Conservation Assessment

for the

Fairy-wand

(Chamaelirium luteum (L.) A.Gray)

U.S.D.A. Forest Service, Eastern Region

Shawnee National Forest

Hoosier National Forest

7 November 2006

Steven R. Hill, Ph.D.
Illinois Natural History Survey
Division of Biodiversity and Ecological Entomology
1816 South Oak Street
Champaign, Illinois 61820

ILLINOIS
NATURAL
HISTORY
SURVEY

This document is undergoing peer review, comments welcome

Cover photo:

Chamaelirium luteum (L.) A.Gray, from Delaware Wildflowers website. Image copyright 2005 David G. Smith. Male plant.

http://www.delawarewildflowers.org/0468.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This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation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. Margaret Wingard has been especially helpful.

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 information on this locally rare plant. Among these, Mike Homoya provided information about the plant in Indiana, and John Taft provided some insights on the plant in Illinois.

Portions of a conservation assessment for this species in New England authored in 2003 by Dorothy J. Allard of Montpelier, Vermont, were used for several sections of this report, and these have been acknowledged in the appropriate places. I would like to thank Dorothy for the use of this material.

Thanks also to Dr. John E. Fairey, III, emeritus of Clemson University, Clemson, South Carolina, who enjoyed showing many of us his "Fairey-wand".

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 Fairy-wand, *Chamaelirium luteum* (L.) A.Gray, 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 Fairy-wand to date. *Chamaelirium luteum* is a perennial herb with somewhat fleshy roots, crowded basal spatulate leaves, and white flowers in elongate spike-like, male or female inflorescences, and it is normally (15-) 30-60 (-150) cm tall. The genus contains only the single species, and, when in flower, it is quite distinctive, yet it can be overlooked when sterile. The species has both ornamental and medicinal uses, it is widespread in the eastern United States and in a very small area of adjacent Canada, and it is known historically from twenty-four states including the District of Columbia and one province, from Michigan and Ontario, east to Massachusetts, and south to Florida and Louisiana. It is an upland forest species only rarely associated with wetlands and it grows in a wide range of soils that are often acidic. Globally, its ranking is G5 (secure world-wide), its National status in the United States is N5 (secure nationally), and it has been ranked as historic only in Canada (NH). The Fairy-wand (or "Fairy Wand", "Devil's-bit", or "Blazing-star") is listed as endangered and imperiled in Connecticut (S1), Illinois (S1), Indiana (S1), and Massachusetts (S1), and as threatened in New York (S1S2). It has been listed as Critically Imperiled in Delaware (S1) and it is listed as a species of Special Concern in Arkansas (S3). In Forest Service Region 9, the Fairy-wand 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 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: *Chamaelirium luteum* (L.) A.Gray [1848]
Common Names: Fairy-wand; Fairywand; Fairy Wand; Devil's-bit; Blazing-star; Rattlesnake-root; False Unicorn Root; Helonias; Starwort; Stargrass; Star Grub Root.
Synonymy:
Veratrum luteum L. [1753]
Melanthium luteum (L.) Thunb. [1784]
Melanthium dioicum Walter [1788]
Helonias pumila Jacq. [1789]
Helonias lutea (L.) KerGawl. [1807]
Chamaelirium carolinianum Willd., nom. illegit. [1808]
Helonias dioica (Walter) Pursh [1814]
Ophiostachys virginica Delile, nom. illegit. [1815]
Diclinotrys albiflorum Raf. [1825]
Veratrum flavum Schult.f. [1830]
Chamaelirium obovale Small [1901]

Class: Liliopsida (Flowering Plants - Monocotyledons)
Family: Liliaceae (The Lily Family) or Melanthiaceae (The Camas Family)
Plants Code: CHLU (U.S.D.A. NRCS plant database, W-1)
http://plants.usda.gov/

The lily genus *Chamaelirium* contains a single species, *Chamaelirium luteum* (L.) A.Gray, found only in eastern North America (Utech 2002). The species is most common in temperate to warm-temperate, moist meadows, thickets, rich forested slopes, and mountain coves from 0-1,100 meters in elevation. The genus is most closely related to the east Asian *Chionographis* Maximowicz, and they form a classic disjunct pair of the ancient northern hemisphere Arcto-Tertiary forest, which was broken ultimately into smaller isolated forests by the glaciers during the Pleistocene epoch. Other genera considered to be somewhat closely related have been placed with *Chamaelirium* and *Chionographis* within the Liliaceae subfamily Melanthioideae, now more frequently treated as the family Melanthiaceae (not to be confused with the dicot family Melianthaceae !). The additional related genera (in North America) include, conservatively, *Amianthium* A.Gray, *Melanthium* L., *Schoenocaulon* A.Gray, *Stenanthium* (A.Gray) Kunth, *Veratrum* L., and *Zigadenus* Michx.

The Fairy-wand was first named *Veratrum luteum* by Linnaeus [in 1753], who noticed that it closely resembled the False Hellebore (*Veratrum*) in flower structure, and he thought that the flowers were yellow (*luteum* in Latin means 'deep-yellow' or 'golden-yellow') because the specimen at hand had indeed faded to yellow. In reality, the flowers are white when fresh. In the subsequent years the genus *Veratrum* and its close relatives were redefined several times, and,

currently, the species is generally placed within *Chamaelirium* Willd. The generic name *Chamaelirium* was derived from the Greek word *chamae* [or *chaimi*], on the ground, and *lirion* [or *leiron*], a white lily, probably because the original specimen may have been dwarfed, or because the primary leaves of the plant are at the base of the stem and often rest on the ground. The genus is very distinct. The species can be somewhat variable, and the separate male and female plants appear to be quite different from each other, so that additional names were proposed over the years to account for this variation (see Synonymy above). However, these variants are now all recognized to be common expressions within a single species, and no additional species or subspecific entities are currently recognized as valid for this plant.

There are several common names for this plant currently in frequent use, and there is no single standardized common name for it. Both 'Fairy-wand' (or 'Fairywand', 'Fairy Wand') and 'Devil's-bit' are widely used. 'Fairy-wand' appears to have gained increasing acceptance in the literature and it has been used here. It describes well the delicate, even ethereal, white flower spike of the male plants particularly well. The common name 'Blazing-star' is one of the most confusing of the common names sometimes used, because it generally is used for the genus *Liatris*, a bright purple-flowered member of the Asteraceae, and most would not associate it with *Chamaelirium*.

DESCRIPTION OF THE SPECIES

Chamaelirium luteum, the Fairy-wand, is a slow-growing **perennial herb** from a stout, nodose rhizome; the roots are fibrous and fleshy. Plants are unisexual (dioecious). The **stems** are persistent in pistillate plants, erect to nodding, simple, hollow, and glabrous. **Leaves** are persistent, evergreen, crowded in basal rosettes, and reduced in size on the stem above; the leaf blades are glabrous, with entire to minutely undulate margins; basal blades are petiolate, spatulate to oblanceolate in shape (obtuse at the apex), and measure 5-20 cm long x 1.5-6 cm wide; upper stem leaves are sessile oblanceolate to linear and 3-8 cm x 1-1.5 cm wide. **Staminate plants** have 5-20 leaves and are 30-70 cm tall. **Pistillate plants** have 15-50 leaves, and are 30-120 cm tall and up to 150 cm tall in fruit. **Inflorescences** are terminal and single, and bractless; in staminate plants they are conspicuous, racemose, rarely spiciform, (4-) 7-12 (-15) cm long and 10-15 mm wide, and have a nodding apex (see cover illustration); in pistillate plants they are usually inconspicuous, very slender (about 4 – 10 mm wide), racemose or spiciform, and up to 35 cm long in fruit. **Flowers** are unisexual, with staminate and pistillate on different plants, or occasionally they are bisexual, bractless, and weakly syncarpous; the flowers are bractless; the **petals and sepals** all look the same (thus called tepals), there are 6, spreading to ascending, not fused, white to greenish white fading yellowish (in the males), 1-veined, narrowly linear-spatulate, and nectaries are absent; in the divergent (spreading) white **staminate flowers** the tepals are 3-4 mm long, there are 6 extrorse (facing outward) stamens, with flattened separate unequal filaments (the outer filaments are longer); anthers are white and attached at their bases and they are 2-locular, 0.5 mm long, and oblong-oblanceolate; in the ascending white to greenish **pistillate flowers** the tepals are 2-3 mm

long, staminodes are present, the elliptic to obovate ovary is superior, 3-locular, deeply 3-lobed, with 3 persistent styles 1.5-2 mm long that are recurved, separate from each other, and linear-clavate; the sessile stigmas are papillate along the upper surface. **Fruits** are capsular, ovoid-oblong, 7-14 mm x 5-6 mm, erect, 3-locular, with loculicidal dehiscence. There are 2-4 reddish brown **seeds** per locule (8-12 according to Allard 2003), they are 1.8-2 mm long, elliptic to linear oblong, with broad wing-like arils that increase their size to 5-6 mm. The chromosome number is $x = 12$. *Chamaelirium* flowers in the late spring to early summer. (Adapted from Gleason and Cronquist 1991 and Utech 2002).

When in flower, this herb is quite distinctive and not likely to be confused with other species in the area. When immature and found as a loose rosette or as a single leaf, it might be confused with a seedling *Lilium* or *Trillium*, or possibly with rosettes of *Clintonia*. *Chamaelirium* rosettes often have reddish leaf petioles, and the leaves are more firm and persistent than those of *Clintonia* (Hill, pers. obs.).

The roots of the Fairy-wand are sometimes used medicinally, and the common names 'Starwort' or 'False Unicorn Root' are sometimes used for them. This can present problems in the herbal industry because it can then be confused with the 'True Unicorn Root' (*Aletris farinosa* L.). Another name that is frequently used for the plant in the herbal industry is 'Helonias', despite the fact that this plant is not related very closely to the genus *Helonias* (W-2). According to Lewis and Elvin-Lewis (1977), the roots have been used as a diuretic. According to several Internet sources (*e.g.*, W-3, W-4, W-5), False Unicorn Root (*Chamaelirium luteum*) has a long-standing reputation as a uterine tonic and it was widely used by North American Indians as a woman's herb. *Chamaelirium* was traditionally used to prevent miscarriage and has a reputation for improving fertility. In Western herbal medicine, it has been used to treat pregnancy problems and ovarian cysts. It regulates hormonal imbalances (especially after use of the birth control pill ceases), brings on suppressed or delayed menstruation yet is also extremely useful in cases of threatened miscarriage (W-5). It can be used for morning sickness and ovarian pain. Generally, small amounts are used because large doses can cause nausea and vomiting.

HABITAT AND ECOLOGY

The Fairy-wand has been given a national wetland indicator status of FACU- or FAC, indicating that the species can occur either in wetlands or non-wetlands depending on the region [FACU = Facultative Upland, the species usually occurs in non-wetlands (estimated probability 67%-99%), but it can occasionally be found in 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, *Chamaelirium luteum* has been specifically designated as a FACU- species (Reed 1988; W-1; W-6), indicating that it only rarely is associated with wetlands in this area. Overall, these habitats include moist meadows (sometimes calcareous), bogs, thickets, somewhat open and dry forested sites, rich moist forested slopes,

and mountain coves from 0-1,100 meters in elevation. Other recorded habitats where this herb has been found include bottomlands, wet savannas, dry woods, barrens, and bluffs. It is relatively rare in the northern portions of its range, and it appears to prefer, and is most common in, the more moderate climates of the central and southern Appalachian Mountains, avoiding the eastern coastal plain almost completely.

A review of the literature demonstrates that this herb has a variety of plant associates and habitats throughout its range. *Chamaelirium luteum* grows mainly in moist woods (mesic upland forests) on well-drained slopes, though it can also be found on more level sites as well. Floras generally list the habitat of *Chamaelirium luteum* as "meadows, thickets, and rich woods" in the central and northeastern United States and adjacent Canada (Fernald 1950), "moist woods and bogs" in the northeastern United States and adjacent Canada (Gleason and Cronquist 1991), "moist or dry-mesic woods" in New England and adjacent New York (Magee and Ahles 1999), "moist meadows and thickets" in West Virginia (Strausbaugh and Core 1978), "rich woods" in the Blue Ridge physiographic province (Georgia, North Carolina, South Carolina, Tennessee, and Virginia; Wofford 1989), "rich, mesic wooded slopes and coves" in North and South Carolina (Radford *et al.* 1968), "rich woodlands, wooded slopes, coves, sometimes in dry open woods and meadows; in the southernmost part of the range sporadic in seasonally wet pine savannas and flatwoods" in the southeastern United States (Godfrey and Wooten 1981), "flatwoods and bluffs" in the Florida panhandle (Clewell 1985), and "moist thickets and meadows" in central Florida (Wunderlin 1982). This species tends to flower only in more open areas, and sterile rosettes predominate in more shaded habitats (Allard 2003).

The soils where it grows are normally acidic, but sometimes they can be neutral to somewhat alkaline depending on the substrate. The species does not appear to have a strong pH preference. A manual on the cultivation of medicinal herbs describes the soil conditions of natural populations as loam or sandy loam with a pH of 4.5 to 6, and suggests that the soils used for cultivation should be of high organic content and “on the acid side” (Cech 2002). This contrasts with the pH of 6.8 to 7.2 reported for the soils of a natural New York population (Carrolan 1982).

At the northeastern limits of its range (Massachusetts) common associates include the trees *Acer rubrum, Betula* spp., *Fagus grandifolia, Pinus strobus, Quercus montana*, and *Tsuga canadensis*, the shrub *Kalmia latifolia*, and herbs such as *Maianthemum canadense*, *Pyrola elliptica*, and *Lycopodium* spp. In northern habitats influenced by calcareous substrate, associates may include the trees *Acer saccharum*, *Betula papyrifera*, *Fraxinus americana*, *Ostrya virginiana*, and *Quercus rubra*. The Fairy-wand can occur in both disturbed secondary forests and undisturbed primary forests, and it can be locally common (Utech 2002, W-2, W-7). Carrolan (1982) states that the most likely sites to find *Chamaelirium luteum* in New York are calcareous wet meadows with 10-40 percent shrub cover and that contain some of the following species: *Myrica pensylvanica, Ceanothus americanus, Potentilla fruticosa, Gaylussacia baccata, Castilleja coccinea, Gentiana crinita, Parnassia glauca*. Three of these species (*Potentilla fruticosa,*

Castilleja coccinea, Parnassia glauca) are also known from one of the Connecticut sites (Allard 2003).

In Indiana the Fairy-wand grows in both exposed relatively dry sites and in more mesic forests, such as on an exposed limestone slope and also in woods dominated by beech and oak in southern Indiana (Deam 1940). The Indiana plants are on the east edge of the Highland Rim Natural Region. At one site in Harrison County it grows on a level, sparsely wooded site above a limestone cliff (Homoya, pers. comm.). Other associated trees there are *Pinus virginiana* and *Quercus montana*. In the more mesic forest sites this species is associated with the trees *Cornus florida*, *Fagus grandifolia, Quercus alba*, and *Sassafras albidum*. It can also be found with the herbs *Comandra umbellata, Lithospermum caroliniense*, and *Phytolacca americana* (Deam 1940).

In Illinois, *Chamaelirium luteum* grows on low, wooded hillsides in the extreme southern tip of the state (Mohlenbrock 1986, 2002). Herbarium labels on specimens in the Illinois Natural History Survey herbarium (ILLS) list its habitats as 'woods', 'low thicket', and 'rocky wooded slope'. The extant sites include a mesic floodplain forest, a dry-mesic forest bordering a barrens, as well as a seep springs (as defined by White and Madany 1978; Shawnee National Forest 2005).

Sites where *Chamaelirium luteum* grows in the heart of its range in central North Carolina and northwestern South Carolina include slopes in forests dominated by the trees *Fagus grandifolia, Acer rubrum*, and *Liriodendron tulipifera*, or on drier, westward sloping sites with the trees, *Liquidambar styraciflua*, *Nyssa sylvatica*, *Oxydendrum arboreum*, *Pinus* spp., and several *Quercus* species, and also often on northeast-facing slopes associated with the trees *Carya tomentosa, Liriodendron tulipifera*, and several *Quercus* species (Meagher 1980; Hill pers. obs.). The most abundant shrub and herb species associated with *Chamaelirium luteum* at these sites include *Desmodium nudiflorum, Iris cristata, Hexastylis* spp., *Euonymus americanus, Kalmia latifolia*, and *Polygonatum biflorum*. Other common herbaceous species that grow with *Chamaelirium luteum* in the Carolinas are *Amianthium muscaetoxicum, Arisaema triphyllum, Carex* spp., *Galax aphylla*, *Luzula* spp., *Polystichum acrostichoides, Stellaria pubera*, *Trillium* spp., and others. According to the National Vegetation Classification used in the Southeastern United States (W-8), *Chamaelirium luteum* is considered to be a characteristic component of the upland *Pinus strobus* Forest Alliance, and, specifically, of the *Pinus strobus* / *Kalmia latifolia* – (*Vaccinium stamineum, Gaylussacia ursina*) Forest. It is also considered to be a typical member of the upland *Quercus prinus* [*Q. montana*] – (*Quercus coccinea, Quercus velutina*) forest Alliance, and, specifically, of the (*Quercus prinus, Quercus coccinea*) / *Kalmia latifolia* / *Galax urceolata* [*Galax aphylla*] Forest.

Chamaelirium luteum once occurred in Ontario, Canada, and its habitat there, taken from specimen labels, included sandy brush, open grassland, swamps, and moist thickets (Allard 2003).

DISTRIBUTION AND ABUNDANCE

Chamaelirium luteum, the Fairy-wand, is widespread in portions of the temperate and warm-temperate areas of the eastern United States and adjacent Canada, and it is known to occur historically in twenty-three states and the District of Columbia, namely, Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia (Utech 2002, W-1, W-2). The occurrence of Fairy-wand in Michigan has been questioned. Voss (1972, p. 422) states: "Despite other reports from the state, the only Michigan collection seen was one made by Farwell at Detroit in 1917 (BLH). Since he collected many cultivated plants the same day, it is possible that this one was not native." In Canada, this herb has been found only in the province of Ontario where it was considered to be rare (White *et al.* 1982) and now probably extirpated. *Chamaelirium luteum* once occurred in up to five sites in Ontario, and is known currently only from herbarium specimens (Allard 2003). *Chamaelirium* is relatively rare in the northern portion of its range, and becomes more common in the mid- to southern Appalachian Mountains of Pennsylvania, Virginia, North Carolina, and South Carolina (W-2). Its range includes both formerly glaciated and unglaciated areas, but it is far less common in the formerly glaciated areas. It appears to be an 'old' species that dates back to the ancient pan-Arctic Tertiary forest, and its closest relative is still to be found in China (Utech 2002). As with most other species, it becomes scarce at the margins of its range. Its historic range assessed on a county basis also may have been 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. One detailed study in New England (Allard 2003) indicates that *Chamaelirium luteum* occurred historically in 24 towns in Connecticut and Massachusetts. Currently, the species is known in only eight towns in the two states.

Based upon its state rankings (W-2) only, this herb would appear to occur most frequently in North Carolina and West Virginia (as a S5 species) and in Kentucky (as an S4 species). It is not ranked in ten of the twenty-three states where it is known to occur (W-2), so its frequency cannot be precisely determined in those states. Fairy-wand is local within most of its range. A combination of records from several sources (see appendices) gives somewhat different results on the frequency of *Chamaelirium*. Records from floras and herbarium labels show that this herb has been found in more than 50 counties in North Carolina, about 45 counties in Virginia, 43 counties in Tennessee, and more than 35 counties in Pennsylvania. It has been found in more than 20 counties in Alabama, Georgia, Kentucky, New York, and Ohio. In the remaining fifteen states (including the District of Columbia) *Chamaelirium* has been found in 19 or fewer counties, though its frequency within each county can be greatly variable. Additional details on the distribution of this herb can be found in Kartesz and Meacham (1999), Allard (2003), and several Internet sites (*e.g.*, W-1, W-2). Representative specimens of this herb have been listed in Appendix 1. A summary of the distribution of the Fairy-wand has been presented in Appendix 2.

In the east-central states, the species has been found in Illinois (where it is at its northwestern range limit in the extreme southeast corner of the state) and in Indiana, as well as in neighboring Kentucky, but not in adjacent Missouri or Iowa (Yatskievych, pers comm., Mohlenbrock and Ladd 1978, Deam 1940). Its current range within the United States appears to include the same states as today. It has not been listed as Extirpated (or Historic) in any state as yet (W-1, W-2) but it may no longer be extant in the province of Ontario, Canada (Allard 2003).

Within the U.S. Forest Service Eastern Region (Region 9) *Chamaelirium luteum* is known to be present within the Shawnee National Forest in Illinois and the Finger Lakes National Forest in New York. It is considered by the Forest Service to be at risk in Illinois but not in New York. It has not been found in the Hoosier National Forest in Indiana. It is most likely present in several other Region 9 forests, despite the lack of reports. It is found in several National Forests of the Appalachian region generally to the southeast, in Region 8, including the Bankhead National Forest (AL), Conecuh National Forest (AL), Oconee National Forest (GA), Daniel Boone National Forest (KY), Holly Springs National Forest (MS), Uwharrie National Forest (NC), Francis Marion National Forest (SC), Sumter National Forest (SC), Jefferson National Forest (VA), and, undoubtedly, others.

In Illinois, where it is listed as Endangered, the species has been reported historically in Hardin, Massac, and Pope counties (Mohlenbrock 1986, 2002; Mohlenbrock and Ladd 1978; Shawnee National Forest 2005) and it is still known to exist in all three counties. Within the Shawnee National Forest it is found along Burke Branch in a mesic floodplain forest at Burke Branch Research Natural Area, in a seep springs in the Cretaceous Hills Ecological Area, along the sandy banks of Massac Tower Springs Ecological Area, just outside of the protected barrens areas in southern Pope County in a dry-mesic open woods on a south-facing slope near the Ohio River, and outside of the Kaskaskia Woods Ecological Area in a ravine (Shawnee National Forest 2005). These sites are located within the Shawnee Hills Natural Division, Lesser Shawnee Hills Section and in the Coastal Plain Natural Division, Cretaceous Hills Section of Illinois (Schwegman *et al.* 1973).

In Indiana, *Chamaelirium luteum* is thought to exist today only in Harrison County, but it was historically known in at least four additional counties (Crawford, Floyd, Jefferson, Vanderburgh) in the extreme southern part of the state (W-1; W-2; Deam 1940; Homoya, pers. comm.).

The populations of this herb in Illinois and other areas of 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 the region. 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, and there is good evidence that *Chamaelirium luteum* reproduces far better in open forest areas (Allard 2003); the suppression of fires later may have led to a decline in the

number of populations. However, it is just as likely that open woodlands where it may have occurred have been developed or disturbed by agriculture and housing in the past 200 years, in which case there may have been a significant population decline for that reason as well.

There is only a little data available on population sizes for this herb, and herbarium label data rarely include its local frequency or abundance. It is known that within its center of frequency in North Carolina that populations can contain thousands of individuals (Allard 2003) but there is little data on the density of the populations and the area covered by each. Many colonies consist of a few scattered plants found over a relatively wide area (Hill, pers. obs.) even in the Carolinas. Detailed studies by Meagher, summarized by Allard (2003), involved populations in North Carolina that contained between 450 and 2,220 plants. Work in New York by Utter and colleagues (presented in more detail by Allard 2003) involved populations ranging in size from 1,200 to 3,600 individuals. Certainly, in some areas the populations can be quite large.

PROTECTION STATUS

The Nature Conservancy currently lists *Chamaelirium luteum*, the Fairy-wand, as a G5 plant (W-2), indicating that the species is fully secure worldwide. In the United States, overall, the species is given the National Heritage rank of N5 (for similar reasons). The species is also found in Canada, and it has been nationally ranked as NH (possibly historic only) in that country.

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. The state rankings vary somewhat. *Chamaelirium luteum* is listed as Endangered in Connecticut, Illinois (Illinois Endangered Species Protection Board [IESPB] 2005), Indiana, and Massachusetts, in all of which it is also ranked as S1 – critically imperiled. It has also been ranked as critically imperiled (S1) in Delaware and it has been included on the list of rare vascular plants of Delaware (McAvoy 2001). It has been listed as Threatened in New York, as well as critically imperiled to imperiled (S1S2). It has been ranked as vulnerable (S3) in Arkansas (a species of Special Concern), Maryland, and New Jersey (W-1; W-2). It is considered to be secure (S5) in North Carolina and West Virginia, and apparently secure (S4) in Kentucky. It has not been ranked in the remaining eleven states (including the District of Columbia) where it has been found (W-2). It is most at risk at the margins of its range.

The Fairy-wand is at risk and 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 (W-9; Shawnee National Forest 2005).

Table 1 lists the official state rank for *Chamaelirium luteum* assigned by each state's Natural Heritage program according to the Nature Conservancy at their Internet site (W-2). Appendix 3 explains the meanings of the acronyms used (W-10).

A summary of the current official protection status for *Chamaelirium luteum* follows:

U.S. Fish and Wildlife Service:	Not listed (None)
U.S. Forest Service:	Listed as at risk in the Shawnee National Forest only, Region 9
Global Heritage Status Rank:	G5
U.S. National Heritage Status Rank:	N5
Canada National Heritage Status Rank:	NH

Table 1: S-ranks for *Chamaelirium luteum* [Heritage Element Code: PMLIL0F010]

State/Province	Heritage S-rank	
UNITED STATES		
Alabama	SNR	
Arkansas	S3	
Connecticut	S1	[Endangered]
Delaware	S1	
District of Columbia	SNR	
Florida	SNR	
Georgia	SNR	
Illinois	S1	[Endangered]
Indiana	S1	[Endangered]
Kentucky	S4	
Louisiana	S2S3	
Maryland	S3	
Massachusetts	S1	[Endangered]
Michigan	SNA	
Mississippi	SNR	
New Jersey	S3	
New York	S1S2	[Threatened]
North Carolina	S5	
Ohio	SNR	
Pennsylvania	SNR	
South Carolina	SNR	
Tennessee	SNR	
Virginia	SNR	
West Virginia	S5	
CANADA		
Ontario	SH	

LIFE HISTORY

The following includes excerpted and / or modified portions of the conservation and research plan for *Chamaelirium luteum* by Allard (2003).

Chamaelirium luteum is a dioecious or occasionally polygamo-monoecious perennial herb. It shows strong differentiation in life history and ecological characteristics between male and female plants. Male and female plants flower synchronously (Zomlefer 1997) and are

insect-pollinated (Carrolan 1982, Meagher 1986). Specific pollinators are not known. A longhorn beetle
(Cerambycidae) was seen by surveyors in 2002 on top of one male flower at a Connecticut population (Allard 2003), presumably collecting pollen. Despite the synchronous flowering, the male flowers are far more conspicuous early in the season.

The flowering period of *C. luteum* occurs earlier and fruiting occurs later in the southern part of the range. Radford *et al.* (1968) report flowering from March to May and fruiting from September to November for the Carolinas, while Gleason and Cronquist (1991) report June flowering for plants in the northeastern United States. Flowering in North Carolina takes place over a one-to-two week or two-to-three week (Meagher 1986, Meagher and Thompson 1987) period. Blau and Venezia (1983) found that plants in two New York populations near its northern range limit flowered in June and July. Allard (2003) observed male plants in flower at two Connecticut sites in mid-June 2002. In Illinois, plants flower in May and June (Mohlenbrock 1986) and Illinois specimens at the ILLS herbarium were collected from 9 May to 12 June. On average, herbarium specimens demonstrate that the Fairy-wand is most frequently seen in flower in most of its range during the last week of May. However, it is not uncommon to find the plants in flower in late April in the southern portions of the range, and some plants have been collected in flower as late as 24 June and even later in New Jersey and points north (data from herbarium specimens).

The male flower spike is far more conspicuous and showy than the female spike, even in bud, and it appears to open its flowers before that of the female for this reason. The more greenish, narrow female spikes are often overlooked in the field. The flowering stalks of male plants wither and disappear after the flowers wilt, while the female flowering stalks continue to develop and elongate as the fruits mature, becoming more conspicuous. Inflorescence length and the number of leaves on a flowering stalk are positively correlated with flower number in both male and female plants; male plants produce many more flowers than do female plants. In studied populations in North Carolina, males produced 180-450 flowers per inflorescence, whereas females produced 25-46 flowers (Meagher and Antonovics 1982, Smouse *et al.* 1999). Females rarely, if ever, flower two years in succession (Meagher 1981). In any given population, the number of plants in flower varies from year to year and is probably dependent upon yearly climate fluctuations, although the conditions that support a greater degree of flowering are unknown (Meagher 1978, Carrolan 1982).

Fruiting stalks are quite durable and can remain on a plant for two or three years (Meagher 1978). This fact makes searches for the plant possible nearly all year. Fruit set in North Carolina populations was 97-100 percent (Meagher 1991). Carrolan (1982) reports that seed dispersal is by wind, while Meagher and Thompson (1987) state that seed dispersal has not been investigated. They surmise that since the flowering stalk of *C. luteum* is somewhat springy, seeds may be disengaged and thrown from the loculicidal capsules if the stalk is pulled back and released. Therefore, strong winds or animals brushing against plants might contribute to dispersal. The taller

height of the female plants may be an adaptation to increase the distance to which seeds can be spread (Meagher 1978, Meagher and Antonovics 1982). Presumably, the wing-like arils on the seeds may also increase dispersal distance. Studies in one mapped North Carolina population (Meagher and Thompson 1987) revealed that seed dispersal distances averaged 10.1 – 10.4 m.

In studies using seeds from Tennessee plants, the seeds of *Chamaelirium luteum* exhibited "nondeep simple morphophysiological dormancy" (Baskin *et al.* 2001). Seeds would not germinate unless 1) they had undergone a period of cold weather followed by warming temperatures, and 2) embryos grew to almost double their length at the time of shedding after cold stratification was complete and during the warming period (Baskin *et al.* 2001). In addition, light was required for germination. Meagher and Thompson (1987) found that seeds of North Carolina plants stored at room temperature did not survive for more than one year. Cech (2002) reported that the viability of seeds grown from cultivation could be extended to two years by storing them under refrigeration at low humidity. In seed viability studies done at the New England Wild Flower Society, seeds stored in closed containers in a refrigerator maintained their viability for at least three years (Allard 2003). A bit of conflicting evidence on seed dormancy is presented by a germination experiment conducted with seeds from a Connecticut population. According to Allard (2003) on September 20, 2000, D. Norris collected 16 seeds from a single plant of *C. luteum* and placed them in moist potting soil. Germination began on October 17 and continued until about fifty percent of the seeds had germinated. This suggests that the seed dormancy shown in Tennessee plants may not be consistent throughout the range of the species. Immediate germination may be favored in northern populations for some proportion of the seed, or seeds that have dried completely (as was true of the Tennessee seeds) may become dormant and require pretreatment. In their study of the Fairy-wand, Meagher and Thompson (1987) observed that most seedlings had germinated in areas with some kind of local disturbance that removed leaf litter, indicating a germination preference or requirement for either light or bare soil. This corresponds well with greenhouse studies by Baskin *et al.* (2001) that showed that light was needed for germination.

Meagher's studies, summarized in more detail by Allard (2003), centered around a long-term monitoring study on the species biology of *Chamaelirium luteum* that was conducted in North Carolina. After analyzing his field data, Meagher formed several conclusions. *Chamaelirium luteum* showed strong differentiation between the sexes in life history and in ecological characteristics. Females were larger than males, flowered less frequently, had a higher mortality rate, and therefore were less common in the populations. The higher mortality rate was attributed to greater resource depletion due to flowering in females relative to flowering in males, with a consequent lessening of resistance to environmental fluctuations (Meagher and Antonovics 1982). The male-biased sex ratio in *Chamaelirium luteum* had been reported prior to Meagher's work (Silliman 1957, Radford *et al.* 1968), but he examined the phenomenon more intensively (Meagher 1978, 1981, Meagher and Antonovics 1982). Natural populations of *Chamaelirium luteum* consisted of male plants, female plants, and plants that were vegetative and therefore not able to be identified to sex. Meagher classified sex ratios of *C. luteum* and other dioecious perennial species into three groups: 1) the seedling, or primary sex ratio; 2) the adult, or secondary

sex ratio; and 3) the sex ratio among flowering plants in any given year, or ephemeral sex ratio. By planting seeds of *C. luteum* and following them to sexual maturity, he showed that the primary sex ratio was about one to one. After seven years of censusing, the cumulative sex ratio of adults in natural populations showed an excess of males, varying from 1.74 to 2.47 males to one female. In addition, the ephemeral sex ratio was even more strongly biased toward male plants, with a range of from 2.37 to 14.0 males to one female. The excess of males was due to higher mortality rates of females and a corresponding lower longevity. Since plants were tagged and tracked from year to year, the authors were able to determine that shifting between sexes did not occur. Population projection matrices for the North Carolina populations predicted that overall population sizes were stable (Meagher 1982). Males and females in the North Carolina populations showed spatial segregation in their distribution in three out of four populations (Meagher 1980, Meagher and Burdick 1980). Nearest neighbor and Monte Carlo analysis showed that male plants were clustered with other male plants, and female plants were clustered with other female plants. Males occurred in denser clusters than did females. Meagher showed that this spatial segregation was, at least in part, due to differences in environmental requirements of the sexes. He did this by examining associated plant species at different quadrat scales and showing that male and female plants were distributed in different vegetation zones (Meagher 1978, Meagher 1980). Since the geographic extent of each *Chamaelirium* population was, on average, less than 0.1 hectare, differentiation among zones occurred at a very small scale. In South Carolina, it is generally observed that male plants occur in drier sites with relatively nutrient-poor soils (such as clay) and female plants occur in more mesic sites with richer soils (such as loam), and the latter sites may also have a somewhat higher pH (Hill, pers. obs.). This tends to agree with the observations by Meagher.

Vegetative plants were smaller and had a higher mortality rate than either male or female plants. The higher mortality rate of vegetative plants was at least partly due to the fact that this category was dominated by seedlings and younger plants, and plants in these life stages are generally more vulnerable to mortality than older, well-established plants (Harper 1977). Size of rosettes in any given year was positively correlated with probability of flowering in the next year and size of inflorescence (Meagher and Antonovics 1982). Plant size not only influenced the probability of flowering, but was also influenced by flowering. In a year in which a plant flowered, the basal rosettes of both male and female plants were smaller than they were in the previous year, although the reduction in size was greater for female plants (Meagher 1978). The number of years to sexual maturity was estimated by growing plants in a phytotron and inducing yearly growth cycles using changes in temperature and day length (Meagher and Antonovics 1982). The simulated age of first flowering of male plants, on average, was slightly less than that of female plants, although both male and female plants took about four induction cycles to achieve sexual maturation. In the field, the juvenile period was shown to last at least six years (Meagher 1981). The North Carolina and New York studies provide us with an understanding of the species biology of *Chamaelirium luteum* both at the center and at the northern edge of its range. In the two New York populations in which it was initially studied, the sex ratio of flowering plants in 1983 was 3 males to one female in one population and 2.7 males to one female in the other (Blau and Venezia 1983). Because North

Carolina populations showed an ephemeral sex ratio range of from 2.37 to 14.0 males to one female, the limited New York data indicate a greater relative production of female inflorescences within populations roughly comparable in size to the North Carolina populations, but because ratios vary from year to year, more data are needed to be certain of this.

Flowering and successful seed set may be less frequent in the climatic conditions present in the northern portions of its range, but not enough data have been published to make a clear determination. A smaller percentage of plants in New York populations flowered in the year studied than did plants averaged over several years in North Carolina populations. North Carolina populations had a ten to 20 percent average annual flowering rate (Meagher 1978), while only five to eight percent of New York populations flowered in 1983 (Blau and Venezia 1983).

Two additional notable differences between plants in the New York populations and the North Carolina populations have emerged from the studies summarized by Allard (2003). First, of the two, only the New York plants sometimes produce two or more rosettes from one rhizome (Blau and Venezia 1983). In North Carolina, more than 1,000 plants were dug in one population, and no subterranean connections were found between rosettes (Meagher 1978). While the production of multiple rosettes from one rhizome has been reported as a means of vegetative reproduction (Blau and Venezia 1983, Utter and Hurst 1990), in the strict sense, vegetative reproduction has not been shown. In order for successful vegetative reproduction to occur, there must be a means of separation of the rosettes from each other and spread of plants from the original plant into the surrounding areas. These clones must form their own independent root system with which to tap water and nutrients from the environment. This has not been demonstrated in the New York populations. Rhizomes of *C. luteum* are short and the rosettes of multiple-rosetted plants grow close together. A corresponding rhizome elongation has not been observed, and there is no obvious other means whereby ramets might be spread. Nonetheless, there may be some selective advantage to the formation of multiple rosettes from one rhizome. Perhaps multiple rosettes may increase the likelihood of survival of the plant should one or more of the rosettes succumb to disease or insect predation. The presence of multiple rosettes from one rhizome was also reported in a two-year study of one site in Berkshire County, Massachusetts (Blau 1988, Dunn 1989). Each rosette of the plants with multiple rosettes was smaller than rosettes of single-rosetted plants. Seventeen percent and 12 percent of the plants in the Massachusetts study had multiple rosettes in 1988 and 1989, respectively. No plants were flowering. The production of multiple rosettes from one rhizome may not be limited to populations at the northern edge of the range. Moser (1917) reports two rhizome forms in material collected from the Baltimore, Maryland, area: upright rhizomes with numerous leaf bases at the crown, suggesting a single rosette, and oblique rhizomes that show "one or more stem scars," implying the formation of more than one rosette from these rhizomes. In addition, an illustration of the roots, rhizome, and leaves of *Chamaelirium luteum* in Cech (2002), a book describing the cultivation of at-risk medicinal herbs, shows a branched rhizome supporting two crowns. Finally, although Meagher did not find multiple rosettes on plants in his North Carolina sites, some of the plants that he grew in the greenhouse from seeds collected in North Carolina produced multiple rosettes (Allard 2003). This evidence suggests that multiple

rosette production may be the norm, rather than the exception.

Another difference between North Carolina and New York populations is that although populations in both areas contain a small percentage of individuals that are polygamo-monoecious, only those in the New York populations produce seeds from flowers with both male and female parts (Allard 2003). It should not be assumed that this difference is unique to edge-of-range populations, that it is the consequence of genetic isolation, or that it developed due to greater environmental stresses at the edge of *C. luteum*'s range. The viability of the seeds of New York polygamo-monoecious plants is not known, and studies of populations that are geographically intermediate between New York and North Carolina have not been conducted.

POPULATION BIOLOGY AND VIABILITY

Chamaelirium luteum regularly flowers and fruits throughout its range and it has no known reproductive problems, as discussed in the previous section. Each female plant generally has a single fruiting stem. This herb grows in widely scattered and often isolated 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.

It is generally understood by botanists that fertility is normally 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. *Chamaelirium* generally avoids the possibility of inbreeding because the individual plants are unisexual, obviously preventing self-pollination. Individuals in such a population can, however, be very closely related, and can even be progeny from a single introduction event, and so they can posses little genetic variability. 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 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-11).

An example of negative effects thought to have arisen through isolation of populations can be seen in the case of another monocot, 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 appeared to be indicated in that grass. That plant survives as a rare relict in the vegetative state only. There is no data at this time on the fertility of the seeds produced in the Illinois and Indiana populations of *Chamaelirium*. While it is a vulnerable species in the

Midwest, the Fairy-wand does appear to be secure in other areas with suitable habitat remaining. Whether it persists or not in the future in areas where it is currently scarce appears to depend on the survival and maintenance of its habitat.

POTENTIAL THREATS

Globally, the Fairy-wand is considered to be secure (see Protection Status above). In some portions of the United States, however, it is critically imperiled and endangered, as in Connecticut, Delaware, Illinois, Indiana, and Massachusetts. It is also imperiled to vulnerable in several additional states. It is most at risk at the margins of its range. Known threats to *Chamaelirium luteum* include habitat loss, habitat degradation from shading and natural succession, competition from invasive species, all-terrain vehicle damage, and deer herbivory. Another potential threat is the collection of plants from the wild for medicinal or ornamental use (Allard 2003).

Throughout its range populations appear to have been eliminated by human activities. In New England, it is assumed that development has eliminated many populations through habitat loss or modification (Allard 2003). Most of the habitats of *Chamaelirium* are suitable for housing or other forms of development throughout its range. Allard (2003) indicates that *Chamaelirium luteum* occurred historically in 24 towns in Connecticut and Massachusetts. Currently, the species is known in only eight towns in the two states, and many of the historic sites have been modified or lost to development as the human population has increased. In Illinois, where the species is known to be associates with seep springs at one site, hydrological disturbances leading to the drying out of these seeps may be a threat to the species (Shawnee National Forest 2005).

Because *Chamaelirium luteum* requires fairly open surroundings in order to flower, the increase in vegetation density that often follows human disturbance such as the intensive logging of mature forests may also threaten populations. Such a situation probably is a case in Sheffield, Massachusetts, presented by Allard (2003) where *C. luteum* barely persists under a dense forest of young oaks and pine. *Chamaelirium luteum* often occurs along trails in forests, and trampling and erosion along the trails by humans and horses is a potential threat. This must be weighed against the potential benefits to the plant provided by a more open canopy, trail maintenance, and the possible dispersal of seeds by humans or other large animals moving along the trails and brushing up against fruiting stalks. Natural forest maturation, or the natural closure of the forest canopy, also threatens the Fairy-wand. It has been shown that the species will not reproduce well under low light conditions as seen in a mature forest with a closed canopy. Openings, such as those caused by tree fall or fire, as well as those naturally occurring near streams and outcrops, tend to produce more flowering and seed production in this species (Allard 2003, Shawnee National Forest 2005).

Competition from invasive species is possible at sites where *Chamaelirium luteum* occurs (Allard 2003). The species has been shown to be potentially threatened by *Rosa multiflora* and by *Lonicera* spp. in particular. Other aggressive exotics in the southern portions of its range, such as

kudzu (*Pueraria lobata*) and wisteria (*Wisteria sinensis*) can also engulf and eliminate the Fairy-wand. In Illinois, it is thought that the Japanese honeysuckle (*Lonicera japonica*) and the exotic grass Eulalia (*Microstegium vimineum*) can become serious threats to this herb (Shawnee National Forest 2005).

Another type of habitat degradation that is known to have occurred and has the potential to occur at other sites with trails is the destruction of plants and habitat by all-terrain vehicles (ATVs). ATVs can cause serious soil erosion, especially in wet weather (Allard 2003). Certainly road construction and mining or quarrying activities can also eliminate entire populations of the species.

The destructive effects of deer herbivory is evidenced by a literature report from New York, notes in the Heritage files for Connecticut, and by other field observations by Allard (2003). As is often the case for other species of lilies and orchids, only the flowering stalk is eaten (Allard 2003, Blau and Venezia 1983). Some insect herbivory on leaves has also been noted. The extent of deer herbivory varies from population to population. Only a small percentage of the flowering stalks were eaten by deer in specific study situations (Allard 2003). In a Connecticut population only one stalk out of 20 was eaten in 2002. This implies that either *C. luteum* is not particularly favored by deer, or that the deer population in the area was not dense enough to pose a serious threat. Nonetheless, when only a small proportion of the plants in a population will flower in any growing season, even the removal of a few inflorescences is a matter for concern. In another endangered Connecticut population the inflorescences of three out of seven blooming plants was eaten by deer in 2002. The deer population in this area may be been denser or deer may frequent the area more regularly. Deer often use existing footpaths for travel through forested terrain, and, conversely, many footpaths have begun as deer trails, so that the chances for deer to encounter *Chamaelirium luteum* plants that grow near trails may be greater even if the deer population is not locally large. This may suggest that the creation of trails in the vicinity of a Fairy-wand population may increase damage to these plants by deer.

Because only the root and rhizome of *Chamaelirium luteum* is used for medicinal purposes, collection from the wild destroys the plant. The U.S.D.A. Forest Service treats *C. luteum* as a non-timber forest product and issues permits for its collection on some national forests, particularly in the southern Appalachians (Chamberlain *et al.* 2002). Collection of *C. luteum* from the wild for medicinal or ornamental uses is a potential threat to populations in New England and the Midwest.

As stated in the previous section on Population Biology and Viability, it is generally believed among biologists that habitat fragmentation can also have profound effects on the success and persistence of small local populations through a process known as inbreeding depression. 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 this plant, random genetic drift may have already occurred and this may have caused negative effects to the species. This genetic drift may cause the individuals to be less adaptive to competition and environmental change.

At the current time, *Chamaelirium luteum* appears to be secure within the Shawnee National Forest, but the populations are small and not all are protected. Acquisition or increased protection of additional sites would most likely assist in its conservation.

RESEARCH AND MONITORING

The Fairy-wand has been the subject of considerable study in New England and North Carolina (Allard 2003). There has been little data obtained from studies of the plant in Illinois and Indiana, and some additional research and experimentation will be required to understand the species as it occurs in this region. *Chamaelirium luteum* has only recently been listed as an endangered plant in Illinois (IESPB 2004, 2005) and there is much to learn about it in this region. At this time, one of the primary basic research needs is to determine its current and historical range through the location and examination of the widely scattered herbarium specimens of the plant from the Midwest region. Fieldwork is an integral part of this and can be concurrent. Because *Chamaelirium luteum* does not flower in shaded situations and because rosettes are more difficult to notice in the wild, additional populations may actually be present in Illinois and Indiana. Some training may be required to allow the recognition of this plant in its vegetative state. Unless one has become quite familiar with populations of this plant, the young or sterile plants can be easily mistaken for other similar rosette or seedling species (Hill, pers. obs.). Until more local persons are trained to identify this plant (that only infrequently may flower in our region) its true extent here may not be fully understood.

A significant amount of information is known concerning the life history of the plant (Allard 2003), but few specific details are known for the local populations in Illinois and Indiana, especially concerning fertility, dispersal mechanisms, early establishment requirements, growth rates, and genetic health (including variability). Studies already conducted on populations in New England, New York, and North Carolina can suggest both methodology and the primary areas of interest.

Annual monitoring of existing populations of the Fairy-wand will 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, and threats from exotic species. 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, 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 newly opened 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 an open habitat is needed to support a viable population. In particular, research on the use of fire management, already shown to have promising results, would be useful towards the understanding and preservation of the Fairy-wand in our area.

Monitoring of the forests where it still occurs or where it has been introduced may assist in determining what the local environmental parameters should be for optimal health for this herb. Where it still occurs, periodic surveys are needed to determine the basic health and productivity of the population by periodically counting the numbers of individuals. This is the only means to determine population trends accurately (W-2). Reproductive success can be estimated by counting the number of fruiting stems or fruiting tufts produced each season because seedlings and young plants cannot easily be identified in the field. Ratios have been calculated, based upon the number of fruiting plants, that can be used to estimate the probable numbers of male plants and juveniles that are also in the overall local population (Allard 2003). 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 a growing season at each site for basic phenology data. Such basic facts as fungal associations (if any), longevity, and yearly variations in colony size over a long period are not precisely known for populations in Illinois and Indiana, though these statistics are better known for the species in the Northeast and Southeast.

Once new populations are found, voucher specimens should be made according to techniques described in Hill (1995) or other similar references. Similar habitat should be explored for the plant at its flowering and fruiting seasons. There are rather large 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 (see Habitat section above) and these should also occur with the species in Illinois. These indicator plants can be very useful in facilitating the discovery of additional populations of this herb. Particular attention should be made to search for and / or monitor this herb at its peak period for flowering in one's local area, normally in mid May (especially – see cover illustration) to early June when the male flowers are most visible; the female flowers and fruiting stalks are relatively well camouflaged in comparison and are harder to find. It is quite possible that populations of this species either have been overlooked because of difficulties in field identification of sterile plants or because of the lack of adequate voucher material.

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

The primary conservation objective for *C. luteum* in New England is the maintenance of healthy, viable populations of the species at its remaining 11 extant sites (Allard 2003). Certainly the same is true for the few known populations in the Midwest as well (approximately 5 extant sites only are known in Illinois). In order to achieve this, land acquisition of several sites may be necessary, followed by active management to reduce canopy cover and competition from invasive species. Augmentation of the smaller populations may be necessary. Because this species is not only rare but also appears to have significant medicinal value, its survival in this portion of the country is of considerable interest.

There are no known restoration efforts being conducted specifically on *Chamaelirium luteum* in Illinois or Indiana, but the restoration potential of this and similar species may be good. Fruit production in this species appears to be dependable when conditions in its habitat are suitable. However, the species, while widely distributed, is not common in the midwestern states. There appears to be a significant amount of habitat available where restoration efforts can occur in southern Illinois, and its habitat can be created in some areas through selective thinning of trees and by fire management. It may be necessary to purchase private land already dedicated to other uses that has had historic populations of the species on it and to restore the habitat on this land for this plant.

In order to restore this species to areas where it may have historically occurred, it is generally thought that the habitat itself must be restored (W-2); this is the generally recommended method to manage populations of this and other rare plants, *i.e.*, to protect and manage their habitat. Protection of the hydrology, topography, and exposure within and near the sites is crucial, and natural fire regimes are to be allowed. Added fire management is thought to be beneficial for this plant. The work of Baskin *et al.* (2001) and others can serve as a guide to the conditions required (Allard 2003). It is important to obtain and include a buffer area in order to protect the Fairy-wand populations from potential threats. The specific effects of herbicides on this broad-leaved herb are thought to be generally harmful, so herbicides are not yet recommended in the management program without additional study. The control of exotic species threatening a given population,

then, should also seek alternative solutions.

As also described in the previous section of this report, it is generally recommended that the habitat quality where this and other rare plants grow should be monitored on a regular basis and an assessment of the specific threats to all populations should be made (W-2). Successful management or restoration of the Fairy-wand depends on periodic surveys of both the environment in which it grows as well as the monitoring of population sizes and individual plants. Nearby land use should be noted – as in the case of the conversion of areas to tree plantations and other crops and the chemical and hydrologic effects on adjacent vegetation, as well as the appearance of new trails or road construction. While many herbicides are thought to be detrimental, so are fertilizers, which, in this habitat, can cause an increase of native and exotic invasives that can crowd out the *Chamaelirium* and other scarce natives adapted to these often nutrient-poor soils.

Actual restorations of any 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 (a plant community *reconstruction* rather than a restoration). Local plants should be propagated for planting in such an effort. Most perennial herbs are normally easily propagated by means of seeds, though the occurrence of some plants with branched rhizomes, such as the Fairy-wand, may allow some vegetative propagation. According to at least one Internet site, *Chamaelirium* can be propagated by dividing the rhizomes in early spring or in the fall (W-5). Plants can be started from seed, but the rhizome divisions may allow for a faster fully established plant. *Chamaelirium* likes to grow in rich open woods or under the shade of hardwood and conifers. It prefers a moist, acidic soil that drains well. Richo Cech, author of *Growing At-Risk Medicinal Herbs* (2002), recommends a soil pH ranging from 4.5 to 6, with a high humic content. If planting in a natural woods setting, Cech suggests locating the planting beds in a conifer or mixed hardwood-derived loam, a sandy loam (like in the North Carolina piedmont region), or bottom land, where leaf mulch does not accumulate. Look for a site where other woodland plants grow such as Solomon's seal (*Polygonatum*), lady's slipper orchid (*Cypripedium*), *Hepatica*, wild ginger (*Asarum canadense*), or perhaps an existing native stand of *Chamaelirium* (W-5).

The surface of the rhizome is covered with small eyes that have the ability to produce growth buds and roots, according to Cech (2002). Cech recommends cutting rhizomes into sections as narrow as one-quarter inch, leaving the disk-shaped pieces to callus overnight. Plant these in pots, keeping the soil moist and the pots shaded until the new plants emerge. In a well-prepared three-foot wide bed with high organic matter, transplant the young plants six to ten inches apart by staggering the plantings. Top dress beds with a light covering of mulch. Cech recommends pine needles, bark mulch, or rotted conifer-derived sawdust. Add mulch as needed throughout the growing season. Plants should be mature in four to six years after planting.

Germinating *Chamaelirium* seed is not very difficult, according to Cech (2002), but the seed does need to go through a period of cold then warm stratification, according to Baskin *et al.* (2001). Baskin *et al.* also found that germination of Fairy-wand seed was much higher when seeds were exposed to light (as described above in the section on Life History). Cech recommends seeding flats with a high organic soil mix comprising of two parts peat moss, one part decomposed pine needles, one part perlite, and one-half part sand. In late fall or early winter, gently sow the newly harvested dried seed approximately one-eighth of an inch deep in flats or in prepared outdoor, shaded seedbeds. When the seedlings emerge in spring or early summer, Cech suggests leaving the young seedlings undisturbed for at least one growing season before transplanting out into permanent locations.

It is not known what the minimum population size should be for the viability of this species in the wild, or for many other rare species. In the case of the Fairy-wand it should be kept in mind that one would need both male and female plants in any population. Several sources have useful information that may be of assistance in this area (Allard 2003, Given 1994, Menges 1991, Shaffer 1987).

The Fairy-wand is available commercially from several nurseries, normally as plants, because of its ornamental and medicinal qualities. A check of the Internet also reveals numerous sources of the dried roots for medicinal use. Because of the desirability of this plant for ornamental gardens and because of its medicinal use, the plant has become increasingly uncommon in much of its range.

SUMMARY

Chamaelirium luteum is a perennial herb with somewhat fleshy roots, crowded basal spatulate leaves, and white flowers in elongate spike-like, male or female inflorescences, and it is normally (15-) 30-60 (-150) cm tall. The genus contains only the single species, and, when in flower, it is quite distinctive, yet it can be overlooked when sterile. The species has both ornamental and medicinal uses, it is widespread in the eastern United States and in a very small area of adjacent Canada, and it is known historically from twenty-four states including the District of Columbia and one province, from Michigan and Ontario, east to Massachusetts, and south to Florida and Louisiana. It is an upland forest species only rarely associated with wetlands and it grows in a wide range of soils that are often acidic. Globally, its ranking is G5 (secure world-wide), its National status in the United States is N5 (secure nationally), and it has been ranked as 'historic only' in Canada (NH). The Fairy-wand (or "Fairy Wand", "Devil's-bit", or "Blazing-star", in addition to other common names) is listed as endangered and imperiled in Connecticut (S1), Illinois (S1), Indiana (S1), and Massachusetts (S1), and as threatened in New York (S1S2). It has been listed as Critically Imperiled in Delaware (S1) and it is listed as a species of Special Concern in Arkansas (S3). In Forest Service Region 9, the Fairy-wand 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 margins of its range.

Suggested research priorities for this locally rare herb include attempts to locate additional populations, and to determine, through controlled and cautious experimentation, the best management techniques to insure its survival and increase (such as controlled use of fire and the selective thinning of canopy trees to open the habitat), to determine the genetic diversity of populations, and to determine a means to increase the numbers of individuals within the local populations. Management through enforced protection of its habitat, either through enforcement of existing regulations or through the creation of new rules for restricted access to the sites (particularly recreational and equestrian access), appears to be necessary to allow it to persist where it may occur. Because of its use as a medicinal herb, special care is needed to prevent poaching or illegal harvesting in southern Illinois and Indiana where it is already endangered.

The suggested management for extant colonies of *Chamaelirium luteum* is generally to preserve and manage its habitat by means of the protection of current hydrology (including erosion control), through protection from land development, by protection from indiscriminate or nearby herbicide or fertilizer application, by protection from soil disturbance and physical damage to the plants and habitat by vehicles, animals, and people (including harvesting), and by protection of the habitat from the establishment of invasive species. Fire management is likely to be beneficial. At this time, with proper management, the current populations in southern Illinois and Indiana should persist for a time, but considering the increasing importance of medicinal herbs and increasing recreational and economic land usage where it occurs, its long-term chances of survival in these states may not be good. The establishment of additional populations will be, most likely, only through active human efforts.

REFERENCES

Allard, D.J. 2003. *Chamaelirium luteum* (L.) A.Gray, Devil's Bit, Conservation and Research Plan for New England. Prepared for the New England Wild Flower Society, Framingham, MA. 34 pp.

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.

Baskin, C. C., J. M. Baskin, and E. W. Chester. 2001. Morphophysiological dormancy in seeds of *Chamaelirium luteum*, a long-lived dioecious lily. Journal of the Torrey Botanical Society 128: 7-15.

Blau, T. 1988. Report: population monitoring, 1988 season, Devil's Bit *(Chamaelirium luteum*), Berkshire County, Massachusetts. Unpublished report submitted to the Massachusetts Natural Heritage and Endangered Species Program, MA Division of Fisheries and Wildlife, Rte. 135, Westborough, MA [cited by Allard 2003].

Blau, T. and K. Venezia. 1983. The 1983 population study of *Chamaelirium luteum* in the Pawling Nature Reserve, Dutchess County, New York. Unpublished Report submitted to The Lower Hudson Chapter of The Nature Conservancy. Report obtained from the Massachusetts Natural Heritage and Endangered Species Program, MA Division of Fisheries and Wildlife, Rte. 135, Westborough, MA [cited by Allard 2003].

Carrolan, T. L. 1982. Report on the Conservation Status of *Chamaelirium luteum* in the Northeast: a Candidate Endangered Species in New York, Pennsylvania, New Jersey, Connecticut and Massachusetts. Unpublished Report to The Nature Conservancy, RD 2, Chestnut Ridge Road, Mt. Kisco, NY [cited by Allard 2003].

Cech, R. 2002. Growing At-Risk Medicinal Herbs. Horizon Herbs, Williams, OR.

Chamberlain, J. L., R. J. Bush, A. L. Hammett, and P. A. Araman. 2002. Managing for nontimber products. Journal of Forestry 100: 8-14.

Chester, E.W., B.E. Wofford, R. Kral, H.R. DeSelm, and A.M. Evans. 1993. Atlas of Tennessee Vascular Plants. Vol. 1. Pteridophytes, Gymnosperms, Angiosperms: Monocots. Misc. Publ. no. 9, The Center for Field Biology, Austin Peay State University, Clarksville, TN.

Clewell, A. F. 1985. Guide to the Vascular Plants of the Florida Panhandle. University Presses of Florida, Tallahassee. 605 pp.

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

Dunn, T. B. 1989. Report: population monitoring, 1989 season (second year of study), Devil's Bit *(Chamaelirium luteu*m), Berkshire County, Massachusetts. Unpublished report submitted to the Massachusetts Natural Heritage and Endangered Species Program, MA Division of Fisheries and Wildlife, Rte. 135, Westborough, MA [cited by Allard 2003].

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

Given, D.R. 1994. Principles and Practice of Plant Conservation. Timber Press, Portland Oregon.

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. and J. W. Wooten. 1981. Aquatic and Wetland Plants of Southeastern United States, Monocotyledons. The University of Georgia Press, Athens, Georgia.

Harper, J. L. 1977. Population Biology of Plants. Academic Press, New York, NY.

Harvill, A.M., C.E. Stevens, and D.M.E. Ware. 1977. Atlas of the Virginia Flora, Part 1. Pteridophytes through Monocotyledons. Virginia Botanical Associates, Farmville.

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.

Illinois Endangered Species Protection Board [IESPB]. 2004. Additions, deletions, and changes to the Illinois list of threatened and endangered plant species as approved by the Board at its 121st meeting, February 20, 2004, Springfield, Illinois. 8 pp.

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.

Lewis, W.H. and M. P. F. Elvin-Lewis. 1977. Medical Botany – Plants affecting man's health. John Wiley & Sons, New York. 515 pp.

MacRoberts, D.T. 1989. A Documented Checklist and Atlas of the Vascular Flora of Louisiana: Pteridophyta, Gymnospermae, and Monocotyledoneae. Bulletin of the Museum of Life Sciences No. 7. Louisiana State University at Shreveport.

Magee, D.W. and H.E. Ahles. 1999. Flora of the Northeast. University of Massachusetts Press: Amherst.

McAvoy, W.E. 2001. Rare Vascular Plants of Delaware. Delaware Natural Heritage Program, Division of Fish and Wildlife. Smyrna, DE. 35 pp.

Meagher, T. R. 1978. The Evolutionary Consequences of Dioecy in *Chamaelirium lutea*m, a Perennial Plant Species. Ph.D. dissertation, Duke University, Durham, NC.

Meagher, T. R. 1980. Population biology of *Chamaelirium luteum*, a dioecious lily. I. Spatial distributions of males and females. Evolution 34: 1127-1137.

Meagher, T. R. 1981. Population biology of *Chamaelirium luteum*, a dioecious lily. II. Mechanisms governing sex ratios. Evolution 35: 557-567.

Meagher, T. R. 1982. The population biology of *Chamaelirium lutea*m, a dioecious member of the Lily family: two-sex population projections and stable population structure. Ecology 63: 1701-1711.

Meagher, T. R. 1986. Analysis of paternity within a natural population of *Chamaelirium luteum.* I. Identification of most-likely male parents. The American Naturalist 128:199-215.

Meagher, T. R. and J. Antonovics. 1982. The population biology of *Chamaelirium lutea*m, a dioecious member of the lily family: life history studies. Ecology 63: 1690-1700.

Meagher, T. R. and D. S. Burdick. 1980. The use of nearest neighbor frequency analyses in studies of association. Ecology 61: 1253-1255.

Meagher, T. R. and E. Thompson. 1987. Analysis of parentage for naturally established seedlings of *Chamaelirium luteum* (Liliaceae). Ecology 68: 803-812.

Menges, E.S. 1991. The application of minimum viable population theory to plants. Pp. 45-62 *In* D.E. Falk and K.E. Holsinger (Eds.), Genetics and Conservation of Rare Plants. Center for Plant Conservation. Oxford University Press, New York, New York.

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.

Moser, J. 1917. The pharmacognosy of helonias. American Journal of Pharmacy 89: 291-296.

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. 1183 pp.

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).

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.

Shaffer, M. 1987. Minimum viable populations: coping with uncertainty. Pp. 69-86 *in* M.E. Soulé (ed.), Viable Populations for Conservation. Cambridge University Press, Cambridge, UK.

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

Silliman, F. E. 1957. *Chamaelirium luteum* (L.) Gray: a Biological Study. Ph.D. dissertation, The University of North Carolina, Chapel Hill, NC.

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.

Smouse, P. E., T. R. Meagher, and C. J. Kobak. 1999. Parentage analysis in *Chamaelirium luteum* (L.) Gray (Liliaceae): why do some males have higher reproductive contributions? Journal of Evolutionary Biology 12: 1069-1077.

Strausbaugh, P. D. and E. L. Core. 1978. Flora of West Virginia. Second Edition. Seneca Books, Inc., Grantsville, West Virginia.

Thomas, R.D. and C.M. Allen. 1993. Atlas of the Vascular Flora of Louisiana. Vol. I: Ferns & Fern Allies, Conifers, & Monocotyledons. Louisiana Department of Wildlife and Fisheries: Baton Rouge. 218 pp.

Utech, F. H. 2002. *Chamaelirium* Willdenow, Ges. Naturf. Freunde Berlin Mag. Neuesten Entdeck. Gesammten Naturk. 2: 18. 1808. Pp. 68-69. *In* Flora of North America Editorial Committee. 2002. Flora of North America North of Mexico. Volume 26 Magnoliophyta: Liliidae: Liliales and Orchidales. New York: Oxford University Press. 723 pp.

Utter, J. M. and A. W. Hurst. 1990. The significance and management of relict populations of *Chamaelirium luteum* (L.) Gray. Pages 180-184 in Ecosystem Management: Rare Species and Significant Habitats. New York State Museum Bulletin 471, New York State Museum, Albany.

Voss, E.G. 1972. Michigan Flora. Part I. Gymnosperms and Monocots. Cranbrook Institute of Science and the University of Michigan Herbarium. Bulletin 55. 488 pp.

White, D.J., R.V. Maher, and G.W. Argus. 1982. Atlas of the Rare Vascular Plants of Ontario. Ottawa.

White, J. and M.H. Madany. 1978. Classification of natural communities in Illinois. Pp. 310-405 (Appendix 30) *In*: White, J. 1978. Illinois Natural Areas Technical Report, Volume 1. Survey Methods and Results. Urbana. Illinois Natural Areas Inventory.

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

Wunderlin, R. P. 1982. Guide to the Vascular Plants of Central Florida. University Presses of Florida, Gainesville, Florida.

Zomlefer, W. B. 1997. The genera of Melanthiaceae in the southeastern United States. Harvard Papers in Botany 2: 133-177.

WEBSITES CONSULTED

W-1. U.S.D.A., NRCS. 2006. 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. NatureServe Explorer (The Nature Conservancy): An online encyclopedia of life. 2006. Version 1.6. Arlington, Virginia, USA. http://www.natureserve.org/

W-3. Sacred Earth Newsletter – Ethnobotany and Ecotravel. Vol. 1. No. 6. September 2002. http://sacredearth.com/Ezine/September2002/Sept2002.php

W-4. Holisticonline.com; for Alternative and Integrative Medicine. http://www.holisticonline.com/Herbal-Med/_Herbs/h236.htm

W-5. 10 Medicinal Herbs with Economic Promise. The North Carolina Arboretum, Asheville, NC. 3 November 2006. http://www.ncarboretum.org/Superb_Herbs/chamaelirium.html

W-6. National Wetlands Inventory. U.S. Fish and Wildlife Service, Washington, DC. http://www.fws.gov/nwi/

W-7. Massachusetts List of Endangered, Threatened and Special Concern Species. Division of Fisheries and Wildlife. http://mass.gov/dfwele/dfw/nhesp/nhrara.htm

W-8. National Vegetation Classification – Southeastern United States. April 1999. http://biology.usgs.gov/npsveg/grsm/elcode.pdf

W-9. 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-10. 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-11. Botany On-line - Reproductive Isolation. University of Hamburg, Germany. http://www.biologie.uni-hamburg.de/b-online/e38/38d.htm

W-12. Atlas of Florida Plants. University of South Florida. Accessed 21 September 2006. http://www.plantatlas.usf.edu/

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 *Chamaelirium luteum* examined or cited in the literature

Herbaria:

CLEMS = Clemson University, Clemson, South Carolina. GH = Gray Herbarium of Harvard University, Cambridge, Massachusetts. ILLS = Illinois Natural History Survey, Champaign. MO = Missouri Botanical Garden, St. Louis. NCU = University of North Carolina, Chapel Hill. NY = New York Botanical Garden, Bronx. UNAF = University of North Alabama, Florence. VT = University of Vermont, Burlington. WIS = University of Wisconsin, Madison.

ALABAMA: BIBB CO.: Six Mile Creek at end of McKinney Rd, NW of Six Mile, 21 May 1973, *Kral 50267* (MO); **CHILTON CO.**: ravine above Mulberry River ca. 1 mi SE of US 82 crossing SE of Maplesville, 20 May 1973, *Kral 50232* (MO); **CHOCTAW CO.**: 1.9 miles south of Butler on state highway 17, 10 Apr 1966, *Iltis 25178* (WIS); **DEKALB CO.**: ca. 5 mi E of Mentone by AL 117, 26 May 1974, *Kral 52913* (MO); **JACKSON CO**.: Sand Mountain, May 1917, *Graves 1057* (MO); **LAWRENCE CO**.: jct. of Forest Service Road 244 and AL Rt. 33 in the Bankhead National Forest, 28 Apr 1990, *Jones & Jones 4860* (WIS); **LEE CO.**: Auburn, 24 Apr 1897, *Earle & Baker s.n.* (MO); **MARION CO.:** along edge

of Little New River off S side of county road 40, ca. 4.0 miles east of Brilliant, 14 Oct 1989, *Markham s.n.* (UNAF).

ARKANSAS: PULASKI CO.: base of Maumelle Mountain near Pinnacle, 1 Jun 1923, *Palmer 23005* (MO); near Little Rock, May 1837, *s. col.* (MO); **SALINE CO.**: just west of railroad tracks SW of Traskwood and AR 259 at Garland Co. line and 0.8 mi N of Grant Co., 27 May 1992, *Thomas et al. 129048* (MO).

CONNECTICUT: **MIDDLESEX CO.:** Southington, 3 Jun 1897, *Bissell 205 [2630]* (MO).

DELAWARE: NEW CASTLE CO.: Centreville, Jun 1866, *Commons s.n.* (MO).

DISTRICT OF COLUMBIA: in viciniis Washington, D.C., 12 Jun 1878, *Chickering, Jr. s.n.* (MO); Dalecarlia Reservoir, D.C., 23 May 1905, *Painter 1310* (MO); Washington, D.C., 26 May 1896, *Steele s.n.* (MO); Rock Creek, Washington, D.C., 29 May 1889, *Churchill s.n.* (MO).

FLORIDA: DUVAL CO.: near Jacksonville, 28 Apr 1894, *Curtiss 4781* (MO); South Jacksonville, 12 Apr 1897, *Lighthipe 447* (MO); San Pablo, 14 Apr 1897, *Churchill s.n.* (MO); **LAKE CO.:** in vicinity of Eustis, 16-31 Jul 1894, *Nash 1379* (MO).

GEORGIA: CHARLTON CO.: Folkston, 11 May 1930, *Blanton 6363* (MO); **CLAY CO.**: 0.5 mi S of Fort Gaines, 6 May 1947, *Thorne 3721* (MO); **DEKALB CO.**: near Stone Mountain, 22 May 1897, *Eggert s.n.* (MO); **STEPHENS CO.**: 1.3 mi SW of confluence of Panther Creek and Tugaloo River along Panther Creek, 12 May 1976, *Solomon 1782* (MO).

ILLINOIS: HARDIN CO.: Little Rock Creek, 4 mi W of Lamb, 9 May 1957, *Evers 53134* (ILLS); **MASSAC CO.**, Near # 1, 7 miles NW of Metropolis, 18 May 1932, *Pepoon & Evers 3768* (ILLS).

KENTUCKY: CALLOWAY CO.: jct. Hwy 121 and Hwy 280, N on 280 to Crappie Hollow Shores, 0.6 mi on dirt road to Blood River, 27 Apr 1974, *Funk 467* (MO); **WARREN CO.**: sandstone top of 'Knob" 1 mi S of Boiling Springs, 1 Jul 1969, *Conrad 246* (MO); **WOLFE CO.:** Sky Bridge Area, Daniel Boone National Forest, 28 May 1975, *Evers & Evers 114378* (ILLS).

LOUISIANA: WASHINGTON PARISH: beside LA 436, 4 mi E of Pine, 9 May 1970, *Thomas et al. 18558* (MO).

MARYLAND: BALTIMORE CO.: along tributary of Big Gunpowder River west of Big Falls Road near Monkton, 11 May 1981, *Hill 10004A* (VT).

MASSACHUSETTS: BERKSHIRE CO.: near Mt. Pleasant, 31 May 1891, *Blanchard s.n* (MO);

MISSISSIPPI: GRENADA CO.: near Grenada, 17 May 1932, *Millsaps 3809* (WIS); **JACKSON CO.:** Ocean Springs, May 1892, *Skehan 18b* (WIS); **LAMAR CO.:** Lake Serene, 14 May 1969, *Rogers 1201-C* (MO); **PEARL RIVER CO.**: 4 miles south of the X Roads, Rich woods, 3 May 1964, *Sargent 8169* (WIS).

NEW JERSEY: **HUNTERDON CO.:** Califon, 14 Jun 1898, *Fisher 14649* (WIS); **MORRIS CO.:**

Succasunna, 13 Jun 1909, *Mackenzie 4121* (MO); **SUSSEX CO.**: Cranberry Lake, 24 Jun 1906, *Mackenzie 2124*, (MO); Franklin, Jun 1879, *Rusby 8311* (MO).

NEW YORK: WESTCHESTER CO.: Yorktown, *s.d., Greene s.n.* (WIS); **TOMPKINS CO.**: Ithaca, 15 Jun 1879, *Henry s.n.* (WIS).

NORTH CAROLINA: CALDWELL CO.: Globe Road south of Blowing Rock, 17 May 1969, *Hager s.n.* (WIS); **CHATHAM CO.**: along US 64, 0.4 miles east of jct. of Co. Rt. 1506, ca. 8 miles west of Pittsboro, 25 May 1970, *Leonard 3198* (NCU, WIS); **COLUMBUS CO.**: Nokina, 31 May 1931, *Schallert 231* (WIS); **DURHAM CO.**: Roxboro Rd., Little River, 200 yds. W of bridge, 25 Jun 1940, *Hood 36* (MO); **GUILFORD CO.:** woods near Greensboro, 25 May 1925, *Schallert s.n.* (WIS); **MACON CO.:** slopes in the mountains, 27 May 1897, *Biltmore [Umbach] Herbarium315b* [*6561*] (MO; WIS); dry hillsides, Horse Cove, 14 May 1896, *Biltmore Herbarium 315* (MO); **ONSLOW CO.**: Jacksonville, 16 May 1930, *Moldenke 1245* (MO); 1 mi N of Gum Branch on Quaker Bridge Rd., 11 May 1948, *Boyce & Moreland 64* (MO); **ORANGE CO.:** vicinity of Chapel Hill, May 1899, *Ashe 13471* (WIS); **SWAIN CO.**: Twentymile Loop Trail, Great Smoky Mtns. Natl. Park, 3 May 2002, *Philipe et al. 34064* (ILLS); **WILKES CO.:** near Mart Branch, on all's Mill road, Brushy Mtns., Jun 1939, *Stewart 3807* (WIS).

OHIO: ERIE CO.: Sandusky, 2 Jun 1894, *Moseley 2890* (WIS); **HOLMES CO.:** Hardy Township, 20 Aug 1914, *Drushel s.n.* (MO); **STARK CO.:** Canton, Jun 1835, *Diehl 108* (MO).

PENNSYLVANIA: CHESTER CO.: Westtown, 10 Jun 1886, *Leeds s.n.* (MO); West Chester, *s.d., Darlington s.n.* (WIS); **DELAWARE CO.:** 1 mile NE of Lima 9 Jun 1933, *Hermann 4316* (MO); **LANCASTER CO.**: Jun 1884, Glen *s.n.* (MO).

SOUTH CAROLINA: **GREENVILLE CO.**: slopes of Caesar's Head, 3 Sep 1876, *Engelmann s.n.* (MO); **LANCASTER CO.**: 40 Acre Rock, ca. 2 mi SE of Taxahaw, 17 May 1976, *Boufford et al. 18364* (MO); **MCCORMICK CO.**: 6 mi SW of McCormick, 18 Sep 1949, *Duncan 10393* (MO); **OCONEE CO.:** N side of ridge N of Co. Rd. 143, 0.8 mi W of Rt. 11, near Peach Orchard Branch of Eastatoe Creek, 9 May 1988, *Hill & Horn 19259* (CLEMS, GH, MO, NY, VT); **PICKENS CO.**: Route 11, E side of Lake Keowee, 23 April 1986, *Hill 16628* (CLEMS).

TENNESSEE: BLOUNT CO.: near Sevier County line on Walland–Pigeon Forge Road, 29 May 1965, *Chester 718* (MO, WIS); slopes above Montvale Springs, 25 Apr 1965, Chester *441* (WIS); **CLAIBORNE CO.:** near Powell River, Highway 25E south of Harrogate, 9 May 1965, Chester *620* (WIS); **COCKE CO.:** along the French Broad River between Paint Rock and Del Rio, 30 Aug 1897, *Kearney Jr. 918* (MO); **DICKSON CO.:** by US 70 1.1 mi E of White Bluff, 18 Sep 1974, *Kral 54208* (MO); **FRANKLIN CO.:** woods near Sherwood, 8 Jun 1897, *Eggert s.n.* (MO); **HAMILTON CO.:** Lookout Mountain near Chattanooga, 25 May 1901, *Trelease s.n.* (MO); **HENDERSON CO.:** near Lexington, 20 May 1920, *Palmer 17548* (MO); **KNOX CO.:** Knoxville, 18 May 1898, *Ruth 142* (MO); **LEWIS CO.:** shaley streambank by TN 99, 4 mi. WSW of Hampshire, 9 May 1972, *Kral 46393* (MO); **SEVIER CO.:** abandoned road to Dupont Springs Hotel, 22 May 1965, *Chester 684* (WIS); trail from Baker Place to Bogles Springs on Compton Creek, 8 Jun 1965, *Chester 785* (MO, WIS); **SHELBY CO.:** near Memphis, 12 May 1920, *Palmer 17464* (MO).

VIRGINIA: CRAIG CO.: Craig's, 22 Aug 1903, *Steele 83* (MO); **FAIRFAX CO.**: open woods, 30

May 1921, *Newbold 650* (MO); **GILES CO.:** powerline cut on top of Bald Knob Mountain, 18 Jun 1969, *Musselman 2836* (WIS); **GREENSVILLE CO.**: rich deciduous wooded slope by Three Creek slightly above the 'fall-line' NW of Emporia, 11 May 1940, *Fernald & Long 11804* (MO); **ROCKBRIDGE CO.:** "Back Run" near Glasgow, 3 Jun 1891, *Churchill s.n.* (MO).

WEST VIRGINIA: GREENBRIER CO.: moist rocky woods, rare, near White Sulphur Springs, 29 Aug 1903, *Mackenzie 406* (MO); **PENDLETON CO.:** Lake shore, Lake Terra Alta, 28 Aug 1930, *Berkley 1782* (MO); **POCAHONTAS CO.:** 0.5 mi S of Arborvale, 28 Jun 1942, *Anderson s.n* (MO).

APPENDIX 2.

The Historic Distribution of *Chamaelirium luteum* in the United States.

Information from herbarium specimens and the literature.

(If in more than 10 counties, then only number of counties included.)

STATE	COUNTIES	NOTES
Alabama	24 counties, mostly central	(W-1)
Arkansas	Bradley, Hot Springs, Jefferson, Ouachita, Pulaski, Saline, Union	(W-1, W-2), Smith (1978).
Connecticut	Fairfield, Hartford, Litchfield, Middlesex, New Haven, Tolland	(W-1, W-2) Magee and Ahles (1999).
Delaware	New Castle	(W-1, W-2)
District of Columbia	Present	(W-1, W-2)
Florida	12 counties, northern 1/3 of state	(W-1, W-2, W-12)
Georgia	23 counties, mountains and piedmont	(W-1, W-2)
Illinois	Hardin, Massac, Pope	(W-1, W-2) Mohlenbrock and Ladd 1978; Mohlenbrock 1986; includes Shawnee N.F.

Indiana	Crawford, Floyd, Harrison, Jefferson, Vanderburgh	(W-1, W-2) Homoya, pers. comm.
Kentucky	25 counties, widespread	(W-1, W-2); includes Daniel Boone N.F.
Louisiana	Lincoln, Natchitoches, Ouachita, St. Helena, St. Tammany, Tangipahoa, Washington, West Feliciana	(W-1, W-2) MacRoberts 1989; Thomas and Allen 1993
Maryland	Baltimore (probably more)	Herbarium specimens.
Massachusetts	Berkshire	(W-1, W-2); Magee & Ahles (1999)
Michigan	Wayne	(W-1, W-2); may not be native according to Voss (1972).
Mississippi	18 counties, concentrated in the northeastern ¼ of the state	(W-1, W-2)
New Jersey	11 counties, excluding coastal plain	(W-1, W-2)
New York	About 24 counties, western and southeastern parts of state	(W-1, W-2)
North Carolina	More than 50 counties throughout	(W-1, W-2); Radford *et al.* (1968); Herbarium specimens
Ohio	About 27 counties, mostly eastern ½ of state	(W-1, W-2)
Pennsylvania	More than 35 counties, mostly southern ½ of state	(W-1, W-2)
South Carolina	19 counties, mostly mountains and piedmont	(W-1, W-2); Radford *et al.* (1968); Herbarium specimens
Tennessee	43 counties, nearly throughout the state	(W-1, W-2); Chester *et al.* (1993).
Virginia	About 45 counties, western 2/3 of state	(W-1, W-2) Harvill *et al.* (1977).
West Virginia	17 counties, scattered, excluding extreme southwestern part of state	(W-1, W-2) Strausbaugh and Core (1978).

APPENDIX 3.

Natural Diversity Database Element Ranking System

Modified from: http://www.natureserve.org/explorer/ranking.htm [W-10]

Global Ranking (G)

G1
Critically imperiled world-wide. 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 world-wide. 6 to 20 element occurrences OR 809.4 to 4,047 ha (2,000 to 10,000 ac) known on the planet.

G3
Vulnerable world-wide. 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 world-wide. 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.

GNR
Not ranked globally. The element is not known sufficiently or there is some question as to its ranking at the current time.

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. **NNR** = not 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. **TNR** = not ranked at the taxonomic level in question.

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.

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

SNR, SU, S?
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 that the rank is **S2** than **S2S3**, but less certainty than **S2** alone.