.
Costa Rica, Guatemala, Honduras, Mexico

Fraxinus velutina Torr.
Mexico, United States

Fraxinus xanthoxyloides (G.Don) Wall. ex A.DC.
Pakistan, Afghanistan, China, India

Fraxinus xanthoxyloides *(Arboretum Wespelaar)*

APPENDIX 1
Full list of evaluated *Fraxinus* species

Species	Red List Category	Red List Criteria	*Ex situ* Collections
Fraxinus americana L.	CR	A3e+4ae	197
Fraxinus angustifolia Vahl	LC		126
Fraxinus anomala Torr. ex S.Watson	LC		11
Fraxinus apertisquamifera H.Hara	LC		7
Fraxinus baroniana Diels	VU	B1ab(iii)	17
Fraxinus berlandieriana A.DC.	LC		6
Fraxinus bungeana A.DC.	LC		36
Fraxinus caroliniana Mill.	EN	A3e+4ae	21
Fraxinus chiisanensis Nakai	EN	B2ab(ii,iii)	6
Fraxinus chinensis Roxb.	LC		104
Fraxinus cuspidata Torr.	LC		6
Fraxinus dimorpha Coss. Durieu	EN	A2cd+3cd+4cd; B2ab(i,ii,iii,v)	13
Fraxinus dipetala Hook. & Arn.	LC		22
Fraxinus excelsior L.	NT		184
Fraxinus ferruginea Lingelsh.	LC		0
Fraxinus floribunda Wall.	LC		10
Fraxinus gooddingii Little	LC		5
Fraxinus greggii A.Gray	LC		19
Fraxinus griffithii C.B.Clarke	LC		28
Fraxinus hookeri Wenz.	DD		1
Fraxinus hubeiensis S.Z.Qu,C.B.Shang & P.L.Su	EN	B1ab(v)	0
Fraxinus insularis Hemsl.	LC		33
Fraxinus lanuginosa Koidz.	LC		31
Fraxinus latifolia Benth	NT		65
Fraxinus longicuspis Siebold & Zucc.	LC		35
Fraxinus malacophylla Hemsl.	LC		5
Fraxinus mandshurica Rupr.	LC		97
Fraxinus micrantha Lingelsh.	DD		2
Fraxinus nigra Marshall	CR	A3e+4ae	59
Fraxinus odontocalyx Hand.-Mazz. ex E.Peter	LC		1
Fraxinus ornus L.	LC		167
Fraxinus pallisiae Wilmott	DD		25
Fraxinus paxiana Lingelsh.	LC		47
Fraxinus pennsylvanica Marshall	CR	A3e+4ae	180
Fraxinus petenensis Lundell	DD		0
Fraxinus platypoda Oliv.	LC		30
Fraxinus potosina Brandegee	EN	B1ab(i,iii)	2
Fraxinus pringlei Lingelsh	LC		0
Fraxinus profunda (Bush) Bush	CR	A3e+4ae	40
Fraxinus punctata S.Y.Hu	DD		0
Fraxinus purpusii Brandegee	LC		0
Fraxinus quadrangulata Michx.	CR	A3e+4ae	90
Fraxinus raibocarpa Regel	LC		7
Fraxinus reflexiflora Lundell	DD		0
Fraxinus rufescens Lingelsh	LC		0
Fraxinus sieboldiana Blume	LC		71
Fraxinus sogdiana Bunge	LC		34
Fraxinus stylosa Lingelsh	LC		12
Fraxinus texensis (A.Gray) Sarg.	NT		17
Fraxinus trifoliolata W.W.Sm.	DD		3
Fraxinus uhdei (Wenz.) Lingelsh.	LC		23
Fraxinus velutina Torr.	LC		56
Fraxinus xanthoxyloides (G.Don) Wall. ex A.DC.	LC		23

Fraxinus angustifolia *(Ian Harvey-Brown)*

Fraxinus griffithii *(Arboretum Wespelaar)*

APPENDIX 2
Participating institutions

Adkins Arboretum, Alpengarten Villacher Alpe, Annapolis Royal Historic Gardens, Arboreto di Arco - Parco Arciducale, Arboretum at Kutztown University, Arboretum at Penn State, The, Arboretum at the University of California, Santa Cruz, Arboretum des Grands-Murcins, Arboretum Freiburg-Günterstal, Arboretum Groenendaal - Flemish Forest Department - Houtvesterij Groenendaal, Arboretum i Jardí Botànic Pius Font i Quer, Arboretum Kirchberg, Arboretum Lenego Banku Genów Kostrzyca, Arboretum Mustila, Arboretum National des Barres (et Fruticetum Vilmorinianum), Arboretum of The Barnes Foundation, Arboretum Oudenbosch, Arboretum Stední lesnické školy, Arboretum Waasland, Arboretum Wespelaar, Arizona-Sonora Desert Museum, Arnold Arboretum of Harvard University, The, Atlanta Botanical Garden, Auckland Botanic Gardens, Aullwood Garden MetroPark, Baker Arboretum, Bakuriani Alpine Botanical Garden, Baoji Botanical Garden (Shaanxi), Bartlett Tree Research Laboratories Arboretum, Bayard Cutting Arboretum, Bedgebury National Pinetum & Forest, Belmonte Arboretum, Bendigo Botanic Gardens, White Hills, Benmore Botanic Garden, Berkshire Botanical Garden, Betty Ford Alpine Gardens, Bibliotheque Centrale, Biodôme de Montréal - Botanical Garden, Birmingham Botanical Gardens and Glasshouses, Bishop Museum - Checklist of Cultivated Plants of Hawai'i, Blue Mountains Botanic Garden, Mount Tomah, Bogor Botanic Gardens (Centre for Plant Conservation), Bokrijk Arboretum, Boone County Arboretum, Botanic Garden Government College University, Lahore (BGGC), Botanic Garden Meise, Botanic Garden of Petrozavodsk State University, Botanic Garden of Poltava National Pedagogical University, Botanic Garden of Rostock University, Botanic Garden of Smith College, The, Botanic Garden of Tver State University, Botanic Garden, Delft University of Technology, Botanic Gardens of South Australia, Botanic Gardens of the Heard Natural Science Museum, Botanical Garden - Institute of the Volga State Technological University, Botanical Garden of Chelyabinsk State University, Botanical Garden of Moscow Palace of Pioneers, Botanical Garden of Pyatigorsk State Pharmaceutical Academy, Botanical Garden of Tartu University, Botanical Garden of Tavrichesky University, Botanical Garden of the University of Zagreb, Botanical Garden of the V.L. Komarov Botanical Institute, Botanical Garden of Vilnius University, Botanical Garden, Natural History Museum of Denmark, Botanical Garden-Institute, Ufa Research Center, Botanische Gärten der Universität Bonn, Botanische Tuin De Kruidhof, Botanische Tuin Groningen Domies Toen, Botanischer Garten der Carl von Ossietzky-Universitat Oldenburg, Botanischer Garten der Friedrich-Schiller-Universitaet, Botanischer Garten der J.W. Goethe-Universitat, Botanischer Garten der Justus-Liebig Universität Giessen, Botanischer Garten der Ruhr-Universität Bochum, Botanischer Garten der Technischen Universitaet Darmstadt, Botanischer Garten der Technischen Universitaet Dresden, Botanischer Garten der Universitaet des Saarlandes, Botanischer Garten der Universität Freiburg, Botanischer Garten der Universitat Kiel, Botanischer Garten der Universitat Osnabruck, Botanischer Garten der Universitat Osnabruck-Seed Bank, Botanischer Garten der Universität Ulm, Botanischer Garten der Westfaelischen Wilhelms Universitaet, Botanischer Garten und Botanisches Museum Berlin-Dahlem- Seed Bank, Bowman's Hill Wildflower Preserve, Boyce Thompson Arboretum, Brenton Arboretum, The, Brisbane Botanic Gardens, Brooklyn Botanic Garden, Brookside Gardens, C. M. Goethe Arboretum, Cambridge University Botanic Garden, Catalogue of Medicinal Plants of Ukrainian Botanic Gardens and Parks, Catalogue of Rare Plants of Ukrainian Botanic Gardens and Parks, Central Siberian Botanical Garden, Centro di Ateneo Orto Botanico dell'Università degli Studi di Padova, Changchun Forest Botanic Garden, Jilin, Charles R. Keith Arboretum, The, Chester M. Alter Arboretum, Chicago Botanic Garden, Chihuahuan Desert Gardens, Cleveland Botanical Garden, Coastal Maine Botanical Gardens, Connecticut College Arboretum, Conservatoire Botanique National du Brest, Conservatoire Botanique Pierre Fabre, Conservatoire et Jardin botaniques de la Ville de Genève, Conservatoire et Jardins Botaniques de Nancy, Core Facility Botanical Garden, Cornell Botanic Gardens, Dawes Arboretum, The, Dawyck Botanic Garden, Dendrological garden of the Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Denver Botanic Gardens, Denver Botanic Gardens - Seed Bank, Denver Zoological Gardens, Desert Botanical Garden, Desert Botanical Garden - Seed Bank, Dixon National Tallgrass Prairie Seed Bank at Chicago Botanic Garden, Dominion Arboretum and Central Experimental Farm, Donald E. Davis Arboretum, Dow Gardens, Duke Farms, DuPage Forest: Forest Preserve District of DuPage County, Dutch Open Air Museum / Nederlands Openluchtmuseum, Eden Project, The, EEB Biodiversity Education and Research Greenhouses, Eloise Butler Wildflower Garden & Bird Sanctuary, Eötvös Loránd University Botanic Garden, Fairchild Tropical Botanic Garden, Fellows Riverside Gardens, Fernwood Botanical Garden and Nature Preserve, FES Iztacala Banco de Semillas, Finnish Museum of Natural History / Helsinki University Botanic Garden, Florida Botanical Gardens, Forstbotanischer Garten der Technischen Universitaet Dresden, Forstbotanischer Garten Eberswalde, Forstbotanischer Garten und Arboretum, Fort Worth Botanic Garden, Frederik Meijer Gardens & Sculpture Park, Fullerton Arboretum, Fundacion Jardín Botánico Nacional Viña del Mar, Gainesway Farm, Gardens at SIUE, The, Gardens of Fanshawe College and A.M. Cuddy Gardens, Gareev Botanical Garden of the National Academy of Sciences, Kyrgyzstan, Garvan Woodland Gardens, Ghent University Botanic Garden, Giardino Botanico Alpino alle Viotte di M. Bondone, Giardino Botanico Friuli Cormor, Gibraltar Botanic Gardens, Glasgow Botanic Gardens, Gradina Agro-Botanica din Cluj-Napoca, Grapevine Botanical Gardens at Heritage Park, Great Lakes Forestry Centre Arboretum, Green Bay Botanical Garden, Green Spring Gardens, Grugapark und Botanischer Garten der Stadt Essen, Hangzhou Botanical Garden, Harmas de Fabre, Harriet Irving Botanical Gardens, Hershey Gardens, Hof ter Saksen Arboretum, Hohhot Arboretum, Holden Arboretum, The, Hortus Botanicus Amsterdam, Hortus Botanicus Reykjavikensis, Hoyt Arboretum, Hunan Forest Botanical Garden, Huntington Botanical Gardens - Seed Bank, il Giardino della Minerva, Incheon Arboretum, Istituto e Orto Botanico dell'Universita di Pavia- Seed Bank, Istituto ed Orto Botanico della Universita- Seed Bank, Jade Garden Natural Arboretum, Jangheung Natural Arboretum, Jardi Botanic de Barcelona, Jardí Botànic de la Universitat de València, Jardi Botanic de Soller, Jardim Botanico da Madeira, Jardim Botânico da Universidade de Coimbra, Jardim Botânico da Universidade de Lisboa, Jardim Botânico da Universidade de Trás-os-Montes e Alto Douro, Jardim Botânico da Universidade do Porto, Jardim Botânico Tropical, Jardín Botánico Atlántico de Gijón, Jardin Botanico Benjamin F. Johnston, Jardín Botánico Carlos Thays, Jardin Botanico de

Cordoba- Seed Bank, Jardin Botanico de la Facultad de Estudios Superiores, Jardin Botanico de la Universidad Autónoma de Guerrero, Jardin Botanico de la Universidad Autonoma de Puebla, Jardín Botánico de San Quintín, Jardín Botánico Francisco Javier Clavijero, Jardín Botánico Lucien Hauman, Jardin Botanico Todos Santos, Jardin Botanique Camifolia, Jardin Botanique Alpin de la Jaÿsinia, Jardin Botanique de la Ville de Caen, Jardin Botanique de la Ville de Lyon, Jardin Botanique de l'Université de Strasbourg, Jardin Botanique de Marnay sur Seine, Jardin botanique de Paris, Jardin Botanique et Arboretum Henri Gaussen, Jardin Botanique Yves Rocher, Jardin Conservatoire des Plantes Tinctoriales, Jardin des Plantes, Jardin des Plantes de Paris et Arboretum de Chevreloup, Jardin Etnobotanico y Museo de Medicina Tradicional y Herbolaria, Jardins des Plantes de l'Université, JC Raulston Arboretum, Jeju Botanical Garden, Yeomiji, Jerusalem Botanical Gardens, John C. Gifford Arboretum, Juliana Alpine Botanical Garden, Kalmthout Arboretum, Kee-chung-san Botanic Garden, Keum Kang Arboretum, Korea Botanic Garden, Kunming Botanical Garden, Kurpark Bad Bellingen, Lady Bird Johnson Wildflower Center, Landis Arboretum, Les Jardins Suspendus, Leuven Botanic Garden, Lewis Ginter Botanical Garden, Living Desert Zoo and Gardens, Ljubljana University Botanic Garden, Logan Botanic Garden, Longwood Gardens, Los Angeles County Arboretum and Botanic Garden, Lushan Botanical Garden, Maijishan Arboretum (Gansu), Main Botanical Garden, Russian Academy of Sciences, Maribor University Botanic Garden, Mary Cairncross Scenic Reserve, Matthaei Botanical Gardens & Nichols Arboretum, Maymont Foundation, Meadowlark Botanical Gardens, Mercer Botanic Gardens, Millennium Seed Bank, Minnesota Landscape Arboretum, Missouri Botanical Garden, Missouri Botanical Garden - Seed Bank, Missouri State Arboretum, Montreal Botanical Garden / Jardin botanique de Montréal, Moore Farms Botanical Garden, Morden Arboretum Research Station, Morris Arboretum, The, Morton Arboretum, The, Moscow State University Botanical Garden, Mount Auburn Cemetery, Mountain Botanical Garden of the Dagestan Scientific Centre, Mountain Top Arboretum, Museo Orto Botanico di Roma, Nanjing Botanical Garden Mem. Sun Yat-sen, Naples Botanical Garden, National Arboretum Canberra, National Botanic Garden of Latvia, National Botanic Garden of Wales, National Botanical Conservatory of Corsica, National Botanical Garden of Georgia, National Garden- Seed Bank, National Museum de História Natural e da Ciência"- Seed Bank", National Plant Germplasm System - USDA-ARS-NGRL, National Rhododendron Garden, National Tree Seed Centre, Nebraska Statewide Arboretum, Neuer Botanischer Garten der Universität Göttingen, New Brunswick Botanical Garden, New England Wild Flower Society - Garden in the Woods, New York Botanical Garden, The, Niagara Parks Botanical Gardens and School of Horticulture, The, Noosa Botanic Gardens, Norfolk Botanical Garden, North Carolina Arboretum, The, Northwest Trek Wildlife Park, Novosibirsk Dendropark, Oekologisch-Botanischer Garten Universitaet Bayreuth, Oklahoma City Zoo and Botanical Garden, Orto Botanico - Università degli Studi di Catania, Orto Botanico Carmela Cortini" - Università di Camerino", Orto Botanico dell'Università degli studi di Siena, Orto Botanico dell'Universita della Calabria, Orto Botanico di Bergamo Lorenzo Rota, Orto Botanico di Perugia, Orto Botanico Giardino dei Semplici, Oxford University Botanic Garden, Paignton Zoo Environmental Park, Palacký University Botanic Garden, Palmengarten der Stadt Frankfurt am Main, Parque Botânico da Tapada da Ajuda, Patterson Garden Arboretum, Peavy Arboretum, Pha Tad Ke Botanical Garden, Philodassiki Botanic Garden, Plant Gene Resources of Canada, Polly Hill Arboretum, The, Pukekura Park, Purdue Arboretum, The, Pyunggang Botanical Garden, Quarryhill Botanical Garden, Queens Botanical Garden, Rancho Santa Ana Botanic Garden, Rancho Santa Ana Botanic Garden - Seed Bank, Reading Public Museum and Arboretum, The, Real Jardín Botánico Juan Carlos I, Real Jardin Botanico, CSIC, Reiman Gardens, Rio Grande Botanic Garden, Riverview Horticultural Centre Society, The, Rogów Arboretum of Warsaw University of Life Sciences, Royal Botanic Garden Edinburgh, Royal Botanic Gardens Kew (Wakehurst), Royal Botanic Gardens Sydney, Royal Botanic Gardens, Kew, Royal Botanic Gardens, Victoria - Melbourne Gardens, Royal Botanical Gardens, Ontario, Royal Horticultural Society's Garden, Harlow Carr, Royal Horticultural Society's Garden, Hyde Hall, Royal Horticultural Society's Garden, Rosemoor, Royal Horticultural Society's Garden, Wisley, Royal Roads University Botanical Gardens, Royal Tasmanian Botanical Gardens, Royal Veterinary and Agricultural University Arboretum, Sakhalin Botanical Garden, San Diego Botanic Garden, San Diego Zoo Safari Park, San Francisco Botanical Garden, Santa Barbara Botanic Garden, Sarah P. Duke Gardens, Scott Arboretum of Swarthmore College, The, Seeds of Success (SOS), Sentier de Decouverte, Shanghai Botanical Garden, Shanghai Chenshan Botanical Garden, Shaw Nature Reserve of the Missouri Botanical Garden, Sheffield Botanical Gardens, Sherwood Fox Arboretum, Siberian Botanical Garden of Tomsk State University, Singapore Botanic Gardens, Sister Mary Grace Burns Arboretum, Smithsonian Gardens - Tree Collection, Smithsonian National Zoological Park, Spring Grove Cemetery and Arboretum, St. Andrews Botanic Garden, St. Kilda Botanic Garden, State Arboretum of Virginia (Orland E. White Arboretum), State Botanical Garden of Georgia, The, Station Alpine du Lautaret, Stavanger Botanic Garden, Stellenbosch University Botanical Garden, Taltree Arboretum & Gardens, Tasmanian Arboretum Inc, Tatton Garden Society/Quinta Arboretum, The B.M. Kozo-Polyansky Botanical Garden of Voronezh State University, The Balkan Botanic Garden at Kroussia Mountains, The Balkan Botanic Garden at Kroussia Mountains- Seed Bank, The Linnaean Gardens of Uppsala (Uppsala University), The Sir Harold Hillier Gardens, The Tree Register of the British Isles, The University of Guelph Arboretum, Timaru Botanic Garden, Toronto Zoo, Trees Atlanta, Tyler Arboretum, UC Davis Arboretum, Ukrainian National Forestry University Botanic Garden, United States National Arboretum, Universidad Politécnica de Madrid- Seed Bank, University of Alabama Arboretum, University of Alberta Botanic Garden, University of British Columbia Botanical Garden, University of California Botanical Garden at Berkeley, University of Delaware Botanic Gardens, University of Dundee Botanic Garden, University of Idaho Arboretum & Botanical Garden, University of Oslo Botanical Garden, University of Washington Botanic Gardens, Utrecht University Botanic Gardens, V.N. Sukachev Institute of Forest SB RAS, Federal Research Center Krasnoyarsk Science Center SB RAS, Vanderbilt University Arboretum, VanDusen Botanical Garden, W. J. Beal Botanical Garden, Wallace Desert Gardens, Waugh Arboretum, Wentworth Castle Gardens, Westonbirt, The National Arboretum, Willowwood Arboretum, Wind River Canopy Crane Research Facility, Wuhan Botanic Garden, Wutaishan Arboretum (Shanxi), Xi'an Botanical Garden, Xishuangbanna Tropical Botanical Garden, CAS, Yinchuan Botanical Garden (Ningxia).

APPENDIX 3
IUCN Red List Categories and Criteria

EXTINCT (EX)
A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time-frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)
A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time-frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)
A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)
A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)
A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)
A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)
A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)
A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

THE CRITERIA FOR CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE

CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
   1. An observed, estimated, inferred or suspected population size reduction of ≥90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
      (a) direct observation
      (b) an index of abundance appropriate to the taxon
      (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
      (d) actual or potential levels of exploitation
      (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

   2 An observed, estimated, inferred or suspected population size reduction of ≥80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may

not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
   1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a-c:
      a. Severely fragmented or known to exist at only a single location.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations
         (v) number of mature individuals.
      c. Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.

   2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a-c:
      a. Severely fragmented or known to exist at only a single location.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations
         (v) number of mature individuals.
      c. Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:
   1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

   2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
      (a) Population structure in the form of one of the following:
         (i) no subpopulation estimated to contain more than 50 mature individuals, OR
         (ii) at least 90% of mature individuals in one subpopulation.
      (b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
   1. An observed, estimated, inferred or suspected population size reduction of ≥70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
      (a) direct observation
      (b) an index of abundance appropriate to the taxon
      (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
      (d) actual or potential levels of exploitation
      (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
   1. Extent of occurrence estimated to be less than 5000 km^2, and estimates indicating at least two of a-c:
      a. Severely fragmented or known to exist at no more than five locations.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations
         (v) number of mature individuals.
      c. Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.

   2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a-c:

      a. Severely fragmented or known to exist at no more than five locations.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations
         (v) number of mature individuals.
      c. Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:
   1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

   2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
      (a) Population structure in the form of one of the following:
         (i) no subpopulation estimated to contain more than 250 mature individuals, OR
         (ii) at least 95% of mature individuals in one subpopulation.
      (b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
   1. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
      (a) direct observation
      (b) an index of abundance appropriate to the taxon
      (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
   1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a-c:
      a. Severely fragmented or known to exist at no more than 10 locations.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations
         (v) number of mature individuals.
      c. Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.

   2. Area of occupancy estimated to be less than 2000 km^2, and estimates indicating at least two of a-c:
      a. Severely fragmented or known to exist at no more than 10 locations.
      b. Continuing decline, observed, inferred or projected, in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) area, extent and/or quality of habitat
         (iv) number of locations or subpopulations
         (v) number of mature individuals.
      c. Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:
   1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

   2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
      (a) Population structure in the form of one of the following:
         (i) no subpopulation estimated to contain more than 1000 mature individuals, OR
         (ii) all mature individuals are in one subpopulation.
      (b) Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:
   1. Population size estimated to number fewer than 1000 mature individuals.

   2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Source: IUCN (2001)

The Red List of Fraxinus

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