**Crop Vulnerability Statement for**

**Woody Landscape Plant Germplasm**

*Updated September 2020*

**Summary**

Genetic resources are the foundation of American agriculture’s current and future success - the security, health, and genetic integrity of these resources must be safeguarded. Protecting, managing, and utilizing collections of woody landscape plant genetic resources present significant challenges. These include resolution of taxonomic misidentifications and nomenclatural confusion; conservation of at-risk populations with high genetic diversity; evaluation of those with an unknown potential to invade; and dealing with large plants that have long generation times and often recalcitrant seed-storage qualities. Thus, woody landscape plants uniquely require substantial resources to collect, preserve, evaluate, and distribute the germplasm appropriately.

Genetic diversity in many U.S. landscapes is insufficient as these landscapes rely on too few cultivars or taxa or they are over-planted with one cultivar or taxon to create monocultures. This makes the landscapes vulnerable to a host of known and cryptic biotic and abiotic threats, and less likely to provide the ecosystem and societal services for which they were designed. As part of the solution to create resilient landscapes across an urban, suburban, and rural gradient, we must effectively acquire, curate, evaluate, distribute and use woody landscape plant genetic resources.

Due to the breadth of genera and shifting plant genetic resource needs of the nursery industry, it is impractical to list specific threatened or priority genera in this Crop Vulnerability Statement (CVS). Instead, this CVS serves to identify themes of threats and vulnerabilities to woody landscape plants and provides a foundation upon which to support germplasm collection, evaluation, and management priorities as biotic or abiotic threats to specific genera emerge. In this adaptive management approach, priority or targeted genera are established based on critical threats identified through interactive and regular input from stakeholders (breeders, nursery industry, CGC members, conservationists, urban foresters). In this responsive model, priority is assigned to taxa based on a combination of their use/value to the US nursery industry, their potential to tolerate abiotic stresses in areas where they are currently underutilized, and species that are threatened or imperiled in their native habitats.

This CVS complements and supports the Crop Vulnerability “Quad” for Woody Landscape Plant Germplasm, which will be reviewed and updated annually when the WLPCGC meets. The “Quad” functions as an “at-a-glance” summary document that is especially useful for conveying information to ARS’s Office of National Programs or Administrators.

1. **Introduction**

There is a growing body of knowledge demonstrating that landscape trees and shrubs are essential resources that enhance residential, public, and commercial environments, particularly urban and suburban settings. These plants play key ecological roles by mitigating poor air and water quality, sequestering carbon, decreasing runoff and erosion, and supporting storm water management. Landscape plants add value to residential and commercial property, increase sales, and reduce energy and maintenance costs of buildings and roadways. They also play key roles in recreational activities and human well-being, which generates revenue for municipalities through use of public space and tourism. In addition to the broad impact on citizens and communities, landscape plants support the horticulture industry, which contributes $196 billion to the US economy across a diverse array of businesses. Specifically, nursery growers contribute over $4.2 billion in sales resulting from 8,000 operations, the majority of which are small (<$500,000 in annual sales) family-owned businesses. The U.S. is the world’s largest producer of and market for woody landscape crops. These growers depend on a diverse and dynamic array of woody landscape plants for resistance to pests and diseases, tolerance to environmental extremes, adaptation to planting in sustainable landscapes, and meeting changing consumer demands and trends. As the US becomes more urbanized, not only do the vital role that woody landscape plants play in our communities and within society become more pronounced, but their social and economic value substantially increases.

There are between 1,200 and 1,500 genera that constitute the array of woody landscape plants found in the entire United States (Rehder, 1940), of which ~200 are commonly planted in U.S. landscapes. Historically, introduction of new material was heavily weighted towards international rather than domestic collections, due in part to the floristic richness of areas such as eastern Asia, where similarities in climatic and edaphic factors have led to successful introduction, cultivation, and integration of novel plant germplasm into American horticulture. However, the demand for native North American landscape plants has increased in the last two decades, driven by federal land managers, conservationists, the nursery industry, and the public. Native plant sales rose to 22% of total nursery sales in 2003 (Hodges et al., 2008) and are expected to continue to increase (Brzuszek et al., 2007; Brzuszek and Harkess, 2009; Cartabianco and Lubell, 2013; Kauth and Perez, 2011). This is due in part to increased awareness of the spread of exotic, invasive plant species and the potential impact on native plants and ecosystems (Reichard and White, 2001), and value-driven judgments on native plant use for sustainable landscapes (Kendle and Rose, 2000). For both native and non-native species, genetically diverse germplasm is necessary to maintain the underlying genetic variation essential to create landscapes resilient in the face of global change (Johnson et al., 2010).

Compared to other crop commodities in the United States, breeding efforts of woody landscape plants are disproportionately low, especially considering the value of woody landscape plants to the U.S. economy. A 1994 survey published as the ‘National Plant Breeding Study-I’ in 1996 by Iowa State University revealed there were 18 ornamental breeders at universities (11.7 woody); five ornamental breeders in ARS (four woody); and 64 ornamental breeders in industry (23.9 woody, omitting pine). Because of the long life cycles and the high cost involved in breeding woody plants, most small nurseries cannot afford the investment to operate breeding programs; many nurseries simply select and release new cultivars through chance seedling selection or mutations. A few genera, such as rhododendrons and roses, have hobbyist breeders; however, these efforts primarily focus on breeding for large showy flowers or other aesthetic qualities and often do not involve multi-generation crossing programs to incorporate resistance to pests or tolerance to urban and other environmental stresses. Today, fewer public institutions have active woody ornamental breeding programs. These include the USDA/ARS U.S. National Arboretum, the University of Connecticut, University of Minnesota, Rutgers University, Texas A&M, North Carolina State University, University of Georgia, Mississippi State University, University of Arkansas, North Dakota State University, University of Florida, Cornell University, Ohio State University, University of Hawaii, and Oregon State University. Decreased support levels have resulted in many public institutions either reducing or eliminating their breeding programs, and of the university programs, it is likely that some pending retirements will not be re-filled with woody plant breeders. The Morton Arboretum, Holden Arboretum, and Longwood Gardens are the only privately funded arboreta known to have active breeding programs in woody landscape plants.

1. **Urgency and extent of crop threats and vulnerabilities**

As summarized above, woody landscape plants are an important, vital part of the US economy, the environment, and society. There are a host of pressures and concerns which threaten these plants and their managed landscapes; one of the most serious issues is the relative lack of genetic diversity of landscape plants which is critical in building resiliency in the face of other threats. While there is great potential for many additional genera and species to be used as landscape plants, the genetic base of individual species under cultivation is often narrow. In fact, some woody landscape plants are represented by only a few clones, or points of introduction from wild sources. Moreover, many urban landscapes rely upon just a few species. For instance, green ash, redtip photinia, American sycamore, honeylocust, silver maple, freeman maple, Indian hawthorn, and Bradford pear are all used extensively in certain regions. Such a narrow genetic base increases a landscape’s vulnerability to catastrophic loss by insects, diseases, and environmental stresses, as shown by several examples during the past 70 years. Extensive and uniform plantings of American elm resulted in major losses of urban street trees due to Dutch elm disease, beginning in the 1950s. During the same time period, the Lethal Yellowing phytoplasma decimated vast numbers of Atlantic Tall coconut palms in Florida. More recently, the imported wooly adelgid has caused widespread destruction of hemlocks in the eastern United States. And ashes, many planted to replace American elm, are now under attack from the emerald ash borer with devasting losses to natural and urban forests from Illinois to the eastern seaboard, and westward to Colorado. Multiple genera in the Lauraceae, including sassafras, are threatened by an introduced ambrosia beetle which causes a lethal fungal infection. Lastly, numerous woody genera are threatened by the spotted lanternfly which is rapidly spreading from the mid-Atlantic region. In addition to these and many other well-known pests (see below) that pose significant risk to woody landscape plants, monitoring for future biotic threats must be ongoing as host preferences change and novel pests continue to be unintentionally imported.

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| **Serious Pests of Woody Landscape Plants** |
| Pest | Current species at risk |
| Asian Gypsy Moths | Numerous North American woody plant species |
| Asian Longhorn Beetle | Numerous ornamental trees incl. Maple, Birch, Elm |
| Balsam Woolly Adelgid | Fir, particularly Fraser Fir |
| Beech Leaf Disease | All beech species |
| Brown Marmorated Stink Bug | Ornamental and fruit trees incl. Maple, Ash, *Prunus* |
| Chestnut Blight | North American *Castanea* |
| Coconut Rhinoceros Beetle | Palm trees |
| Dogwood Anthracnose | *Conus florida* and *C. nuttallii* |
| Dutch Elm Disease | Elm and Zelkova |
| Emerald Ash Borer | North American Ash and potentially *Chionanthus* |
| European Cherry Fruit Fly | Select *Prunus* spp. |
| European Gypsy Moth | 300 spp. of trees and shrubs |
| Erythrina Gall Wasp | Erythrina in Hawaii |
| False Codling Moth | >100 host plants incl. Hibiscus, Oak, Persimmon, Walnut |
| Hemlock Woolly Adelgid | *Tsuga* spp. |
| Hickory Dieback | *Carya* spp. |
| Laurel Wilt | Lauraceae trees and shrubs |
| Lethal Yellowing | Palm trees |
| Light Brown Apple Moth | >2000 species incl. trees and agricultural crops |
| Oak Wilt | *Quercus* spp. |
| Phytophthora lateralis | *Cupressaceae, Taxaceae, Actinidiaceae* |
| Rose Rosette Disease | *Rosa* cultivars |
| Spotted Lanternfly | Ornamental and fruit trees incl. Maple, Oak, Pine, Sycamore |
| Sudden Oak Death | >75 spp. Incl. Oak, Viburnum, Witchhazel, Lilac, Rhododendron |
| Thousand Canker Disease | Black Walnut |
| Viburnum Leaf Beetle | *Viburnum* spp. |

Abiotic (i.e., environmental) stresses also threaten woody landscape plant germplasm in the U.S., particularly in urban environments, and are expected to become more pronounced as a result of climate change. As weather patterns fluctuate, these environments (and plant material growing in them) experience extremes in precipitation (droughts and flooding) and temperature (absolute highs and lows, as well as late- and early-season events). Survival of woody landscape plants in urban environments relies on their tolerance to other abiotic stresses, including soils that are often heterogenous, compacted, calcified, or laden with salts; air pollution; vandalism; and other human-induced factors. Unlike most other crop plants, woody landscape plants contribute extensively to the long-term health and stability of natural and man-made ecosystems, and are often used to ameliorate or remediate these stress-prone environments. Therefore, it is critical that we identify, conserve, evaluate, and distribute a diverse palette of germplasm that can tolerate these conditions, or develop tolerant selections through breeding.

Woody landscape plants are not only threatened by, but can act as, biological invaders. The WLPCGC recognizes that while plant introduction and improvement are the foundation of modern horticulture, yielding a diversity of useful plants for managed landscapes and gardens, a small proportion of introduced plant species become invasive and cause negative impacts to natural systems and biological diversity (Richardson and Rejmánek, 2011; Williamson and Fitter, 1996). The issue is complicated by the fact that species can be invasive in some regions, but not in others, and the impacts of biological invaders can occur at times and places far removed from the site of introduction. These principles have been reiterated by several groups, including the National Invasive Species Council established by the Federal Executive Order 13112 on February 3, 1999, and the St. Louis Declaration (December 2001). The National PLANTS Database (http://plants.usda.gov), maintained by the USDA NRCS, maintains lists of invasive, threatened, and endangered plants**.** Thus, it is essential that known or potential invasiveness be considered when making decisions regarding woody landscape plant priority genera, collection/exchange proposals, and curation.

On the other end of the extreme are the plants in nature that are threatened with extinction. Concerns about these plants have resulted in federal, state and local legislation including the Endangered Species Act of 1973 (ESA). The ESA was enacted to protect endangered plant and animal species and their habitats. Ex situ germplasm collections preserve endangered woody plants and their populations and provide essential material for research and reintroduction programs. Maintenance, distribution and research on rare plants also support the nursery industry, as numerous species of woody plants of conservation value in the US and abroad are also recognized ornamentals (e.g., *Hamamelis ovalis, Rhododendron vaseyi, Kolkwitzia amabilis* just to name a few). A growing number of nurseries are playing an active role in the preservation and reintroduction of threatened and endangered plants. Many activities related to US threatened and endangered species are coordinated by the Center for Plant Conservation, along with federal, state and regional conservation alliances. International transportation of endangered species is governed by the Convention on International Trade in Endangered Species (CITES). These and other challenges – accelerated changes in land use, degradation in soil, water and air quality, and changes in the political climate towards plant collecting – decrease genetic diversity in natural populations and restrict access to genetic resources in many key locations. Thus, it is imperative that the genetic base of vulnerable target species be expanded while opportunities allow.

Post-collection, woody plant germplasm is subject to logistical vulnerabilities that are distinct from many other crops. Species categorized as having desiccation-intolerant (recalcitrant) seeds cannot be stored using traditional methods. In such instances, germplasm preservation may require budwood storage, tissue culture, or cultivation of living plants within *ex situ* sites. Ex situ conservation of living organisms offers convenient access to material for research activities and a source for further collection and distribution of seed and clonal germplasm. However, these collections require more space, and the plants can outcross with related taxa. For some species, seed desiccation-tolerance or seed dormancy-breaking remains unknown, therefore requiring years of study to adequately assess. Given that all seed has a finite storage time, all accessions will ultimately require recollection at the taxon- or population-level, or regeneration of seed ex situ. For woody plants, regeneration from seed may take several decades and require special considerations for pollination vectors and outcrossing protection.

1. **Status of Woody Landscape Plant Genetic Resources in the NPGS available for reducing genetic vulnerabilities**

Woody landscape plant germplasm is conserved by numerous institutions both within and beyond the National Plant Germplasm System (NPGS). The following sections describe NPGS institutions with Woody Landscape Plant holdings.

*National Plant Germplasm System (NPGS)*–The NPGS is one of the components of the U.S. National Genetic Resources Program which also conserves genetic resources of animals, microbes and invertebrates. The mission of the NPGS is to collect, document, maintain, evaluate, enhance, distribute and preserve the plant genetic resources necessary for improving the quality and production of economic crops important to U.S. and global agriculture.

*National Germplasm Resources Laboratory (NGRL)* – The National Germplasm Resources Lab facilitates the acquisition, exchange, and documentation of crop genetic resources important to world food security. This is accomplished by coordinating plant exploration activities for the U.S. National Plant Germplasm System; conducting research on plant pathogens of quarantine significance; facilitating activities of the Crop Germplasm Committees; and developing and operating an information management system, GRIN-Global (Germplasm Resources Information Network) that documents USDA’s genetic resource collections. The Plant Exchange Office (PEO) manages the USDA/ARS Plant Exploration/Exchange program to acquire needed germplasm for the NPGS. Scientists develop proposals according to PEO guidelines. The proposals are first reviewed and endorsed by the appropriate Crop Germplasm Committee, then reviewed by a subcommittee of the NPGS for possible funding. The PEO works with the proposed host country to obtain the necessary access to their germplasm and develops any required agreements concerning the use, ownership and distribution of the germplasm. Collected germplasm and documentation are forwarded to the appropriate NPGS collection where they are maintained according to NPGS policy. PEO also supports the NPGS by facilitating NPGS distributions, maintaining liaisons with USDA/APHIS, assigning the NPGS PI numbers, helping determine NGPS germplasm needs, participating in plant explorations, and developing international collaborations to support germplasm activities.

*Pertinent National Plant Germplasm System Repositories -* Within the NPGS, a network of active sites located throughout the U.S. manages working collections of a diverse array of plant germplasm and associated information. A summary of relevant NPGS active sites is presented in the following table. Information on the sites can be found at www.ars‑grin.gov/npgs/holdings.html. Active sites deal directly with germplasm users and are dedicated to making germplasm and information available for research and crop improvement. The most comprehensive collections are managed by the Woody Landscape Plant Germplasm Repository (WLPGR) in Beltsville, MD and Washington, DC.The overall objectives of the WLPGR are to introduce, maintain, and distribute diverse and wild-origin genetic resources of trees and shrubs for landscape use through collection, exchange, and evaluation. Woody plant germplasm is also evaluated for production potential and further characterized using biochemical and molecular DNA technologies. The repository is responsible for maintaining 218 genera. More than 1,400 accessions of seeds are maintained in a medium-term storage facility, and 2,800 plants are maintained on the grounds at Beltsville, MD and Washington, DC.

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| **NPGS active sites with important collections of woody landscape plants** |
| **Site** | **Location** | **Pertinent Collections** | **Form Held** |
| Woody Landscape Plant Germplasm Repository (including the US National Arboretum) | Beltsville, MD, and Washington, DC | 218 genera | Plants, seeds |
| North Central Regional Plant Introduction Station | Ames, IA | ca. 30 genera | Seeds, plants  |
| National Clonal Germplasm Repository | Brownwood and Somerville, TX | *Carya* | Plants |
| National Clonal Germplasm Repository | Corvallis, OR | *Corylus, Cydonia, Pyrus, Ribes, Rubus, Sambucus, Sorbus, Vaccinium* | Plants, seeds |
| National Germplasm Repository | Davis, CA | *Actinidia, Diospyros, Ficus, Juglans, Morus, Olea, Pistacia, Prunus, Punica, Vitis* | Plants |
| Plant Genetic Resources Unit | Geneva, NY | *Malus, Prunus, Vitis* | Plants, seeds |
| Plant Genetic Resources Management Unit | Griffin, GA | *Hibiscus*, *Indigofera, Leucaena, Pueraria, Senna*, woody legumes | Seeds, plants |
| Tropical Plant Genetic Resource Management Unit | Hilo, HI | *Artocarpus, Averrhoa, Bactis, Canarium, Carica, Dimocarpus, Litchi, Macadamia, Malpighia, Nephelium, Passiflora, Psidium* | Plants |
| Tropical Agriculture Research Station | Mayaguez, PR | Tropical genera | Plants |
| National Germplasm Repository | Miami, FL | Sub-tropical genera | Plants |
| Western Regional Plant Introduction Station | Pullman, WA | *Amorpha, Artemisia,* *Genista* and various range shrubs | Seeds, plants |
| National Clonal Germplasm Repository | Riverside, CA | *Citrus* and related Rutaceae, *Phoenix* | Plants |

*National Laboratory for Genetic Resource Preservation (NLGRP) -* NPGS working collections are made more secure through intentional duplication in a base collection designed for long-term conservation. The NPGS base collection is managed by the NLGRP (formerly known as the National Seed Storage Laboratory) in Fort Collins, CO. The NLGRP, through its two plant-oriented research units, services active sites by providing back-up under the best possible storage conditions and by developing and testing protocols that improve long-term preservation and viability monitoring. In addition, the NCGRP houses collections for the Plant Variety Protection Office, the Center for Plant Conservation, and various other institutions. The NLGRP does not generally distribute its collections directly to users, but collaborates closely with curators at the active sites to improve conservation and management.

At present, only small proportions of most of the pertinent woody landscape plant germplasm collections are backed up at the NLGRP, but the Center is conducting research on preserving clonal materials (including vegetative buds) under cryogenic conditions, which should accelerate the back-up process.

* 1. ***Status of Germplasm Acquisition – exploration and exchange***

Before germplasm can enter any of the NPGS repositories, it must be acquired. The acquisition of foreign and domestic plant germplasm through exploration and exchange is vital to expand plant diversity and drives the sustained growth of the nursery and landscape industries. Plant exploration activities have not always been coordinated with preservation; consequently, the germplasm and the associated information on many of these resources are no longer available. In the past decade, the NPGS has developed effective protocols for obtaining access to plant genetic resources in many countries, established ethical and standardized plant collecting methods, and has continued to support numerous explorations. In addition, successful explorations have been conducted by botanic gardens, as well as under commercial, university, and individual sponsorship. However, international law now dictates that genetic resources are a sovereign resource of the country of origin and no longer the common heritage of humankind. Consequently, access to plant genetic resources in many countries is limited. New strategies that include increased collaboration and additional resources are now required to continue international plant exploration and exchange activities. Additionally, importing germplasm carries inherent risks, such as the introduction of potentially invasive plants and other biological pests.

Many botanic gardens and arboreta are involved in domestic and international plant exploration activities. Some of these gardens are: the US National Arboretum, the Holden Arboretum, Dawes Arboretum, Polly Hill Arboretum, Morton Arboretum, Chicago Botanic Garden, Morris Arboretum of the University of Pennsylvania, Longwood Gardens, University of Washington Botanic Gardens, Missouri Botanical Garden, the Arnold Arboretum of Harvard University, California Botanic Garden, Desert Botanical Garden, The Montgomery Botanical Center, Fairchild Gardens, Atlanta Botanical Garden, Huntington Botanical Gardens, JC Raulston Arboretum (North Carolina State University), National Tropical Botanical Garden, Quarryhill Botanical Garden, Denver Botanic Gardens, Santa Barbara Botanic Garden, UC Davis Arboretum, University of California at Berkeley, and Lyon Arboretum (University of Hawaii). In turn, most of these institutions share their germplasm with other gardens and repositories or universities, including those within the NPGS. Plant exploration and collecting has also been improved by the formation of consortia. Examples include the North America-China Plant Exploration Consortium (NACPEC) and the Plant Collecting Collaborative.

The WLPCGC must work with NPGS curators to determine if priority genera are represented by known sources and if the collections include representative genetic diversity. Based on this assessment, future collection/exchange programs can be tailored to fill gaps in species, collection locations, or specific traits.

* 1. ***Status of Germplasm Evaluation***

The value of germplasm is often not fully realized until it has been characterized or evaluated in field or landscape settings. It can then be further enhanced by breeders and other scientists and recipients of germplasm after distribution. Evaluation of landscape plant germplasm is conducted by numerous institutions as part of their introduction programs, encompassing a range of evaluation, breeding and selection projects. Because many botanic gardens, universities and nurseries conduct these evaluations, it is often difficult to standardize the data due to genotype × environment effects, or difficulties in linking provenance data to evaluation results.

Most woody landscape plants are evaluated based on the accession’s value as a cultivar per se, and not on its genetic potential in a long-term breeding program. The long maturation period for woody plants, coupled with the fact that most woody landscape plants evaluated are not far removed (genetically) from their natural populations, exacerbates the issue. Thus, plant lineages that may possess unique genetic traits are often discarded prematurely because initial evaluation reveals limitations in specific adaptation or other characteristics. Ideally, plant germplasm should be characterized for all important traits, including disease and insect resistance, tolerance to various environmental stresses, amenability to production, and aesthetic qualities such as habit and foliar and floral characteristics.

Provenance trials and biosystematic studies are also used to evaluate woody plant germplasm. Although valuable, one limitation of these reports is a lack of evaluation of aesthetic or landscape characteristics. Many studies are often limited in scope, not associated with germplasm preservation, or do not have data linked to other projects which examined similar accessions/provenances.

Fortunately, there are projects underway to develop standardized databases containing pertinent evaluation data; however, little effort has been made to coordinate their activities. Such projects include the USDA-Natural Resources Conservation Service Woody Plant Evaluations made by Plant Materials Centers for conservation purposes. In 1995, the WLPCGC developed a general framework of basic descriptors for characterizing and evaluating woody landscape plant germplasm in GRIN. Other efforts include the description systems established by the *Malus, Pyrus, Prunus, Juglans, Vitis,* and Small Fruits Crop Germplasm Committees for GRIN (primarily for characteristics dealing with fruit and nut production, although some descriptors will be useful to other users). Of these examples, only the GRIN-Global system is directly connected to germplasm preservation.

Two programs stand out with respect to evaluation of woody landscape plant material – the North Central Regional Ornamental Plant Trials (The NC-7 Trials), and the Southern Extension and Research Activities-Information Exchange Group-27 (SERA-IEG-27). The NC-7 Trials began in 1954 to gain knowledge about useful plants for the nursery trade of the central and upper Midwestern states by emphasizing detailed, long-term evaluations of plant survival, growth and aesthetic characteristics across a broad range of sites. The Trials rely on a network of cooperators at ~30 sites located throughout the North Central region and in other states with similar climatic characteristics. Cooperators are located at land-grant universities and experiment stations, public gardens, and the region’s four USDA-NRCS Plant Materials Centers. There are now nearly fifty years of data collected from ten-year trials of more than 500 accessions of landscape trees, shrubs and vines, including a much wider range of genera than are maintained at the North Central Regional Plant Introduction Station. Data on plants distributed for testing since 1984 are held in a database available at: www.ars-grin.gov/ars/MidWest/Ames/trialhmpge.html and, when possible, are also linked to accessions in the GRIN database.

The Southern Extension and Research Activities-Information Exchange Group - 27 (SERA-IEG 27) was formed in 1996 and is sponsored by the Southern Association of Agricultural Experiment Station directors and Southern Extension directors. Representatives from extension and research programs from thirteen land-grant universities and the U.S. National Arboretum cooperatively evaluate ornamental plant germplasm adaptable to the southeastern U.S. The objective is to identify, evaluate, select, and disseminate information on superior, environmentally sustainable landscape plants for nursery production and landscape systems in the southeastern U.S. The group is currently evaluating ~20 woody plants, although evaluation reports are not yet available.

* 1. ***International Cultivar Registration Authorities***

While not directly associated with germplasm collection, evaluation, or distribution, the International Cultivar Registration Authorities (ICRAs) are worth mentioning. Appointed by the International Society for Horticultural Science, the ICRAs promote stability in the nomenclature of cultivars and cultivar groups within designated plant groups (primarily genera), and produce and promote authoritative checklists and registers of all names known to have been in use in such groups. Each ICRA records and registers cultivar and cultivar group names and collects information on the cultivar, including illustrative materials and evaluation data. An ICRA registrar may be an individual with superior knowledge of the taxon, or may be a member of a plant society, governmental organization, botanic garden, or university. Some genera of woody ornamental landscape plants have their own registrar (e.g. boxwood, holly, and camellia), while most fall under the registration authority for unassigned woody plants. Although the ICRA does not conduct trials, judge distinctness of cultivars, or judge the superiority of one cultivar over another, the organization that sponsors the ICRA often does participate in evaluation of plant materials. A list of ICRAs can be found at www.ishs.org/icra/index.htm .

1. **Other Genetic Resource Capacities**

No single organization has the resources to acquire and manage the woody ornamental plant genetic resources of the world. Collaboration between partners – federal, state, private, and non-profit – is crucial to ensure long-term conservation of this germplasm. Listed below are several organizations outside NPGS that play active roles in landscape plant germplasm preservation.

*USDA Natural Resources Conservation Service -* The Natural Resources Conservation Service (NRCS) Plant Materials Program collects plants and develops technologies for the successful conservation and use of these natural resources. The program consists of a network of Plant Materials Centers and Plant Materials Specialists strategically located throughout the United States, which provide conservation solutions for critical habitats, environmental concerns, management practices, and key farm and ranch programs. The collection of native woody species by the Plant Materials Program represents a tremendous germplasm resource. Currently, a limited amount of NRCS germplasm is submitted to NPGS for long-term preservation. Many of the species collected by NRCS can be evaluated for ornamental or landscape use, in addition to conservation uses. More information on the Plant Materials Program can be found at: http://Plant-Materials.nrcs.usda.gov .

*USDA-Forest Service –* The mission of the Forest Service (USFS) is to achieve quality land management under the sustainable multiple-use management concept to meet the diverse needs of people. While the focus is not on germplasm collections per se, the conservation of U.S. forest and grassland ecosystems has carry-over into WLP germplasm. For example, USFS operates the National Seed Laboratory in Dry Branch, GA that works with the NCGRP to preserve native grasses, forbs, and tree species through long-term seed storage. Other programs include the National Botany and Rare Plants Program, the Institute of Forest Genetics at Placerville, CA; the Dorena Genetic resource Center in Cottage Grove, OR; and a partnership with the American Public Gardens Association to conserve and manage biological diversity. In addition, recommendations for a comprehensive strategy to conserve forest genetic resources have been developed (see *The Status of Temperate North American Forest Genetic Resources.* Report No. 16, University of California Genetic Resources Conservation Program, Davis, CA, D.L. Rogers and F.T. Ledig (eds.).

*American Public Gardens Association (APGA) -* The plant collections of North American botanical gardens and arboreta represent taxonomic and genetically diverse resources originating throughout the world, including rare or endangered species, documented wild-provenances, and modern and historic cultivars. With nearly 300,000 accessions growing on approximately 100,000 acres of North American gardens, these collections represent priceless genetic repositories. They are vital to a wide swath of scholarship including basic botanical and ecological research, natural product and drug discovery, horticultural evaluation and breeding programs, and conservation efforts. As public-facing museums, these gardens are adept at sharing their collections with members of society, academia, and the commercial nursery industry.

The Plant Collections Network of the APGA (PCN, previously called the North American Plant Collections Consortium, NAPCC), was established in the early 1990s with two primary purposes: 1) coordinate a continent‑wide effort among botanical gardens for the conservation of plant genetic resources and biodiversity; and 2) elevate curatorial standards for the management of plant collections. Since 1995, APGA and the USDA-ARS have partnered with the NPGS to support the development of the PCN program. This NPGS collaboration with APGA has dramatically expanded the conservation, management and utilization of plant genetic resources. To date, ARS has partially funded a PCN Manager and the publication of materials to promote the development of collections for targeted conservation. In return, the PCN plant collections greatly expand the availability of plant genetic resources to the NPGS and the broader user community for carrying out their missions. Currently, almost 150 Nationally Accredited Plant Collections (most of which are individual genera) are being curated in over 75 different participating gardens and arboreta. A Tree Gene Conservation Partnership between APGA and the US Forest Service was launched in 2015 to establish living gene banks of at-risk tree species, by collecting seed from across the native range to capture broad genetic diversity, and then distribute propagules to public gardens for safeguarding in ex situ collections. Efforts focus on taxa native to US forests which cannot be conserved through traditional seedbanking methods. The partnership awards matching funds on a competitive basis to APGA members to support collaborative scouting and collecting trips, propagation, and distribution of propagules.

*Private, industry, and university collections –* There is significant unreported woody landscape plant crop germplasm outside the formal plant germplasm preservation community. This germplasm is held and maintained by individuals and institutions ranging from personal collections to nurseries and universities. Unfortunately, germplasm in these holdings varies significantly in the quality and completeness of its documentation. Many taxa have been systematically collected and preserved, yet due to inconsistent curatorial standards or lack of long-term resources, are vulnerable to loss. This includes research collections at universities that are assembled over a scientific career, and then destroyed when the faculty member retires. Without NPGS’ knowledge about the quality, quantity and location of these holdings, the plants are unavailable as genetic resources. Plant societies, nursery professionals, public garden professionals and university personnel may be able to provide information on or access to this germplasm.

*Herbaria* – Although not necessarily associated with living collections, the numerous herbaria affiliated with arboreta, botanic gardens, universities, and museums constitute a valuable resource for woody landscape plant germplasm. They not only serve critical repositories for vouchers of living collections, but are essential components of natural history collections to identify plants and document natural distributions including plant invasions.

1. **Prospects and Future Development**
	1. ***Priority Issues***

*Outreach*: Germplasm is most valuable if it is being used. The WLPCGC recommends raising awareness of germplasm resources available to researchers, breeders, and industry through the Plant Collections Network, Botanic Gardens Conservation International, public gardens, and the USDA. In addition, communication about funding opportunities for woody landscape plant genetic resources should be enhanced.

*Germplasm inventory, acquisition, and distribution*: Before recommendations can be made on which genera and species need to be collected, comprehensive inventories need to be developed, including those from NPGS (in GRIN-Global) and holdings associated with the PCN. This could also include a gap analysis of at-risk genera held by accredited collections. Standards for seed/plant collecting and distribution should be developed and disseminated to ensure that collecting trips result in germplasm of adequate quality and quantity to support long-term research and conservation.

*Germplasm characterization and research*: The WLPCGC recommends that evaluation and development efforts focus on underutilized North American trees and shrubs that have landscape potential. Phylogenetic research is also needed to facilitate effective breeding strategies, and population genetic studies are needed to evaluate diversity within and among populations of important woody landscape plant taxa. Additionally, many important genera are missing information on fundamental attributes such as genome size and chromosome numbers, which have immediate application to breeders. Characterization and evaluation of woody landscape plants focusing on broad adaptability, disease/pest resistance, and fecundity should also continue.

***5.2 Maintain and Enhance Partnerships***

*APGA – PCN -* The task of maintaining woody plant germplasm cannot be fulfilled by any one organization. Continuing the strong partnership between ARS and APGA has several important benefits, including a more complete representation of the germplasm of managed taxa, efficient germplasm management, and back-up of germplasm at multiple sites. In the future, resources could be directed toward increased support for coordination, database linkages with distributed querying, expanded institutional participation, and continued improvement of curatorial and evaluative expertise. We recommend that GRIN nomenclature be used if there is no established synonymy (www.ars-grin.gov/npgs/tax/index.html).

*NRCS -* Although the Plant Materials Program already cooperates with the NPGS, further enhancement of this relationship is possible in the following areas: preservation of NRCS collections; submission of existing collections to NPGS; and collaborative funding and planning for collecting and evaluations.

*Other partnerships* – Several additional partnerships should be explored to leverage scarce resources. These include strengthening collaboration with the US Forest Service, exploring partnerships with nursery growers, and enhancing collaboration with Universities.

1. **References and useful links**

**(Note – this section and the references in the document have not been updated – the CGC is working on this)**

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