Distribution and Research Advances of National Key Protected Wild Plants in Hubei Province (Postprint)

Authors: Wei Xinzeng, Pu Yunhai, Shi Hongwen, Xiao Zhiqiang, Jiang Mingxi

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Abstract

Based on the "National Key Protected Wild Plant List" released by the National Forestry and Grassland Administration and the Ministry of Agriculture and Rural Affairs in 2021, a revised list of national key protected wild plants in Hubei Province was compiled through literature review, specimen examination, field surveys, and expert consultation. County-level (including municipal districts) geographic distribution maps were created, and research progress on national key protected wild plants in Hubei Province was reviewed from perspectives including scientific research status, threat status, and conservation status. The results indicate: (1) There are currently 155 species of national key protected wild plants in Hubei Province, comprising 11 first-class and 144 second-class species. (2) The spatial distribution of national key protected wild plants in Hubei Province is uneven, with primary concentrations in western and southwestern Hubei, particularly in the Shennongjia Forest District and Lichuan City. (3) Species receiving more research attention include those with economic value, flagship species, and regionally representative species. Additionally, over one-third of species (55) have received virtually no research attention. Research on national key protected wild plants in Hubei Province has focused on genetic diversity and genetic structure, future distribution prediction under global change scenarios, and phylogeography. (4) According to the "China Biodiversity Red List—Higher Plants Volume", national key protected wild plants in Hubei Province include 9 critically endangered species, 30 endangered species, 41 vulnerable species, and 19 near-threatened species. The primary threat factors are direct harvesting or logging, habitat degradation or loss, and intrinsic species characteristics. (5) Currently, 137 species of national key protected wild plants (88%) in Hubei Province are wholly or partially located within protected areas, while the remaining 18 species (12%) occur entirely outside protected areas. Hubei Province has ex-situ conservation records for 93 species of national key protected wild plants through introduction and cultivation, while 62

species lack ex-situ conservation records. Moreover, only a very few species have undergone wild reintroduction practices. (6) Currently, seven wild plant species in Hubei Province (five of which are endemic to Hubei) have not yet been included in the national key protected wild plant list despite their limited distribution ranges and vulnerability to intrinsic factors and human disturbance. Furthermore, this paper identifies weaknesses and gaps in current research and conservation efforts for national key protected wild plants in Hubei Province and proposes targeted conservation strategies and research recommendations.

Full Text

Preamble

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Geographic Distribution and Research Progress of National Key Protected Wild Plants in Hubei Province

WEI Xinzeng[1,2], PU Yunhai[3], SHI Hongwen[4], XIAO Zhiqiang[5], JIANG Mingxi[1,2]*

[1]CAS Key Laboratory of Aquatic Botany and Watershed Ecology, Wuhan Botanical Garden, Chinese Academy of Sciences, Wuhan 430074, China; [2]University of Chinese Academy of Sciences, Beijing 100049, China; [3]Wild Animal and Plant Conservation Station of Hubei Province, Wuhan 430079, China; [4]Wuhan Institute of Landscape Architecture, Wuhan 430081, China; [5]Yangtze River Biodiversity Research Center, China Three Gorges Corporation, Wuhan 430010, China

Abstract: Based on the *List of National Key Protected Wild Plants* (2021 edition) released by the National Forestry and Grassland Administration and Ministry of Agriculture and Rural Affairs of China, we compiled an updated provincial list of nationally protected wild plants in Hubei Province through literature review, herbarium examination, field investigation, and expert consultation. We mapped their geographic distribution at the county (district) level and reviewed research progress, threatened status, and conservation status. The results show: (1) Hubei Province currently hosts 155 national key protected wild plant species, including 11 Category I and 144 Category II species. (2) The geographic distribution is highly uneven, concentrated primarily in western and southwestern Hubei, with Shennongjia Forestry District and Lichuan City harboring the greatest numbers. (3) Well-studied species are mainly those with economic value, flagship species, and regionally representative taxa, while over one-third (55 species) have received virtually no research attention. Research has focused on genetic diversity and structure, future distribution prediction under global change, and phylogeography. (4) According to the *China Red List of Biodiversity—Higher Plants Volume*, Hubei's protected flora includes 9 critically endangered, 30 endangered, 41 vulnerable, and 19 near-threatened species. Major threats include direct harvesting/logging, habitat degradation/loss, and

intrinsic species factors. (5) Currently, 137 species (88%) are wholly or partially within protected areas, while 18 species (12%) occur entirely outside them. Ninety-three species have been introduced and cultivated ex situ, while 62 species lack any ex situ conservation records, and very few species have undergone reintroduction. (6) Seven wild plant species (five endemic to Hubei) with limited distribution ranges remain unlisted despite being affected by intrinsic and anthropogenic factors. This paper identifies weaknesses and gaps in current research and conservation efforts and proposes targeted strategies and recommendations.

Keywords: National Key Protected Wild Plants, geographic distribution, research gap, endangered category, in situ conservation, ex situ conservation, Hubei Province

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Hubei Province is located in central China along the middle and upper reaches of the Yangtze River, within a transitional zone between northern and southern climates, and characterized by a subtropical monsoon climate. The central-southwest China region is internationally recognized as a biodiversity hotspot (Myers et al., 2000; Ying, 2001). Hubei features diverse vegetation types (Qiao et al., 2021) and rich plant diversity with numerous rare, endangered, and endemic species (Ge et al., 1998; Zhang et al., 2009; Dong et al., 2016; Jiang, 2019). The province hosts 6,292 vascular plant species belonging to 292 families and 1,571 genera, including 216 bryophyte species (51 families, 114 genera), 426 fern species (41 families, 102 genera), 100 gymnosperm species (9 families, 29 genera), and 5,550 angiosperm species (191 families, 1,326 genera). Over 150 nationally protected wild plants occur naturally in Hubei, including *Metasequoia glyptostroboides*, *Ginkgo biloba*, *Taxus wallichiana* var. *chinensis*, *T. wallichiana* var. *mairei*, *Pinus dabeshanensis*, *Davidia involucrata*, and *Ormosia henryi*. Among these, *Sinojackia huangmeiensis* is endemic to Hubei.

Hubei has long prioritized resource surveys and conservation of nationally protected wild plants (Ge et al., 1998; Zhang et al., 2009; Jiang, 2017, 2019; Wang et al., 2017; Du and Zheng, 2018). Peng and Li (1990) reported 57 nationally protected plant species in Hubei based on the 1982 list compiled by the State Council Environmental Protection Office and Institute of Botany, Chinese Academy of Sciences, with 16 additional species included in the second batch. Dong et al. (2016) documented 129 endemic seed plant species in Hubei, with the greatest concentration in the Daba Mountains, where most are effectively protected in situ within nature reserves.

The rediscovery of key protected species marks important milestones in Hubei's conservation efforts. *Berchemiella wilsonii* and *Heptacodium miconioides* were first discovered in Xingshan County, Hubei, in 1907. In 2001, *B. wilsonii*, a Category II nationally protected species presumed extinct for nearly a century, was rediscovered in Hubei Houhe National Nature Reserve (Li et al., 2004). In 2022, *H. miconioides*, missing for over 100 years, was found in Hubei Nanhe

National Nature Reserve (Zhang et al., 2023).

The *List of National Key Protected Wild Plants* serves as a critical reference for biodiversity conservation in China. It clarifies conservation targets and provides direct guidance for effective protection measures while establishing legal foundations for combating illegal harvesting and unsustainable utilization (Lu et al., 2021; Yang et al., 2022). The 2021 edition includes approximately 1,101 wild plant species with substantial adjustments to taxonomic groups, protection categories, and species additions/removals (Wu et al., 2023). Based on this updated list, our study systematically clarifies species inventory changes, geographic distribution, research status, endangerment levels, threat factors, and conservation gaps for nationally protected wild plants in Hubei at the provincial scale, providing essential information for targeted conservation strategies.

1. Changes to Hubei's National Key Protected Wild Plant List

According to the 2021 *List of National Key Protected Wild Plants*, integrated with results from Hubei's first and second national surveys, extensive literature review (including reserve survey reports and local floras), herbarium records, and expert consultation, we compiled a list of 155 nationally protected wild plant species in Hubei (Appendix). This includes 11 Category I and 144 Category II species. By management authority, 92 species (e.g., *Metasequoia glyptostroboides*, *Davidia involucrata*, *Emmenopterys henryi*, *Triaenophora rupestris*) fall under forestry and grassland departments, while 63 species (e.g., *Ceratopteris thalictroides*, *Paeonia rockii*, *Camellia sinensis*) are managed by agricultural and rural departments.

Compared with the previous list, three major changes occurred: First, protection levels were adjusted for three species. *Pinus dabeshanensis* was upgraded from Category II to Category I, while *Bretschneidera sinensis* and *Brasenia schreberi* were downgraded from Category I to Category II. Second, 111 species were newly added, with Orchidaceae contributing the most (37 species), followed by Melanthiaceae (18 species). Among these additions, five species were classified as Category I: *Calanthe sieboldii*, *Dendrobium flexicaule*, *D. huoshanense*, *Paeonia qiui*, and *Paeonia rockii*. The remaining 106 species, including *Leucobryum juniperoideum*, *Huperzia chinensis*, *Amentotaxus argotaenia*, and *Actinidia chinensis*, were designated Category II. Third, seven species were removed: *Camphora officinarum* and *Camptotheca acuminata* were deleted from the new list; *Magnolia officinalis* subsp. *biloba*, *Davidia involucrata* var. *vilmoriniana*, and *Toona ciliata* var. *pubescens* were merged with *Houpoea officinalis*, *Davidia involucrata*, and *Toona ciliata*, respectively; and *Cinnamomum japonicum* was confirmed as cultivated in Hubei.

2. Geographic Distribution of National Key Protected Wild Plants in Hubei

Based on county-level (district) distribution data, nationally protected wild plants exhibit extremely uneven spatial distribution in Hubei, with the fewest species in the central hills and Jianghan Plain, and the highest concentration in western and southwestern regions, particularly in Shennongjia Forestry District and Lichuan City [Figure 1: see original paper]. This pattern aligns with previous findings. Ge et al. (1998) identified western and northwestern Hubei as distribution centers for 62 naturally occurring rare and endangered plants. Zhang et al. (2009) divided Hubei into six regions (northwest, southwest, central hills, northeast, southeast, and Jianghan Plain lakes) and found the first batch of 51 nationally protected species most concentrated in southwestern Hubei.

This uneven distribution pattern is closely related to topographic features. Mountains serve as biodiversity hotspots and refugia for rare and endangered plants (Tang et al., 2006; Perrigo et al., 2020), and Hubei's protected flora is primarily montane. The province's topography forms an incomplete basin open to the south, surrounded by mountains on the east, west, and north, with low-lying central areas. Mountainous regions comprise four main sections: northwestern mountains (eastern extension of the Qinling Range, including Wudang Mountain, and eastern Daba Mountains with Shennongjia, Jingshan, and Wushan, peaking at Shennongding at 3,106.2 m); southwestern mountains (northeastern extension of the Yunnan-Guizhou Plateau, including Dalou and Wuling mountains); northeastern mountains (Tongbai-Dabie range at the Hubei-Henan-Anhui border); and southeastern mountains (Mufu range at the Hubei-Hunan-Jiangxi border). In contrast, hilly (central and northeastern Hubei) and plain (Jianghan and eastern Yangtze plains) areas harbor fewer protected species.

3. Research Status of National Key Protected Wild Plants in Hubei

Using Chinese and scientific names of the 155 nationally protected species in Hubei as keywords, we searched CNKI and Web of Science, filtering results for studies conducted within Hubei. We determined the number of publications and research fields for each species, presented as a word cloud [Figure 2: see original paper].

Well-studied species are primarily those with economic value, such as *Nelumbo nucifera*, *Camellia sinensis*, *Houpoea officinalis*, *Gastrodia elata*, *Coptis chinensis*, *Bletilla striata*, and *Brasenia schreberi*. Flagship or regionally representative species like *Ginkgo biloba*, *Metasequoia glyptostroboides*, *Davidia involucrata*, *Berchemiella wilsonii*, *Myricaria laxiflora*, *Tetracentron sinense*, *Cercidiphyllum japonicum*, and *Emmenopterys henryi* have also received considerable attention. However, over one-third (55 species) remain virtually unstudied, including 21 orchids, 12 Melanthiaceae species, and taxa such as *Cibotium barometz*, *Podocarpus macrophyllus*, *Pseudotsuga sinensis*, *Michelia wilsonii*, and *Ilex kaushue*.

Most are newly added in the 2021 list, while some have limited distribution or unclear resource status. Future research should strengthen studies on Hubei endemics (e.g., *Sinojackia huangmeiensis*), regional endemics (e.g., *Berchemiella wilsonii*, *Monimopetalum chinense*, *Heptacodium miconioides*), and newly listed but poorly studied species (e.g., *Calanthe sieboldii*, *Paeonia qiui*, *Leucobryum juniperoideum*).

Research on Hubei's protected plants concentrates on genetic diversity and structure, future distribution prediction under global change, phylogeography, secondary metabolites, pathogens, phylogenetics, community characteristics, conservation strategies, morphological traits, and new distribution records [Figure 2: see original paper]. Genetic diversity is the most frequent keyword over the past 30 years, benefiting from rapid molecular marker development—from isozymes, RAPD, and ISSR (Kang et al., 2005; Li and Ge, 2006; Tian et al., 2012) to microsatellites and AFLP (Liu et al., 2006; Qi et al., 2012), and more recently to SNPs from reduced-representation and whole-genome sequencing (Chen et al., 2020; Xu et al., 2023). The second most common theme is species distribution modeling under global change, facilitated by accessible environmental data and modeling tools. Studies range from single-species distribution modeling (Tang et al., 2017) to multi-species modeling for critically endangered genera with limited occurrence data (Yang et al., 2020; Pan et al., 2022) and simulations of diversity pattern changes (Peng et al., 2022). Based on keyword frequency, future research should emphasize resource surveys and assessment, endangerment mechanisms, recruitment limitation, artificial propagation (seed germination, tissue culture, cutting), ex situ conservation, and reintroduction.

4. Threatened Status and Causes for National Key Protected Wild Plants in Hubei

The *China Red List of Biodiversity—Higher Plants Volume* includes 99 of the 155 nationally protected species naturally distributed in Hubei. Threat categories comprise critically endangered, endangered, vulnerable, and near-threatened species. Specifically, nine critically endangered species include *Ginkgo biloba*, *Amentotaxus argotaenia*, *Brasenia schreberi*, *Paris undulata*, *Calanthe sieboldii*, *Dendrobium flexicaule*, *D. wilsonii*, *Rosa lucidissima*, and *Echinocodon draco*. Thirty endangered species include *Metasequoia glyptostroboides*, *Saruma henryi*, *Bletilla striata*, *Triaenophora rupestris*, and *Heptacodium miconioides*. Forty-one vulnerable species include *Sinojackia huangmeiensis*, *Acer miaotaiense*, *Paeonia rockii*, *Paeonia qiui*, *Michelia wilsonii*, *Taxus wallichiana* var. *chinensis*, and *T. wallichiana* var. *mairei*. Nineteen near-threatened species include *Bretschneidera sinensis*, *Paris polyphylla*, *Camphora longepaniculata*, *Cypripedium henryi*, and *Zelkova schneideriana*.

Primary threat factors include direct harvesting/logging (39 species), habitat degradation/loss (34 species), intrinsic biological factors (10 species), interspecific impacts (3 species), natural disasters (3 species), and environmental pollution (1 species). Twenty-seven species face two or more simultaneous

threats. Overall, external factors—particularly anthropogenic disturbance—represent the primary threats. Therefore, strengthened regulation to prevent illegal harvesting and habitat restoration for population recovery are urgently needed. For species threatened by intrinsic factors, research should focus on developing and implementing appropriate recovery techniques.

5. Conservation Status

5.1 In Situ Conservation

In situ conservation is the most direct approach for protecting rare and endangered plants and their native habitats, typically implemented through national and provincial nature reserves, national parks, and national wetland parks. Ge et al. (1998) found that 55 of 62 naturally distributed rare and endangered plant species (88.7%) in Hubei received in situ protection. Based on the first batch of the national list, Zhang et al. (2009) reported that 47 of 51 protected species in Hubei were effectively conserved within nature reserves or protected plots. The number of protected species in Hubei has increased from over 50 in the first batch to over 150 in the 2021 edition, while nature reserves expanded from 49 in 2008 to 82 in 2018 (Zhang et al., 2009; Department of Ecology and Environment of Hubei Province, 2018).

Based on the 2021 list, we found that 18 species (11.6%) remain entirely outside protected areas [Figure 3: see original paper]. Twelve species (7.7%) have only a single wild population outside protected areas: *Monimopetalum chinense* (Tongshan County), *Podocarpus macrophyllus* (Zhushan County), *Camphora longepaniculata* (Changyang County), *Cymbidium ensifolium* (Enshi Prefecture), *Cymbidium erythraeum* (Chongyang County), *Cymbidium elegans* (Yichang City), *Epigeneium fargesii* (Enshi Prefecture), *Rosa chinensis* var. *spontanea* (Enshi Prefecture), *Sinojackia xylocarpa* (Wuhan City), *Sinojackia henryi* (Wuhan City), *Sinojackia rehderiana* (Wuhan City), and *Changium smyrnioides* (Yangxin County). Six species (3.9%) have multiple populations but all occur outside protected areas: *Torreya grandis*, *Houpoea officinalis*, *Ottelia alismoides*, *Camellia sinensis*, *Echinocodon draco*, and *Chuanminshen violaceum*.

Fifty-two species (33.5%) are entirely within protected areas [Figure 3: see original paper]. Thirty-one species (20.0%) have only a single wild population, including *Sinojackia huangmeiensis*, *Pinus dabeshanensis*, *Taiwania cryptomerioides*, and *Cypripedium fargesii*. Twenty-one species (13.5%) have multiple populations entirely within protected areas, including *Acer miaotaiense*, *Torreya fargesii*, *Abies chensiensis*, and *Paeonia qiui*.

Eighty-five species (54.8%) have multiple populations distributed both inside and outside protected areas [Figure 3: see original paper], including *Davidia involucrata*, *Berchemiella wilsonii*, *Taxus wallichiana* var. *chinensis*, *T. wallichiana* var. *mairei*, *Cercidiphyllum japonicum*, *Tetracentron sinense*, *Em-*

menopterys henryi, *Cibotium barometz*, *Saruma henryi*, and *Triaenophora rupestris*.

5.2 Ex Situ Conservation

Ex situ conservation represents a crucial complementary approach for protecting rare and endangered plants. Hubei has a long history of ex situ conservation for nationally protected species. Based on the earlier protected plant list, Wang et al. (1988) identified protected plant species and their distribution in Hubei, analyzing conservation status and challenges with botanical gardens and nature reserves as focal points. Wang et al. (1995) documented 54 rare and endangered species conserved ex situ at Wuhan Botanical Garden, Chinese Academy of Sciences, and 34 species transplanted across three elevational gradients in Hubei Tongshan Jiugongshan National Nature Reserve. Zhang et al. (2009) noted slow progress in ex situ conservation for the 51 nationally protected species in Hubei based on the first batch of the national list.

Since the 1990s, the Three Gorges Project has prompted extensive assessment and implementation of ex situ conservation for rare and endangered plants in the reservoir area. Jin et al. (1993) evaluated natural conditions and conservation needs for establishing the Yangtze River Three Gorges Botanical Garden, laying the foundation for its establishment in Yichang in 1998. Lin et al. (1996) reviewed the introduction, collection, and preservation of medicinal plants from the Hubei section of the Three Gorges Project at Wuhan Botanical Garden. Ye et al. (2000) designed plant communities for ex situ conservation of rare species from the Three Gorges Reservoir Area at Jiugongshan Reserve based on climatic similarity. Wang et al. (2003) systematically reviewed the natural distribution and ex situ conservation of the endemic species *Myricaria laxiflora* in the Three Gorges Reservoir Area.

Based on the 2021 list, we compiled preliminary data on ex situ cultivation in Hubei, primarily involving Wuhan Botanical Garden (Chinese Academy of Sciences), Three Gorges Botanical Garden, Yangtze Rare Plant Research Institute (China Three Gorges Corporation), and Wuhan Institute of Landscape Architecture. Currently, 93 nationally protected species have been introduced and cultivated, while 62 species lack ex situ conservation records. Among 11 Category I species naturally distributed in Hubei, nine (*Davidia involucrata*, *Metasequoia glyptostroboides*, *Ginkgo biloba*, *Taxus wallichiana* var. *chinensis*, *T. wallichiana* var. *mairei*, *Pinus dabeshanensis*, *Calanthe sieboldii*, *Dendrobium huoshanense*, and *Paeonia rockii*) are conserved ex situ, while *Paeonia qiui* and *Dendrobium flexicaule* are not. Among 144 Category II species, 84 including *Sinojackia huangmeiensis*, *Heptacodium miconioides*, and *Berchemiella wilsonii* have ex situ protection, while 60 species including *Ilex kaushue*, *Triaenophora rupestris*, and *Rosa lucidissima* lack records. Notably, *Sinojackia huangmeiensis* has been cultivated at multiple sites including Shuisha Park in Lichuan, Jinjiata Management Station of Jiugongshan National Nature Reserve, and botanical gardens in Shandong, Zhejiang, Hainan, Yunnan, Guangdong, and Hubei, with

some ex situ populations already flowering and fruiting.

Supported by the National Program for Rescue and Conservation of Plant Species with Extremely Small Populations and the national botanical garden system construction, ex situ conservation in Hubei has developed rapidly over the past decade. However, 40.0% of species still lack ex situ protection, and most cultivated species have not undergone effectiveness evaluation. Future efforts should focus on: (1) strengthening top-level design to accelerate development of a systematic ex situ conservation network in Hubei and central China, addressing current lack of systematic planning and spatial imbalance; (2) enhancing resource surveys and artificial propagation to facilitate introduction of unprotected species; (3) improving site selection, provenance determination, and sampling strategies to enhance adaptability and genetic representation (Wei and Jiang, 2021); and (4) conducting long-term monitoring of ex situ populations to evaluate adaptation from functional traits, genetic coverage, and fitness perspectives, strengthening effectiveness assessment (Liu et al., 2018; Wang et al., 2021; Xiao et al., 2021).

5.3 Reintroduction

Reintroduction cases for nationally protected wild plants in Hubei remain extremely limited. Documented examples include *Myricaria laxiflora*, *Davidia involucrata*, *Phoebe bournei*, *Taxus wallichiana* var. *chinensis*, and *Changiostyrax dolichocarpus*. Only *Myricaria laxiflora* reintroduction in the Three Gorges Reservoir Area has been reported in the literature (Xiao and Jiang, 2020). Therefore, for species with small wild populations, especially those facing extirpation, urgent attention to artificial propagation and reintroduction is needed.

6. Research Gaps for National Key Protected Wild Plants in Hubei

Between 2017-2019, Jiang (2017, 2019) published *Rare and Endangered Plants in Hubei* and *Field Guide to Rare and Endangered Plants in Hubei*, listing provincial-level protected plants. In December 2023, the Hubei Forestry Bureau released the *List of Wild Plant Species with Extremely Small Populations in Hubei*—the first official endangered plant list for the province—containing 30 species, 23 of which are nationally protected. Additionally, seven species with limited distribution ranges remain unlisted despite being affected by intrinsic and anthropogenic factors. Five are named after Hubei localities: *Fraxinus hupehensis*, *Primula hubeiensis*, *Manglietia patungensis*, *Yulania pilocarpa*, and *Prunus hongpingensis*. Five are Hubei endemics: *Fraxinus hupehensis*, *Primula hubeiensis*, *Deinanthe caerulea*, *Yulania pilocarpa*, and *Prunus hongpingensis*.

Fraxinus hupehensis (Oleaceae), also known as duijie bai la or Hubei bai la, is a large deciduous tree endemic to China, distributed in Jingshan and Zhongxiang counties of Hubei, with type specimens collected in Jingshan.

Primula hubeiensis (Primulaceae) is a perennial herb endemic to Hubei, with type specimens collected in Jiugongshan National Nature Reserve, Tongshan County (Li et al., 2017).

Deinanthe caerulea (Hydrangeaceae), also known as yin mei cao, is a perennial herb with distinct ornamental value, featuring bifurcate leaf apices and blue flowers. Currently known only from western Hubei (Yichang, Zigui, Xingshan, Shennongjia, Fangxian, Nanzhang, Baokang, and Gucheng counties), its wild populations are extremely rare with unclear resource status, requiring strengthened surveys, germplasm evaluation, and sustainable use research. Wuhan Botanical Garden has conducted ex situ conservation for this species.

Manglietia patungensis (Magnoliaceae) is an evergreen tree endemic to China, listed as Vulnerable in the *China Red List of Biodiversity—Higher Plants Volume* and *China Plant Red Data Book*, with IUCN status VU. In Hubei, it occurs in Badong, Lichuan, and Xianfeng counties, with additional populations in Sichuan, Chongqing, Jiangxi, and Hunan. Wuhan Botanical Garden has conducted wild resource surveys, ex situ conservation, and reintroduction for this species.

Yulania pilocarpa (Magnoliaceae) is a deciduous tree endemic to China, listed as Endangered in the China Red List with IUCN status EN. Its distribution covers less than 100 km^2, with severe habitat degradation and loss. It occurs only in Luotian and Yingshan counties of Hubei, urgently requiring enhanced field surveys, artificial propagation, and ex situ conservation.

Prunus hongpingensis (Rosaceae) is a deciduous tree endemic to China, not yet included in IUCN or national red lists. It occurs only in Shennongjia Forestry District with extremely few individuals. Immediate wild resource surveys and assessment are needed for listing and effective conservation. Dai et al. (2023) sequenced its whole genome, clarified phylogenetic relationships with relatives, and elucidated its evolutionary history and local adaptation.

Primula filchnerae (Primulaceae) is a biennial herb endemic to China, known only from Hubei (Zhushan and Zhuxi counties) and Shaanxi (Xunyang, Yangxian, and Mianxian counties). First collected and described by German scholars in 1904, it remained undiscovered thereafter and the type specimen was destroyed. In 2006, Hubei botanists rediscovered it after more than a century and designated a neotype (Gan and Li, 2015). Wuhan Botanical Garden and Xi'an Botanical Garden have conducted artificial propagation, ex situ conservation, and reintroduction for this species.

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Appendix: 2021 Edition of Hubei Province National Key Protected Wild Plants List

Species	Family	Protection Category	Remark
Leucobryum juniperoideum	Leucobryaceae	Category II	Added
Huperzia chinensis	Lycopodiaceae	Category II	Added
Huperzia crispata	Lycopodiaceae	Category II	Added
Huperzia emeiensis	Lycopodiaceae	Category II	Added
Huperzia nanchuanensis	Lycopodiaceae	Category II	Added
Huperzia serrata	Lycopodiaceae	Category II	Added
Huperzia sutchueniana	Lycopodiaceae	Category II	Added
Cibotium barometz	Cibotiaceae	Category II	—
Ceratopteris thalictroides	Pteridaceae	Category II	—
Ceratopteris pteridoides	Pteridaceae	Category II	—
Ginkgo biloba	Ginkgoaceae	Category I	—
Podocarpus macrophyllus	Podocarpaceae	Category II	Added
Metasequoia glyptostroboides	Cupressaceae	Category I	—
Taiwania cryptomerioides	Cupressaceae	Category II	—
Amentotaxus argotaenia	Taxaceae	Category II	Added
Cephalotaxus oliveri	Taxaceae	Category II	—

Species	Family	Protection Category	Remark
Taxus wallichiana var. *chinensis*	Taxaceae	Category I	—
Taxus wallichiana var. *mairei*	Taxaceae	Category I	—
Torreya fargesii	Taxaceae	Category II	—
Torreya grandis	Taxaceae	Category II	—
Abies chensiensis	Pinaceae	Category II	—
Picea neoveitchii	Pinaceae	Category II	—
Pinus dabeshanensis	Pinaceae	Category I	Changed to Category I
Pseudolarix amabilis	Pinaceae	Category II	—
Pseudotsuga sinensis	Pinaceae	Category II	—
Brasenia schreberi	Cabombaceae	Category II	Changed to Category II
Saruma henryi	Aristolochiaceae	Category II	Added
Houpoea officinalis	Magnoliaceae	Category II	Merged with *Magnolia officinalis* subsp. *biloba*
Liriodendron chinense	Magnoliaceae	Category II	—
Michelia wilsonii	Magnoliaceae	Category II	—
Cinnamomum longepaniculatum	Lauraceae	Category II	—
Machilus nanmu	Lauraceae	Category II	Added
Phoebe bournei	Lauraceae	Category II	—
Phoebe zhennan	Lauraceae	Category II	—

Species	Family	Protection Category	Remark
Ottelia alismoides	Hydrocharitaceae	Category II	Added
Paris delavayi	Melanthiaceae	Category II	Added
Paris bashanensis	Melanthiaceae	Category II	Added
Paris fargesii	Melanthiaceae	Category II	Added
Paris fargesii var. *petiolata*	Melanthiaceae	Category II	Added
Paris fargesii var. *oblongifolia*	Melanthiaceae	Category II	Added
Paris marmorata	Melanthiaceae	Category II	Added
Paris polyphylla	Melanthiaceae	Category II	Added
Paris polyphylla var. *alba*	Melanthiaceae	Category II	Added
Paris polyphylla var. *chinensis*	Melanthiaceae	Category II	Added
Paris polyphylla var. *latifolia*	Melanthiaceae	Category II	Added
Paris polyphylla var. *pseudothibetica*	Melanthiaceae	Category II	Added
Paris polyphylla var. *scabra*	Melanthiaceae	Category II	Added
Paris polyphylla var. *stenophylla*	Melanthiaceae	Category II	Added
Paris polyphylla var. *yunnanensis*	Melanthiaceae	Category II	Added
Paris thibetica	Melanthiaceae	Category II	Added

Species	Family	Protection Category	Remark
Paris undulata	Melanthiaceae	Category II	Added
Paris nitida	Melanthiaceae	Category II	Added
Paris qiliangiana	Melanthiaceae	Category II	Added
Cardiocrinum cathayanum	Liliaceae	Category II	Added
Fritillaria anhuiensis	Liliaceae	Category II	Added
Fritillaria monantha	Liliaceae	Category II	Added
Fritillaria taipaiensis	Liliaceae	Category II	Added
Lilium fargesii	Liliaceae	Category II	Added
Lilium papilliferum	Liliaceae	Category II	Added
Anoectochilus roxburghii	Orchidaceae	Category II	Added
Bletilla striata	Orchidaceae	Category II	Added
Calanthe striata var. *sieboldii*	Orchidaceae	Category I	Added
Changnienia amoena	Orchidaceae	Category II	Added
Cremastra appendiculata	Orchidaceae	Category II	Added
Cymbidium ensifolium	Orchidaceae	Category II	Added
Cymbidium faberi	Orchidaceae	Category II	Added
Cymbidium floribundum	Orchidaceae	Category II	Added
Cymbidium goeringii	Orchidaceae	Category II	Added
Cymbidium kanran	Orchidaceae	Category II	Added
Cymbidium erythraeum	Orchidaceae	Category II	Added
Cymbidium elegans	Orchidaceae	Category II	Added

Species	Family	Protection Category	Remark
Cymbidium macrorhizon	Orchidaceae	Category II	Added
Cypripedium debile	Orchidaceae	Category II	Added
Cypripedium fargesii	Orchidaceae	Category II	Added
Cypripedium fasciolatum	Orchidaceae	Category II	Added
Cypripedium flavum	Orchidaceae	Category II	Added
Cypripedium franchetii	Orchidaceae	Category II	Added
Cypripedium henryi	Orchidaceae	Category II	Added
Cypripedium japonicum	Orchidaceae	Category II	Added
Cypripedium guttatum	Orchidaceae	Category II	Added
Dendrobium fargesii	Orchidaceae	Category II	Added
Dendrobium flexicaule	Orchidaceae	Category I	Added
Dendrobium huoshanense	Orchidaceae	Category I	Added
Dendrobium hancockii	Orchidaceae	Category II	Added
Dendrobium loddigesii	Orchidaceae	Category II	Added
Dendrobium lohohense	Orchidaceae	Category II	Added
Dendrobium moniliforme	Orchidaceae	Category II	Added
Dendrobium nobile	Orchidaceae	Category II	Added
Dendrobium officinale	Orchidaceae	Category II	Added
Dendrobium wilsonii	Orchidaceae	Category II	Added
Gastrodia elata	Orchidaceae	Category II	Added
Gymnadenia orchidis	Orchidaceae	Category II	Added
Pleione bulbocodioides	Orchidaceae	Category II	Added

Species	Family	Protection Category	Remark
Pleione forrestii	Orchidaceae	Category II	Added
Pleione pleionoides	Orchidaceae	Category II	Added
Pleione hookeriana	Orchidaceae	Category II	Added
Corydalis saxicola	Papaveraceae	Category II	Added
Dysosma difformis	Berberidaceae	Category II	Added
Dysosma majoensis	Berberidaceae	Category II	Added
Dysosma pleiantha	Berberidaceae	Category II	Added
Dysosma delavayi	Berberidaceae	Category II	Added
Dysosma versipellis	Berberidaceae	Category II	Added
Sinopodophyllum hexandrum	Berberidaceae	Category II	Added
Coptis chinensis	Ranunculaceae	Category II	Added
Coptis chinensis var. *brevisepala*	Ranunculaceae	Category II	Added
Nelumbo nucifera	Nelumbonaceae	Category II	—
Tetracentron sinense	Trochodendraceae	Category II	—
Paeonia qiui	Paeoniaceae	Category I	Added
Paeonia rockii	Paeoniaceae	Category I	Added
Paeonia cathayana	Paeoniaceae	Category II	Added
Cercidiphyllum japonicum	Cercidiphyllaceae	Category II	—
Rhodiola yunnanensis	Crassulaceae	Category II	Added
Glycine soja	Fabaceae	Category II	Added
Ormosia henryi	Fabaceae	Category II	—
Ormosia hosiei	Fabaceae	Category II	—

Species	Family	Protection Category	Remark
Ormosia nuda	Fabaceae	Category II	Added
Prunus kansuensis	Rosaceae	Category II	Added
Rosa chinensis var. *spontanea*	Rosaceae	Category II	Added
Rosa lucidissima	Rosaceae	Category II	Added
Berchemiella wilsonii	Rhamnaceae	Category II	Added
Zelkova schneideriana	Ulmaceae	Category II	—
Morus wittiorum	Moraceae	Category II	Added
Fagus hayatae	Fagaceae	Category II	—
Quercus oxyphylla	Fagaceae	Category II	Added
Monimopetalum chinense	Celastraceae	Category II	—
Trapa incisa	Lythraceae	Category II	—
Acer miaotaiense	Sapindaceae	Category II	Added
Eurycorymbus cavaleriei	Sapindaceae	Category II	—
Citrus cavaleriei	Rutaceae	Category II	Added
Phellodendron chinense	Rutaceae	Category II	—
Toona ciliata	Meliaceae	Category II	Merged with *Toona ciliata* var. *pubescens*
Bretschneidera sinensis	Akaniaceae	Category II	Changed to Category II
Myricaria laxiflora	Tamaricaceae	Category II	Added
Fagopyrum dibotrys	Polygonaceae	Category II	—

Species	Family	Protection Category	Remark
Davidia involucrata	Nyssaceae	Category I	Merged with *Davidia involucrata* var. *vilmoriniana*
Camellia sinensis	Theaceae	Category II	Added
Sinojackia dolichocarpa	Styracaceae	Category II	—
Sinojackia xylocarpa	Styracaceae	Category II	—
Sinojackia henryi	Styracaceae	Category II	Added
Sinojackia rehderiana	Styracaceae	Category II	Added
Sinojackia huangmeiensis	Styracaceae	Category II	Added
Actinidia arguta	Actinidiaceae	Category II	Added
Actinidia chinensis	Actinidiaceae	Category II	Added
Actinidia macrosperma	Actinidiaceae	Category II	Added
Emmenopterys henryi	Rubiaceae	Category II	—
Osmanthus venosus	Oleaceae	Category II	Added
Triaenophora rupestris	Orobanchaceae	Category II	—
Ilex kaushue	Aquifoliaceae	Category II	Added
Echinocodon draco	Campanulaceae	Category II	Added
Heptacodium miconioides	Caprifoliaceae	Category II	—
Panax japonicus	Araliaceae	Category II	Added
Panax japonicus var. *bipinnatifidus*	Araliaceae	Category II	Added

Species	Family	Protection Category	Remark
Panax japonicus var. *major*	Araliaceae	Category II	Added
Changium smyrnioides	Apiaceae	Category II	Added
Chuanminshen violaceum	Apiaceae	Category II	Added

Note: Species marked with * are managed by the Ministry of Agriculture and Rural Affairs; all others are managed by the National Forestry and Grassland Administration. "—" indicates species included in the 1999 list with unchanged protection status and no merged taxa.

Note: Figure translations are in progress. See original paper for figures.