

Picking Up the Pawpaws: The Rare Woody Plants of Ontario Program at the University of Guelph Arboretum

Sean Fox

It might surprise you to learn that, in Canada, species such as *Magnolia acuminata* (cucumbertree), *Betula lenta* (sweet birch), and *Morus rubra* (red mulberry) are among those that are listed as endangered in the wild (see Table 1). You may be thinking, “Really, *Betula lenta*? It grows all over the place in the eastern United States!” It’s true that the majority of woody plant species at risk in Canada are quite secure in the United States, so why the concern? Is there really a need for conservation?

Conserving an organism at the species level is generally regarded as the most immediate and crucial objective of many conservation programs. In the case of a species that is critically endangered on a global scale, simply ensuring the survival of a few individuals is often a significant challenge. But even many globally common plant species have conservation needs. Often these species do not have a very high representation of diverse genetic material archived in ex-situ collections simply because they are not considered to be a high priority for conservation. To compound this, the limited germplasm that is archived is often accessed from similar populations from the core of a species geographic range. By collecting from more provenances, including those at the extremes of a species’ range, we can come closer to fully conserving and representing the genetic diversity of the species.

After the Laurentide Ice Sheet began receding nearly 12,500 years ago, the forests of eastern North America began their march northward. Species migration is a dynamic and ongoing process, and while many species have already pushed into the tundra region in the far north of Canada, most other species have only extended into southern Canada far more recently. These regional populations, on the forefront of a long migration into northern latitudes, must adapt

to an array of environmental conditions that are often very different from those found at the core of the geographic range. Adapted gene complexes enable a plant to adjust to the timing of the local annual growth cycle, including bud break, root growth, shoot and leaf elongation, bud development, diameter growth, and cold acclimation. The genetic variation present in



NANCY ROSE

Notable for its bright yellow fall foliage, sweet birch (*Betula lenta*) is a rare find in Canada.



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Flowering dogwood (*Cornus florida*) blooming in Ontario.

these range extensions is very significant from a conservation standpoint since these particular genotypes may provide crucial genetic material to allow a species to migrate and fill various regional niches.

The Ontario populations of woody species, at the northern extent of their natural range, represent adaptations to our northern conditions. *Liriodendron tulipifera* from Ontario are more likely to be suitable for forestry planting in that province than seedling stock from a Virginia source. *Cornus florida* from Ontario-based provenances have proven, in cold hardiness trials, to be more winter hardy in Canada than nursery stock sourced from farther south. As migration pressures increase due to a rapidly changing climate, it may become even more critical to conserve these northern genotypes. Unfortunately, the pace of abiotic change in the environment is likely to be far ahead of biotic survival for many species. The continued

exploitation and segregation of suitable habitat adds another dynamic to an already challenging scenario for in-situ conservation.

UNDERSTANDING SPECIES AT RISK IN CANADA

Taking the time to thoroughly understand the legislative conditions regulating species at risk in Canada, as in many other parts of the world, can be an exercise in patience. The federal government of Canada's National Strategy for the Protection of Species at Risk is composed of the National Accord for the Protection of Species at Risk (NAPSR), established in 1996; the Habitat Stewardship Program (HSP), established in 2000; and the Species at Risk Act (SARA) established in 2003.

The National General Status Working Group (NGSWG) was formed in 1996 to support the mandate of the NAPSR, and is charged with establishing status rankings for all species in

Table 1. At-risk woody taxa listed federally in Canada (2011)

Taxon	Canadian Range	COSEWIC Status	SARA Status
<i>Betula lenta</i>	Ontario	Endangered	Endangered
<i>Castanea dentata</i>	Ontario	Endangered	Endangered
<i>Celtis tenuifolia</i>	Ontario	Threatened	Threatened
<i>Cornus florida</i>	Ontario	Endangered	Endangered
<i>Fraxinus quadrangulata</i>	Ontario	Special Concern	Special Concern
<i>Gymnocladus dioicus</i>	Ontario	Threatened	Threatened
<i>Hibiscus moscheutos</i>	Ontario	Special Concern	Special Concern
<i>Juglans cinerea</i>	Ontario, Quebec, New Brunswick	Endangered	Endangered
<i>Magnolia acuminata</i>	Ontario	Endangered	Endangered
<i>Morus rubra</i>	Ontario	Endangered	Endangered
<i>Pinus albicaulis</i>	Alberta, British Columbia	Endangered	No Status
<i>Ptelea trifoliata</i>	Ontario	Threatened	Threatened
<i>Quercus shumardii</i>	Ontario	Special Concern	Special Concern
<i>Rosa setigera</i>	Ontario	Special Concern	Special Concern
<i>Salix brachycarpa</i> var. <i>psammophila</i>	Saskatchewan	Special Concern	Special Concern
<i>Salix chlorolepis</i>	Quebec	Threatened	Threatened
<i>Salix jejuna</i>	Newfoundland and Labrador	Endangered	Endangered
<i>Salix silicicola</i>	Nunavut, Saskatchewan	Special Concern	Special Concern
<i>Salix turnorii</i>	Saskatchewan	Special Concern	Special Concern
<i>Smilax rotundifolia</i>	Ontario, Nova Scotia	Threatened (Great Lakes Population)	Threatened (Great Lakes Population)
<i>Vaccinium stamineum</i>	Ontario	Threatened	Threatened

*Rosa setigera*

Canada. The species that are assessed as potentially at risk are suggested as candidates for further review to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC was officially established in 1977, but was legally implemented as the authority for species at risk assessments under SARA in 2003. COSEWIC maintains a list of wildlife species in need of conservation initiatives and also a candidate list of species in need of further evaluation. The role of COSEWIC is advisory and the ultimate decision to place an organism on the Species at Risk List falls upon SARA and the federal government. SARA pro-

Cucumbertree (*Magnolia acuminata*): Canada's First Endangered Tree

Magnolia acuminata was the first tree in Canada to be listed as endangered by COSEWIC in 1984. In 2003, this species was re-evaluated as endangered under the SARA and plans for a recovery strategy were developed.

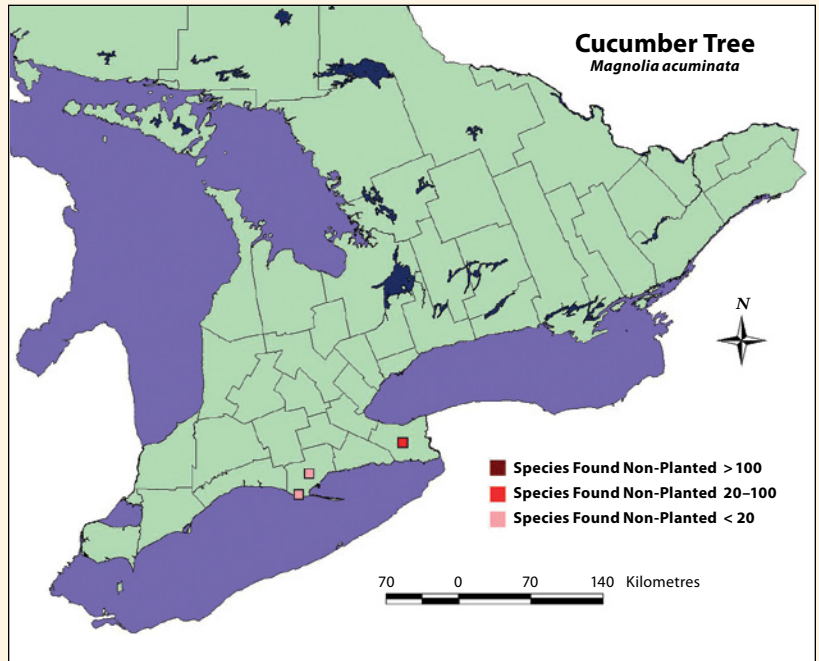
Cucumbertree has always had a very limited distribution in Canada and is currently only known to occur in two areas of southwestern Ontario. In total, only 283 naturally occurring individuals are known to survive in 12 small, extant populations. These individuals represent an extreme northern extension for a species that forms its most abundant core population in the central Appalachian range of the United States.

The cucumbertrees remaining in Ontario are generally in good health; however, the habitat that supports them is highly fragmented. This segregation has not only reduced the reproductive fitness of the remaining populations (perhaps due in part to a reduction in pollinator-supporting habitat), but it has also eliminated suitable conditions for seedling regeneration. The range of cucumbertree also happens to lie within the most heavily populated area of human settlement in Canada and one of the most rapidly-developing regions in North America.

In-situ conservation efforts to identify and protect individual trees in isolated woodlots have had some success. However, further steps are required to ecologically connect these remaining sites in order to allow this magnificent species to continue its natural migration within Ontario.



Canada's largest cucumbertree (*Magnolia acuminata*) is about 18 meters (59 feet) tall and has a trunk dbh (diameter at breast height) of 143 centimeters (56 inches).



The very limited natural Canadian range of cucumbertree (*Magnolia acuminata*) in the southwestern Ontario.

vides federal legislation aimed at preventing wildlife species from becoming extinct and to aid in their recovery.

COSEWIC only suggests species for listing after a detailed report is written, so only a limited number of rare species have been formally assessed. Therefore, a reduction in natural populations remains a strong concern, even with

SARA in place. To add even more confusion, SARA does not apply to plant species on public land under provincial jurisdiction, so as signatories to the NAPS, all provinces and territories are mandated to oversee their own programs to protect species at risk. In Ontario, the Endangered Species Act (ESA) was officially implemented in 2007.



The unusual flower and ripening fruit of pawpaw (*Asimina triloba*).

THE RARE WOODY PLANTS OF ONTARIO PROGRAM

Back in 1978, well before terms such as climate change and global warming were used with any regularity, Dr. John Ambrose, curator of the University of Guelph Arboretum, embarked on a mission to begin evaluating and protecting rare woody flora in Ontario. His goal was not simply to cultivate an ex-situ accession of each species from an Ontario provenance, but to actually capture as much representation of the wild populations in Ontario as possible. With

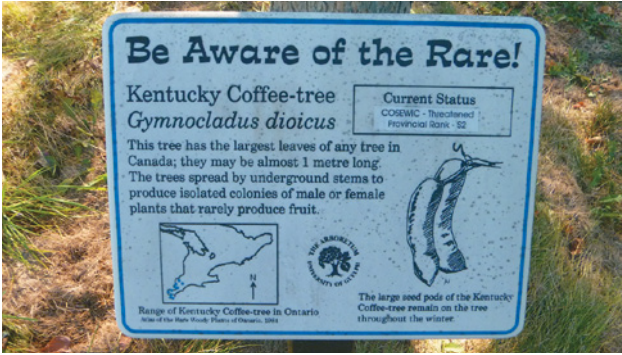
this target in mind, the Rare Woody Plants of Ontario Program was born.

The first phase of the program was lovingly dubbed “Picking up the Pawpaws” in reference to one of Ontario’s most unique and seemingly out-of-place native plant species, *Asimina triloba*, which looks more suited to the tropics. The aim was to conduct extensive surveys of all of southern Ontario’s rare woody species to better understand their distribution and relative abundance. This also doubled as an outreach program to educate the general public about some of Ontario’s unique plant species that they had never even heard of before, let alone knew existed in Canada. Many property owners were excited to learn that the inconspicuous green shrubs in their back forty were actually rare and significant species. As a sense of pride and stewardship began to develop, some of these citizens moved forward in the following decades to become active members in non-governmental conservation and naturalist organizations. Some of these groups continue to play a prominent role in spreading the initial message of the program: the importance of in-situ conservation.

Much of the information gathered during the initial surveys also continues to prove invaluable in the ongoing development of legislatively-important COSEWIC assessments. Even after his retirement from the botanical garden world, Dr. Ambrose continues to play a leading role in protecting rare species in Ontario, including surveying and writing COSEWIC reports for at-risk species.

AN EXCELLENT SITUATION FOR EX-SITU CONSERVATION

The second phase of the Rare Woody Plants of Ontario program revolved around developing a strong ex-situ conservation program at the University of Guelph Arboretum, which spans 165 hectares (408 acres) with over 1,700



A series of interpretive plaques were created for Ontario's rare woody plants with support from BGCI Canada's *Investing in Nature: A Partnership for Plants* program. Here, Kentucky coffeetree (*Gymnocladus dioicus*) is highlighted in the University of Guelph Arboretum's World of Trees collection.



PEGGY HURST

John Ambrose (right), with botanists Lindsay Roger and Gerry Waldron, upon their discovery of a new species to Canada, swamp cottonwood (*Populus heterophylla*), in 2002.

The Eastern Redbud (*Cercis canadensis*): O Canada—Its Home and Native Land?

A specific epithet like “*canadensis*” might lead one to believe that eastern redbud floods the under-story of the great northern forests. But, despite its seeming patriotism to Canada, this beautiful species is not quite as common in the north as one might think.

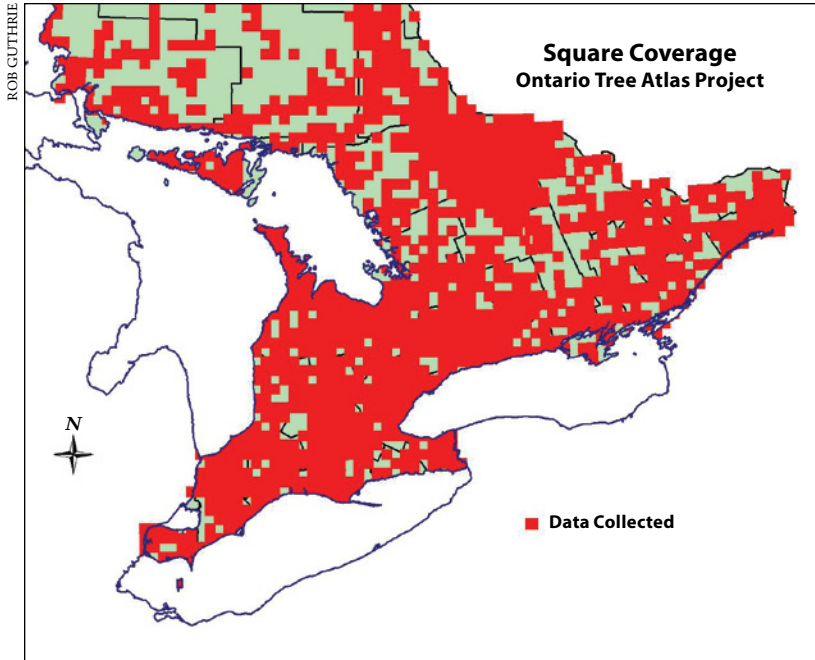
In Gerry Waldron's wonderful book, *Trees of the Carolinian Forest* (2003), he quotes the great Canadian botanist, John Macoun, as he recounts his first and only sighting of eastern redbud on Canadian soil in 1892:

... I was informed that a remarkable tree grew on the south end of the island, that many years ago produced an abundance of lovely red flowers in early spring before the leaves came out ... the next day I examined the south point and found the tree. It had been undermined by the waves and fallen inland, and more than half its limbs were dead, but it still bore leaves and what remained was quite healthy. It will soon disappear, but the record of its existence will remain.

This tree that Macoun happened across remains the only naturally-occurring individual ever discovered in Canada. This plant grew at Fish Point, Pelee Island, in Lake Erie—the most southerly point in all of Canada, and, as he predicted, was eventually swallowed by the lake as the shoreline eroded away. While there are naturalized populations established in parts of southwestern Ontario, as escapees from cultivated stock, eastern redbud is now officially ranked as extirpated in Canada.



These flower buds of eastern redbud (*Cercis canadensis*) show the species' interesting trait of cauliflory (flower and fruit production from woody stems). This accession (1988-0284.002) in the World of Trees collection at the University of Guelph Arboretum is from a cold-hardy provenance in Wayne County, Michigan.



Locations surveyed by the University of Guelph Arboretum for the presence of naturally-occurring, at-risk species are displayed in this map of southwestern Ontario.

taxa of woody flora represented in its collections. The major emphasis is on the woody flora of eastern North America, with special attention being given to the rare woody flora of Ontario.

After initial surveys were completed, provenance-based germplasm collections were made in order to capture as great a representation of a species' provincial population as possible. Vegetative propagules were gathered for the establishment of a germplasm repository at the University of Guelph Arboretum, in the form of living gene banks. The gene banks at the Arboretum are arranged as seed orchards and serve two main purposes:

(1) To provide ex-situ back up for failure at in-situ conservation



This pumpkin ash (*Fraxinus profunda*) accession (1994-0010.001) in the World of Trees collection at the University of Guelph Arboretum was cultivated from seed collected in Essex County, Ontario, very shortly after the discovery of the species in Canada in 1992.



Here, the blue ash (*Fraxinus quadrangulata*) gene bank at the University of Guelph Arboretum provides a secure site for a faculty research project.

Table 2. Accessions of known, wild, Ontario-based provenance for selected rare woody taxa under cultivation at the University of Guelph Arboretum.

Taxon	Risk Ranking*	Total Number of Accessions	Total Number of Individuals
<i>Aesculus glabra</i>	G5, S1	5	20
<i>Asimina triloba</i>	G5, S3	8	12
<i>Betula lenta</i>	G5, S1	9	44
<i>Campsis radicans</i>	G5, S2	3	4
<i>Carya laciniosa</i>	G5, S3	6	25
<i>Carya glabra</i>	G5, S3	3	7
<i>Castanea dentata</i>	G4, S3	2	3
<i>Celtis tenuifolia</i>	G5, S2	5	13
<i>Cornus drummondii</i>	G5, S4	5	26
<i>Cornus florida</i>	G5, S2	8	17
<i>Euonymus atropurpurea</i>	G5, S3	6	16
<i>Fraxinus profunda</i>	G4, S2	1	3
<i>Fraxinus quadrangulata</i>	G5, S3	20	26
<i>Gleditsia triacanthos</i>	G5, S2	7	38
<i>Gymnocladus dioicus</i>	G5, S2	26	87
<i>Hibiscus moscheutos</i>	G5, S3	1	2
<i>Juglans cinerea</i>	G4, S3	12	32
<i>Liriodendron tulipifera</i>	G5, S4	11	15
<i>Magnolia acuminata</i>	G5, S2	16	37
<i>Morus rubra</i>	G5, S2	5	21
<i>Morella pensylvanica</i>	G5, S1	3	3
<i>Pinus rigida</i>	G5, S2	4	5
<i>Platanus occidentalis</i>	G5, S4	10	18
<i>Ptelea trifoliata</i>	G5, S3	22	43
<i>Quercus ellipsoidalis</i>	G5, S3	2	2
<i>Quercus muehlenbergii</i>	G5, S4	16	64
<i>Quercus prinoides</i>	G5, S2	2	9
<i>Quercus shumardii</i>	G5, S3	4	9
<i>Rosa setigera</i>	G5, S3	6	8

* G-global, S-provincial

G1-extremely rare, G2-very rare, G3-rare to uncommon, G4-common, G5-very common
S1-critically imperiled, S2-imperiled, S3-vulnerable, S4-apparently secure, S5-secure

efforts related to habitat loss and natural calamities. This is especially critical for many hardwood species that possess recalcitrant seeds that are difficult to store under conventional seed banking practices.

(2) To produce enough seed, through open or controlled pollination, to take the seed collecting pressure off of natural populations in Ontario. Seed produced will provide a valuable and readily accessible resource for restoration efforts, in addition to supplying material with promising horticultural attributes with respect to cold hardiness.

Today, a number of species that are at risk in Ontario have their germplasm archived within the Arboretum's gene banks and plant collections (see table 2). Much of the research conducted to develop germination and cultivation requirements for these rare species was published in 2008 in the book *Growing Trees from Seed* by Henry Kock, late University of Guelph Arboretum horticulturist. The accessions established at the Arboretum represent a significant portion of the genetic diversity for these very rare species at the northern extreme of their geographic range. Several of these accessions are from provenances that have already been lost in the wild.

In addition, many of the early provenance-based seed collections were distributed internationally to botanical organizations for more broad-based ex-situ archiving. A look through the plant inventories of many botanical gardens and arboreta will display cultivated material of species from these Ontario provenances.

PLANTING SEEDS FOR THE FUTURE

The Rare Woody Plants of Ontario Program was first initiated at the University of Guelph Arboretum over 30 years ago, and conservation efforts focusing on Ontario's native woody



The first crop, in 2006, from the shellbark hickory (*Carya laciniosa*) gene bank at the University of Guelph Arboretum.



Pawpaw (*Asimina triloba*) seedlings growing in the nursery at the University of Guelph Arboretum.

flora continue to this day. In addition to the endeavors already discussed, the Arboretum is currently engaged in several activities to build upon our conservation programs.

In 2006, after the early passing of our beloved horticulturist, Henry Kock, an endowment was established to help provide long-term, sustainable funding for our conservation programs. Henry's mission—to archive naturally-occurring Dutch elm disease-tolerant Ameri-

Kentucky Coffeetree (*Gymnocladus dioicus*): Distribution within the University of Guelph Arboretum

WHILE gene banking various accessions within seed orchards makes archiving and maintaining plant material simpler, a strong effort has also been made to establish accessions in suitable botanical and horticultural collections throughout the Arboretum. Distributing our conservation collections in this fashion serves several purposes:

- Accessions throughout our 165 hectare (408 acre) site provide insurance measures against localized disturbances (e.g., weather events, vandalism).
- The incorporation of rare native flora into various formal collections increases the value of our interpretive programs and provides visitors with the opportunity to see important species that are unlikely to be spotted in the wild.
- At-risk species planted throughout the site provide strategic long-term protection for the Arboretum property itself against any potential outside development activities in the future.

A well-established Kentucky coffeetree seed orchard is now starting to bear fruit, but you can also find accessions of known, wild provenance in other locations within the Arboretum.



A view from within the Kentucky coffeetree (*Gymnocladus dioicus*) gene bank at the University of Guelph Arboretum.

Table 3. Accessions of *Gymnocladus dioicus* under cultivation at the University of Guelph Arboretum of known, wild, Ontario-based provenance.

Collection or Area	Number of Represented Accessions	Number of Represented Individuals
Gene Bank Seed Orchard	26	65
World of Trees Collection	1	7
Leguminosae Family Collection	6	6
Native Trees of Ontario Collection	1	5
Gosling Wildlife Gardens: Native Plant Garden	1	1
RJ Hilton Center Accent Planting	1	1
Arboretum Nursery Archival Plantings	2	2

ANNE HANSEN



Late University of Guelph Arboretum horticulturist Henry Kock standing next to Canada's largest eastern flowering dogwood (*Cornus florida*).

can elm (*Ulmus americana*) germplasm at the Arboretum—provided the incentive to refer to this as the Henry Kock Tree Recovery Endowment. This endowment provides the opportunity to work with not only elm, but also with any other woody species in Ontario that are in need of recovery efforts in the future.

Ontario's Elm Recovery Project is currently operated out of the University of Guelph Arboretum with an archival germplasm repository in the beginning stages of development. The provincial Butternut Recovery Program was initiated several years ago by the Forest Gene Conservation Association (FGCA) with the Arboretum serving as one of their archival planting sites. The Royal Botanical Gardens (RBG Ontario) is currently undertaking a program to breed pure,



HENRY KOCK

The accessioned plants in the cucumbertree (*Magnolia acuminata*) gene bank at the University of Guelph Arboretum bear mature fruit on an annual basis.



Over the past ten years, several bumper crops have been produced in the sweet birch (*Betula lenta*) gene bank at the University of Guelph Arboretum.

non-hybridized red mulberry (*Morus rubra*), a species endangered in Ontario because of white mulberry (*Morus alba*) invasion. The University of Guelph Arboretum serves as a partner and site for a future ex-situ conservation collection.

Provincial field studies and seed collection trips are ongoing for species at risk in Ontario,

with a particular emphasis on recently discovered species such as *Quercus ellipsoidalis* (1978), *Fraxinus profunda* (1992), *Quercus ilicifolia* (1994) and *Populus heterophylla* (2002). These are important species that we hope to further incorporate into our ex-situ collections at the Arboretum.

As our existing seed orchards continue to produce increasingly sound crops, we are now in the position to better distribute this seed to nurseries and local conservation authorities to aid in their restoration activities. Large crops of seed will also be archived at the National Tree Seed Center in Fredericton, New Brunswick, and the Ontario Tree Seed Plant in Angus, Ontario. Seed will continue to be available to other botanical institutions for conservation and research purposes.

In this modern era, and with an unstable economy, most botanical gardens and arboreta are facing tough challenges with budget and staff cuts. As the years have progressed at the University of Guelph Arboretum, we've also had to make difficult decisions regarding the activities that we have the capacity to engage in successfully. While we've had to scale back several of our display-based horticultural collections, we've found that our conservation programs have helped to provide a niche that further defines the mission of our organization.

It must always be remembered that ex-situ conservation programs, as valid and critical as they are, don't hold a candle to ecosystem conservation, expansion, and linkage. These in-situ conservation activities must be represented in our highest aspirations as citizens and nations. However, the important role that botanical gardens and arboreta can play must not be underestimated either. Whether it is the education, outreach, research, stewardship, or conservation hat that is being worn, public gardens are in a unique position to be meaningfully engaged in rare flora programs both locally and globally.

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