



Collection Development Plan: Nationally Accredited *Stewartia* Collection™

Version 1.2
May 2019

I. MISSION AND PURPOSE

Polly Hill Arboretum Mission Statement

“To perpetuate the experimental tradition in horticulture established by Polly Hill by sharing knowledge of plants and scientific procedure through educational programs, research, plant conservation, and exploration. The Arboretum seeks to preserve its meadows and woodlands, to promote an understanding of its collections, and to encourage their utilization for scholarship, observation, and the enjoyment of all”

Purpose of Collection Development Plan

The Nationally Accredited *Stewartia* Collection at Polly Hill Arboretum (hereafter, the Arboretum) advances the organization’s mission by advancing botanical research, plant conservation, curatorial excellence, and collaborative partnerships. Temperate *Stewartia* thrive at the Arboretum, and were a horticulturally important group to our founder, Polly Hill, who selected and named nine cultivars.

This document serves to (1) provide a global summary and definition of the genus *Stewartia*, including taxonomic treatment and cultivated resources, (2) document the historical development of the Arboretum’s *Stewartia* collection, (3) define staff roles, extramural partners, and evaluate opportunities/threats to the collection, and (4) enumerate specific objectives related to collection development, their significance, and an action plan to achieve each objective.

This plan is intended to serve as a living document, to be reviewed and updated annually.

II. OVERVIEW OF *STEWARTIA*: IN SITU, EX SITU

Stewartia s.l. (Theaceae) has been circumscribed to include ca. 20 species, including a paraphyletic *Stewartia* s.s. of ENA and EAS, and monophyletic *Hartia* from southern China and northern Indochina (Lin et al. 2019). *Stewartia* s.s. and *Hartia* are frequently distinguished on the basis of deciduous vs. evergreen leaves, respectively, but the segregation is phylogenetically artificial. Nevertheless, *Hartia*’s subtropical distribution renders the group largely unfit for cultivation at the Arboretum (USDA Hardiness zone 7a).

Although considerable taxonomic uncertainty remains within deciduous *Stewartia*, these species (including sub-specific ranks and cultivars) represent the focus of the Arboretum’s collection. Included in this group are two, well-resolved species from ENA: *S. malacodendron* L. (nomenclatural type) and *S. ovata* (Cav.) Weath. Both *S. malacodendron* and *S. ovata* are listed as species of Least Concern by the Red List, growing naturally in ~10 states each. Although their distributions include many of the same states, *S. malacodendron* is predominately found in the coastal plains of the southeast and Gulf of Mexico, whereas *S. ovata* is found at higher elevations in mountainous ravines (Fig 1). Few sympatric populations may exist, though one site was documented in 2007, in Winston Co. Alabama (Tim Boland, personal communication)

An additional nine taxa are indigenous to China, Korea, and Japan, (*S. acutisepala* P.I. Chiu & G.R. Zhong, *S. koreana* Nakai, *S. monadelpha* Sieb. & Zucc., *S. pseudocamellia* Maxim., *S. rostrata* Spongberg, *S. rubiginosa* Hung T. Chang, *S. serrata* Maxim., *S. shensiensis* Hung T. Chang, and *S. sinensis* Rehder & E.H. Wilson) yet recent work by Lin et al. (2019) suggests that

only six Old World species exist for *Stewartia* s.s., due to ancient introgression events. Asian *Stewartia* s.l. have all been ranked as species of Least Concern or Data Deficient by the Red List (Beech et al. 2017).

In cultivation, numerous selections have been named for individuals with unique flower colors (petals and stamens), growth habits (fastigiated and dwarfed), and foliage (glaucous & glossy leaves, exceptional fall color). Spontaneous hybridization has been documented with several species, including *Stewartia* × *henryae*, a *S. pseudocamellia* & *S. monadelphica* cross (Spongberg 1974), and *Stewartia* ‘Scarlet Sentinel’, and adventive *S. pseudocamellia* & *S. ovata* hybrid (Del Tredici and Li 2002).

There are a limited number of gardens with developed *Stewartia* collections; most notably The Arnold Arboretum and Polly Hill Arboretum in Massachusetts (both PCN collection holders), Quarryhill Botanical Garden in California, and Herkenrode Arboretum in Belgium (Hsu et al. 2008). More widespread distribution of *Stewartia* has been hindered by notoriously difficult propagation requirements for both seed and cuttings (Nair et al. 2008), particularly for commercial operations. Presently, a list of named cultivars together with descriptions of distinction does not exist.

III. ASSESSMENT OF STEWARTIA COLLECTION AT THE ARBORETUM

Background

Stewartia is a historically important collection at the Arboretum, and the first accession (*S. koreana*), grown from seed in 1958, is still thriving. Polly Hill noticed early on that *Stewartia* performed well on the Arboretum’s acidic, sandy soils, and offered multiple seasons of interest to her garden: large summer blossoms, fall color, and (for most spp.) vibrant winter bark. Polly’s experimentation and keen eye resulted in her naming nine cultivars.

Polly was 98 years old when the Arboretum’s *Stewartia* collection was accredited as a national collection (then, NAPCC) in 2005. At the time, the Arboretum’s collection represented 19 taxa, and a goal of obtaining ~25 taxa was presented in the application. The Arboretum currently holds 98 individual accession-items, representing 23 unique taxa. 51% of the Arboretum’s 71 *Stewartia* accessions are of documented wild provenance.

In 2016, the International Society for Horticultural Science appointed the Arboretum as the international cultivar registration authority for *Stewartia*. This designation will allow the Arboretum to stay at the forefront of new cultivar introductions.

Site considerations

The Arboretum is located near the center of the Island of Martha’s Vineyard, where it benefits from the maritime climate (warmer winters, cooler summers) but is far enough from the coastline to avoid damaging effects of salt-spray and sustained wind. The cultivated area at the Arboretum is approximately 25 acres, with 40 acres adjacent maintained as native (oak) forest. The climate and soils of the site have proved favorable for *Stewartia* cultivation, so much so that several species eagerly come up as volunteers within garden beds, along stone walls, and within forest edges/gaps.

In consideration of further development of the *Stewartia* collection, the primary challenges faced by the Arboretum are availability of additional planting space and, to a lesser extent, extended

summer droughts. There are few cultivated spaces remaining at the Arboretum which are suitable for medium-sized trees. To overcome this predicament, the Arboretum has been conducting targeted deaccession and removal of many large trees (non-Stewartia) that provide little to no value to the overall living collection. Secondly, the Arboretum is preparing a 2-acre expansion (“Woodland Garden”) into the edge of the oak forest. The existing oak canopy will remain intact to provide suitable conditions for Stewartia and other woodland species.

With few exceptions, the Arboretum does not have automatic irrigation. During extended summer droughts, young and/or valuable plantings must be hand watered. Thus far, supplemental watering has not been a significant problem, though it should be taken into consideration for future plantings/expansion.

Management

Plant acquisition, legal and ethical guidelines, and plant documentation protocols are specified by the Arboretum’s Living Collections Policy (LCP), and administered by the Living Collections Committee. The curator is responsible for implementation of the LCP, and ensuring the documentation, verification, management, and development of the Stewartia collection are performed to the highest possible standards. The curator fulfills requests for plant records and germplasm exchange, and makes data publicly available online and in print. The plant recorder performs regular inventories of the collection, maintains maps, labels, and signage, and coordinates workflow of plant documentation between departments. The plant recorder maintains Stewartia vouchers in the preserved collection, and creates new vouchers as necessary. The plant propagator cultures seed collected from the wild, and appropriately maintains accession-items within production until they are planted within the living collection. The propagator also clones exceptional specimens in order to share with other institutions and serve as duplicate (backup) germplasm in the case of unforeseen disasters. The horticulture and grounds staff ensure the health and safety of plants in the collection, provide care and maintenance to each specimen, and conduct plant removals (deaccessions) as deemed necessary by the collections committee.

Accessibility

The Arboretum’s grounds are open daily, year round, from dawn to dusk. During the growing season, general tours of the Arboretum are led by docents, and specialized tours given by staff are led on a regular basis.

A current inventory of the Arboretum’s living collection may be accessed at any time via the Arboretum Explorer website (<https://pollyhill.arboretumexplorer.org>), hosted by IrisBG. In addition, the Arboretum’s website maintains a section devoted to Stewartia that includes a dichotomous key and technical descriptions of all species, as well as a page of hyperlinked resources of scientific literature.

Stewartia germplasm will be shared upon request and at the discretion of the Curator.

IV. COLLECTION DEVELOPMENT OBJECTIVES AND ACTION PLAN

After 15 years of growth as a Nationally Accredited Plant Collection, the continued development of the Arboretum's *Stewartia* collection has been grouped within four primary categories:

1. Collection Growth
2. Collection Safeguarding
3. Collection Documentation
4. Collection Research

Specific objectives within each category are listed below, followed by an action plan for each objective. Section V of this document specifies target completion dates and other pertinent information.

1. Collection Growth

Objective 1-1. Acquire and trial all species of Stewartia s.s., with a focus on wild origin.

The Arboretum currently holds six taxa (species-level), of which four were collected with documented wild-origin. As a long-term goal to include all species in the collection, four additional species will be sought that are not presently in the collection: *S. acutisepala*, *S. shensiensis*, *S. rubiginosa*, and *S. serrata*. The Arboretum will first seek out material of garden origin to trial for cold-hardiness, with an ultimate goal of sourcing these species from the wild. Quarryhill Botanical Garden grows several of these species, and would be a logical starting point to request germplasm. Each of these species are indigenous to Southern China, and while the Arboretum has not been part of a China expedition, it may be possible to encourage NACPEC members to collect seed on the Arboretum's behalf.

Objective 1-2. Increase sampling range for North American Stewartia taxa.

The geographic proximity of *Stewartia malacodendron* and *Stewartia ovata* has allowed the Arboretum to collect from numerous populations in Eastern North America (Fig 1). At present there are eight and 21 wild-collected accessions for these species, respectively. Future collecting work in North America will focus on expanded sampling from across these species' ranges. Thus far, *S. ovata* has only been collected from the center of its distribution, and future collections will target the eastern-, southern-, and western-most populations. *S. malacodendron* has a broader range, and there remain large areas that have not yet been sampled. The Arboretum will prioritize sampling to the periphery of this species range, particularly southern and coastal populations that remain un-sampled and may be at greatest risk.

Objective 1-3. Expand representation of new and unique cultivars.

The Arboretum will seek out and acquire additional cultivars that have been bred or selected by others. Although limited clones exist within *Stewartia*, many selections have been made in Europe and have not yet been introduced to cultivation in North America.

2. Collection Safeguarding

Objective 2-1. Accession and cultivate replicates of valuable cultivars.

During her tenure, Polly Hill selected and named nine *Stewartia* clones:

- S. × henryae* ‘Skyrocket’
- S. malacodendron* ‘Delmarva’
- S. ovata* ‘Red Rose’
- S. ovata* ‘Royal Purple’
- S. ovata* ‘White Satin’
- S. pseudocamellia* ‘Ballet’
- S. pseudocamellia* ‘Milk and Honey’
- S. pseudocamellia* ‘Mint Frills’
- S. sinensis* ‘Mei-Li-Shu’

All but one of these cultivars exists as a single accession in the Arboretum’s living collection. The Arboretum will vegetatively propagate each cultivar to safeguard one or more replicates in the event of a disaster. Replicates will be planted within the living collection or held as stock trees within the production area.

Objective 2-2. Distribution of Germplasm.

The Arboretum will identify germplasm of significant value and make it available to other institutions. This will include excess seed or seedlings that result from wild-collecting expeditions, and well as clones of cultivars and other noteworthy specimens within the collection. The Arboretum will compile a list of contacts at other gardens that can be notified of excess material that is available for distribution. Special priority will be given to garden with existing *Stewartia* collections, particularly the Arnold Arboretum, whom also hold a Nationally Accredited *Stewartia* Collection.

3. Collection Documentation

Objective 3-1. Documentation of the living collection.

The Arboretum will continue to maintain plant records to the highest possible standards. Each accession record has multiple associated files, and these shall be held in perpetuity by the Arboretum. These files include:

- Source data related to plant acquisition, including maps, field notes, correspondence, and trip reports. Similarly, permits granted by federal, state, and local agencies, as well as documentation of plant import/export will be archived for each accession.
- Digital records held within IrisBG documenting source information, taxonomic history, and item-specific history including status changes, phenological data, mapped location(s), and physical measurement.
- Hard-copy backup of digital records stored on 5 x 8” accession and deaccession cards.
- Preserved collection (dried vouchers) held within the Arboretum’s herbarium. Preserved collections belonging to particular accessions may include both material from the source

population (material seed parent) and from the resulting progeny that are itemized within the living collection.

Objective 3-2. Annual reporting.

Each year, the Arboretum will produce a complete inventory of the living collection. A subset of these data, encompassing the *Stewartia* collection, will be sent to the Plant Collections Network Program Manager.

4. Collection Research

*Objective 4-1. Assemble and publish a master-list of *Stewartia* cultivars.*

The total number and scope of *Stewartia* cultivars in the horticultural trade has not been documented. It is estimated that several dozen cultivars have been named, many of which are originated in Europe and have not been introduced to the North American trade. The Arboretum will identify nurserymen and public gardens on an international scale to document those selections that have been named, and write a brief narrative including history and unique qualities for each cultivar. The resulting file will be made available on the Arboretum's website, and may be submitted for publication.

Objective 4-2. Conduct plant propagation research.

Stewartia are notoriously difficult to propagate both sexually and asexually (Nair et al. 2008). This is a limiting factor for many objectives listed within this document. For example, seeds desiccate rapidly leading to a permanent loss in viability. Seeds that are sown immediately have been noted as 'doubly dormant', requiring at least 2 years to germinate under natural conditions. As a result, seeds collected from the wild should be sown without delay and prior to drying, which can be exceedingly difficult to accomplish when collecting internationally (where seeds must be fully cleaned and pass through customs inspections). The time required for germination then delays the assessment of a successful collection over which time more seeds may lose viability due to natural processes. Asexual propagation via stem cuttings has shown great promise due to the ease of adventitious rooting, but failure of cuttings to overwinter successfully (first year) has been widely reported. This phenomenon has discouraged many nursery owners from making *Stewartia* more widely available commercially, and similarly limits the Arboretum's ability to receive new clones, or share clones with other institutions.

The Arboretum will investigate both aspects of *Stewartia* propagation, by formally assessing the nature of seed viability and dormancy breaking, as well as optimizing protocols for asexual propagation via stem cuttings.

Objective 4-3. Study the phenotypic correlations within species-complexes.

The Arboretum will use its living collection to study the trait similarities among species with disputed nomenclature. As an example, various authorities and arboreta recognize *S. koreana*, while others consider this a synonym of *S. pseudocamellia*. To the Arboretum's knowledge, there is only one cultivated example of *S. pseudocamellia* of Japanese origin currently in a North American collection (Quarryhill Botanic Garden). Otherwise, all *S. pseudocamellia* of documented origin can be traced back to Korea. The Arboretum's *S. pseudocamellia* collections from Japan in 2018 will be used to compare purported phenotypic differences in a common garden. The Arnold Arboretum and Morris Arboretum involved in the

Japan 2018 expedition can additionally act as replicate sites for study. Additional taxa worthy of consideration include the legitimacy of the variety *S. ovata* var. *grandiflora*, and species complexes presented by Lin et al. (2019) including *S. serrata/rostrata* and *S. sinensis/acutisepala/monadelpha*.

V. COLLECTION DEVELOPMENT OBJECTIVES PUNCHLIST

	Action list	Target year	Considerations
1. Collection Growth			
1-1	<i>Acquire and trial all species of Stewartia.</i>		
	Request propagules from Quarryhill and other institutions	2019	
	Participate in expeditions/seed share in Asia	ongoing	PHA expedition to Japan scheduled 2019, consult NACPEC
	Trial new acquisitions for Island climate and cold-hardiness	ongoing	
1-2	<i>Increase sampling range for N.A. Stewartia taxa.</i>		
	Develop a strategic plan to prioritize populations of interest	2019	<i>Stewartia ovata</i> & <i>S. malacodendron</i>
	Plan and execute seed expeditions by priority	2020, onward	
	Reevaluate effectiveness, sampling range, missed populations	2025, onward	
1-3	<i>Expand representation of new and unique cultivars.</i>		
	Research and source cultivars that exist in North America	2019-2020	
	Research and source cultivars that exist in Europe	2020-2021	will require permits and collaboration
	Research and source cultivars that exist in Asia	2020-2022	will require permits and collaboration
2. Collection safeguarding			
2-1	<i>Accession and cultivate replicates of valuable cultivars.</i>		
	Generate replicates of each Polly Hill cultivar (9)	2019-2020	via stem cuttings
	Plant one or more duplicate(s) of each cv within collection	2021-2023	As growth/size allows
	Compile and share list of rooted cultivars available for distribution	2021	Distribution to other institutions, as growth/size allows
2-2	<i>Distribution of Germplasm.</i>		
	Compile a list of institutions with an interest in <i>Stewartia</i> cultivation	2019, ongoing	
	Email list of surplus inventory when applicable	2020, ongoing	surplus seedlings or rooted cuttings from expeditions/propagation

Fulfil material requests	2020, ongoing	
--------------------------	------------------	--

3. Collection Documentation

3-1	<i>Documentation of the living collection.</i>		
	Inventory, assess, label check/update entire <i>Stewartia</i> collection	recurring annually	
	Produce/deposit voucher(s) of all trees in living collection	2019-2020	2019-2020 to clear backlog, then ongoing as young trees mature
	Photograph each accession item	2019-2020	digital images added within IrisBG database
3-2	<i>Annual reporting.</i>		
	Compile and archive inventory/report of living collection	recurring annually	PHA internal use
	Regularly update living collection inventory hosted elsewhere	recurring annually	i.e., PCN, BGCI.

4. Collection Research

4-1	<i>Assemble and publish a master-list of cultivars.</i>		
	Compile/publish list to include documentation of origin and merit	2019	
4-2	<i>Conduct plant propagation research.</i>		
	cuttings: develop hypotheses to test overwintering survival	2019	
	cuttings: strike cuttings of 2-3 genotypes for pilot study	2019-2020	
	cuttings: assess pilot results, update, large scale factorial	2020-2021	
	seed: develop hypotheses re: viability & dormancy break	2019	
	seed: prepare treatments for pilot study	2019-2021	≥2 years to germinate under natural conditions
	seed: assess pilot results, update, retest	2021-2023	≥2 years to germinate under natural conditions
4-3	<i>Phenotypic correlations within species-complexes</i>		
	Grow-out recently collected seed* for evaluation	ongoing, long-term	*expeditions in NA and Japan 2016-2019
	Resample wild populations as needed	ongoing, long-term	
	Assess morphology and physiology	ongoing, long-term	

VI. APPENDICES

Citations

Beech E, M Barstow, M Rivers (2017) The red list of Theaceae. BGCI, Surrey, UK

Del Tredici P, J Li (2002) *Stewartia* ‘Scarlet Sentinel’. *Hortscience* 37(2): 412-414

Hsu E, T Boland, K Camelbeke (2008) *Stewartia* in cultivation. *The Plantsman* 7(2): 78-87

Lin H-Y, Y-J Hao, J-H Li, C-X Fu, PS Soltis, DE Soltis, Y-P Zhao (2019) Phylogenetic conflict resulting from ancient introgression following species diversification in *Stewartia* s.l. (*Theaceae*). *Molec. Phylo. Evol.* 135: 1-11

Nair A, D Zhang, J Smagula, D Hu (2008) Rooting and overwintering stem cuttings of *Stewartia pseudocamellia* Maxim. relevant to hormone, media, and temperature. *HortSci* 43(7):2124-2128

Spongberg SA (1974) A review of deciduous-leaved species of *Stewartia* (*Theaceae*). *J. Arnold Arboretum* 55(2):182-214

Fig 1. Approximated range map of *Stewartia malacodendron* and *Stewartia ovata* in the United States. Points represent populations that were sampled by PHA, with specimens currently active in the living collection



