Global Survey of

*Ex situ Zelkova* Collections

Botanic Gardens Conservation International

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## Acknowledgements

The project was carried out in close association with Dr. Gregor Kozlowski of the Botanic Garden of the University of Fribourg in Switzerland. The survey was coordinated and carried out by Fan Huan and Douglas Gibbs.

Many botanic gardens around the world have freely contributed data to the survey (Annex 2), and their contributions are gratefully acknowledged. BGCI would also like to acknowledge the assistance of the following organisations in the promotion of the survey and the collection of data: American Public Gardens Association, Chinese Academy of Science (CAS) Botanic Gardens Committee, European Botanic Gardens Consortium.

Cover image: *Zelkova abelicea* (Dr. Gregor Kozlowski)
Summary

Zelkova is a small genus that comprises six tree species in the northern hemisphere with a disjunct distribution.

Botanic Gardens Conservation International (BGCI) and the Botanic Garden of the University of Fribourg in Switzerland have come together to jointly develop a global action plan for the conservation of threatened Zelkova species. This survey forms the first phase of this project, the results of which will go to inform the genetic analysis in the next phase.

The survey identified that all of the Zelkova taxa are currently held in living collections by botanic gardens and arboreta. In total 255 Zelkova records\(^1\), from 137 institutions in 27 countries were identified. Of the 255 records included in the analysis, just 17 records of the most threatened Zelkova taxa (Z. sicula and Z. abelicea) were identified.

The report concludes by a series of recommendations based on the results of the survey including: up to date conservation assessments, the strengthening of existing ex situ collections, establishing new collections, carrying out genetic analysis of collections of wild populations, implementing restoration and reintroduction activities, involving local communities and organisation in conservation activities and developing public awareness programmes.

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\(^1\) For the purposes of this survey, a record/collection is the presence of a single living Zelkova taxon within an institution and may include multiple accessions and/or individuals.
Introduction

Zelkova (Ulmaceae) is a small genus that comprises six tree species in the northern hemisphere. It is an interesting genus with a disjunct distribution: three species in eastern Asia, one species in western Asia and two species in the Mediterranean.

The most endangered species in the genus is Zelkova sicula, discovered only recently in Sicily. The known number of individuals does not exceed a few hundred (rarely larger than 2 meters in height) and covers a very small area of the southeastern part of the island. Zelkova sicula is currently listed as Critically Endangered according to IUCN’s Red List Categories and Criteria, and is the only Zelkova to be of recent assessment.

Another Mediterranean island endemic, Zelkova abelicea, is restricted to Crete (Greece). Its conservation status is Vulnerable (VU), but this assessment needs to be updated as it was carried out over ten years ago and against a former version of IUCN’s Red List Categories and Criteria. More recent field expeditions and investigations have discovered several new populations; however, it is proposed to keep the Vulnerable status due to expanding road constructions, intensive grazing and other anthropogenic activities.

The third Zelkova which has been assessed against IUCN’s Red List Categories and Criteria is Z. carpinifolia. However, like Z. abelicea, its assessment (Near Threatened) was carried out over ten years ago and against a former version of the Categories and Criteria and therefore needs to be re-assessed. Z. abelicea distribution includes a number of countries in western Asia (Turkey, Georgia, Armenia, Azerbaijan and Iran), however it is thought to be threatened in a number of places.

The three East Asian Zelkova species have much larger distributions and have not been assessed against the IUCN’s Red List Categories and Criteria, however this should not be interpreted as they are not under threat. As for Z. carpinifolia and Z. abelicea, these three East Asian taxa need their conservation status to be re-assessed or assessed for the first time.

Based on the current assessments, attention is required to ensure that both Z. sicula and Z. abelicea, the 2 taxa considered to be at most risk of extinction (Critically Endangered and Vulnerable), are conserved. It is clearly important that these taxa are represented in well-managed ex situ collections as an insurance policy for the future and in support of Target 8 of the Global Strategy for Plant Conservation (GSPC).

Global Strategy for Plant Conservation, Target 8:

60% of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10% of them included in recovery and restoration programmes

At the same time habitat protection and restoration should be reviewed and mechanisms put in place for local people to be involved in and benefit from the in situ conservation and management of these globally important trees.
**Methods**

An international survey of *ex situ* collections of *Zelkova*, building on information held within BGCI’s *PlantSearch* Database, was undertaken by BGCI. The results of the survey have enabled us to identify precisely which species are currently held in *ex situ* collections. From this information, the gaps and the opportunities have been identified in order to develop a prioritised plan for the long term integrated conservation of the *Zelkova*.

All BGCI’s institutional members were invited to participate in the survey; however participation in the survey was not limited to BGCI members. Awareness of and invitations to participate in the survey was promoted through BGCI’s website ([www.bgci.org](http://www.bgci.org)), a number of mailing lists and a range of networks, organisations and events including: American Public Gardens Association (APGA), Chinese Academy of Science (CAS) Botanic Gardens Committee, European Botanic Garden Consortium.

The survey of *ex situ* collections was carried out through a range of methods, including:

- Analysis of data held in BGCI’s *PlantSearch* database ([www.bgci.org/plant_search.php](http://www.bgci.org/plant_search.php))
- Through direct contact with botanic gardens and networks holding *Zelkova* collections
- Data collected from online databases of living collections:
  - Database of Asian Plants in Cultivation maintained by Quarryhill Botanical Garden and California Academy of Sciences ([research.calacademy.org/research/botany/quarryhill/index.asp](http://research.calacademy.org/research/botany/quarryhill/index.asp))

In addition to the presence or absence of a *Zelkova* from a collection, the following closed questions were also asked:

- Is this *Zelkova* from a known wild source or from horticultural/unknown origin?
  - horticultural or unknown source
  - of known wild provenance
- What is the approximate size of the collection?
  - 1 individual
  - 2 to 10 individuals
  - 11 to 30 individuals
- Is this *Zelkova* collection part of a restoration or reintroduction programme?
  - no
  - Translocation
  - Re-inforcement/Supplementation
  - Rehabilitation
  - Conservation/Benign Introduction
  - Ecosystem restoration

The resulting submissions were cross-checked with the accepted names with synonyms of *Zelkova*.

Although efforts were made to limit their impact on the final results, the survey has inherent limitations which mean that it can never be considered to be truly exhaustive and final. Surveys, such as this one, can be limited by issues correct identification of specimens, the degree of participation by collection holders in the survey and the dynamic nature of *ex situ* collections which evolve and change over time. Also, important additional specimens may be held in private collections which are not covered by this survey.
Results

General findings

The survey identified that all of the Zelkova taxa are currently held in living collections by botanic gardens and arboreta. In total 255 Zelkova records\(^1\), from 137 institutions in 27 countries were identified. Of the 255 records included in the analysis, just 17 records of the most threatened Zelkova taxa (Z. sicula and Z. abelicea) were identified. This is not unsurprising since these two Zelkova species are the two with the most restricted natural distribution; both are small island endemics. The Zelkova with the widest natural distribution, Z. serrata, is also the most common Zelkova in botanic garden collections.

\[\text{Figure 2. Botanic gardens with known Zelkova collections.}\]

\[\text{Table 1. Summary results}\]

<table>
<thead>
<tr>
<th>Taxon</th>
<th>RDL Category</th>
<th>Number of Collections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z. abelicea</td>
<td>VU</td>
<td>14</td>
</tr>
<tr>
<td>Z. carpinifolia</td>
<td>LR/nt</td>
<td>57</td>
</tr>
<tr>
<td>Z. schneideriana</td>
<td>NE</td>
<td>44</td>
</tr>
<tr>
<td>Z. serrata</td>
<td>NE</td>
<td>106</td>
</tr>
<tr>
<td>Z. sicula</td>
<td>CR</td>
<td>3</td>
</tr>
<tr>
<td>Z. sinica</td>
<td>NE</td>
<td>31</td>
</tr>
</tbody>
</table>

\(^1\) For the purposes of this survey, a record/collection is the presence of a single living Zelkova taxon within an institution and may include multiple accessions and/or individuals.
**Collections in the country of origin**

Target 8 of the GSPC calls for *ex situ* collections to be held where possible in the country of origin. All of the *Zelkova* taxa are found to limited degrees in countries of their origin.

- *Z. abelicea* (VU) 2 collections
- *Z. carpinifolia* (LR/nt) 1 collection
- *Z. schneideriana* (NE) 10 collections
- *Z. serrata* (NE) 12 collections
- *Z. sicula* (CR) 1 collection
- *Z. sinica* (NE) 3 collections

**Ex situ collections representativeness**

The survey attempted to gauge how representative the *ex situ* collections are by requesting information on the size of the collection and whether the collection is derived from known wild sources or not.

<table>
<thead>
<tr>
<th>Table 2. Number of collections by source of material.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Z. abelicea</strong></td>
</tr>
<tr>
<td>VU</td>
</tr>
<tr>
<td><strong>Z. carpinifolia</strong></td>
</tr>
<tr>
<td><strong>Z. schneideriana</strong></td>
</tr>
<tr>
<td><strong>Z. serrata</strong></td>
</tr>
<tr>
<td><strong>Z. sicula</strong></td>
</tr>
<tr>
<td><strong>Z. sinica</strong></td>
</tr>
</tbody>
</table>

However, relatively little information about the source of the material and the size of the collections was submitted (See Table 2) and it is difficult to draw conclusions about how representative the known *ex situ* collections are and their value to restoration and recovery action. Even if the collections are based on wild collected material, it does not guarantee that the associated documentation linking the collections to their sources exists or is at a level which supports their value to future restoration and reintroduction activities.

*Zelkova sicula* is so rare in the wild and in horticulture that the collections identified in this survey are almost certainly based on wild collected material since there are no known other sources.
Recommendations and the way forward

This survey forms an important step in the development of a global plan for the conservation of Zelkova taxa. Whilst all the known Zelkova taxa are known to horticulture and are currently in botanic gardens, relatively few collections are known to be based on wild sourced material and relatively few are known in the countries of their natural distribution. Therefore, in order to support the long term conservation of Zelkova a number of priorities and actions can be identified. With the most restricted natural distributions, the Mediterranean and Western Asia Zelkova species should be the priority taxa if it is not possible to include all 6 species.

With this in mind the report recommends the following actions:

- **The current conservation status of all Zelkova taxa should be assessed against the IUCN Red List Categories and Criteria.** With the exception of Z. sicula, all Zelkova species need to be reassessed or assessed for the first time. The assessments should include the development of detailed distribution maps for each species.

- **Strengthen and develop existing ex situ collections to ensure that they are representative, accessible and safe.** It is important that all Zelkova species are held in at least 2 secure ex situ collections that are representative of the natural diversity of the taxa and located whenever possible in the country of origin. This should involve the genetic analysis of ex situ collections and the comparison of this diversity with the natural diversity of wild populations.

- **Develop and implement restoration and reintroduction activities for the most threatened taxa.** The taxa which are under risk of extinction should be the focus of concerted conservation efforts to strengthen and conserve the remaining wild populations by appropriate methods.

- **Involve local communities and organisations in conservation activities.** As with all successful conservation activities, the involvement of the local communities and organisations is critical to the long term conservation of threatened species, and should be encouraged and supported from the earliest stages of planning conservation activities.

- **Develop public awareness and understanding programmes in regions where Zelkova species are at most threat.** To support current conservation efforts and develop new opportunities, public awareness and understanding programmes need to be developed and implemented as an integral component of conservation activities. This includes both areas where Zelkova species naturally occur and are utilised, as well as regions where they are of horticultural interest.

The Botanic Garden of the University of Fribourg, Switzerland, will take forward the development of the Zelkova action plan through the next phase. The University of Fribourg, in association with partners around the world, aims to carry out genetic analysis of ex situ collections and wild populations. They will focus on the three most restricted Zelkova species but where possible will also include the other species in the analysis. Whilst collecting genetic material for analysis, the University of Fribourg will gather more in depth information on the existing collections and wild populations in support a detailed action plan to ensure the long term conservation of Zelkova. During this period, potential pilot sites, projects and conservation partners will also be identified.
Annex 1  

**Zelkova taxonomy**

Extant species of *Zelkova* (accepted names with the most commonly used synonyms in parentheses)

<table>
<thead>
<tr>
<th>Species:</th>
<th>Distribution:</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Z. sicula</em> Di Pasquale, Garfi &amp; Quezel</td>
<td>Sicily (Italy)</td>
</tr>
<tr>
<td><em>(Z. cretica</em> Spach.)*</td>
<td></td>
</tr>
<tr>
<td><em>Z. abelicea</em> (Lam.) Boiss.</td>
<td>Crete (Greece)</td>
</tr>
<tr>
<td><em>(Z. cretica</em> Spach.)*</td>
<td></td>
</tr>
<tr>
<td><em>Z. carpinifolia</em> (Pall.) K. Koch</td>
<td>Turkey, Georgia, Armenia, Azerbaijan, Iran</td>
</tr>
<tr>
<td><em>(Z. ulmoides</em> Schneid.)*</td>
<td></td>
</tr>
<tr>
<td><em>(Z. crenata</em> Spach.)*</td>
<td></td>
</tr>
<tr>
<td><em>(Z. hircana</em> Grossh. &amp; Jarm.)*</td>
<td>[perhaps a separate species from the Hyrcanian region in Iran/Azerbaijan]</td>
</tr>
<tr>
<td><em>Z. sinica</em> C. K. Schneider</td>
<td>China</td>
</tr>
<tr>
<td><em>(Z. schneiderana)</em></td>
<td></td>
</tr>
<tr>
<td><em>Z. schneideriana</em> Hand.-Mazz.</td>
<td>China</td>
</tr>
<tr>
<td><em>(Z. schneiderana)</em></td>
<td></td>
</tr>
<tr>
<td><em>Z. serrata</em> (Thunb.) Makino</td>
<td>Japan, Korea, Kuril Islands (Russia), Taiwan, China</td>
</tr>
<tr>
<td><em>(Z. formosana</em> Hayata)*</td>
<td></td>
</tr>
<tr>
<td><em>(Z. keaki</em> Maxim.)*</td>
<td></td>
</tr>
<tr>
<td><em>(Z. acuminata</em> Planch.)*</td>
<td></td>
</tr>
<tr>
<td><em>(Z. hirta</em> C. K. Schneider)*</td>
<td></td>
</tr>
<tr>
<td><em>(Z. tarokoensis</em> Hayata)*</td>
<td></td>
</tr>
<tr>
<td><em>(Z. japonica</em> Dippel.)*</td>
<td></td>
</tr>
</tbody>
</table>
Annex 2  Participating institutions

The following 137 institutions from 27 countries are gratefully thanked for their contribution of data to this report:

Arboretum Bokrijk, Belgium; Arboretum Freiburg-Guenterstal im Staatlichen Forstamt Freiburg, Germany; Arboretum Groenendaal, Belgium; Arboretum Kalmthout, Belgium; Arboretum of the Barnes Foundation, United States of America; Arboretum Oudenbosch, Netherlands; Arboretum Volčji potok, Slovenia; Bergius Botanic Garden, Sweden; Botanic Gardens of Adelaide, Australia; Botanic Gardens Trust, Sydney, Australia; Botanical Garden Faculty of Science, Croatia; Botanical Garden of Delft University of Technology, Netherlands; Botanical Garden of Vilnius University, Lithuania; Botanical Garden, Natural History Museum - University of Oslo, Norway; Botanische Gärten der Universität Bonn, Germany; Botanischer Garten der J.W. Goethe-Universität, Germany; Botanischer Garten der Johannes Gutenberg Universität Mainz, Germany; Botanischer Garten der Philippus-Universität, Germany; Botanischer Garten der Ruhr-Universität Bochum, Germany; Botanischer Garten der Technischen Hochschule, Germany; Botanischer Garten der Universität Bern, Switzerland; Botanischer Garten der Universität des Saarlandes, Germany; Botanischer Garten der Universität Düsseldorf, Germany; Botanischer Garten der Universität Freiburg, Germany; Botanischer Garten der Universität Kiel, Germany; Botanischer Garten der Universität Osnabrück, Germany; Botanischer Garten der Universität Ulm, Germany; Botanischer Garten der Wilhelm-Pieck Universität, Germany; Botanischer Garten Dresden, Germany; Botanischer Garten Jena, Germany; Botanischer Garten und Botanisches Museum Berlin-Dahlem, Germany; Botaniska Trädgården vid Uppsalan Universitet, Sweden; Brisbane Botanic Gardens, Australia; Bristol Zoo Gardens, United Kingdom; Brooklyn Botanic Garden, United States of America; Brookside Gardens, United States of America; Cambridge University Botanic Garden, United Kingdom; Chicago Botanic Garden, United States of America; Conservatoire Botanique National de Brest, France; Conservatoire et Jardins Botaniques de Nancy, France; Davis Arboretum, United States of America; Denver Botanic Gardens, United States of America; Dunedin Botanic Garden, New Zealand; Ente Giardini Botanici Villa Taranto, Italy; Forstbotanischer Garten, Germany; Forstbotanischer Garten Tharandt, Germany; Forstbotanischer Garten und Arboretum, Germany; Ganan Arboretum of Jiangxi, China; Guillin Botanical Garden, China; Hangzhou Botanical Garden, China; Hefei Botanical Garden, China; Hergest Croft Gardens, United Kingdom; Hof ter Saksen, Belgium; Hortus Botanicus Amsterdam, Netherlands; Hortus Botanicus Catiensis, Italy; Hortus Botanicus Lovaniensis, Belgium; Howick Arboretum, United Kingdom; Huntington Botanical Gardens, United States of America; J.C. 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Sun Yat-Sen, China; National Botanic Gardens of Ireland, Ireland; Natural History Museum of Denmark, Denmark; Neuer Botanischer Garten der Universität Göttingen, Germany; North Coast Regional Botanic Garden, Australia; Oekologisch-Botanischer Garten Universität Bayreuth, Germany; Orto Botanico dell'Universita' di Palermo, Italy; Orto Botanico Università degli Studi di Padova, Italy; Oxford University Botanic Garden, United Kingdom; Paimont Zoological and Botanical Gardens, United Kingdom; Parque Botânico da Tapada da Ajuda, Portugal; Philodassiki Botanic Garden, Greece; Phipps Conservatory, Inc., United States of America; Quarryhill Botanical Garden, United States of America; Rogów Arboretum of Warsaw University of Life Sciences, Poland; Royal Botanic Garden Edinburgh, United Kingdom; Royal Botanic Gardens, kew, United Kingdom; Royal Botanic Gardens, Kew - Wakehurst Place, United Kingdom; Royal Botanic Gardens, Melbourne, Australia; Royal Veterinary and Agricultural University Arboretum, Denmark; Sentier de Découverte, France; Shanghai Botanic Garden, China; Shanghai Chenshan Botanical Garden, China; Shenyang Arboretum Institute of Applied Ecology, China; Singapore Botanic Gardens, Singapore; South China Botanical Garden, China; St.Kilda Botanical Garden, Australia; Stavanger Botanic Garden, Norway; Stichting Arboretum Wespelaar, Belgium; Tatton Garden Society/Quinta Arboretum, United Kingdom; Tbilisi Botanical Garden, Georgia; The Arnold Arboretum of Harvard University, United States of America; The Botanic Garden of Smith College, United States of America; The Dawes Arboretum, United States of America; The Harris Garden, United Kingdom; The Holden Arboretum, United States of America; The Los Angeles County Arboretum & Botanic Garden, United States of America; The Mediterranean Agronomic Institute of Chania, Greece; The Morton Arboretum, United States of America; The New York Botanical Garden, United States of America; The Niagara Parks Commission - Botanical Gardens and School of Horticulture, Canada; The North Carolina Arboretum, United States of America; The Royal Horticultural Society, United Kingdom; The Royal Horticultural Society's Garden, Hyde Hall, United Kingdom; The Royal Horticultural Society's Garden, Rosemoor, United Kingdom; The Scott Arboretum of Swarthmore College, United States of America; The Sir Harold Hillier Garden and Arboretum, United Kingdom; Trinity College Botanic Garden, Ireland; United States National Arboretum, United States of America; Universite Montpellier 1, France; University of Budapest Botanic Garden, Hungary; University of Copenhagen, Denmark; University of Helsinki Botanic Garden, Finland; University of Washington Botanic Gardens, United States of America; Utrecht University Botanic Garden, Netherlands; VanDusen Botanical Garden, Canada; Westonbirt Arboretum, United Kingdom; Wuhan Botanical Garden, China; Xi'an Botanical Garden, China; Xishuangbanna Tropical Botanical Garden, China.