

BRIEF REPORT

Assessing Magnoliaceae through time: Major global efforts to track extinction risk status and ex situ conservation

Jean Linsky¹  | Emily E. D. Coffey¹  | Emily Beech²  | Malin Rivers²  |
Daniele Cicuzza³  | Sara Oldfield⁴  | Dan Crowley²¹Atlanta Botanical Garden, Atlanta, Georgia, USA²Botanic Gardens Conservation International, Richmond, UK³Faculty of Science, School of Biology, Universiti Brunei Darussalam, Bandar Seri Begawan, Brunei⁴IUCN SSC Global Tree Specialist Group, Cambridge, UK**Correspondence**

Jean Linsky, Atlanta Botanical Garden, GA 30309, Atlanta, GA, USA.

Email: jlinsky@atlantabg.org**Funding information**

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Societal Impact Statement

Comprehensive Red List assessments act as valuable resources for informing protected area designations, national protected species legislation and action strategies, and international biodiversity agreements, yet they are lacking for many plant families. Magnoliaceae is one of the most comprehensively assessed families, as coordinated efforts have taken place since 2007 to assess all species in the family. Due to the many efforts to assess these species, comparisons of the assessments and ex situ data over time and an investigation of the most recent (2021) information are essential to guiding the development of national, regional, and global conservation strategies for Magnoliaceae species in a time of increased global collaboration between conservation organizations.

KEYWORDS

conservation assessments, ex situ, International Union for Conservation of nature (IUCN) Red List, Magnoliaceae, prioritization

1 | INTRODUCTION

The process of evaluating the conservation status of a species is key to providing the baseline information needed to develop effective and efficient conservation strategies. Such threat assessments also inform protected area designations, national protected species legislation, and international biodiversity agreements (e.g., Global Strategy for Plant Conservation) among other protective measures for species. Since its establishment in 1964, the IUCN Red List of Threatened Species has become a global standard for species threat assessments and supports the evaluation and tracking of species extinction risk over time (IUCN, 2022).

Magnoliaceae, a diverse tree family represented by two genera and over 330 species, is found throughout the Neotropics and East and Southeast Asia (Rivers et al., 2016). The trees of this family are ecologically, economically, and culturally important throughout

their ranges as key forest species, sources of medicine, timber, and horticultural plants and as icons for traditional practices (e.g., Domínguez-Yescas & Vázquez-García, 2019; Lobdell, 2021). Existing expert networks in Magnoliaceae horticulture, research, and conservation have driven the focus in studying and assessing this ancient plant group, including the Magnolia Society International and the Global Tree Specialist Group. Due to the efforts of these species experts and other conservation professionals, Magnoliaceae is one of the most comprehensively assessed plant groups on the IUCN Red List, along with Birches, Cacti, Conifers, Cycads, Maples, Oaks, and Proteaceae (Crowley et al., 2020; IUCN, 2021a). The first major effort to assess all species in the family, *The Red List of Magnoliaceae*, was published in 2007 (Cicuzza et al., 2007), and 151 of 245 known taxa were assessed at that time. In 2016, *The Red List of Magnoliaceae-revised and extended* included assessments of 93 newly described species as well as updates of previously

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assessed species (Rivers et al., 2016). Between the 2016 publication and 2021, at least 19 more species have been described and assessed and others updated based on growing knowledge of wild species status.

Comprehensive assessments of the Magnoliaceae have contributed to assessing research progress (Cires et al., 2013), developing species-specific conservation strategies (e.g., Vázquez-García et al., 2021) and guiding practical conservation projects (e.g., in Linsky, 2021). Additionally, these assessments have contributed to in-depth monitoring of ex situ conservation of the group (e.g., the 2008 and 2016 ex situ surveys). Progress on the numbers of threatened species present in ex situ collections, the quality of those collections, and institutions engaged in Magnoliaceae conservation can be, and have been, tracked over time. On the occasion of the publication of the State of the World's Trees (BGCI, 2021a) and with a growing contribution of taxon level data on species presence in ex situ collections of Magnoliaceae, a summary of Red List assessments from 2007, 2016, and 2021 and species presence in ex situ collections is presented. Trends in the number of species assessed in each IUCN Red List category over time as well as 2021 statistics are presented. The presentation of the number of species in various threat categories and endemism at the national/territorial level, general statistics on the ex situ status of species as well as examples of species which have newly been included in ex situ collections provides timely guidance for developing regional conservation strategies when collaboration between plant conservation organizations is increasing.

2 | METHODS

Data on assessments published in Ciczuzza et al. (2007) and Rivers et al. (2016) and on the IUCN Red List in December 2021 (IUCN, 2021b) including taxon name and IUCN Red List category [Extinct (EX), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD)] were gathered for all species in Magnoliaceae. Only species-level assessments are included in this analysis. For all species which have assessments published on the Red List as of 2021, the category rank for that species in 2016 and 2007 was compared with the current (2021) rank. Not Evaluated taxa are those which were accepted taxa at the time of each Red List publication but were not evaluated against the criteria due to insufficient information available on these species. Species were categorized as “not described” if they are currently on the Red List but had not been described at the time of the 2016 and/or 2007 publications. The assessment category of each taxon was compared between 2016 and 2021 to specify recent changes in assessment (e.g., reassessment to a higher threat category, movement from Data Deficient to another conservation rating). Country level distribution for each species on the 2021 list was gathered from the IUCN Red List assessments, BGCI's GlobalTreeSearch Database (BGCI, 2021b), and expert consultation to identify countries/territories with high proportions of threatened endemic Magnoliaceae and to bring attention to the urgency of Magnoliaceae conservation in those areas.

Ex situ collection datasets for 2008 and 2016 were gathered from the *Global Survey of ex situ Magnoliaceae Collections* (BGCI, 2008) and *The Red List of Magnoliaceae-revised and extended* ex situ survey section (Rivers et al., 2016). This includes counts of the number of institutions reporting each assessed species in ex situ collections at the time of those publications. To gather the 2021 data set, in August 2020, all records for *Magnolia* and its synonyms were downloaded from BGCI's PlantSearch database (BGCI, 2020). In addition, taxon level lists of ex situ *Magnolia* collections not on PlantSearch were gathered from institutions known to hold significant *Magnolia* collections. Accession level data, which includes detailed information on the provenance of the individuals in collections, were gathered over multiple years through ex situ surveys. Requests to institutions with ex situ collections to provide *Magnolia* accession level data were distributed in 2018 and July 2019 via email and social media. Further targeted requests for accession level data were sent to priority institutions based on PlantSearch records in August 2020. A combined list of the *Magnolia* species in each institution from the taxon and accession surveys was created, and duplicate records were removed (i.e., where an institution reported a species in both PlantSearch and via the accession surveys, the species is counted only once at that institution). These records were used to calculate the number of institutions reporting each *Magnolia* species. Records used to calculate the number of institutions holding *Liriodendron* species were downloaded from BGCI's PlantSearch database in December 2021. This ex situ survey data from 2018 to 2021 are reported as the 2021 ex situ survey of Magnoliaceae in this analysis.

3 | RESULTS

The number of Magnoliaceae species assessed between 2007, 2016, and 2021 has increased due to new species being described, information about species becoming increasingly available, and coordinated assessment efforts including the Global Tree Assessment. In particular, the number of evaluated species increased between 2007 and 2016 due to inclusion of 93 newly described *Magnolia* species and assessment of 78 species which were Not Evaluated in 2007 for which more information was gathered (Rivers et al., 2016). As of 2021, the IUCN Red List contains assessments for a total of 349 taxa within the Magnoliaceae: 333 species and 16 infraspecific taxa (subspecies and varieties). A total of 172 species are assessed as threatened (CR, EN, or VU), 101 species as Data Deficient, and 60 species as not threatened (NT or LC) (Figure 1).

Between the 2016 publication and 2021, there are 9 new CR assessments due to new species descriptions, 13 new EN assessments due to new species descriptions and updates to former assessments, and 3 new VU assessments due to updates and new species descriptions. More specifically, during this time, six species were updated from DD to other categories: *Magnolia platyphylla* (EN), *Magnolia ptari-tepuiana* (EN), *Magnolia pubescens* (EN), *Magnolia sinacolinii* (EN), *Magnolia vargasiana* (VU), and *Magnolia zoquepopolucae* (EN). The 10 species listed as Not Evaluated (NE) in 2016 have all been assessed

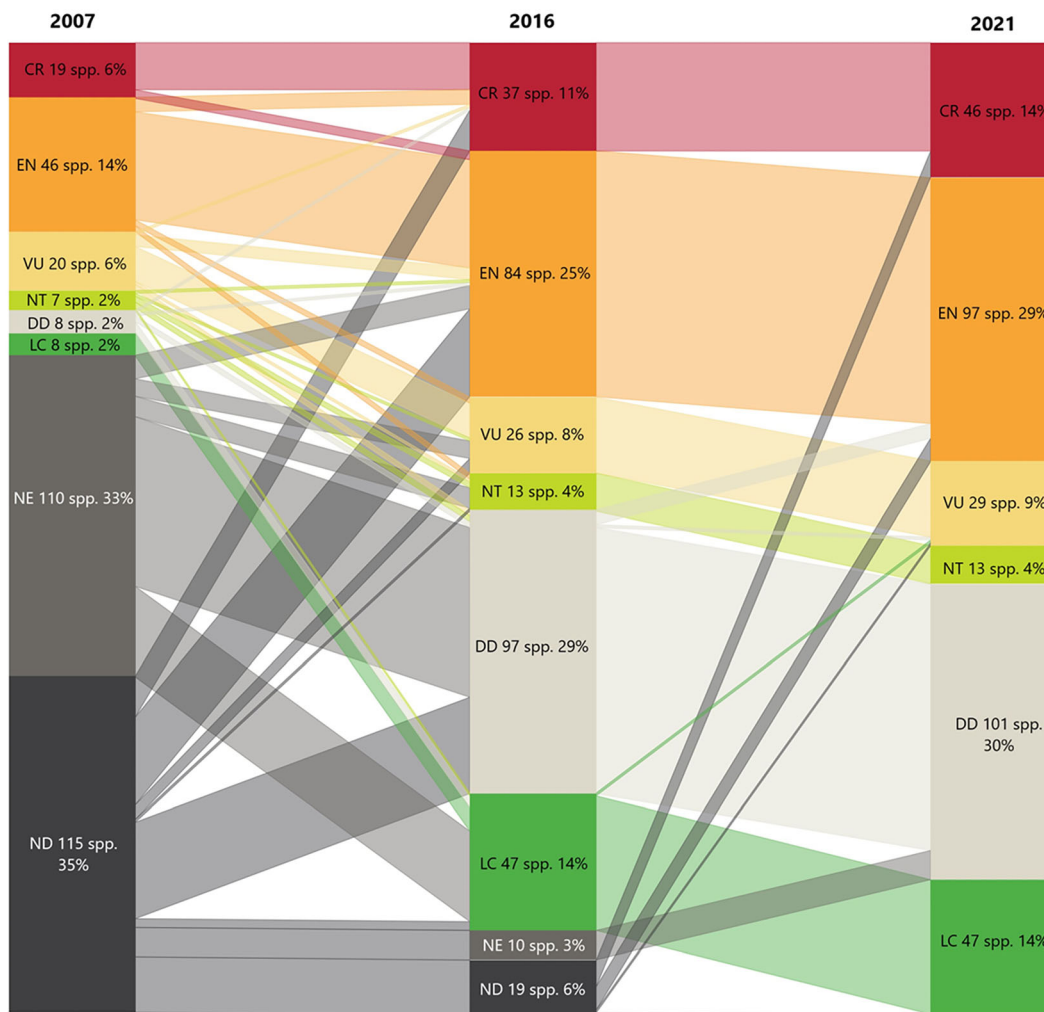


FIGURE 1 The changes in International Union for Conservation of Nature (IUCN) Red List category of 333 currently accepted species (spp.) of Magnoliaceae as published in 2007, 2016, and 2021. CR: critically endangered; DD: data deficient; EN: endangered; LC: least concern; NE: not evaluated; ND: not described; NT: near threatened; VU: vulnerable

as Data Deficient as of 2021, based on various taxonomic concerns. *Magnolia crassifolia* is now assessed under the species name *Magnolia arroyoana* based on the current taxonomic understanding of this species (Molinari-Novoa, 2016). While the changes in assessment generally reflect availability of more information and not true status changes, these updates provide valuable information for addressing conservation issues. For example, in 2021, *M. sabahensis* was updated from LC to VU based on more detailed information on the Area of Occupancy of the species (Tanggaraju et al., 2021).

Endemic Magnoliaceae species are present in 26 countries/territories. China, Mexico, Colombia, Ecuador, and Vietnam are the top five countries with the most endemic Magnoliaceae species (Figure 2). In 11 countries/territories, all endemic species are assessed as threatened: Colombia (31 species), Cuba (3 species), Thailand (3 species), Venezuela (2 species), Puerto Rico (2 species), Haiti (2 species), Bolivia (2 species), Philippines (2 species), Dominican Republic (2 species), Taiwan (1 species), and Myanmar (1 species). As endemics, these species should be priority for conservation action within their countries or territories of origin. In four countries, more than a third of the

endemic species are assessed as Data Deficient: China (29 species), Indonesia (4 species), Malaysia (2 species), and Brazil (2 species).

In the 2021 ex situ survey, a total of 11,453 Magnoliaceae records were provided by institutions globally. This included 5094 records matching *Magnolia* species or synonyms (i.e., not including cultivars or infraspecific taxa). The amount of species records increased from the 2016 survey by 618 and the number of institutions reporting collections increased by 32 (Table 1). In the 2021 survey, a total of 169 species are reported in ex situ collections of a total of 333 Magnoliaceae species surveyed (Figure 3). This includes 77 (45%) threatened species in ex situ collections, globally. In 2008 and 2016, similar percentages of threatened species were reported in ex situ collections at 42% and 43%, respectively (BGCI, 2008; Rivers et al., 2016). Between 2016 and 2021, the proportion of Endangered, Vulnerable, Near Threatened, and Data Deficient species for each year reported in ex situ collections has increased, while the proportion of Critically Endangered species for each year reported in ex situ collections has decreased and proportion of Least Concern species for each year has remained the same (Figure 3).

FIGURE 2 Number of endemic Magnoliaceae species which are threatened, not threatened or data deficient per country/territory

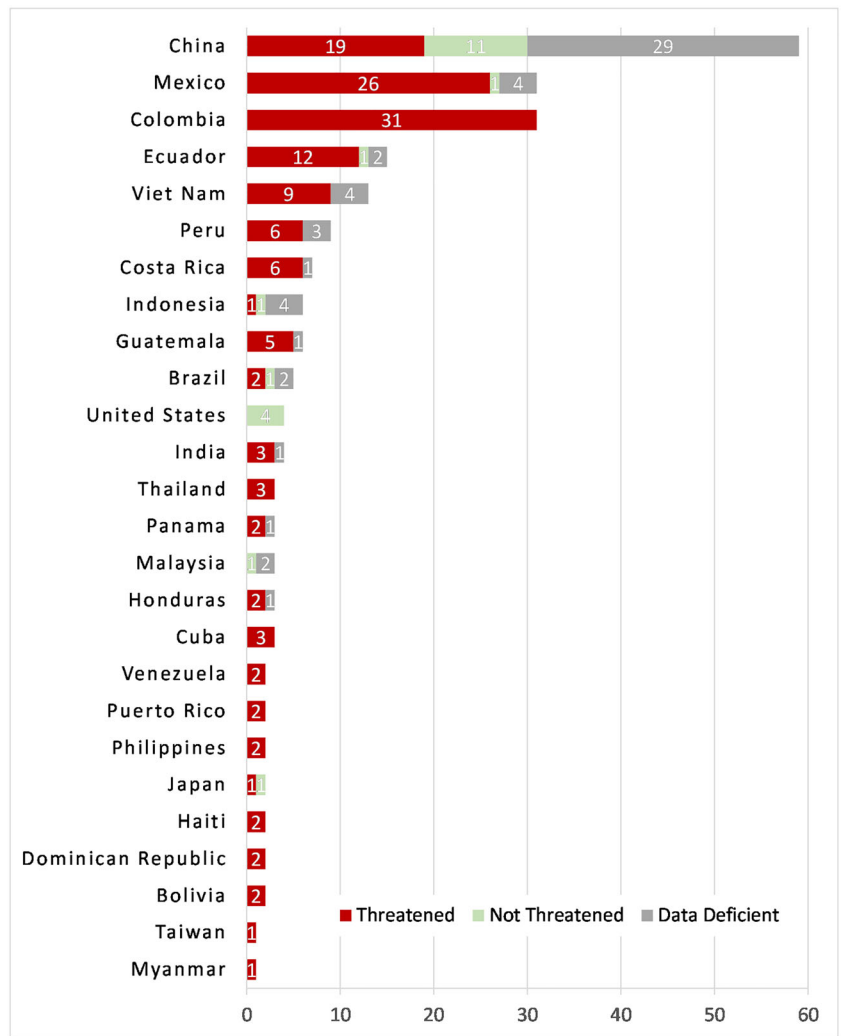


TABLE 1 Comparison of results of Magnoliaceae ex situ surveys from 2008, 2016 and 2021

Ex situ	2008	2016	2021
Number of records	2781	9918	11,453
Number of institutions contributing records	238	490	522
Number of records matching species or synonyms	2274	4476	5094

FIGURE 3 Comparison of percentage of Magnoliaceae species reported in ex situ collections by International Union for Conservation of nature (IUCN) Red List Category in 2016 and 2021. The numbers in the columns are the species count. CR: critically endangered; DD: data deficient; EN: endangered; LC: least concern; NT: near threatened; VU: vulnerable



As of 2021, 15 species which were unreported from ex situ collections in 2016 are now present in ex situ collections. These are *Magnolia citrata* (LC), *M. dodecapetala* (VU), *M. iltisiana* (VU), *M. jaliscana* (EN), *M. mannii* (VU), *M. oaxacensis* (EN), *M. ofeliae* (CR), *M. philippinensis* (DD), *M. poasana* (NT), *M. portoricensis* (EN), *M. rzedowskiana* (EN), *M. tarahumara* (DD), *M. vallartensis* (CR), *M. vovidesii* (EN), and *M. yoroconte* (VU) (Dataset S1).

4 | DISCUSSION

The comprehensive assessment of the extinction risk of Magnoliaceae continues to be achieved, as new taxa are described, by the coordinated sharing of data by those carrying out field work on Magnoliaceae as observed in the number of species which were assessed in 2016 following a lack of data in 2007. The assessment of Magnoliaceae has led to conservation action via practical Global Tree Campaign (GTC) projects and increased representation of threatened species in ex situ collections (e.g., GTC, 2020: Conserving five threatened Magnolias in México). The species newly present in ex situ collections are the start of more comprehensive conservation of the species, for example, providing material for development of propagation protocols and initiation of genetically representative collections. The growing contribution of data by gardens and other plant conservation organizations holding ex situ Magnoliaceae collections to centralized databases such as PlantSearch and collaborative collection management programs allows for efficient and effective planning and conservation. The assessment of Magnoliaceae has also led to the growth of regional groups involved in conservation of Magnoliaceae (e.g., at the meeting of the Neotropical Magnolia Conservation Consortium in 2019) and the establishment of the Global Conservation Consortium for Magnolia (GCCM).

Updates of species conservation assessments, particularly those currently listed as Data Deficient, will be necessary for ensuring that conservation plans address the current, known threats to and apply appropriate actions for Magnoliaceae species. In particular, a number of endemic taxa of Southeast Asia are currently assessed as DD and require focused field surveys to fully assess their threat status. Surveys are recommended to create a more complete understanding of the threat to Magnolias in this region. Comprehensive assessments highlight priority regions for Magnoliaceae conservation action including the Caribbean, where all species are assessed as threatened. The assessments along with information on current and priority conservation actions for these species can be used to identify gaps in conservation and be applied to action plans. Additionally, tools such as the Conservation Tracker within BGCI's GlobalTree Portal (BGCI, 2021c) aid in sharing assessment and action information for effective planning.

The investigation of ex situ records of Magnoliaceae species presented here provides a big picture view of collection and potential conservation efforts within this plant family. The number of records of Magnoliaceae reported over time have increased as more gardens report to PlantSearch and/or accession surveys; however, understanding the conservation value and impact of these collections

requires a more in-depth analysis than we are able to present here. As an initial step to understanding and improving the conservation of Magnoliaceae species ex situ, the up-to-date assessments and ex situ accession data were used in the application of conservation gap analysis methodologies and presented in the Global Conservation Gap Analysis of Magnolia (Linsky et al., 2022). This includes identifying gaps in data availability for ex situ collections as well as summarizing provenances of collections to begin to assess conservation value. Groups of gardens, such as those in the GCCM, will use this report to guide development of integrated conservation strategies and continue to monitor the conservation value of collections at a more in-depth level. Examples of on-going projects include conservation planning for threatened species in South America, analysis of genetic diversity of individuals held in ex situ (e.g., <https://conservetrees.org/>), and creation of seed orchards based on previous genetic analysis of wild and captive populations (von Kohn et al., 2018).

While conservation assessments provide a snapshot of the wild status of these species, it is paramount to take practical action to address their conservation needs, working both in situ and ex situ to ensure that species do not go extinct. Many of the species newly reported in ex situ collections between 2016 and 2021 are a result of integrated conservation projects specifically supporting Magnoliaceae conservation (e.g., GTC). The GCCM aims to build on the best practices of these projects and connect individuals and institutions to develop strategic plans and implement action for the conservation of threatened members of this ancient plant family.

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CONFLICT OF INTEREST

Malin Rivers, co-author of this paper, is an editor of this special issue.

AUTHOR CONTRIBUTIONS

J.L., E.C., and D. Crowley planned and designed the research; J.L. collected and analyzed data; all authors interpreted results; J.L. wrote the manuscript; and E.C., E.B., D. Crowley, M.R., D. Ciczuzza, and S.O. provided valuable editing and comments.

DATA AVAILABILITY STATEMENT

The Red List data that support the findings of this study are openly available in The IUCN Red List of Threatened Species (<https://www.iucnredlist.org/>). The 2021 ex situ data that support the findings of this study are available in the supporting information of this article (Dataset S1).

ORCID

Jean Linsky  <https://orcid.org/0000-0002-3657-9283>

Emily E. D. Coffey  <https://orcid.org/0000-0002-9199-2943>

Emily Beech  <https://orcid.org/0000-0002-1107-254X>
 Malin Rivers  <https://orcid.org/0000-0001-9690-1353>
 Daniele Cicuzza  <https://orcid.org/0000-0001-9475-2075>
 Sara Oldfield  <https://orcid.org/0000-0003-3706-5986>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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