Conservation Assessment

for the

Bigleaf Snowbell

(Styrax grandifolius Ait.)

Steven R. Hill, Ph.D.
Division of Biodiversity and Ecological Entomology
Biotic Surveys and Monitoring Section
1816 South Oak Street
Champaign, Illinois 61820

ILLINOIS NATURAL HISTORY SURVEY

Prepared for the U.S.D.A. Forest Service, Eastern Region (Region 9), Shawnee and Hoosier National Forests

INHS Technical Report 2007 (65)
Date of Issue: 17 December 2007

Cover photo:

Styrax grandifolius Ait., from the website: In Bloom – A Monthly Record of Plants in Alabama; Landscape Horticulture at Auburn University, Auburn, Alabama.

http://www.ag.auburn.edu/hort/landscape/inbloomapril99.html

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

Table of Contents

ACKNOWLEDGMENTS

I would like to thank the staffs of the United States Forest Service, Shawnee and Hoosier National Forests, for the opportunity to compile these conservation assessments and for their invaluable assistance with data and field opportunities. Beth Shimp and Steve Widowski have been particularly helpful in facilitating these cost share agreements.

I would also like to thank the grants and contracts staff of the Illinois Natural History Survey and the University of Illinois, Champaign, for their assistance with logistics necessary to complete these reports.

Curators of several herbaria, cited in the appendices to this report, were very helpful in allowing access to the collections to obtain data on this plant. Several people also assisted by contributing additional information on this locally rare plant, including George Yatskievych in Missouri, Mike Homoya in Indiana, and Mike Vincent in Ohio.

This material is based upon work supported by the U.S.D.A. Forest Service, Eastern Region, under Cost Share Award No. AG03-CS-11090804-024. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the U.S.D.A. Forest Service, Eastern Region.

EXECUTIVE SUMMARY

This Conservation Assessment is a review of the taxonomy, distribution, habitat, ecology, and status of the Bigleaf Snowbell, *Styrax grandifolius* Ait., throughout the United States and in the U.S.D.A. Forest Service lands, Eastern Region (Region 9), in particular. This document also serves to update knowledge about the potential threats, and conservation efforts regarding the Bigleaf Snowbell to date. The Bigleaf Snowbell is an individual small tree or colonial shrub varying from 1 – 4 meters tall, with showy, fragrant white bell-like flowers in axillary racemes, and it is normally found on slopes in shade near streams in mesic to dry-mesic upland forests. The species is known only from the United States, and it grows primarily in the southeastern states. It is known historically from fifteen states, from Virginia and Florida west to Illinois, Arkansas and Texas. The Bigleaf Snowbell has not been found in Missouri. It has declined in recent decades and is scarce at the margins of its range in the upper Midwest. Globally, its ranking is G5 (secure world-wide); its National ranking in the United States is NNR (not ranked nationally). It is most common in Georgia, Louisiana, Mississippi, and North Carolina. The Bigleaf Snowbell is listed as Endangered in Illinois and Indiana, and it is presumed Extirpated in Ohio. In Forest Service Region 9, the Bigleaf Snowbell is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest where it has not been found. It is at risk at the northern margin of its range.

In addition to species listed as endangered or threatened under the Endangered Species Act (ESA), or species of Concern by U.S. Fish and Wildlife Service, the Forest Service lists species that are Sensitive within each region (RFSS). The National Forest Management Act and U.S. Forest Service policy require that National Forest System land be managed to maintain viable populations of all native plant and animal species. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the entity throughout its range within a given planning area.

The objectives of this document are to:

-Provide an overview of the current scientific knowledge on the species.

-Provide a summary of the distribution and status on the species range-wide and within the Eastern Region of the Forest Service, in particular.

-Provide the available background information needed to prepare a subsequent Conservation Approach.

NOMENCLATURE AND TAXONOMY

Scientific Name: *Styrax grandifolius* Ait. [1789; orig. *Styrax grandifolium* Ait.]
Common Names: Bigleaf Snowbell; Big-leaf Snowbell; Bigleaf Snowbell Bush; Big-leaf Snowbell Bush; Large-leaf Snowbell; Large-leaved Storax
Synonymy: none known

Class: Magnoliopsida (Flowering Plants - Dicotyledons)
Family: Styracaceae (The Storax Family)
Plants Code: STGR4 (USDA NRCS plant database, W-1)
http://plants.usda.gov/

The woody genus *Styrax*, described by Linnaeus in 1753, contains approximately 120 species worldwide, most of which are found in the Mediterranean region, Southeast Asia, western Malaysia, tropical America, and warm-temperate North America (Mabberley 1987). Four species grow in North America, north of Mexico, namely, *Styrax americanus* Lam. (widespread in the southeastern U.S.), *Styrax grandiflorus* Ait. (also southeastern U.S.), *Styrax platanifolius* Engelm. ex Torr. (Texas only; includes *Styrax texanus* Cory), and *Styrax redivivus* (Torr.) Wheeler of California (Kartesz and Meacham 1999). The genus is the type genus of the family Styracaceae, the Storax or Snowbell Family, and the name *Styrax* is based upon an ancient name for the plant. This family has 12 genera, only one other of which, *Halesia* (the Silverbell), is native in North America. The family is placed within the order Ebenales, along with the Ebenaceae, the Ebony family, making the persimmon (*Diospyros*) a not so distant relative. *Styrax* in North America inhabits diverse habitats, from cypress swamps (*Styrax americanus*) to very dry California chaparral (*Styrax redivivus*). The genus *Styrax* has been treated as masculine, feminine, and neuter in gender at various times – Linnaeus considered it neuter (epithets ending in *–um*), other botanists have considered it feminine because all trees in ancient times were considered to be feminine (epithets ending in *–a*), but the actual word is masculine in gender (epithets usually ending in *–us*). Nicolson and Steyskal (1976) provided a review of this history and concluded that the genus, like *Panax*, should be treated as masculine, with appropriate masculine epithet endings. The common name for the genus is often given as "Storax".

The Bigleaf Snowbell was first described and named, as *Styrax grandifolium*, by British botanist William Aiton in 1789 based on plants cultivated in England originally sent from South Carolina. The species is quite distinct, and it has been well-known since the 1700s, and no other names have been proposed for this species. The epithet '*grandifolium*' is derived from the Latin prefix '*grandi-*' or large, and the Latin noun *folia* [*-us*, *-um*], or leaf – hence the common name, 'Bigleaf Snowbell', Snowbell being a common name sometimes applied to the genus because of its clusters of pure white flowers resembling snow, with each flower resembling a hanging bell (Fernald 1950). The specific epithet was variously spelled '*grandifolia*' and '*grandifolius*'

as well because of the gender confusion described by Nicolson and Steyskal (1976), the latter masculine ending now being generally accepted.

DESCRIPTION OF THE SPECIES

Styrax grandifolius, the Bigleaf Snowbell, grows either singly as a small **tree** 2- 3.5 (-4) m tall, or also commonly as a multistemmed, rhizomatous **shrub**, then often 1-2 m tall, forming large colonies, and its vegetative parts are all generally pubescent with sparse to dense stellate hairs (typical for the family); the **bark** is dark and streaked; the **leaves** are deciduous, simple, alternate, exstipulate, and broadly obovate to suborbicular in shape with broadly tapered to rounded bases, the **petioles** are 2-10 mm long, the **blades** are up to (5-) 8-15 (-20) cm long x (3-) 4-10 (-15) cm wide, apiculate to rounded or obtuse or abruptly short-acuminate, nearly entire to obscurely denticulate, pale and stellate pubescent beneath (often densely so, making the underside of the leaf appear white to grayish), dark green above and nearly glabrous or pubescent along the larger veins; the **inflorescences** are stellate-tomentose, axillary, drooping, racemose and elongate cymes on short-shoots, to (5-) 15 cm long, and usually 5-12 (-20) flowered; the lowest flowers are usually subtended by a reduced leaf or leaflike-bract, the others have tiny bracts; the showy **flower** is pendulous, white, fragrant, and convolute-imbricated in bud; the **calyx** is composed of 5 fused sepals, somewhat tubular and shortly 5-lobed; the **corolla** is white, and the 5 petals are fused at their bases and free above, the corolla is (10-) 15-20 (-22) mm long and pubescent, spreading-campanulate in profile, and the lobes are spreading to recurved; there are 10 **stamens** with short partly fused filaments and large (elongate) and conspicuous yellow to yellow-orange anthers; the **style** is linear, white, and somewhat exceeds the anthers; the partly inferior **ovary** is 3-locular, at least basally, and stellate pubescent; the **fruit** is a pendent, dry, subglobose or ellipsoid, drupe-like 3-valvate 1-2 seeded capsule 7-9 mm in diameter, the lower third adherent to the persistent calyx. The plants normally flower in April and May, and the fruits are dry and brown in September. The chromosome number is $2n = 32$. (Adapted from Fernald 1950, Radford *et al.* 1968, Godfrey 1988).

Some individuals may resemble *Styrax americanus*, but *Styrax grandifolius* has 5-20 larger flowers in racemes 5-10 cm long (not solitary or paired flowers as is typical in *Styrax americanus*, though sometimes that species can have a short terminal raceme with 2-4 smaller flowers), and it has larger leaves (3-9 cm wide) that are permanently soft-hairy beneath and entire or shallowly toothed (*Styrax americanus* leaves are 1-4 cm wide, glabrous or nearly so, though rarely more densely pubescent in one variety, and they are sharply serrate or serrulate; Gleason and Cronquist 1991; Radford *et al.* 1968).

HABITAT AND ECOLOGY

The Bigleaf Snowbell has been given a national wetland indicator status of FACU or FACU-, indicating that the species normally does not occur in wetlands, and in some areas, it is

essentially never found in wetlands [FACU = Facultative Upland, usually occurs in non wetlands (estimated probability 67 - 99%) but occasionally found on wetlands (estimated probability 1 % - 33%); FACU- = less than Facultative, the species is even less likely to occur in wetlands (estimated probability less than 1 % - 33%)]. In Region 3, including both Illinois and Indiana, *Styrax grandifolius* has been specifically designated a NI species – indicating that insufficient information is available to determine an indicator status in this area (Reed 1988; W-1; W-2).

Styrax grandifolius grows mainly in shaded to open mesic upland forests or in the vicinity of floodplain forests, usually on well-drained slopes in or near wooded ravines and on bluffs. Floras have listed the habitat of *Styrax grandifolius* as "Woods" (Fernald 1950), "Along a stream in woods" (Mohlenbrock 2002), "inhabiting well-drained, mesic woodlands of bluffs and ravines, on rises in floodplain woodlands" (Godfrey 1988), "ravines and mesic slopes" (Wofford 1989), "Calcareous hammocks and floodplain forests" (Wunderlin 1998), and as "Mixed or deciduous forests and upland woods" (Radford *et al.* 1968).

Styrax grandifolius prefers somewhat moist soil, at least part of the year, it benefits from a layer of humus, and the substrate varies from sand to clay, normally with a pH that is somewhat basic to circumneutral to acidic [pH 5-7 (-8?)]. Soil types noted on herbarium labels included rocky clay with humus, sandy soil on hillsides, and gravelly soil. The pH tolerance appears to be quite broad. In South Carolina, the habitats are often unquestionably acidic (Hill, pers. obs.) but in several other states the plants can be in soils associated with limestone. The now extirpated Ohio population grew "on an outcropping ledge of limestone" (from herbarium specimen label: *Stephenson s.n.*). In one case, plants were transplanted from their native habitat (unknown pH) to one that was both very acidic (tested as pH 5) and quite dry, though still shaded; the plants remained alive but were stunted and showed little growth even after 5-10 years (Hill, pers. obs., in SC). Therefore, one might conclude that the optimum pH overall for this species is approximately pH 6-7 or 7.5.

This species tends to be restricted to the coastal plain and piedmont, only rarely reaching the lower portions of the mountains, at elevations from approximately 90 ft – 1,300 ft. Various sources, including herbarium labels, state that it is found in several very diverse habitats, such as on sandy river banks, swamp margins, shale ridges, rocky (limestone) river banks, rocky bluffs, steep mesic ravines, the margin of dry oak-hickory forests, the margin of hardwood – scrub oak forests, rich woods, cove forests, deciduous woods, hillside forests, mixed pine – oak woods, and mesic upland forests. None of these sites are fully exposed fields or prairies – instead, the *Styrax* is most commonly an understory plant in open woodlands in shade. It would appear that the species is not very tolerant of continuous direct sun exposure. *Styrax grandifolius* is known to be tolerant of moderate disturbance (Coder 1996) as well as some types of forest fires (Oosting and Livingston 1964).

Styrax grandifolius grows in several different plant communities or associations. In

Louisiana, where it appears to be most common, Bigleaf Snowbell grows in a community described as the Mixed Hardwood – Loblolly Pine/Hardwood Slope Forest, sometimes divided into the Hardwood Slope Forest and the Mixed Hardwood – Loblolly Pine forest (W-3; W-4). The two communities are similar in species composition but they differ in topographic position and soil moisture, with Hardwood Slope Forests being more mesic. These occur on slopes, often steep, rising out of stream floodplains, and the Mixed Hardwood – Loblolly Pine forest is found upslope and on low ridge tops. The associated species below suggest that the soils at these sites are predominantly acidic. The composition can vary, and the frequency of *Pinus taeda* (Loblolly pine) increases with fire. The **trees** typically associated with *Styrax grandifolius* in Louisiana on the Hardwood Slope Forests include *Carpinus caroliniana, Carya cordiformis, Carya glabra, Carya tomentosa, Cornus florida, Fagus grandifolia, Liquidambar styraciflua, Liriodendron tulipifera, Magnolia acuminata, Magnolia grandiflora, Ostrya virginiana, Oxydendrum arboreum, Pinus taeda, Quercus alba, Quercus shumardii, Quercus michauxii, Quercus nigra, Quercus laurifolia,* and *Quercus velutina*. The understory is often open, and the **shrubs** (or small trees) normally present include *Amelanchier arborea, Ilex ambigua, Illicium floridanum, Symplocos tinctoria, Vaccinium arboreum,* and *Vaccinium elliottii.* There is a moderately diverse **herb/forb** layer including *Arisaema* spp., *Chamaelirium luteum, Hexastylis arifolia, Lilium michauxii, Podophyllum peltatum, Polygonatum biflorum, Prenanthes altissima, Sanicula* spp., *Spigelia marilandica, Tipularia discolor, Trillium* spp., *Uvularia perfoliatum, Viola* spp., and the **ferns** *Phegopteris hexagonoptera* and *Polystichum acrostichoides*. In the Mixed Hardwood – Loblolly Pine Forest the vegetation is similar, and associates, depending on moisture regime, include the **trees** *Acer rubrum, Carya glabra, Carya tomentosa, Fagus grandifolia, Liquidambar styraciflua, Liriodendron tulipifera, Magnolia grandiflora, Nyssa sylvatica, Oxydendrum arboreum, Pinus taeda* (at least 20% of canopy), *Quercus alba, Quercus falcata, Quercus marilandica, Quercus michauxii, Quercus nigra, Quercus pagoda, Quercus stellata,* and *Ulmus americana*. Understory **shrubs** (or small trees) can include *Callicarpa americana, Cornus florida, Crataegus* spp., *Ilex decidua, Ilex glabra, Ilex vomitoria, Malus angustifolia, Morella (Myrica) cerifera, Rhus copallina, Rubus* spp., *Vaccinium arboreum,* and *Vaccinium elliottii,* along with the **vines** *Gelsemium sempervirens* and *Toxicodendron radicans,* and the **herbs** *Mitchella repens* and *Viola* spp. This association of plants, or a subset of it, is typically found where *Styrax grandifolius* grows through most of its range. Oosting and Livingston (1964) found that *Styrax grandifolius* appeared in a similar Loblolly pine community in Orange County, North Carolina, only after a crown fire had occurred (20 years later), and not in an unburned stand.

One forest association specifically includes *Styrax grandifolius* as a common component, namely, the *Quercus prinus – Quercus* spp. / *Vaccinium arboreum* – (*Kalmia latifolia, Styrax grandifolius*) Forest, one of the Southern Interior Low Plateau Dry Oak Forests (W-3). This classification follows the formal International Vegetation Classification system (W-3). This forest association occurs in the south-central portion of the United States and is the dominant forest type found on narrow ridges of the western escarpment of the Eastern Highland Rim

of Tennessee at about 350 m (1,100 ft) elevation. This forest has a canopy strongly dominated by the **tree** *Quercus prinus*, along with *Acer rubrum, Carya alba, Nyssa sylvatica, Pinus echinata* (or *Pinus virginiana* – occasional), *Quercus alba, Quercus coccinea, Quercus rubra,* and *Quercus velutina*, and the understory trees *Cornus florida, Fagus grandifolia, Oxydendrum arboreum*, and *Sassafras albidum* also common. Typical **shrubs** include *Gaylussacia baccata, Hypericum frondosum, Kalmia latifolia, Styrax grandifolius, Vaccinium arboreum, Vaccinium corymbosum, Vaccinium pallidum, Vaccinium stamineum*, and *Viburnum acerifolium*. **Vines** usually include *Smilax glauca* and *Smilax rotundifolia*; **forbs** may include *Antennaria plantaginifolia, Chimaphila maculata, Cypripedium acaule, Epigaea repens* (a subshrub), *Helianthus divaricatus, Helianthus hirsutus,* and *Tipularia discolor*, along with the **graminoid** *Dichanthelium dichotomum*, and the **fern** *Polystichum acrostichoides*. The American Chestnut (*Castanea dentata*) was formerly a dominant in this forest association. The substrate is generally shallow, acidic soils over non-calcareous bedrock of sandstone, conglomerate, and shale or, to the south, over thin loess and siliceous limestones and cherts (W-3).

An herbarium specimen from Madison County, Florida, (*Abbott 19083*) indicated that *Styrax grandifolius* occasionally grows on raised portions of riverbanks within river floodplains, surrounded by the **trees** *Acer rubrum, Liquidambar styraciflua, Cyrilla racemiflora, Quercus* spp., *Fraxinus* spp., and *Taxodium distichum*, with the **shrubs** *Cephalanthus occidentalis* and *Itea virginica*, the **herb** *Senecio glabellus*, the **grass** *Panicum* spp., and the **ferns** *Osmunda* spp. and *Woodwardia areolata*.

In Indiana, the single colony of *Styrax grandifolius* grows in Crawford County, in an area referred to by Deam (1940) as the Chestnut Oak Upland Floral Area. Homoya *et al.* (1985) have included this site within the Shawnee Hills Natural Region, Escarpment Section but close to the margin of the Crawford Upland Section. The plant community where it grows is a dry-mesic upland forest near the top of a large hill on an east-facing slope, and the common associates at the site are the dominant canopy **trees** *Quercus alba* and *Quercus velutina*, and the **vine** *Smilax rotundifolia* is also quite common (Homoya *et al* 1995; Homoya, pers. comm.). Other associates include many of the same species found in Tennessee (see above) and Illinois (below).

In Illinois, the single known colony of *Styrax grandifolius* grows in Alexander County in a small forested ravine with a southern exposure at an elevation of 420 feet, in silty loam (Schwegman 1968; Schwegman 1992). The habitat is more mesic than that at the Indiana site. It is near the base of a steep hill of cherty limestone in rocky soil along a small dry stream bed where it was first discovered by John E. Schwegman in May 1968 (Schwegman 1968). The vegetation has been characterized as a mesic upland forest, dominated by the **trees** *Acer saccharum, Fagus grandifolia, Liriodendron tulipifera,* and *Magnolia acuminata*, and also with *Acer rubrum, Aesculus glabra, Carya cordiformis, Cladrastis kentukea, Cornus florida, Liquidambar styraciflua, Nyssa sylvatica, Populus deltoides, Prunus serotina, Quercus alba, Quercus velutina, Sassafras albidum, Tilia americana*, and *Ulmus americana*. The infrequent **shrub**

Rhododendron prionophyllum is also in the general area, along with *Corylus americana*, *Ilex decidua*, and *Lindera benzoin*; other associates include the **forbs** *Aplectrum hyemale, Cacalia atriplicifolia, Caulophyllum thalictroides, Cypripedium calceolus, Desmodium canum, Lespedeza intermedia, Porteranthus stipulatus, Ruellia pedunculata, Solidago ulmifolia*, and *Valeriana pauciflora*, and the **graminoids** *Agrostis perennans, Arundinaria gigantea, Carex cephalophora, Muhlenbergia sobolifera*, and *Panicum laxiflorum* and the **ferns** *Adiantum pedatum* and *Botrychium virginianum*.

DISTRIBUTION AND ABUNDANCE

Styrax grandifolius, the Bigleaf Snowbell, is restricted to the southeastern to south-central portion of the United States and it has been reported historically in fifteen states, namely, Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Mississippi, North Carolina, Ohio, South Carolina, Tennessee, Texas, and Virginia (W-1, W-3). Its range includes only unglaciated areas. The distribution of this species has decreased somewhat in recent decades. It is considered to be 'historic only' in Ohio (W-1, W-3, W-5; Kartesz and Meacham 1999). As with most other species, it becomes scarce at the margins of its range. Its historic range assessed on a county basis also was greater than its current range. One can generally expect that a decline has occurred in recent decades because of the general loss and degradation of its natural habitats nationally.

The frequency of the Bigleaf Snowbell cannot be estimated precisely based upon its state rankings (W-3) because it is currently not ranked in nine of the fifteen states from which it has been reported. Based on known herbarium records and other sources (see appendices), this shrub/tree would appear to occur (currently and historically) most frequently in Louisiana (42 parishes), North Carolina (34 counties), Georgia (33 counties), Mississippi (33 counties), Alabama (31 counties), Arkansas (29 counties), Tennessee (28 counties), and South Carolina (21 counties). In the other seven states from which it has been reported, *Styrax grandifolius* occurs in fewer than twelve counties. Bigleaf Snowbell can be locally common and the frequency of the species within each county can be greatly variable. Additional details on the distribution of this shrub/tree can be found in Kartesz and Meacham (1999) and several Internet sites (*e.g.*, W-1, W-3). Representative specimens of this species have been listed in Appendix 1. A summary of the world-wide distribution of the Bigleaf Snowbell has been presented in Appendix 2.

The species has been found in Illinois at a single site (where it is at its northwestern range limit in the extreme southwestern part of the state) and in Indiana also at a single site, and it has been found in neighboring Kentucky but not in adjacent Missouri, Wisconsin, or Iowa (W-1, W-3).

In Illinois, where it is listed as Endangered, this plant has been found only in Alexander County within Shawnee National Forest in the Wolf Creek Botanical Area (Herkert and Ebinger 2002; Mohlenbrock 1986, 2002; Mohlenbrock and Ladd 1978; Schwegman 1968; Schwegman

1992; Shawnee National Forest 2005). The colony has approximately 100 stems a meter or more in height, and it has many more, shorter, stems, but it may actually be a single interconnected clonal plant (Schwegman 1992). This site in Illinois is in the Southern Section of the Ozark Natural Division (Schwegman *et al.* 1973; Herkert and Ebinger 2002). No other sites for this species are known in the state (Herkert and Ebinger 2002).

In Indiana, *Styrax grandifolius* is also listed as state Endangered and it is known from a single site in Crawford County on private property not far from the Harrison-Crawford State Forest. It was first found approximately 20 years ago by Mike Homoya (Homoya, pers. comm.; Homoya *et al.* 1995). It was not included within the flora by Deam (1940).

Within the U.S. Forest Service Eastern Region (Region 9) *Styrax grandifolius* has been found within the Shawnee National Forest in Illinois and, formerly, in the Wayne National Forest in Ohio. It has not been found in Missouri. It is considered by the Forest Service to be at risk in Illinois but not in Indiana because it has not been found within the Hoosier National Forest (W-6). *Styrax grandifolius* is unlikely to be present within other Region 9 forests because of its more southern and southeastern distribution. It is found in several National Forests in the southeast, in Region 8, including the Daniel Boone National Forest in Kentucky, the Uwharrie National Forest in North Carolina, the Sumter National Forest in South Carolina, the Chattahoochee National Forest in Georgia, the Ouachita National Forest in Arkansas, the Kisatchie National Forest in Louisiana, and the Sabine National Forest in Texas (and undoubtedly others).

The populations of this shrub/tree in Illinois, Indiana, and Kentucky in the Midwest are scattered widely and the populations are isolated from one another. It is possible that the species was somewhat more common in the region at the time of European settlement, but there is no direct evidence for this because there are few early herbarium records from that early period from this region. The forests in the area are thought to have been kept open by means of fires set by the earlier inhabitants in the area before European settlement, and *Styrax grandifolius* does appear to benefit from some types of forest fires. In addition to fire suppression, in some cases the forests where it may have occurred have since been cut or disturbed by agriculture and housing in the past 200 years, in which case there may have been a significant population decline for those reasons.

There is not much precise data available on actual population sizes, *i.e.*, numbers of individuals, available for the Bigleaf Snowbell. Because *Styrax grandifolius* can be clonal, counts of the numbers of stems may be misleading. In Illinois, Schwegman (1968) reported 30-40 plants (or stems) as well as many small plants produced from root suckers. Later, Schwegman (1992) reported counts of larger stems of 96, with numerous uncounted shorter stems, and he speculated that the colony is actually a clone, and a single individual. In South Carolina, this shrub can be the dominant species on slopes in the forest understory locally, with hundreds of stems (Hill, pers. obs.) but these large colonies are generally local, with large distances between one and

the next colony. At least one vegetation association, ranked as apparently secure, includes *Styrax grandifolius* as a major component, as described above – the *Quercus prinus* - *Quercus* spp. / *Vaccinium arboreum* - (*Kalmia latifolia*, *Styrax grandifolius*) Forest Association, and this plant can be quite abundant locally.

PROTECTION STATUS

The Nature Conservancy ranking for *Styrax grandifolius* is G5 (Secure; W-3), indicating that the species is thought to be secure worldwide. In the United States, overall, the species is given the National Heritage rank of NNR, for unknown reasons, but possibly because it has not been ranked in 10 of the 15 states where it occurs.

In the United States, official protection for this shrub/tree outside of Forest Service lands depends upon state and local laws because it is not listed as federally threatened or endangered. Significant populations of this species occur in several National Forests.

The state rankings vary. *Styrax grandifolius* is listed as Endangered (and ranked as S1, Critically Imperiled) in Illinois (W-3; Illinois Endangered Species Protection Board 2005; Herkert and Ebinger 2002 – as "Bigleaf Snowbell Bush") and in Indiana. It as been ranked as Presumed Extirpated (SX) in Ohio. This species has been ranked as Vulnerable (S3, also on their Watch List) in Virginia. It is not ranked (SNR) in ten additional states. *Styrax grandifolius* is listed as Apparently Secure (S4) in Kentucky. It is at greatest risk at the margins of its range.

In Forest Service Region 9, the Bigleaf Snowbell is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest where it is at Risk (W-6). It has not been found in the Hoosier National Forest. Also within Region 9, *Styrax grandifolius* was once found in the Wayne National Forest in Ohio, where it is now considered to be extirpated (W-5).

Table 1 lists the official state rank for *Styrax grandifolius* assigned by each state's Natural Heritage program according to the Nature Conservancy at their Internet site (W-3). Appendix 3 explains the meanings of the acronyms used (W-7).

A summary of the current official protection status for *Styrax grandifolius* follows:

U.S. Fish and Wildlife Service:	Not listed (None).
U.S. Forest Service:	Listed as at risk in the Shawnee National Forest, Region 9
Global Heritage Status Rank:	G5

U.S. National Heritage Status Rank: NNR

Table 1: S-ranks for *Styrax grandifolius* [Heritage Element Code: PDSTY02020]

State/Province	Heritage S-rank	
UNITED STATES		
Alabama	SNR	
Arkansas	SNR	
Florida	SNR	
Georgia	SNR	
Illinois	S1	[Endangered]
Indiana	S1	[Endangered]
Kentucky	SNA	
Louisiana	SNR	
Mississippi	SNR	
North Carolina	S4	
Ohio	SX	[Presumed Extirpated]
South Carolina	SNR	
Tennessee	SNR	
Texas	SNR	
Virginia	S3	[Watch List]

LIFE HISTORY

Styrax grandifolius is a woody perennial, either a shrub or small tree. Its lifespan is not known, but, because of its often clonal nature, an individual could live for hundreds of years. Plants appear to flower and fruit regularly throughout their range, and they have no known reproductive abnormalities (but see below). *Styrax* flowers are showy and fragrant, and they are visited by several different pollinators, the most common of which are honeybees and bumblebees (Huang *et al.* 2003). Other pollinators reported for members of the genus are swallowtail butterflies, syrphid flies, sphingid moths, wasps, and other groups of bees (*e.g.*, carpenter bees, halictids). Both nectar and pollen are consumed as food, though there are no specialized structures recognizable as nectaries (Huang *et al.* 2003).

Schwegman (1992) has suggested that individual plants of *Styrax grandifolius* may be self-incompatible, because the single colony in Illinois, thought to be a single clone or individual, has never produced seeds during the time period in which it has been observed (1968 – 1992). The breeding system has not been studied in this species of *Styrax*, apparently. The flowers are hermaphroditic, but the pollen may not be self-compatible in some species. An Asian species, *Styrax obassia*, appears to be at least partially self-incompatible, and other species of *Styrax* have been determined to be obligate outcrossers (Huang *et al.* 2003). In many plants, self pollination is generally a backup to ensure that at least some seeds will survive so that the population will not disappear. If the *Styrax grandiflorus* population in Illinois is actually a single clonal plant, and if it is indeed self incompatible, it may never produce seeds and it may be incapable of expanding beyond its current site. It may also be susceptible to sudden extinction (see threats section below).

The Bigleaf Snowbell's flowering period overall is generally from late April to late May. The flower buds appear as the leaves emerge and the flowers generally open at about the same

time that the leaves have reached their mature size. Herbarium specimen labels examined for this study revealed that the earliest date for a collection of this species in flower was 11 April in Florida and 12 April in Texas. The latest seasonal flowers were collected on 28 May in North Carolina. Schwegman (1992) noted flowers on the Illinois population on May 15-18, and they were about 10 days past peak flower on May 18th. The flowering period for *Styrax grandifolius* in Illinois would then seem to be approximately May 5 – May 25. Herbarium specimens had young fruits as early as 4 May in Georgia, and seemingly full-size fruits by 1 June in Alabama, but fully mature fruits appeared to be most frequent on specimens during the period 1-15 September. Most fruits had fallen by October, but a few fruits remained on one specimen collected in early October in Alabama. The leaves usually fall at about this time as well.

Little information exists on *Styrax* seed dispersal mechanisms. The fruit husk is dry and thin and the seeds are quite large and fill most of the fruit, making it appear drupe-like, but there is no fleshy portion for animals to eat. Fruits of *Styrax obassia* in Asia are dispersed by ground mice and food-hoarding birds (Huang *et al.* 2003). This could also be true of the *Styrax grandifolius* seeds, but they also may simply fall near the plant because no specialized seed dispersal mechanism is known. Their spherical shape does allow them to be carried along slopes by water flow (presumably), but they do not float, nor does this species usually grow close enough to water for the seeds to be dispersed in this manner.

Styrax fruits and seeds appear to contain chemicals that discourage most predation, and these chemicals are often found in the rest of the plant as well. The benzofuran egonol and its glycosides occur in the seed oil of several species of *Styrax*. The fruit of *Styrax* contains significant amounts of jegosaponin, a potent defense chemical. Various species of *Styrax* also contain styracitol, P-phenyl ethyl alcohol and coniferin (Huang *et al.* 2003).

Nothing appears to be known about the longevity of *Styrax* seeds or if they persist in a seed bank. Their size and relatively thin seed coat suggest that they may not be a significant component of the forest soil seed bank. At least one study on germination of the seeds of *Styrax japonicus* showed that they germinated best if they received one month of warm stratification followed by 2 months of cold stratification (Roh and Bentz 2003).

POPULATION BIOLOGY AND VIABILITY

Styrax grandifolius is a shrub to small tree that may live for many years, as an interconnected clone or as an individual. In most of its range it appears to flower and fruit regularly. As discussed in the previous section, however, the plants may be self-incompatible, so that seeds may not be produced if only a single clonal individual is present, as may be the case in the Illinois population. Large, variable populations are generally considered to be more viable than smaller, invariable ones, but the latter may persist, instead, as vegetative individuals indefinitely. The population at the single site in Indiana is not a single clone and has a different aspect. That

colony has fertile individuals, and there appear to be three sub-populations (Homoya, pers. comm.). Ninety-two (92) separate genets have been counted at that site, and these cover approximately 0.5 acre; many stems are over 5 ft tall. Based on this limited data, one could hypothesize that the Illinois population resulted from a single successful (chance?) seed introduction, the resulting plant being the only one, perhaps, in the area, and unable to reproduce sexually, surviving as a vegetatively spreading clone. In contrast, the Indiana population may be a relictual, sexually and vegetatively reproducing disjunct colony of plants with a very limited number of genotypes remaining, or (though less likely) it could be the result of a successful seed introduction involving at least 3 different successful seeds (genotypes) that would allow the population to be maintained through both sexual and vegetative reproduction. The fact that *Styrax grandifolius* does not occur north of the southernmost extent of the Ice Age glacial advance perhaps suggests that 1) it is very sensitive to cold and simply cannot survive much further north, or 2) it has not migrated because it does not have an effective dispersal mechanism – it exists only where it has 'always' existed.

It is generally understood that fertility is reduced in inbred populations through the process of autogamy (self-fertilization). Autogamy is useful to the plant when there are small numbers of individuals per area, since the safeguarding of the success of propagation is more important than the production of new genotypes. In primary habitats, those that are generally poorly vegetated, initial success is very important. However, in subsequent periods of vegetation increase, pioneers are often substituted by other, more competitive species (W-8). In the single Indiana population of *Styrax grandifolius*, the population is certainly small and very isolated. Therefore, if pollination should occur, only very limited variation could result if there are only three genetic individuals present. The colony, after millennia, would have a very limited amount of variation because there is almost no chance of fertilization by other genotypes that are not within dispersal range. Continued inbreeding can result in severe reproductive problems caused by genetic drift and a reduction in genetic variation.

An example of negative effects thought to have arisen through the isolation of populations can be seen in the case of a grass, Ofer Hollow Reedgrass (*Calamagrostis porteri* ssp. *insperata* (Swallen) C.W.Greene), which has become isolated on rather dry sandstone bluffs throughout its range. This grass almost never produces viable seed anywhere in its range and this reproductive failure may be a reflection of a high genetic load that has occurred as a result of its long isolation (see Hill 2003). High genetic load can be seen in dominant mutations that result in factors lethal to embryos, and this situation appears to be indicated in that grass. That plant survives as a rare relict in the vegetative state only. One can see the parallel in the case of the single Illinois 'colony' of *Styrax grandifolius* that may also be doomed to survive only in a vegetative state.

Bigleaf Snowbell habitat may be decreasing (see Potential Threats below). It may occur at other suitable sites in Illinois but because of the plant's conspicuous nature when in flower, it is less likely to have been overlooked. It is at the extreme northwestern margin of its range in southern

Illinois, and, therefore, truly suitable habitat for the species may not be common; it appears that it probably was never more common locally. At the margins of a species' range, viability is thought to be very poor, and the precise factors controlling its distribution at these margins are not known. There appears to be little or no chance of natural colonization of new habitat by this shrub/tree in Illinois because of the lack of nearby seed sources and known vectors for its migration here. Therefore, the long-term viability of this very uncommon species in Illinois, as well as in Indiana, depends entirely on the protection and management of the existing populations or on additional introductions by means of human intervention.

POTENTIAL THREATS

Globally, Bigleaf Snowbell has been ranked as secure as a species (see Protection Status above) and so it is not generally considered to be threatened. It is, however, a North American endemic with a somewhat limited overall range and, locally, in Illinois and Indiana, the loss of a single population would eliminate it from each state. This appears to have already happened in Ohio where the single known population has disappeared (W-5). In the other two states, *Styrax grandifolius* is most certainly one of the most endangered plant species. It appears to be unable to increase its range generally, and so may be vulnerable in some other areas in its range as well.

The species is most vulnerable at the margins of its range, and this is the typical condition for most state-rare plants. As the species extends into climatic zones and habitats that are only moderately suitable for it, the individuals become few in number and they are often stressed because of the less than optimal conditions. Bigleaf Snowbell in Illinois and Indiana certainly fits this pattern, though its possible self-incompatibility, a major threat to its survival in the state, makes isolation even more limiting. In addition to these inherent natural limitations, there are other serious threats to the survival of this species. These threats include 1] forest management practices, 2] land-use conversion and development, 3] competition with aggressive native and exotic species, 4] possibly from grazing or foraging animals, 5] extreme cold or extreme drought, 6] local disasters (stochastic events), and 7] habitat fragmentation (W-3; W-5; Schwegman 1992; Shawnee National Forest 2005).

Some forest management practices can threaten this plant. It is generally thought that the elimination of the forest canopy trees shading this species will eliminate it as well. All of the populations occur in the shaded forest understory, and the species appears to be intolerant of full sun (W-3, W-5). Clear-cutting as well as selective logging of the largest trees would have a detrimental effect on *Styrax grandifolius*, a shrub/tree well adapted to shaded understory situations. Its wide leaves are efficient at using filtered sunlight, and the reduction of the larger canopy trees in its vicinity would, most likely, cause a loss from exposure-related problems. The presence of thriving populations growing in deep shade in several states argues against selective cutting or any damage to the larger trees that shade this small tree.

Land development is a distinct danger to native populations of this shrub/tree, and the loss of habitat to residential and business interests, and especially to the construction of dams that drown its ravine habitats, can eliminate large and significant population of this and many other species. There is some data to indicate that *Styrax grandifolius* is tolerant to a moderate amount of landscape level damage (Coder 1996) but the data also indicates that physical injury to the plants as well as compaction and drying of the soil reduces these tolerances. Most development in current times begins by bulldozing and clearing all vegetation from a site before construction, and *Styrax grandifolius* cannot survive such extreme environmental damage. Since European settlement, significant acreages of the previously available habitat have been destroyed, converted to cultivated fields orchards or commercial forests, or they have succumbed to land development (W-3). Some extant populations are in national forests or protected areas, but these have only been found as a result of careful searches at these sites in recent decades; it cannot be determined how many populations were lost at other sites before field botanists began to document this species.

In Illinois and Indiana, and, perhaps, elsewhere, there is some evidence that *Styrax grandifolius* can be overwhelmed and threatened by aggressive native and non-native plant species, especially vines (Homoya, pers. comm.; Schwegman 1992). In Illinois, the non-native and aggressive Japanese honeysuckle (*Lonicera japonica*) and Multiflora rose (*Rosa multiflora*) vines occur at the margin of the Bigleaf Snowbell clone, but they have not done much damage. In 1987 most of the Multiflora rose was hand-pulled (Schwegman 1992). In Indiana, the native Greenbrier (*Smilax rotundifolia*) is viewed as a threat to the population, and it has been trimmed at the margins of the colony (Homoya, pers. comm.). Vines such as Kudzu (*Pueraria lobata*) certainly pose a threat to *Styrax grandifolius* farther south. While *Styrax* is adapted to low light conditions, these aggressive vines are known to monopolize most of what light is available in the understory, leaving little for the *Styrax* and other similar low-light adapted native species.

While there appears to be little data available, Schwegman (1992) has noted that deer browsing completely defoliated 5 ‘plants’ at the margins of the Illinois clone in 1988. One can speculate that livestock or deer overpopulation could do significant damage to such a tiny population as this one, but, in general, deer are not known to seek out this species or consume much of it.

Styrax grandifolius is sensitive to both extreme cold and extreme drought. These two types of climate stress appear to be most evident in a population at the extreme margin of its range (W-3). Towards the center of a species’ range these stresses are usually not evident. The flower buds and young growth of Bigleaf Snowbell are occasionally frozen by a late spring freeze at higher elevations in South Carolina, and the plants do not produce additional flower buds after this (Hill, pers. obs.). Plants at the northern or western limits of their ranges demonstrate these effects especially well. When one examines the soil on the slopes where it grows, one can see that the soil, while well-drained, is also moist, especially in the spring when the species is in active growth (Hill, pers. obs.). It is probable that a severe drought would prevent this species

from most new growth as well as from flowering and fruiting. Moisture stress appears to be an issue with this plant, and prolonged drought may eliminate this species in an area that already has borderline moisture conditions. Evidence of this moisture sensitivity can be seen by the fact that the plant disappears when the canopy is cut and the plant is exposed to full heat and sun, which also dries the soil it is in. When *Styrax grandifolius* is planted on a slope that is drier than its normal habitat, even though shaded, it will remain stunted and not grow significantly, in at least one known case (Hill, pers. obs.).

In cases where a species population is extremely small, as in the cases of *Styrax grandifolius* in Illinois and Indiana, a sudden local disaster can extirpate it. A lightning strike on the last individual of a tree species in a region, for example, or a local flood, local insect infestation, rockfall, or another variation of this type, is capable of causing a local species extinction when only that single individual was present. Any population needs to be large enough that some individuals will survive a local disaster, and a population consisting of one or a few individuals, all of which could succumb to such an infrequent and unlikely event, is vulnerable. These stochastic and unpredictable events are considered to be a serious threat to small populations of any organism (Lacy 1987).

It is generally believed among biologists that habitat fragmentation can have profound effects on the success and persistence of local populations. Over time, as populations become increasingly more isolated, the effects of fragmentation can potentially be observed at the molecular level by reduced genetic frequencies caused by random drift (Barrett and Kohn 1991). When one is considering populations that are already isolated, as in the case of the Illinois and Indiana populations of the Bigleaf Snowbell, random genetic drift may have already occurred and may have caused severe negative effects to the species. The fragmentation of the overall forest results in extant colonies of woodland plants being increasingly remote from one another, and, in this case, *Styrax grandifolius* then exists in small isolated populations with little or no chance of gene exchange with other populations of the species. Genetic drift in these tiny uniform populations can result in an entire population being lost because there is not enough variability to survive or to adapt to changing conditions or new diseases.

At the current time, it appears that the single population of *Styrax grandifolius* in the Shawnee National Forest in Illinois may persist indefinitely with protection, but it is very unlikely to spread significantly or to establish additional colonies. In Indiana as well, the population is likely to persist with protection. Its potential for spread there is uncertain. The species itself is unlikely to be lost because of its frequency in the southeastern states, but, after the loss of the Ohio population, those in Illinois and Indiana may be next.

RESEARCH AND MONITORING

Plants in Illinois and Indiana have been and still are being monitored by personnel in each state because of its Endangered status (W-3; Homoya, pers. comm.; Schwegman 1992; Shawnee National Forest 2005). Few people grow the species as an ornamental, and it has not been the subject of much study either in the wild or in cultivation, so its characteristics and attributes, including disease tolerance and life history, are actually rather poorly known. Few, if any, wild populations elsewhere are being monitored in detail because it is not listed as a sensitive plant in most states where it occurs.

It appears that there is some contradictory evidence in the literature as to the effects of fire on this species. Fire may control the plant height and habit rather than its presence or absence and, in some cases or settings, fire may actually benefit this species (Oosting and Livingston 1964) or, at least, allow it to persist (W-9). Other sources indicate that fire is detrimental to the plant (Shawnee National Forest 2005). It appears that more research is needed to ascertain whether fire management is beneficial or detrimental to the Bigleaf Snowbell in various portions of its range.

While some observers (*e.g.*, Schwegman 1992) have speculated on the species' self-incompatibility, there appears to be no research in the literature on the breeding system of *Styrax grandifolius*. As far as is known, there has been little or no research concerning the fertility of the pollen and seeds of this plant, or on the genetic variability within the species or its populations. However, it is a likely candidate for both types of research. Another important area of research is to determine the factors leading to its establishment in natural populations, including the success rate of seedlings, and the success – or lack of success – in establishing new populations. Seedlings of this plant are either rarely seen or rarely recorded. Only a few limited observations are known concerning the Bigleaf Snowbell's sensitivity to the extremes of cold and moisture as well. Therefore, continued monitoring of wild individuals seems crucial for this species in Illinois and Indiana. Because the populations are somewhat distant and inaccessible, the populations could be lost at these forest sites from unknown causes unless they are monitored; those who have monitored the plants in the past must be sure to show the next generation of botanists where they are. Photographic documentation may help in this regard.

Certainly, *Styrax grandifolius* is so rare in Illinois and Indiana that a primary emphasis should be to continue to try and locate and vigorously protect all remaining populations. Additional searches have been made for this plant (Homoya, pers. comm.), so far without success. Similar habitat should be explored for the plant. There is a rather large area of additional suitable habitat in extreme southern Illinois and Indiana where *Styrax grandifolius* could also exist, and continued searches for the species should be conducted. A list of associates and indicator species has been compiled as a result of field studies in Illinois and other states (see habitat section

above). These indicator plants may be useful in facilitating the discovery of additional populations of this shrub/tree; the typically dominant species associates are really quite abundant in many areas. The leaves of this shrub or small tree alone are normally sufficient for the positive identification of it and leaves are generally easy to obtain. When found, voucher specimens should be made according to techniques described in Hill (1995) or other similar references. It is quite possible that populations of this species have been overlooked because of the probable sterile nature of individuals in the wild, except for its one-month flowering period in the spring.

Basic research and on-site investigations are still needed to determine the best management techniques to be used to preserve this locally rare species. It is generally recommended that the habitat quality where rare plants grow should be monitored on a regular basis and an assessment of the specific threats to all populations should be made (W-3). Long-term monitoring of known populations should continue every year to determine their status under current management activities, to determine the effects of climate and weather extremes on the plants, to eliminate vine encroachment and to prevent logging activities, and to record plant phenology. As part of the basic research on current populations of this species, data such as the counts of numbers of individuals present (or the colony size), the determination of the amount of yearly flowering and seed production, if any, that might occur and an assessment of recruitment rates, if any, are greatly needed in order to monitor population dynamics and to assess the viability of the individual populations found. Individual plants should be monitored over time at each site. Such basic facts as fungal associations or invasions, longevity, and yearly variations in colony size over a long period are important data. Surveys should be conducted during the flowering and fruiting periods of this tree, especially in May and June when they are in flower, and in early September for the fruits.

Botanical surveys conducted by scientists from the Illinois Natural History Survey have shown repeatedly that with sufficient time and funding, and an experienced eye, many plants thought to be extirpated or else threatened or endangered can be found at additional locations (Hill 2002). These sorts of investigations have been important in that they have led not only to the de-listing of species once thought to be rare, but they have also resulted in the discovery of species previously unknown in the state. The U.S. Forest Service and other related agencies have done a fine job in the effort to preserve rare species with the resources that they have available. Much of the locating and monitoring of known populations of rare species in southern Illinois has been conducted by Forest Service biologists in cooperation with Illinois Department of Natural Resources personnel. Similar cooperation occurs in Indiana, of course. However, a continuing problem is that there is neither sufficient funding nor are there enough botanists available to survey the immense area that needs to be covered in the monitoring of the large numbers of sensitive plants, including this one. It appears that a high priority should be given to the training and hiring of additional qualified field botanists to achieve these goals.

RESTORATION

There are no known restoration efforts being conducted on *Styrax grandifolius* anywhere in its range (*i.e.*, active plantings of seedlings or plants to restore the species into suitable habitat) and the restoration potential of this species is largely unknown. This shrub/tree has been recommended by several state and local organizations and departments as a suitable native species in plantings, but these are not restorations, as such. Restoration efforts of forest habitats where it grows are taking place throughout its range, and this may also help the species if it occurs on one or more of those sites.

Management recommendations include the continued protection of populations from disturbance, protection of the tree canopy (no logging allowed), and the periodic elimination of potentially harmful native and exotic aggressive plant species, especially vines, and, possibly, protection from uncontrolled fires (Shawnee National Forest 2005). It should be mentioned that *Styrax grandifolius* does appear to tolerate occasional understory forest fires at least in South Carolina, and these may benefit the species in some cases (Hill, pers. obs.; W-9). The populations that predominantly present the rhizomatous shrub habit, in particular, may benefit from fires that eliminate some of the other species in the understory; then the underground rhizomes may allow the species to regenerate after fires. The species often grows with Mountain Laurel (*Kalmia latifolia*) another species similarly adapted to fire. The literature generally indicates that this species tends to grow in areas protected from fires, so some experimentation would be needed to test its effect on any particular local population before assuming fire management is necessary to restore this species.

The generally recommended method to restore populations of this and other rare plants is to protect and manage their habitat (W-3). Protection of the organic humus-rich surface soil layer of the species' habitat may be crucial, along with the maintenance of a mature forest canopy. Exotic and aggressive species should be completely eliminated from each site. This would entail physically pulling them out because it is very likely that herbicide application would eliminate this shrub / tree at a site as well.

Restorations of native plant species are recommended using only propagated material grown from native, local populations to avoid mixing genotypes not adapted to the local conditions and to avoid compromising the local gene pool. If this rule is not followed, the result is generally the loss of plants because they are not competitive under local conditions, or the introduction of non-adaptive genes may cause a decline in the remaining native plants, or the result could be the success of a plant or plants that cannot be considered truly native (considered by some to be a plant community *reconstruction* rather than a restoration). Local plants should be propagated for planting in such an effort. Shrubs and small trees such as *Styrax grandifolius* can be grown both from seeds and cuttings, in general, but this species is not often propagated and commercially

sold, so much is unknown. Seeds should be gathered from local populations and planted as soon as possible, based on information available on other species. In the case of the Illinois population, it may yet be proven that the one population cannot be propagated sexually because of incompatibility factors. Then a decision must be made whether or not to introduce genetically different plants together in order to obtain seeds and cuttings for planting to increase the number of plants or colonies. The propagation of the single 'sterile' clone may not benefit the Illinois population itself in the long-term, and yet the introduction of individuals from other states may also be undesirable. A difficult choice, indeed. Perhaps the Illinois and Indiana (or closest Kentucky populations) could be interbred to increase the size and viability of the Illinois population under experimental conditions.

Styrax grandifolius is only very rarely available commercially, either as seeds or plants, from native plant nurseries.

SUMMARY

The Bigleaf Snowbell, *Styrax grandifolius* Ait., is an individual small tree or colonial shrub varying from 1 – 4 meters tall, with showy, fragrant white bell-like flowers in axillary racemes, and it is normally found on slopes in shade near streams in mesic or dry-mesic upland forests. The species is known only from the United States, and it grows primarily in the southeastern states; it is known historically from fifteen states, from Virginia south to Florida and west to Illinois, Arkansas and Texas. The Bigleaf Snowbell has not been found in Missouri. It has declined in recent decades and is scarce at the margins of its range in the upper Midwest. Globally, its ranking is G5 (secure world-wide); its National ranking in the United States is NNR (not ranked nationally). It is most common in Georgia, Louisiana, Mississippi, and North Carolina. The Bigleaf Snowbell is listed as Endangered in Illinois and Indiana, and it is presumed Extirpated in Ohio. In Forest Service Region 9, the Bigleaf Snowbell is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest where it has not been found. It is at risk at the northern margin of its range. It is threatened by its possible sexual self-incompatibility and a single plant may not be able to produce seeds, as in Illinois. Threats to this shrub/tree species include logging, land-use conversion and development, competition with aggressive native and exotic species, elimination by grazing or foraging animals (perhaps), extreme cold or extreme drought, local disasters (stochastic events), and habitat fragmentation. Much is not known about its reproductive features and viability as well as about the most effective management practices that would ensure its survival in the Midwest. It could face extirpation in the wild in several states if it is not properly protected, and it is especially vulnerable in Illinois and Indiana in each of which only a single site is known for the species.

Suggested research priorities for this rare small shrub to tree include attempts to locate additional populations and to monitor the remaining individuals in some detail to learn more about its life

history and tolerances. Protection of the sites from intense fire (possibly), competition from aggressive vines, and land development appear to be necessary to allow it to persist where it still grows in these two states. At this time, the establishment of additional populations is unlikely except through active human efforts.

REFERENCES

Barrett, B. C. H. and J. R. Kohn. 1991. Genetic and evolutionary consequences of small population size in plants: implications for conservation. [pp. 3-30 *In* Genetics and conservation of rare plants, D. A. Falk and K. E. Holtzinger, eds. Oxford University Press, New York, NY.

Chester, E.W., B.E. Wofford, and R. Kral. 1997. Atlas of Tennessee Vascular Plants. Vol. 2. Angiosperms: Dicots. Misc. Publ. no. 13, The Center for Field Biology, Austin Peay State University, Clarksville, TN. Note: as *Styrax grandifolia.*

Coder, K. D. 1996. Relative tolerance of tree species to construction damage. Warnell School of Forest Resources, University of Georgia, Extension Publication FOR 96-032. Available at: http://warnell.forestry.uga.edu/service/library/for96-032/index.html

Deam, C. C. 1940. Flora of Indiana. Indiana Department of Conservation - Division of Forestry, Indianapolis.1236 pp.

Fernald, M. L. 1950. Gray's Manual of Botany. Eighth Edition. Dioscorides Press, Portland, OR.

Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. 2nd edition. The New York Botanical Garden, Bronx.

Godfrey, R. K. 1988. Trees, shrubs, and woody vines of northern Florida and adjacent Georgia and Alabama. The University of Georgia Press, Athens, Georgia. 734 pp.

Herkert, J. R. and J. E. Ebinger (eds.) 2002. Endangered and Threatened Species of Illinois: Status and Distribution, Volume 1 - Plants. Illinois Endangered Species Protection Board, Springfield, Illinois. 161 pp.

Hill, S. R. 1995. How to Make a Plant Collection. Herbarium Supply Company, Menlo Park, CA. 8 pp.

Hill, S. R. 2002. Some recent changes in the Illinois flora. Illinois Natural History Survey Reports. Summer 2002. No. 3722.

Hill, S. R. 2003. Conservation Assessment for Ofer Hollow Reedgrass (*Calamagrostis porteri* A.Gray ssp. *insperata* (Swallen) C.W. Greene). Produced for the USDA Forest Service, Eastern Region, by the Center of Biodiversity, Illinois Natural History Survey, Champaign, 28 April 2003. 30 pp.

Homoya, M. A., D. B. Abrell, J. R. Aldrich, and T. W. Post. 1985. The natural regions of Indiana. Proceedings of the Indiana Academy of Science 94: 245-268.

Homoya, M. A., D. B. Abrell, C. L. Hedge and R. L. Hedge. 1995. Additions to the flora of southern Indiana, V and VI. Proceedings of the Indiana Academy of Science 104 (3-4): 213-221.

Huang, Y., P. W. Fritsch, and S. Shi. 2003. A revision of the imbricate group of *Styrax* series *Cyrta* (Styracaceae) in Asia. Annals of the Missouri Botanical Garden 90(4): 491-553.

Illinois Endangered Species Protection Board [IESPB]. 2005. Checklist of Endangered and Threatened Animals and plants of Illinois. Illinois Endangered Species Protection Board. Springfield, Illinois. 16 pp.

Kartesz, J. T. (data) and C. A. Meacham (software). 1999. Synthesis of the North American Flora. Version 1.0. CD-ROM. Biota of North America Program, North Carolina Botanical Garden, Chapel Hill.

Lacy, R. C. 1987. Loss of genetic diversity from managed populations: interacting effects of drift, mutation, immigration, selection, and population subdivision. Conservation Biology 1:143-157.

Mabberley, D. J. 1987. The plant-book, a portable dictionary of the vascular plants. 2nd Ed. p. 564, Cambridge: Cambridge University Press.

MacRoberts, D.T. 1989. A Documented Checklist and Atlas of the Vascular Flora of Louisiana: Dicotyledoneae – Fagaceae to Zygophyllaceae. Bulletin of the Museum of Life Sciences No. 9. Louisiana State University at Shreveport. As *Styrax grandifolia*.

Mohlenbrock, R. H. 1986. Guide to the Vascular Flora of Illinois. Revised and enlarged edition. Southern Illinois University Press. xii + 507 pp.

Mohlenbrock, R. H. 2002. Vascular Flora of Illinois. Southern Illinois University Press. Carbondale. 491 pp.

Mohlenbrock, R. H. and D. M. Ladd. 1978. Distribution of Illinois vascular plants. Southern

Illinois University Press. Carbondale. 282 pp.

Nicolson, D.H. and G. C. Steyskal. 1976. The masculine gender of the generic name *Styrax* Linnaeus (Styracaceae). Taxon 25(5/6): 581-587.

Oosting, H. J. and R. B. Livingston. 1964. A resurvey of a loblolly pine community twenty-nine years after ground and crown fire. Bulletin of the Torrey Botanical Club 91(5): 387-395.

Radford, A. E., H. A. Ahles, and C. R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press: Chapel Hill.

Reed, P. B., Jr. 1988. National list of plant species that occur in wetlands: national summary. U.S. Fish Wildlife Service Biol. Rep. 88(24).

Roh, M. S. and J. A. Bentz. 2003. Germination of *Styrax japonicus* seeds as influenced by storage and sowing conditions Acta Horticulturae 2003 (No. 620): 411-416.

Schwegman, J. E. 1968. *Styrax grandifolia* in Illinois. Castanea 33(4): 348-349.

Schwegman, J. E. 1992. Plant species biology summary for Bigleaf Snowbell Bush; Illinois Department of Natural Resources, Division of Natural Heritage. 2 pp.

Schwegman, J. E., G. B. Fell, M. D. Hutchinson, G. Paulson, W. M. Shephard, and J. White. 1973. Comprehensive plan for the Illinois Nature Preserve system. Part 2. The natural divisions of Illinois. Illinois Nature Preserves Commission, Rockford. 32 pp.

Shawnee National Forest. 2005. Shawnee National Forest biological evaluation of Regional Forester's Sensitive plant species. Forest Plan Revisions. Shawnee National Forest. Harrisburg, Illinois. Available at: http://www.fs.fed.us/r9/forests/shawnee/projects/forest_plan_revision/documents/plant-be.pdf

Smith, E.B. 1978. An Atlas and Annotated List of the Vascular Plants of Arkansas, 2nd printing 1979. University of Arkansas Bookstore, Fayetteville. 592 pp. + addenda.

Thomas, R.D. and C.M. Allen. 1998. Atlas of the Vascular Flora of Louisiana. Vol. III: Dicotyledons, Fabaceae-Zygophyllaceae. Louisiana Department of Wildlife and Fisheries: Baton Rouge. 218 pp. As *Styrax grandifolius*.

Wofford, B. E. 1989. Guide to the Vascular Plants of the Blue Ridge. University of Georgia Press, Athens, Georgia.

Wunderlin, R. P. 1998. Guide to the Vascular Plants of Florida. University Press of Florida, Tampa. 806 pp.

WEBSITES CONSULTED

W-1. U.S.D.A., NRCS. 2007. The PLANTS Database, Version 3.5. National Plant Data Center, Baton Rouge, LA 70874-4490, USA. http://plants.usda.gov/cgi_bin/topics.cgi

W-2. National Wetlands Inventory. U.S. Fish and Wildlife Service, Washington, DC. http://www.fws.gov/nwi/

W-3. NatureServe Explorer (The Nature Conservancy): An online encyclopedia of life. 2007. Version 1.6. Arlington, Virginia, USA. http://www.natureserve.org/

W-4. Conservation Habitats and Species Assessments. Louisiana Department of Wildlife and Fisheries. LA CWCS – December 2005. http://www.wlf.state.la.us/pdfs/experience/Mixed_Hardwood-Loblolly_Pine_Hardwood_Slope_Forest.pdf

W-5. *Styrax grandifolius* Ait., Bigleaf Snowbell. Ohio Department of Natural Resources. http://www.dnr.state.oh.us/dnap/Abstracts/s/styrgran/tabit/1627/Default.aspx

W-6. U.S.D.A. Forest Service, Region 9, Regional Forester Sensitive Plants, Signed by Regional Forester 29 February 2000. List maintenance on 20 October 2003. http://www.fs.fed.us/r9/wildlife/tes/docs/rfss_plants.pdf

W-7. NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.7. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer/ranking.htm

W-8. Botany On-line - Reproductive Isolation. University of Hamburg, Germany. http://www.biologie.uni-hamburg.de/b-online/e38/38d.htm

W-9. Fire and Fire Surrogate Study – Southeastern Piedmont. USDA Southeastern Forest Experiment Station, Clemson, SC. http://www.srs.fs.usda.gov/ffs/species_list.htm

CONTACTS

Shawnee National Forest, Hidden Springs Ranger District, 602 N. 1st Street, Vienna, IL 62995

Elizabeth Longo Shimp (618) 658-2071; e-mail: eshimp@fs.fed.us

Shawnee National Forest, Mississippi Bluffs District, 521 N. Main Street, Jonesboro, IL 62952

Stephen P. Widowski (618) 833-8576; e-mail: swidowski@fs.fed.us

Hoosier National Forest; 811 Constitution Avenue, Bedford, IN 47421

Kirk Larson (812) 275-5987

Steven D. Olson (719) 553-1400; e-mail: solson01@fs.fed.us
Currently: Pike-San Isabel National Forests,
Cimarron-Comanche National Grasslands,
Kachina Drive, Pueblo, CO 81008

Illinois Natural History Survey, 1816 S. Oak Street, Champaign, IL 61820-6970

Dr. Steven R. Hill (217) 244-8452; e-mail: srhill@mail.inhs.uiuc.edu

Illinois Endangered Species Board

Dr. John E. Ebinger (217) 345-3815; e-mail: cfjee@eiu.edu

Indiana Department of Natural Resources, 402 W. Washington St., Indianapolis, IN 46204

Michael A. Homoya (317) 232-0208; e-mail: mhomoya@dnr.state.in.us

Biological Consultant

John E. Schwegman (618) 543-9429; e-mail: botany@wkblue.net

Missouri Botanical Garden, P.O. Box 299, Saint Louis, MO 63166-0299

Dr. George A. Yatskievych (314) 577-9522; e-mail: george.yatskievych@mobot.org

APPENDIX 1

Representative specimens of *Styrax grandifolius* examined or cited in the literature

Herbaria:

CLEMS = Clemson University, Clemson, SC. FLAS = University of Florida, Gainesville, FL. ILLS = Illinois Natural History Survey, Champaign. MO = Missouri Botanical Garden, St. Louis. MU = Miami University, Oxford, OH. OS = Ohio State University, Columbus. UNAF = University of Northern Alabama, Florence.

ALABAMA: CHILTON CO., ca. 10 mi NNE of Verbena, 6 Jun 1972, *Kral 47299* (MO); **CLARKE CO.**, bottoms of Tombigbee River at US 43, SW of Jackson, 1 Jun 1972, *Kral 47093* (MO); **COLBERT CO.**, SW side of Littleville, 24 Apr 1976, *Kral 57725* (MO); **COOSA CO.**, by US 280, ca. 8.2 mi ESE of Scylacauga, 30 Apr 1972, *Kral 45995* (MO); **CRENSHAW CO.**, 1 mile N of AL Hwy. 106, 30 May 2000, *Diamond 11711* (ILLS); **FRANKLIN CO.**, vicinity of Russellville, Oct 1942, *James 52B* (MO); **LAUDERDALE CO.**, Lazenby property near Waterloo, 1 Oct 1986, *Henderson s.n.* (UNAF); Lakeside Highlands, 23 Sep 1986, *Rouse s.n.* (UNAF); **LEE CO.,** near Duncan Hall, AU campus, 17 Apr 1962, *Landers s.n.* (UNAF); Auburn, 24 Apr 1899, *Earle 2029* (MO, MU); **MOBILE CO.**, May 1891, *Mohr s.n.* (MO); **TUSCALOOSA CO.**, Black Warrior River near lock 14, 15 Apr 1929, *Palmer 35383* (MO); **WILCOX CO.**, by AL Rt. 10, ca. 2 mi E of AL Rt. 5 and W of Camden, 9 Jun 1972, *Kral 50445* (MO).

ARKANSAS: GARLAND CO., Gulpha Creek, near Hot Springs, 21 Apr 1925, *Palmer 26845* (MO); N side US Rt. 270, ca. 4 mi NW of Crystal Springs at Murphy Creek just E of Montgomery Co. line, 23 Apr 1998, *Hill 30093* (ILLS, MO); **PULASKI CO.**, ca. 1 mi S of Sleepy Hollow filling station, Cross Roads, 29 Apr 1935, *Lodewyks 229* (MO).

FLORIDA: LIBERTY CO., near Allen Bluff of Apalachicola River, 11 Apr 1931, *Palmer 38538* (MO); 2 mi E of Watson, 16 Apr 1941, *Hubricht B2064* (MO); **MADISON CO**., NW of Perry on US 27, floodplain of Aucilla River, 1 Jul 2004, *Abbott 19083* (FLAS); **PUTNAM CO.**, near Palatka, 16 Apr 1937, *Beardslee 64* (MU); **WALTON CO.**, near Red Bay, 14 Apr 1931, *Palmer 38606* (MO).

GEORGIA: BARTOW CO., S side Allatoona Creek ca. 0.5 mi above jct. with Etowah River, 23 Apr 1948, *Duncan 8095* (MO); **BEN HILL CO.**, WSW of Bowen's Mill, 9.8 mi NNE of Fitzgerald, 4 May 1968, *Faircloth 5192* (MO); **BURKE CO.**, adjacent to High Head, 14.5 mi E of Waynesboro, 10 May 1990, *Jones et al. 25246* (MO); **COFFEE CO.**, edge of Ocmulgee River swamp opposite Lumber City, 11 Sept 1903, *Harper 1992* (MO); **ECHOLS CO.**, SW

side of Little River, 69 mi E of Lake Park, 16 Jul 1965, *Faircloth & Dean 2288* (MO); **STEPHENS CO.**, Currahee Mountain, 4 mi SW of Toccoa, 12 May 1976, *Solomon 1697* (MO); S side of Panther Creek, SW of Yonah Lake, N of Toccoa, 23 Jun 1975, *Boufford & Wood 16788* (MO); **TATTNALL CO.**, Ohoopee River W of Reidsville, 26 Apr 1904, *Harper 2154* (MO).

ILLINOIS: ALEXANDER CO., north of Wolf Creek, 11 Jun 1970, *Schwegman s.n.* (ILLS).

LOUISIANA: BIENVILLE PARISH, 5 mi W of Ringgold, 18 Apr 1957, *Ewan 18985* (MO); **CATAHOULA PARISH,** 0.9 mile from jct. LA Hwy. 124 and LA Hwy. 8 on Hwy. 8, 26 Oct 1974, *French 609* (MU); **LINCOLN PARISH,** Woodlawn Park, 5 Oct 1966, *Peloquin 186* (MO); **OUACHITA PARISH**, W of LA 557 at Caldwell Parish line S of Luna near Little Cypress Creek, 14 Apr 1986, *Thomas 95468* (MO); **NATCHITOCHES PARISH**, Natchitoches, 30 Sep 1915, *Palmer 8745* (MO).

MISSISSIPPI: HOLMES CO., 2 mi W of Lexington, 1 May 1960, *McDaniel 1753* (MO); **WARREN CO.**, Vicksburg, Waterways Experiment Station, 6 Sep 1981, *Heineke 2710* (MO).

NORTH CAROLINA: DURHAM CO., near West Campus, Duke Forest, Chapel Hill, 28 May 1935, *Correll 612* (MO); **FORSYTH CO.**, 28 May 1940, *Schallert s.n.* (MO); **MONTGOMERY CO.**, Uwharrie National Forest, 1 mi NW of Uwharrie, 17 Sep 1992, *Merello & Noyes 359* (MO); **ONSLOW CO.**, near Catherine Lake, 21-25 Apr 1912, *House 4873* (MO); **ROWAN CO.**, Yadkin River above W end of NC Rt. 49 bridge, 6 May 1951, *Fox & Godfrey 4608* (MO); **STANLY CO.**, Yadkin River, 20 Apr 1932, *Palmer 39989* (MO); **WAKE CO**., Morrisville, May 1898, *Ashe 6442* (MO).

OHIO: ATHENS CO., high hill near the Buffalo Beat, Buchtel, 23 May 1925, *Stephenson s.n.* (OS).

SOUTH CAROLINA: AIKEN CO., Aiken, May 1877, *Ravenel s.n.* (MU); **BERKELEY CO.**, Rte. 402 at Wadboo Creek, Cordesville, 18 May 1988, Hill 19458 (CLEMS); **DORCHESTER CO.,** Rt. 61, 1 mile N of Woodlawn Plantation, 16 Jun 1988, *Hill 19637* (CLEMS); **McCORMICK CO.,** 7.5 mi NNW of McCormick on De La Howe School property near Little River, 28 May 1950, *Duncan 10989* (MO); **OCONEE CO.**, near Seneca, 16 May 1929, *Palmer 35413* (MO); Brasstown Creek area, 4.1 mi S of US Rt. 76, N of Co. Rt. 48, Sumter National Forest, 11 May 1989, *Hill & Horn 20543* (MO); Forest Rd 748 (Spy Rock Road), near Riley Moore Falls N of Holly Springs, Sumter National Forest, Andrew Pickens District, 10 May 1993, *Hill 25003* (ILLS, MO, MU); **PICKENS CO.**, Keowee-Toxaway State Park, S side Rt. 11 near Lake Keowee, 21 Jun 1987, *Hill 18113* (MO).

TENNESSEE: DECATUR CO., between Cozette and Sugartree, 10 May 1949, *Sharp et al. 12916* (MO); **DICKSON CO.**, ca. 5 mi W of Dickson by US 70, 13 May 1975, *Kral 55373*

(MO; MU); **HICKMAN CO.**, by TN Rt. 100, 6 mi NE jct. TN Rt. 48 at Fairfield, 6 May 1974, *Kral 56621* (MO); **LEWIS CO.**, Meriwether Lewis State Park above Little Swan Creek, 17 May 1971, *Kral 4265* (MO); **WILLIAMSON CO.**, by TN Rt. 100, N side Fairview, 6 May 1973, *Kral 52674* (MO).

TEXAS: JASPER CO., S of Jasper off Hwy 96 between road to Magnolia Springs and road to Roganville, 14 Apr 1963, *Correll & Correll 27230* (MO); **SABINE CO.**, upper reaches of Mason Creek, NW side Sabine Co. Rd. 37, ca.4.5 mi N of Milam, Sabine National Forest, 12 Apr 1988, *Orzell & Bridges 6194* (MO).

APPENDIX 2.

The Historic Distribution of *Styrax grandifolius* in the United States.
Information from herbarium specimens and the literature.
(If in > 10 counties, then only number of counties included.)

STATE	COUNTIES	NOTES
Alabama	Approximately 31 counties, scattered	W-1; W-3.
Arkansas	Approximately 29 counties, primarily western and southwestern.	W-1; W-3; Smith (1978) [as *Styrax grandifolia*]; includes Ouachita N.F.; Ozark N.F. [probably].
Florida	12 counties, northern and panhandle only.	W-1; W-3.
Georgia	Approximately 33 counties, scattered	W-1; W-3; includes Chattahoochee N.F.
Illinois	Alexander	W-1; W-3; Mohlenbrock & Ladd 1978 [as *Styrax grandifolia*]; Mohlenbrock 1986 [as *S. grandifolia*]; includes Shawnee N.F.
Indiana	Crawford	Homoya *et al.* (1995).
Kentucky	Clay, Garrard, Harrison, Metcalfe, Morgan, Whitley	W-1; W-3; includes Daniel Boone N.F.
Louisiana	42 parishes, excluding coast and delta.	W-1; W-3; MacRoberts (1989) [as *Styrax grandifolia*]; Thomas and Allen (1998) [as *Styrax grandifolius*]; includes Kisatchie N.F.
Mississippi	33 counties nearly throughout [fewest in NW quarter of state]	W-1; W-3.
North Carolina	34 counties, mostly piedmont and coastal plain.	W-1; W-3; Radford *et al.* (1968) [as *Styrax grandifolia*].
Ohio	Athens [historic only]	W-1; W-3; W-5; Mike Vincent (pers. comm.).
South Carolina	21 counties, mostly piedmont and coastal plain.	W-1; W-3; Radford *et al.* (1968) [as *Styrax grandifolia*].
Tennessee	28 counties, scattered, but concentrated in Western Highland Rim.	W-1; W-3; Chester *et al.* (1997) [as *Styrax grandifolia*].
Texas	Angelina, Hardin, Jasper, Newton, Sabine, San Augustine, Shelby, Tyler [extreme SE corner of state]	W-1; W-3.

APPENDIX 3.

Natural Diversity Database Element Ranking System

Modified from: http://www.natureserve.org/explorer/ranking.htm [W-7]

Global Ranking (G)

G1
Critically imperiled worldwide. Less than 6 viable elements occurrences (populations for species) OR less than 1,000 individuals OR less than 809.4 hectares (ha) (2,000 acres [ac]) known on the planet.

G2
Imperiled worldwide. 6 to 20 element occurrences OR 809.4 to 4,047 ha (2,000 to 10,000 ac) known on the planet.

G3
Vulnerable worldwide. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac) known on the planet.

G4
Apparently secure worldwide. This rank is clearly more secure than **G3** but factors exist to cause some concern (i.e. there is some threat, or somewhat narrow habitat).

G5
Secure globally. Numerous populations exist and there is no danger overall to the security of the element.

GH
All sites are historic. The element has not been seen for at least 20 years, but suitable habitat still exists.

GX
All sites are extirpated. This element is extinct in the wild.

GXC
Extinct in the wild. Exists only in cultivation.

G1Q
Classification uncertain. The element is very rare, but there is a taxonomic question associated with it.

National Heritage Ranking (N)

The rank of an element (species) can be assigned at the national level. The **N-rank** uses the same suffixes (clarifiers) as the global ranking system above. Rarely the designation **NNR** is used indicating that the species has not been ranked nationally.

Subspecies Level Ranking (T)

Subspecies receive a **T-rank** attached to the G-rank. With the subspecies, the G-rank reflects the condition of the entire species, whereas the T-rank reflects the global situation of just the subspecies or variety.

For example: *Chorizanthe robusta* var. *hartwegii*. This plant is ranked **G2T1**. The G-rank refers to the whole species range (*i.e.*, *Chorizanthe robusta*, whereas the T-rank refers only to the global condition of var. *hartwegii*. Otherwise, the variations in the clarifiers that can be used match those of the G-rank.

State Ranking (S)

S1
Critically imperiled. Less than 6 element occurrences OR less than 1,000 individuals OR less than 809.4 ha (2,000 ac). **S1.1** = very threatened; **S1.2** = threatened; **S1.3** = no current threats known.

S2
Imperiled. 6 to 20 element occurrences OR 3,000 individuals OR 809.4 to 4,047 ha (2,000 to 10,000 ac). **S2.1** = very threatened; **S2.2** = threatened; **S2.3** = no current threats known.

S3
Vulnerable. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac). **S3.1** = very threatened; **S3.2** = threatened; **S3.3** = no current threats known.

S4
Apparently Secure. This rank is clearly lower than S3 but factors exist to cause some concern (*i.e.*, there is some threat, or somewhat narrow habitat).

S5
Secure. Demonstrably secure to ineradicable in the state.

SH
All state sites are historic; the element has not been seen for at least 20 years, but suitable habitat still exists. Possibly extirpated.

SNR, SU
Reported to occur in the state. Otherwise not ranked.

SNA
Not Applicable – a conservation status rank is not applicable because the species is not a suitable target for conservation activities.

SX
All state sites are extirpated; this element is extinct in the wild. Presumed extirpated.

Notes:

1. Other considerations used when ranking a species or natural community include the pattern of distribution of the element on the landscape, fragmentation of the population/stands, and historical extent as compared to its modern range. It is important to take a bird's eye or aerial view when ranking sensitive elements rather than simply counting element occurrences.

2. Uncertainty about the rank of an element is expressed in two major ways: by expressing the rank as a range of values (*e.g.*, **S2S3** means the rank is somewhere between S2 and S3), and by adding a '?' to the rank (*e.g.* S2?). This represents more certainty than S2S3, but less than S2.