Conservation Assessment

for the

Guyandotte Beauty

(Synandra hispidula (Michx.) Baillon)

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Synandra hispidula (Michx.) Baillon, from the USDA PLANTS website; photographer: Thomas G. Barnes @ USDA-NRCS PLANTS Database

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EXECUTIVE SUMMARY

This Conservation Assessment is a review of the taxonomy, distribution, habitat, ecology, and status of the Guyandotte Beauty, *Synandra hispidula* (Michx.) Baillon, 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 Guyandotte Beauty to date. The Guyandotte Beauty is a delicate biennial herb in the mint family with showy mostly white flowers normally found in moist to wet rich mesic forests on slopes or near streams. The species is known only from the United States, it has a somewhat scattered distribution in the southeastern and central states, and it is known historically from ten states, from New Jersey, western Virginia and North Carolina west to Illinois, Kentucky, Tennessee and northern Alabama. It has declined in recent decades. Globally, its ranking is G4 (apparently secure world-wide); its National ranking in the United States is N4 (apparently secure nationally). It was previously considered for national ranking as a 3C species. It is most common in Indiana, Kentucky, Ohio, and Tennessee. The Guyandotte Beauty is listed as Endangered in Illinois. The species is known from historic records only in North Carolina and it may not be extant in New Jersey. In Forest Service Region 9, the Guyandotte Beauty is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest where it is more common. It is at risk at the margins 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: *Synandra hispidula* (Michx.) Baillon [1891]
Common Names: Guyandotte Beauty; Gyandotte Beauty; Hairy Synandra; Wyandotte Beauty; White Wood-mint
Synonymy: *Lamium hispidulum* Michaux [1803], the basionym
Synandra grandiflora Nuttall [1818]
Torreya grandiflora (Nuttall) Raf. [1818]

Class: Magnoliopsida (Flowering Plants - Dicotyledons)
Family: Lamiaceae (= Labiatae; the Mint Family)
Plants Code: SYHI (USDA NRCS plant database, W-1)
http://plants.usda.gov/

The mint genus *Synandra*, described by botanist Thomas Nuttall in 1818, contains a single species that grows only in North America (Mabberley 1987). The genus has been placed within the mint subfamily Lamioideae of the Mint Family, Lamiaceae (Cantino 1985). For most of its history, *Synandra* has been placed within the subtribe Melittidinae along with its closest North American relatives *Brazoria*, *Macbridea*, *Physostegia*, and *Warnockia*, as well as with the monotypic European genus *Melittis* and the Asian *Chelonopsis* (Scheen *et al.* 2007). Molecular evidence has shown recently that the subtribe Melittidinae is not monophyletic, but the five North American genera listed are monophyletic, and so a new tribe Synandreae has been proposed to include these five closely related genera (Scheen *et al.* 2007). This small group of related, endemic genera is restricted primarily to the southeastern portion of North America. *Synandra* appears to be most common in the open understory of wet to mesic forests on slopes or stream terraces. Another genus *Synandra* was also proposed by Schrader in 1821, but its species, *Synandra amoena* Schrader, is in the Acanthaceae, and resides now in the genus *Aphelandra* because *Synandra* by Nuttall pre-dated *Synandra* Schrader by about three years.

The Guyandotte Beauty was first described and named, as *Lamium hispidulum*, by botanist Andre Michaux in his major work on North American Plants in 1803. In 1818 Thomas Nuttall described the genus *Synandra* and its single species *Synandra grandiflora*, unaware of Michaux's earlier description of the same plant. Baillon corrected the error in 1891, transferring the earlier name to *Synandra* and using the oldest specific epithet for the species as required by the International Code of Botanical Nomenclature (Greuter *et al.* 2000). Some authors credit N.L. Britton with this combination, but his work on this plant occurred later in 1894. The name *Torreya grandiflora* Raf. cannot be used for two reasons – first, its basionym was a later synonym of *Lamium hispidulum* Michx., and the generic name *Torreya* Raf. has been rejected officially in favor of *Torreya* Arn., the name of an important gymnosperm genus (Greuter *et al.* 2000). *Synandra hispidula* has been long recognized as being quite distinct. The generic name was derived from the Greek *syn*, together, and *andros*, man, here referring to the anther, the

male part of the flower, so named because the anthers of each pair of stamens are coherent (Fernald 1950). The specific epithet *hispidula* derives from the Latin word meaning 'stiffly hairy' (Fernald 1950) based on the fact that most of the vegetative portions of the plant are rough-hairy. The common name, Guyandotte Beauty, refers to the Guyandotte River region in southwestern West Virginia, one of the sites where the plant grows.

DESCRIPTION OF THE SPECIES

Synandra hispidula, the Guyandotte Beauty, is a delicate villous-hairy biennial herb generally (0.2-) 0.3 – 0.4 (-0.6) meters tall from thin shallow fibrous roots, with erect, quadrangular, spreading-pubescent, soft stems that are easily flattened by pressing. There are usually 2-3 lower pairs of opposite sparsely hairy stem **leaves**; the lower leaves are long-petioled (petioles 2-10 cm long, often longer than the blades), the simple blades are broadly ovate, deeply cordate, acute to acuminate, crenate margined to coarsely toothed, and thin, (3-) 4-7 (-8) cm long x 3-5.5 cm wide; the floral (bracteal) leaves are sessile and progressively reduced above, each with a single sessile flower; the **inflorescence** is a terminal normally unbranched spicate bracted raceme 3-15 cm long; **flower** pedicels are 0.5-1 mm long; the **calyx** is deeply 4-lobed (lobes slightly shorter than the tube), narrowly campanulate, irregular (each lobe a different size, acuminate, one lobe with a lateral tooth), 7-8 (-10) mm long, inflated, and membranaceus (thin walled), and irregularly veiny; the rather large and showy yellowish and white or pinkish **corolla** (see cover illustration) has a long slender tube that is much expanded above and at the veiny throat; it is zygomorphic and strongly two-lipped and (2.5-) 3-4 cm long; the upper lip is slightly arched and entire or has a minutely erose margin; the lower lip is larger, similar but spreading and 3-cleft, with ovate lobes, the middle one is broadest and notched at its end, and it is often streaked with purple lines; there are four **stamens** fused to the corolla tube and ascending under the upper lip, the filaments are hairy; the anthers are approximate in pairs under the upper lip, the lower pair slightly longer than the upper, each with two divergent locules, one fertile and one smaller and sterile, with the latter locules cohering (connate); the **fruit** is composed of 4 tiny nutlets that are smooth and biconvex. The plants normally flower from late April through May, and the fruits typically mature from May through June. The chromosome number is $2n = 18$. (Adapted primarily from Fernald 1950, Gleason and Cronquist 1991).

The Guyandotte Beauty can be recognized by its conspicuous large (> 2 cm long) flowers each with four stamens with two pairs of connate anthers, by its very few and long-stalked heart-shaped stem leaves, and by its fragile stem that easily compresses. In this regard it is somewhat like the introduced species of *Lamium*, but *Lamium* typically grows as a weed in continuously disturbed areas such as dooryards and agricultural land, and the flowers do not resemble those of *Synandra*, being narrowly tubular.

HABITAT AND ECOLOGY

The Guyandotte Beauty has been given a national wetland indicator status of FACU or FAC, indicating that the species normally does not occur in wetlands, but in some areas, it is equally likely to occur in wetlands as not [FACU = Facultative Upland, usually occurs in non wetlands (estimated probability 67 - 99%) but occasionally found on wetlands (estimated probability 1 % – 33%); FAC = Facultative, the species is equally likely to occur in wetlands or non-wetlands (estimated probability 34% - 66%)]. In Region 3, including both Illinois and Indiana, *Synandra hispidula* has been specifically designated as a FAC species (Reed 1988; W-1; W-2), indicating that it is equally likely to occur in wetlands or non-wetlands in this area. Overall, these habitats include wet to mesic upland forests on slopes as well as in damp thickets and on stream banks. It is relatively rare in most portions of its range, and it appears to prefer, and is most common in, the more moderate climates of the east-central Midwestern states. Because the Guyandotte Beauty tends to grow in mature forests lacking disturbance, and south of the lands affected by Ice Age glaciations, and because it is associated with other scarce endemic species, it may be appropriate to consider it an indicator of rather special areas of older relict vegetation.

Synandra hispidula grows mainly in dense shade to lighter shade in rich, wet to mesic upland forests on slopes in cool, moist places, usually at the bases of deep, wooded ravines in deep leaf mold (Deam 1940; Shawnee National Forest 2005). Floras have listed the habitat of *Synandra hispidula* as "Wet woods, damp thickets and stream-banks" (Fernald 1950), "Rich woods" (Gleason and Cronquist 1991), "Rich woods" (Mohlenbrock 2002), and as "Rich mesic, wooded slopes" (Radford *et al.* 1968). It prefers moist soil; the various sources, including herbarium labels, state that it is found in floodplains, stream terraces (or level woods in dense shade; Deam 1940), roadsides, forests and in upland forests. Moran (1986) states that *Synandra hispidula* prefers undisturbed habitat with densely shading canopies and that it is not tolerant of direct sunlight. Records indicate that it is most frequently found at elevations from 600 feet (in Illinois) to 4,000 feet (in Virginia). The bedrock associated with populations of *Synandra hispidula* is usually calcareous, as in Kentucky where the plant is most common, where the bedrock is often Ordovician-age limestone (Baskin *et al*. 1986).

Through most of its range, *Synandra hispidula* grows within an ecological association called the *Acer* (*nigrum, saccharum*) – *Tilia americana* / *Asimina triloba* / *Jeffersonia diphylla* – Caulophyllum *thalictroides* Forest (also known as the Central Appalachian / Piedmont Rich Cove / Mesic Slope Forest (Twinleaf – Blue Cohosh Type; W-3). This classification follows the formal International Vegetation Classification system (W-3). This forest association occurs in Kentucky, Maryland, and Virginia, and potentially occurs also in Tennessee and West Virginia, an area that approximates the overall range of the Guyandotte Beauty as well. This community type occurs on mesic lower slopes at relatively low elevations over nutrient-rich substrates in the Ridge and Valley, Cumberland, Central Appalachians, and Piedmont geologic zones, and the soils may be derived from limestone, dolomite, shale, siltstone and various metamorphic

and igneous rocks (W-3). These soils are deep, dark, and very fertile, with a high mean pH and calcium levels (Wofford 1989). The canopy **tree** layer is mostly closed (80-100% cover) and its composition is mixed and variable, but either *Acer saccharum* or *Acer nigrum*, or both, are characteristic. Other canopy trees present include *Aesculus lava* (towards the south), *Carya cordiformis*, *Celtis occidentalis*, *Fagus grandifolia* (on well-drained stream terraces), *Fraxinus americana*, *Liriodendron tulipifera*, *Quercus muehlenbergii*, *Quercus rubra*, *Tilia americana*, and *Ulmus rubra*. The understory is sparse, and the **shrubs** (or small trees) normally present include *Asimina triloba*, *Lindera benzoin*, and *Staphylea trifolia*, and there is a rich dense **herb/forb** layer (> 80% cover) of mostly Spring-flowering species, including *Allium tricoccum*, *Arabis shortii*, *Asarum canadense*, *Caulophyllum thalictroides* (common), *Chaerophyllum procumbens Cimicifuga rubifolia*, *Claytonia virginica*, *Delphinium tricorne*, *Dicentra canadensis*, *Dicentra cucullaria*, *Ellisia nyctelea*, *Erigenia bulbosa*, *Erythronium albidum*, *Erythronium americanum*, *Floerkea proserpinacoides*, *Hydrophyllum canadense* (common), *Hydrophyllum virginianum*, *Impatiens pallida*, *Isopyrum biternatum*, *Jeffersonia diphylla* (common), *Mertensia virginica*, *Osmorhiza claytonii*, *Osmorhiza longistylis*, *Panax trifolius*, *Phacelia purshii*, *Phacelia ranunculacea*, *Phlox divaricata*, *Polemonium reptans*, *Sanguinaria canadensis*, *Stylophorum diphyllum*, *Trillium sessile*, *Valeriana pauciflora*, and *Viola pubescens*; **graminoids** found in the herbaceous layer can include *Carex albursina*, *Carex careyana*, *Carex jamesii*, and *Carex sparganioides*, and a few **pteridophytes** occur including *Cystopteris protrusa* and *Dryopteris marginalis*. This forest is especially characteristic of the George Washington and Jefferson National Forests in Virginia (W-3; Fleming 1999).

Fleming and Wofford (2004) described the habitat of *Synandra hispidula* at a site in the Cumberland Plateau of eastern Tennessee. The plants grew in riparian gorges within the mixed mesophytic forest, and the composition strongly resembled that of the forest association described above that occurs in Kentucky, Maryland, and Virginia. In this habitat the plants were associated with the **trees** *Acer leucoderme, Acer negundo, Acer nigrum, Acer saccharum, Aesculus flava, Betula allegheniensis, Carpinus caroliniana, Carya* spp., *Celtis* spp., *Cladrastis kentuckea, Fagus grandifolia, Fraxinus americana, Juglans cinerea, Liriodendron tulipifera, Magnolia acuminata, Morus rubra, Nyssa sylvatica, Ostrya virginiana, Quercus alba, Quercus rubra, Tilia americana, Tsuga canadensis*, and *Ulmus* spp., **shrub** (or small tree) associates included *Asimina triloba, Cornus amomum, Crataegus pruinosa, Ilex decidua, Lindera benzoin, Sambucus canadensis, Staphylea trifolia*, and *Viburnum prunifolium*; associated **vines** included *Amphicarpaea bracteata, Menispermum canadense, Parthenocissus quinquefolia, Toxicodendron radicans, Vitis cinerea*, and *Vitis vulpina*; the associated **herbs/forbs** were many and diverse, and included *Arisaema triphyllum, Asarum canadense, Cacalia atriplicifolia, Caulophyllum thalictroides, Chelone glabra, Collinsonia canadensis, Cryptotaenia canadensis, Disporum* spp, *Iris cristata, Erigenia bulbosa, Erythronium americanum, Helianthus decapetalus, Hydrophyllum* spp, *Impatiens capensis, Ligusticum canadense, Lobelia cardinalis, Phlox* spp., *Pilea pumila, Rudbeckia laciniata, Ruellia caroliniensis, Sanicula* spp., *Smilacina racemosa, Scutellaria incana, Stachys nuttallii, Stylophorum diphyllum, Thalictrum*

pubescens, Uvularia spp., *Viola canadensis*, and *Viola conspersa*; the associated **graminoids** included *Carex albolutescens, Carex albursina, Carex amphibola, Carex careyana, Carex cumberlandensis, Carex kraliana, Carex laxiflora, Carex oligocarpa, Carex planispicata Dichanthelium boscii, Dichanthelium dichotomum, Luzula* spp., and *Poa autumnalis*; associated **pteridophytes** were comparatively sparse, and included *Athyrium filix-femina, Botrychium dissectum, Botrychium virginianum, Cystopteris bulbifera, Dryopteris goldiana, Dryopteris intermedia*, and *Phegopteris hexagonoptera*. Much of the same flora was found associated with *Synandra hispidula* at a site in Rockcastle County, Kentucky (Thompson and Fleming 2004).

Baskin *et al.* (1986) described the vegetation of their study site for *Synandra hispidula* in northern Franklin county, north central Kentucky, as being dominated by the **trees** *Acer negundo, Aesculus glabra, Juglans nigra* (the dominant), *Liriodendron tulipifera, Tilia americana, Ulmus americana*, and *Ulmus rubra*, with saplings of *Acer saccharum* and *Carpinus caroliniana* common in the **shrub layer**. The **herbaceous layer**, as at sites elsewhere, was characterized by a rich and diverse variety of forbs in the spring, including *Collinsia verna, Dicentra canadensis, Dicentra cucullaria, Jeffersonia diphylla, Mertensia virginica, Stellaria pubera, Trillium flexipes, Trillium sessile*, and *Valeriana pauciflora*, with *Impatiens capensis* and *Laportea canadensis* dominating in the summer.

At the northwestern limit of its range, in Illinois, *Synandra hispidula* grows in a restricted habitat of dense shade, often in cool moist places at the bases of deep wooded ravines. It appears to prefer the upper reaches of stream terraces with a north-facing aspect. Its thin shallow root system is found immediately below the detritus layer of thick leaf litter (Shawnee National Forest 2005). The habitat for this species in southern Illinois occurs adjacent to fire-dependent communities and may have been burned at some point in the past (Shawnee National Forest 2005). However, the species normally occurs in deep shade in moist forests, and it is thought that fires are detrimental to its populations. The species associates are essentially the same as listed above for Kentucky and Tennessee, excluding a few species such as *Acer leucoderme, Aesculus flava, Carex cumberlandensis, Carex kraliana, Carex planispicata, Ligusticum canadense, Stellaria pubera*, and *Tsuga canadensis*.

DISTRIBUTION AND ABUNDANCE

Synandra hispidula, the Guyandotte Beauty, is restricted to the south-central and south-eastern portion of the eastern United States (perhaps north as far as New Jersey) and it has been reported historically in ten states, namely, Alabama, Illinois, Indiana, Kentucky, New Jersey, North Carolina, Ohio, Tennessee, Virginia, and West Virginia (W-1, W-3). Its range includes only unglaciated areas. The distribution of this mint has decreased in recent decades. It is considered to be 'historic only' in North Carolina (W-1, W-3; 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. Its occurrence in New Jersey appears to be somewhat doubtful, and not all sources record it from there, and no information on current or historic population sites was found for that state during the preparation of this report.

The frequency of the Guyandotte Beauty cannot be estimated precisely based upon its state rankings (W-3) because it is currently not been ranked in Ohio, and some sources have not included it within New Jersey (*e.g.*, W-1; Kartesz and Meacham 1999). Based on known herbarium records and other sources (see appendices), this herb would appear to occur (currently and historically) most frequently in Kentucky (40 counties), Indiana (20 counties), and Ohio (17 counties). In addition, records from floras and herbarium labels show that this herb has been found in approximately 16 counties in Tennessee, 7 counties in Virginia, 6 counties in West Virginia, and in only 1-2 counties in Alabama, Illinois, and North Carolina. Its distribution in New Jersey is unknown. Guyandotte Beauty is scattered within most of its range, though it can be locally common. The frequency of the species within each county can be greatly variable. Additional details on the distribution of this herb can be found in Kartesz and Meacham (1999) and several Internet sites (*e.g.*, W-1, W-3). Representative specimens of this herb have been listed in Appendix 1. A summary of the world-wide distribution of the Guyandotte Beauty has been presented in Appendix 2.

The species has been found in Illinois (where it is at its northwestern range limit in the extreme southwestern part of the state) as well as in neighboring Kentucky and Indiana, but not in adjacent Missouri, Wisconsin, or Iowa (W-1, W-3). In Illinois, where it is listed as Endangered and where it is at its northwestern range limit, the species has been reported historically and, apparently, still occurs in Jackson and Williamson counties at three sites (Herkert and Ebinger 2002; Mohlenbrock 1986, 2002; Mohlenbrock and Ladd 1978; Shawnee National Forest 2005). The colonies have been reported in the past to have hundreds of plants each. The Williamson County site is on private land; it may be historic only (Herkert and Ebinger 2002). The Jackson County sites lie both within a state park and also within the Shawnee National Forest in at least two overall drainages – north of the Natural Bridge and in the Cave Valley / Cedar Creek areas (Shawnee National Forest 2005). The sites in Illinois are in the Shawnee Hills Natural Division, Greater Shawnee Hills Section and Lesser Shawnee Hills Section (Schwegman *et al.* 1973; Herkert and Ebinger 2002).

In Indiana, *Synandra hispidula* is much more widespread, and it has been reported from at least 20 counties in the southern half of the state, primarily in the Ozark region (Homoya, pers. comm.; herbarium specimens) east and south of the Wabash River. This area includes the Hoosier National Forest. It is too common to be tracked at this time, though it was tracked some years ago (Homoya, pers. comm.). According to Deam (1940) the species is local, but there are usually several plants in a colony or it is found growing for some distance in its restricted habitat.

Within the U.S. Forest Service Eastern Region (Region 9) *Synandra hispidula* has been found within the Shawnee National Forest in Illinois, the Hoosier National Forest in Indiana, and 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 where it is more common. *Synandra hispidula* is unlikely to be present within other Region 9 forests because of its more southern and southeastern distribution. It is found in at least two National Forests in the southeast, in Region 8, the Jefferson National Forest in Virginia, and the Daniel Boone National Forest in Kentucky. Populations are also known within the Great Smoky Mountains National Park.

The populations of this herb 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 period here. The forests in the region are thought to have been kept open by means of fires set by the earlier inhabitants in the area before European settlement, but *Synandra hispidula* is not a fire-dependent species. Instead, this mint appears to grow in microsites that are less likely to be affected by fire. In some cases, the forests where it may have occurred have 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 some data available on population sizes for this herb, much of it from herbarium label data. Ohio populations vary considerably in size from less than a dozen individuals to hundreds (Spooner *et al.* 1983). Herbarium labels on Ohio collections indicated that about 50 scattered plants were found at one site in Adams County and 50-75 plants were found at a second site there, about 100 plants were found at a site in Butler County, in Claremont County within a creek valley a population was estimated to contain 851 flowering individuals, at one site in Franklin County the species was said to be ‘locally common’, 100-200 plants were found in a population in Lawrence County, about 100 plants were found at a site in Hamilton County, about 25-30 plants were found at another site in Hamilton County, a label from Jefferson County stated that the plant was ‘frequent’. At one site in Great Smoky Mountains National Park, Blount County, Tennessee, a population was said to have 22 individuals.

PROTECTION STATUS

The Nature Conservancy ranking for *Synandra hispidula* is G4 (Apparently 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 N4, for the same reason. In most states this species is ranked as far less common and secure than this would suggest.

In the United States, official protection for this herb outside of Forest Service lands depends upon state and local laws because it is not listed as federally threatened or endangered. It

was previously ranked as a 3C species, a species under consideration for Federal listing, but this category has been eliminated. Significant populations of this species still occur in a few National Forests.

The state rankings vary. *Synandra hispidula* 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 "Hairy Synandra"). It also has been ranked as Critically Imperiled (S1) in Alabama and as Imperiled (S2) in Virginia and West Virginia (where also listed as Rare). In Tennessee, the species has been ranked as Imperiled to Vulnerable (S2S3) and it was formerly listed as Threatened in that state in 1986. The species has also been listed as historic only (SH, presumed extirpated) in North Carolina (Massey *et al*. 1983). This species has been ranked as Vulnerable (S3, also on their Watch List) in Indiana. It is not ranked (SNR) in New Jersey and Ohio, though it was previously listed as Threatened and Vulnerable (S3) in Ohio in 1984. While included by a few sources as being within New Jersey, no validated reports of the species were found in that state. *Synandra hispidula* 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 Guyandotte Beauty is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest. It has been found in the Hoosier National Forest, but it is thought to be too common there to be at risk (W-4; Shawnee National Forest 2005). Also within Region 9, *Synandra hispidula* has been found in the Wayne National Forest in Ohio, where it is also considered to be too common to be at risk.

Table 1 lists the official state rank for *Synandra hispidula* 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-5).

A summary of the current official protection status for *Synandra hispidula* follows:

U.S. Fish and Wildlife Service:	Not listed (None); formerly a 3C species.
U.S. Forest Service:	Listed as at risk in the Shawnee National Forest, Region 9
Global Heritage Status Rank:	G4
U.S. National Heritage Status Rank:	N4

Table 1: S-ranks for *Synandra hispidula* [Heritage Element Code: PDLAM1Z010]

State/Province	Heritage S-rank	
UNITED STATES		
Alabama	S1	
Illinois	S1	[Endangered]
Indiana	S3	
Kentucky	S4	
New Jersey	SNR	
North Carolina	SH	
Ohio	SNR	
Tennessee	S2S3	
Virginia	S2	
West Virginia	S2	

LIFE HISTORY

Synandra hispidula is a biennial herb. Some sources describe the plant as a winter annual or perennial (*e.g.*, W-1, Herkert and Ebinger 2002) apparently in error. Baskin *et al.* (1986) presented a review of this confusion in the literature and confirmed by means of several years of observation and study that it is a strict biennial in north central Kentucky, but they were careful to state that their results did not necessarily apply to the species in all portions of its range. Those observations are summarized here. In the field in north central Kentucky, the seeds germinate from February to April and the plants produce a rosette of leaves over the summer. By September, the rosette has no more than three pairs of leaves, by early February eight pairs, and by early April of the second year it has 10-12 pairs (including bracteal leaves). Stem elongation, bolting, begins in early April and flower buds are formed by late April. Flowering begins in early May and continues until early to mid-June. On most plants, seeds are ripe by early to mid-June. Bolting or flowering plants grazed (injured) by white-tailed deer may flower as late as early July, but these individuals apparently produce few viable seeds. The entire plant senesces as the seeds mature, as in the common winter annual agricultural weed genus, *Lamium* (Henbit). So, all surviving plants flower and produce seeds the second spring, after which the entire plant dies. The delicate root system of this species, a threadlike white root system found in moist leaf humus in rich forested areas, is not characteristic of the perennial habit, but instead closely resembles the root system of well-known winter annual weeds such as the introduced mint *Lamium* (Henbit).

Baskin *et al*. (1986) also discovered that most seeds produced (684 in their study, 76%) germinated the first spring after they overwintered. The next year only 77 seeds of the original planting germinated, then only 8 the third year, and none in the fourth. The conclusion was that these seeds are not at all long-lived, and once gone from a site, there is only a limited chance that the plants could reappear or re-establish from the seed bank. The seeds of *Synandra hispidula* have no obvious special adaptations for dispersal; the plants are relatively short and very fragile so seeds are unlikely to scatter far. If an isolated population of this mint were to become extinct, the chances for reestablishment from other sources would be poor (Baskin *et al*. 1986).

Moran (1986) speculated that deer may act as dispersal agents because the plants are often observed being browsed by deer and research has shown that the seeds germinate readily after artificial scarification, a process that occurs naturally as a seed passes through a mammal's digestive system. Apparently this has not actually been demonstrated in nature for this *Synandra*.

Another result of the Baskin *et al.* (1986) study was the realization that in dry years the survival rate of the germinated seedlings is highly reduced. Only 10 out of 74 seedlings at the study site survived until October of 1983 during a very dry year. In the wet year of 1984, 96 of the 101 seedlings tagged survived to October (Baskin *et al.* 1986).

Studies have shown (Cantino 1985) that *Synandra hispidula* is self-compatible and capable of spontaneous autogamy (autonomous selfing in the absence of pollen vectors such as insects; self pollination). The significance of this is that insects are not required for the plant to set viable seeds. Another implication is that with self-pollination, genetic variability, sometimes referred to as hybrid vigor, can be (or is) reduced tremendously. This does not mean at all that the plant discourages cross pollination, the source of hybrid vigor. The flowers are showy and have conspicuous nectar guides (see cover photo) typical of plants that are expending energy to attract insect pollinators. In fact, the flowers are more attractive than most individual mint flowers. Moran (1986) reported that the flowers are visited by bumblebees (*Bombus* spp.). Self pollination is generally a backup to ensure that at least some seeds will survive so that the population will not disappear.

The Guyandotte Beauty's flowering period overall is generally from late April to May, and into early June at high elevations. The labels on herbarium specimens examined for this study revealed that the earliest date for a collection of this species was on May 2 in Ohio when the plants were just beginning to flower, and most individuals were in flower between 14 May and 25 May (the latest flower was seen on a specimen collected on 21 June at an altitude of about 4000 feet in Virginia). Plants had seeds mostly in June (and probably in late May), and by July 18, the plants were senescent (that was the latest date on which a specimen examined had been collected). This is in general agreement with those of Baskin *et al.* (1986) in northeastern Kentucky.

The fruiting stems are herbaceous and not at all durable and they rarely last beyond July of their second year. The seeds simply fall near the plant; no seed dispersal mechanism is known for these plants. While *Synandra* is not specifically detailed, Bouman and Meeuse (1992) have presented much information on the dispersal of the nutlets in the mint family, and some of the principles described by them may apply to this genus as well.

It has been suggested that deer may act as dispersal agents for this mint; plants are often observed as having been browsed by deer, and research has shown that the seeds germinate quite readily upon scarification (Moran 1986; Shawnee National Forest 2005). In contrast, Baskin *et*

al. (1986) observed that deer browsing delays flowering in this mint, and that few viable seeds are produced by the browsed plants.

POPULATION BIOLOGY AND VIABILITY

The Guyandotte Beauty is known to produce seeds successfully, either from self-pollination or by means of outcrossing by insects (Cantino 1985; Moran 1986). This is its only means of reproduction as no vegetative reproduction has been demonstrated. The seeds are short lived and the seedlings are very susceptible to drought (Baskin *et al.* 1986). Furthermore, deer have been observed to eagerly feed on these short-lived plants (Moran 1986). The combination of data from these studies suggests that individual populations of *Synandra hispidula* are very susceptible to local extinction and that they are on the decrease. As evidenced by the distribution of this species as well as by its ranking of Apparently Secure (G4) by the Nature Conservancy (W-3), populations of this species are not critically low in some states, and those populations appear to be fully viable. As a delicate biennial adapted to very specific moisture and shading requirements along with nutrient-rich soils, *Synandra hispidula* appears to be vulnerable to drought conditions and many local perturbations of its environment, including fire. It is likely that short-term changes or sudden environmental destruction will be responsible for the loss of additional populations (see Threats section below).

The pollination biology and viability for populations of *Synandra hispidula* is imperfectly known, but it seems to be vulnerable and unable to increase its overall range. Some data on population dynamics have been recorded (*e.g.* Baskin *et al.* 1986). Seed and seedling viability has been shown to be brief and fragile, respectively. It is possible that small populations of widely scattered plants may not produce many seeds during years in which insect populations are stressed or during droughts when the plants have insufficient water to flower, and this could result in long-term population declines if the situation persists. The fact that populations are generally rather small, less than 100 individuals each, suggests that there are viability problems for the species overall.

It is generally understood that fertility is reduced in inbred populations through the process of autogamy (self-fertilization), common in this mint. 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-6). In plants such as Guyandotte Beauty, all individuals at a site may be very closely related and they can be progeny from a single introduction event, and so they may posses little genetic variability. If there is some outcrossing, fertilization by siblings is the most likely outcome in such cases because there is almost no chance of fertilization by other genotypes unless they are within dispersal range. The populations of this herb in Illinois are isolated from one another by the

nature of their habitat and from those in other states. In theory, continued fertilization within a group of closely related individuals can result in severe reproductive problems in these few isolated populations, and successful seed production, as well as the genetic variation that allows competition with other species, may be compromised (W-6).

An example of negative effects thought to have arisen through the isolation of populations can be seen in the case of a monocot, Ofer Hollow Reedgrass (*Calamagrostis porteri* ssp. *insperata* (Swallen) C.W.Greene), which has become isolated on rather dry sandstone bluffs throughout its range, a situation comparable to plants such as this mint that are isolated in small widely scattered moist pockets of relict forest. 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. It is a vulnerable species in the Midwest and elsewhere, though it does appear to be secure in some other areas with suitable habitat remaining. Whether that grass or the Guyandotte Beauty persist or not in the future in areas where they are currently scarce appears to depend on the survival and maintenance of their habitats.

POTENTIAL THREATS

Globally, Guyandotte Beauty has been judged to be apparently secure at present, but it is a North American endemic with a limited overall range and the number of populations is declining (W-1; W-3). It appears to be unable to increase its range and some populations are thought to be quite vulnerable.

Threats to this species include 1] habitat destruction from urbanization and development, 2] habitat fragmentation, 3] logging and the loss of forest canopy trees from fire, pests and disease, 4] overgrazing by wild and domestic animals, 5] trampling by humans, cattle, and horses, 6] unrestricted recreational use of its habitat, 7] exotic plant competition, 8] industrial, agricultural and domestic pollution (W-3; Shawnee National Forest 2005).

Habitat destruction from urbanization and development can completely eliminate entire populations of plants as well as the habitats on which they depend. This has become a serious problem for many species, and it is a national problem (W-3). Since European settlement, much of the previously available habitat for this and other scarce plants has been destroyed, converted to artificial lakes by damming the gorges where it grows, by conversion of land to orchards or commercial forests, or it has succumbed to land development of many kinds (W-3). Several extant populations of this delicate mint are in national forests or protected areas, and these have only been found as a result of careful searches at these sites in recent decades; it cannot be determined precisely how many populations were lost at other sites before field botanists began

to recognize the decline of this mint and before searches were initiated.

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 populations, random genetic drift may have already occurred and may have caused negative effects to the species. The fragmentation of the overall forest results in extant colonies being increasingly remote from one another, and *Synandra hispidula* then exists in small isolated populations with little to 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 adapt to changing conditions or new diseases.

Another primary threat to the Guyandotte Beauty is the opening of the forest canopy by logging. *Synandra hispidula* is known to disappear from areas after logging, yet it may be capable of recolonizing an area after reforestation given a nearby seed source (Spooner *et al.* 1983). Clear-cutting and logging of the surrounding forest are known threats to this mint (Moran 1986). Exposed plants can wilt quickly and die because their root systems are normally quite shallow. Direct sun tends to remove more water from the plants than they can take up by their weak root system, resulting in the eventual decline and death of individuals and populations if the forest cover is completely removed (Moran 1986). Furthermore, significant logging can change the hydrology and drainage patterns of the forest slopes (W-3). Increased runoff can heighten the frequency and intensity of flooding and subsequent scouring of the light humus soils in which *Synandra hispidula* often grows. The siltation from the runoff can prevent seedling establishment. Complete clearing or cutting of a forest stand could not be done where a colony occurs nor within its watershed upslope without such adverse effects.

The opening of the canopy by the loss of trees in other ways can also threaten *Synandra* populations. Major forest fires can eliminate even canopy trees, and any loss of the canopy can threaten populations of this mint. The elimination of trees by pests or disease has an equivalent effect. One of the trees commonly associated with *Synandra* is the Hemlock (*Tsuga*), though not in Illinois. In recent years, the Hemlock Woolly Adelgid (*Adelges tsugae*), a small, aphidlike insect, has spread and now endangers the health and sustainability of eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*) in the Eastern United States (W-7). One herbarium label with a specimen of *Synandra hispidula* from Blount County, Tennessee, within Great Smoky Mountains National Park stated that the plants were growing in a grove with *Liriodendron tulipifera* and *Tsuga canadensis*, the latter now in danger of elimination by the spreading insect pest, and that the 22 plants found there were in danger of being engulfed by a native stand of *Amphicarpum bracteata* if the *Tsuga* canopy were to disappear. Therefore, one scenario of concern is the decimation of a forest canopy by introduced insect pests, followed by

increased sunlight and loss of a population of this delicate mint when it becomes engulfed by aggressive native local vines.

Synandra hispidula can be eliminated by overgrazing its habitat. Kral (1983) has reported that no plants are found where grazing has been allowed, perhaps due to either the consumption or trampling of the tender plants. The soft edible plants are subject to damage or destruction from the grazing or browsing by wild or domestic animals. Moran (1986) stated that the plants are very susceptible to herbivory, especially from White-tail Deer. Baskin *et al.* (1986) stated that flowering individuals grazed (injured) by white-tailed deer may be forced to flower as late as early July, much later than normal, and that these individuals apparently produce few viable seeds.

Trampling of the delicate plants by humans, cattle and horses is another potential threat to this herbaceous species. The unrestricted human recreational use of its habitat poses a similar threat. The development of user-created trails in the Shawnee National Forest is thought to pose a major threat to several rare plant populations because of the resulting trampling of the plants. The compaction and / or the loss of the humus-rich light soils present can also cause plant colony destruction by human, equestrian, or vehicular traffic. It should be pointed out that people studying this species in the field can also destroy these plants by means of unintentional trampling because they are rather small and vulnerable especially in their early growth stages, and they tend to grow in small compact groups.

As with many other forest species, *Synandra hispidula* is threatened at times by the encroachment of non-native aggressive species, and the removal of these is desirable. In particular, Japanese honeysuckle (*Lonicera japonica*), Chinese Yam (*Dioscorea oppositifolia*), and the grass Eulalia (*Microstegium vimineum*) have been implicated as potential threats to this rare mint (Shawnee National Forest 2005). These rapidly growing species can quickly overwhelm this slow-growing and fragile mint, preventing it from reproducing from lack of light and eventually eliminating an entire colony because of the lack of seed production, along with the lack of a long-term seed bank in this species. Movement of exotic aggressive plant species into an area is often by means of trail or road construction (W-3) and this should be taken into consideration when trails and roads are planned anywhere near a *Synandra* population. Fire may not be an effective means of control for some of the exotic species that may become a problem because this mint is thought to be rather vulnerable to fire damage to itself or to its habitat.

Various types of industrial, agricultural and domestic pollution may have caused the loss of several populations of Guyandotte Beauty around the country. The influx of excrement from horses and other domestic animals as well as the dumping of household and industrial trash can increase the growth of agricultural weeds that would soon overtake and replace populations of this mint. It can also be assumed that herbicides will easily eliminate this plant from an area. Such commonly used herbicides as Roundup are known to be particularly effective against

broadleaf herbs, and so herbicides should not be used in the vicinity of these plants.

At the current time, a very few populations of *Synandra hispidula* persist in the Shawnee National Forest but they appear to be very vulnerable. The species will likely persist if it is carefully protected from habitat change and disturbance.

RESEARCH AND MONITORING

Synandra hispidula regularly flowers and fruits throughout its range and it has no known reproductive problems. This herb grows in widely scattered and often isolated shaded moist forest sites at the margins of its range and there appears to be very little interaction (pollen dispersal or seed exchange) with other populations of the same species in those areas because of its rarity.

Cautious and careful annual monitoring of the extant populations may be essential to the local survival of this species. In parts of its range, both in areas where it is declining and in areas where it is still common, periodic monitoring is needed not only to supply data on the life history of this herb, but also to evaluate the threats to its habitat caused by habitat degradation or destruction, threats from exotic species, and other potential problems. Population stability, reproduction, and vigor should all be monitored. The searches for additional populations are especially needed to re-evaluate the plant's status. While hydrology and humidity fluctuations are assumed to occur in its habitat, and its structure suggests this species is very susceptible to drying conditions, it is not known precisely how much fluctuation can occur without adversely affecting the plants. It is also not known how well this herb can be established in other suitable forest sites, though it is probable that it could be successfully introduced to such sites based upon current knowledge of its habitat preferences. It is not known exactly how much disturbance can occur before an individual population is adversely affected, nor is it known how large a habitat is needed to support a viable population. As stated above, caution must be used to avoid trampling on any seedlings and older plants of the species because they are very fragile. It would be best to monitor these plants as they reach maturity when they can be easily seen and counted, and when seeds are already mature, and also to avoid trampling the first year seedlings in their vicinity.

Monitoring of the forests where it occurs elsewhere may assist in determining what the local environmental parameters should be for optimal health for this herb, to add to existing knowledge provided by Baskin *et al*. (1986). Where it still occurs, periodic surveys are needed to determine the basic health and productivity of the population. This is the only means to determine population trends accurately (W-3). Reproductive success can be estimated by counting the number of fruiting stems produced each season because seedlings may not easily be identified in the field, and they are also quite vulnerable to trampling. As part of the basic research on current populations of this species, data such as counts of numbers of individuals present (or the area covered by the colony), the determination of the amount of yearly flowering

and seed production that might occur, and an assessment of recruitment rates are needed in order to monitor population dynamics and to assess the viability of the individual populations found. Individual plants should be monitored over the first and second growing seasons at each site for basic phenology data. Such basic facts as fungal associations (if any), genetic variability, and yearly variations in colony size over a long period are not precisely known.

An area of research that may be needed is to further test the hypotheses on the role of deer in the maintenance and dispersal of this plant. Moran (1986) suggested that deer may act as dispersal agents and that this mint may actually be dependent on deer for its dispersal, yet Baskin *et al.* (1986) observed that deer foraging on the plants discourages flowering and the production of viable seeds. More work appears to be needed to discover what the actual situation is.

Additional populations of this herb should be sought out during its flowering season. Once new populations are found, voucher specimens should be made to document them according to techniques described in Hill (1995) or other similar references. There are areas of additional suitable habitat in southern Illinois where the herb could also exist. A list of associates and indicator species has been compiled as a result of field studies in other states, especially in Kentucky and Tennessee (see Habitat section above), and these also occur with the species in Illinois. These indicator plants can be very useful in facilitating the discovery of additional populations of this herb. It is quite possible that populations of this species have been overlooked because of searches at the wrong time of year or because a particular year was too dry for its survival. Searches and monitoring should be conducted during the last two weeks of May, coinciding with peak flowering.

Botanical surveys conducted by scientists from the Illinois Natural History Survey and elsewhere have shown repeatedly that with sufficient time and funding, and an experienced eye, many plants thought to be extirpated or else threatened or endangered occasionally 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.D.A. 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, consultants, and students in cooperation with Illinois Department of Natural Resources personnel. 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 more qualified field botanists to achieve these goals.

RESTORATION

There are no known restoration efforts being conducted on *Synandra hispidula* anywhere in its range and the restoration potential of this species is largely unknown. The work of Baskin *et al*. (1986) has shown that this mint can be grown from seeds, and that this is the only known means of reproduction. Restoration efforts of several 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 isolation of populations from trail construction, the elimination of trampling, protection of the tree canopy (no logging allowed), and, possibly, no alterations in the deer populations in the areas where *Synandra hispidula* occur (Moran 1986, Shawnee National Forest 2005). This last recommendation was made because of the hypothesis that deer may actually distribute this mint in their feces, but, as far as is known, this has not been demonstrated and excessive deer browsing may actually be more detrimental than beneficial to this herb.

The generally recommended method to restore populations of this and other rare plants is to protect and manage their habitat (W-3). The Nature Conservancy has protected several important sites for this plant in Kentucky (*e.g.*, the Mary Breckinridge Nature Preserve and the Mrs. Baylor O. Hickman Memorial Preserve), but relatively few sites have been protected in other states within its range. Protection of the rich organic soil layer of the sites may be crucial, along with the maintenance of a mature forest habitat. Exotic and aggressive species must be completely eliminated from each site. This would entail physically pulling them out because it is very likely that herbicide application would eliminate this mint 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 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. Annual and biennial mints such as *Synandra hispidula* are normally easily propagated by means of seeds under controlled conditions. Seeds should be gathered from local populations and planted by the following February onto a site where a new population is desired, followed by monitoring as described.

Synandra hispidula does not appear to be available commercially, either as seeds or plants.

SUMMARY

The Guyandotte Beauty, *Synandra hispidula* (Michx.) Baillon, is a delicate biennial herb in the mint family with showy mostly white flowers, and it is normally found in moist to wet rich mesic forests on slopes or near streams. The species is known only from the United States, and it has a somewhat scattered distribution in the southeastern and central states. It is known historically from ten states, from New Jersey, western Virginia and North Carolina west to Illinois, Kentucky, Tennessee and northern Alabama. It has declined in recent decades. Globally, its ranking is G4 (apparently secure world-wide); its National ranking in the United States is N4 (apparently secure nationally). It was previously considered for national ranking as a 3C species. It is most common in Indiana, Kentucky, Ohio, and Tennessee. The Guyandotte Beauty is listed as Endangered in Illinois. The species is known from historic records only in North Carolina and it may not be extant in New Jersey. In Forest Service Region 9, the Guyandotte Beauty is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest where it is more common. It is at risk at the margins of its range.

Suggested research priorities for this rare herb in Illinois include, first, attempts to locate and protect any additional extant populations. The interrelationships of deer with this plant, and, in particular, the role of deer in its dispersal, should be studied. More practical knowledge about its successful propagation and restoration in the wild is needed, as are studies on how best to protect its habitat from disturbance. The genetic diversity within and between populations is as yet unknown. The exclusion of exotic plants, protection from trampling, the isolation of populations from trails and recreational activities, the prevention of logging, the protection from fires, and the monitoring of deer populations would all seem to be beneficial to this species. Management through strict protection of its habitat, either through enforcement of existing regulations or through the creation of new rules for restricted access (particularly recreational and equestrian access) to any discovered sites, appears to be necessary to allow it to persist where it may occur. At this time, the establishment of additional populations will be only through active human efforts.

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W-5. 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-6. Botany On-line - Reproductive Isolation. University of Hamburg, Germany. http://www.biologie.uni-hamburg.de/b-online/e38/38d.htm

W-7. Pest Alert – the Hemlock Woolly Adelgid. U.S.D.A. Forest Service, Northeastern Region. http://na.fs.fed.us/spfo/pubs/pest_al/hemlock/hwa05.htm

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APPENDIX 1

Representative specimens of *Synandra hispidula* examined or cited in the literature

Herbaria:

ILLS = Illinois Natural History Survey, Champaign. MO = Missouri Botanical Garden, St. Louis. MU = Miami University, Oxford, OH. WIS = University of Wisconsin, Madison.

ILLINOIS: JACKSON CO., Giant City State Park, 3 Jun 1980, *Christ s.n.* (MO); Giant City State Park, Makanda, 21 May 1941, *McCree, Jr. 768* (MO); T10S, R2W, near center of Sect. 9, 17 Jun 1989, *Smith 1414* (ILLS).

INDIANA: BROWN CO., Yellowwood lake area, E of Bloomington, Jackson Creek Trail at edge of Sol Pogue Creek, 17 May 1986, *Yatskievych & McCrary 86-67* (MO); **FOUNTAIN CO**., near Veedersburg, 5 Jun 1905, *Deam s.n.* (MO); **FRANKLIN CO.**, Road 52, about 3 mi W of Metamora, 25 May 1946, *Friesner 20331* (MO); **JEFFERSON CO.**, Hanover, Jun 1876, *Young s.n.* (MO); **LAWRENCE CO**., Oolitic, 24 May 1940, *Fassett & Shinners 20866* (WIS).

KENTUCKY: FAYETTE CO., Elk Lick Falls, 19 May 1923, *McFarland 107* (MO); **HARDIN CO.**, east of plot # 94, 23 May 1992, *Banks 5232* (MU); **KENTON CO.**, Covington, Fort Knox Military Reserve, 20 May 1889, *Herrick s.n.* (MU); **MADISON CO.**, near Big Hill, 12 May 1959, *Morgan 71* (MO); **MENIFEE CO.**, along Red River below KY 715 opposite Chimney Rock, 4 May 1974, *Meijer s.n.* (MO); **? CO.**, *s.d.* [1830s?], *Short 13208* (MO).

OHIO: ADAMS CO., tributary of Ohio Brush Creek, Twp. Rt. 88 (Tater Ridge Road), Oliver Twp., 2 Jun 1981, *Shelley 260* (MU); **BUTLER CO.**, Bachelor Estate, east of Oxford, Harker's Run, May 1996, *Fitton 52* (MU); **CLERMONT CO.**, Camp Freidlander, 27 May 1999, *Dister s.n.* (MU); **FRANKLIN CO.**, Blendon Woods Metro Park, Blendon Twp., 20 Jun 1980, *Cusick 20116* (MU); **HAMILTON CO.**, Hab. Fernbank - ad ripas fluminis Ohio, prope "North Bend", s.d. [1830s?], *Short 366* (MO); near Cincinnati, 20 May 1883, *Lloyd s.n.* (MO); Cincinnati, 1834, *Frank s.n.* (MO); Loveland, 19 May 1878, *James 2050* (WIS); **JEFFERSON CO.**, Guyan Hollow, Wayne Twp., 17 Jul 1987, *Hammer 413* (MU); **LAWRENCE CO.**: Kaiser Hollow, Wayne National Forest, near Connors Creek, 9 May 1985, *Cusick 24205* (MU).

TENNESSEE: BLOUNT CO., Great Smoky Mountains National Park, White Oaks Sinks, 18 Jul 2005, *Phillipee et al. 37789* (ILLS); **DAVIDSON CO.**, near Nashville, Apr –, *Gattinger 2050* (MO); **JACKSON CO.**, Pine Lick Road along creek, Apr 2000, *Philippe & Wilson s.n.* (ILLS).

VIRGINIA: SMYTH CO., south slope of White Rock Mountain, 21 June 1892, *Small s.n.* (MO); same locality, 22 Jun 1892, *Britton s.n.* (MU).

WEST VIRGINIA: OHIO CO., Wheeling, 24 May 1879, *Dietz 2050* (MO).

APPENDIX 2.

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

STATE	COUNTIES	NOTES
Alabama	Jackson	W-1; W-3
Illinois	Jackson, Williamson	W-1; W-3; Mohlenbrock & Ladd 1978; Mohlenbrock 1986; Shawnee National Forest 2005; includes Shawnee N.F.
Indiana	20 counties, mostly southern half of state	W-1; W-3; Deam (1940); Homoya, pers. comm.
Kentucky	40 counties, mostly eastern half of the state	W-1; W-3; includes Daniel Boone N.F.
New Jersey	?	W-3
North Carolina	Swain	W-1; W-3; Radford *et al.* (1968)
Ohio	17 counties, mostly southern half of state	W-1; W-3; W-4; Mike Vincent (pers. comm.); Spooner *et al.* (1983).
Tennessee	16 counties, mostly central third of state.	W-1; W-3; Chester *et al.* (1997).
Virginia	Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise	W-1; W-3
West Virginia	Kanawha, Logan, Mingo, Monongalia, Ohio, Wayne	W-1; W-3

APPENDIX 3.

Natural Diversity Database Element Ranking System

Modified from: http://www.natureserve.org/explorer/ranking.htm [W-5]

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.

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.