New England Plant Conservation Program

Silene stellata (L.) Aiton f.
Starry Campion

Conservation and Research Plan for New England

Prepared by:
Lauren Brown

For:

New England Wild Flower Society
180 Hemenway Road
Framingham, MA 01701
508/877-7630
e-mail: conserve@newfs.org • website: www.newfs.org

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SUMMARY

Silene stellata (L.) Aiton f. is a summer-flowering, herbaceous perennial in the Caryophyllaceae (Pink Family). The species ranges from Connecticut west to Minnesota and eastern Oklahoma and Texas, and south to Georgia and Louisiana. *Silene stellata* is common in parts of its range, less so in others. It occurs in New England in only two sites, both in Connecticut and both recently discovered, but it used to occur more frequently in the state. *Silene stellata* is found most often in dry woods, almost always in association with oaks, but also grows in prairies, savannas, rich woods, and along railroad tracks, roadsides, and river edges. Of the two Connecticut populations, one is in an oak-hickory woods and the other grows along the edge of a fifth-order river.

Herbarium specimens indicate that *Silene stellata* was formerly more common in Connecticut, growing in habitats and even localities that still exist but do not now support the species. Reasons for its decline are unclear, but hypotheses include: canopy closure from the maturing forest; fire suppression; herbivory; invasive species; and hydrologic alterations.

No research has been done on *Silene stellata per se*. Habitat information is gleaned from botanical field guides and manuals and early 20th century plant community studies. What little is known about the species' biology comes mainly from wildflower nurseries raising the species for savanna restoration projects. The species germinates and grows easily in cultivation, where it does best in full to part sun and well-drained soil. In the wild, *Silene stellata* seems most often to occur in situations of filtered shade or partial sun. Anecdotal reports suggest multiple pollinators and adequate fruit set.

The recommended conservation objective in New England is to focus only on Connecticut, with augmentation of one population, maintenance of another, and establishment of three additional populations through relocation of historic populations, *de novo* searches or reintroduction. Seed banking is essential as is landowner notification and education. Another high-priority conservation objective is to gain a better understanding of its habitat requirements and its tolerance for flooding and to undertake research on its reproductive biology.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Full plans with complete and sensitive information are made available to conservation organizations, government agencies, and individuals with responsibility for rare plant conservation. This excerpt contains general information on the species biology, ecology, and distribution of rare plant species in New England.

The New England Plant Conservation Program (NEPCoP) of the New England Wild Flower Society is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

In 1996, NEPCoP published "*Flora Conservanda*: New England." which listed the plants in need of conservation in the region. NEPCoP regional plant Conservation Plans recommend actions that should lead to the conservation of *Flora Conservanda* species. These recommendations derive from a voluntary collaboration of planning partners, and their implementation is contingent on the commitment of federal, state, local, and private conservation organizations.

NEPCoP Conservation Plans do not necessarily represent the official position or approval of all state task forces or NEPCoP member organizations; they do, however, represent a consensus of NEPCoP's Regional Advisory Council. NEPCoP Conservation Plans are subject to modification as dictated by new findings, changes in species status, and the accomplishment of conservation actions.

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection.

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I. BACKGROUND

INTRODUCTION

Silene stellata L. Aiton f., a member of the Caryophyllaceae (Pink family), is an herbaceous perennial found primarily in oak woods and savannas. The most frequently used common name is starry campion, but the names widowsfrill (Kartesz 1999, USDA, NRCS 2002, USDA ITIS 2002) and whorled catchfly (USDA ITIS 2002) are sometimes encountered. Both the specific epithet *stellata* and the common descriptor "starry" derive from the many-fringed radially arranged white petals. *Silene stellata*, which grows as far west as Oklahoma, is known in New England from only two extant sites, both in Connecticut. This document reports on the status of *Silene stellata*, examines the factors that encourage or discourage the survival of the species, and makes recommendations for its conservation in New England. These recommendations include a goal of five populations with a total of 500 plants, the goal to be achieved either through *de novo* searches, relocation of historic populations, augmentation of existing populations, introduction, or reintroduction.

DESCRIPTION

Silene stellata is easily distinguished from other members of its genus and its family by its mainly whorled leaves, usually in fours, and its extensively fringed petals. The puberulent stems grow to one meter in height, with several emanating from one crown in a distinct cluster, thus making it easy to distinguish one individual plant from another. Though one source (Mitchell 1993) describes the underground structure as a rhizome, others (Fernald 1950, Gleason and Cronquist 1991) describe it as a crown, and Alan Wade, partner of Prairie Moon Nursery which has grown the plant, reports no evidence of a rhizomatous habit (personal communication). The 1 cm-long and 1-5 cm-wide leaves, which vary in shape from broadly ovate to narrowly lanceolate, clasp the stems at the swollen nodes. They vary in texture from smooth to scabrous above while they are usually puberulent beneath. The pale pink or white flowers are borne in an elongate compound panicle. The flowers have a fused five-lobed calyx, 7-12 mm long, which inflates in fruit. Each of the five petals has a claw and a fimbriately lobed blade with eight to twelve lacerations. The perfect flowers have ten stamens, three stigmas, three styles, and one ovary which, upon fertilization of the many small ovules, becomes a six-parted capsule that splits to about two-thirds of its length. The petals, which are wooly at the base, are 13-22 mm long. The reniform seeds, c. 1.5 mm long and 1 mm wide, are rugose and somewhat compressed. The above description is based on personal observations and descriptions from Gleason and Cronquist (1991) and Mitchell (1993).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

According to Mitchell (1993), synonyms for *Silene stellata* (L.) Aiton f. include:

- *Cucubalus stellatus* L. (Linnaeus 1753)
- *Evactoma stellata* (L.) Nieuwl. (Nieuwland 1913)
- *Evactoma stellata* var. *scabrella* Nieuwl. (Nieuwland 1913)
- *Silene stellata* var. *scabrella* (Nieuwl.) Palmer & Steyerm. (Palmer and Steyermark 1935)
- *Silene scabrella* (Nieuwl.) G. N. Jones.

Nieuwland (1913) named a variety *scabrella*, distinguished by scabrous pubescence on the inflorescence, stem, and leaves and generally occurring "to the west" and "farther North." This variety is recognized by Gleason and Cronquist (1991) but not by most other sources (Kartesz 1999, USDA ITIS 2002, NatureServe 2002). For the purposes of this document, the variety is not considered valid. *Silene stellata* is in the subfamily Silenoideae.

SPECIES BIOLOGY

Flowering time for *Silene stellata* for the most part is summer – June through August (Gleason and Cronquist 1991, Greller 1977, Kucera 1952, Connecticut Natural Diversity Data Base, unpublished data) – but flowers linger into September and October (Swink 1952; William Moorhead, Consulting Botanist, personal communication). It is not uncommon to find flowers and fruits on one plant at the same time from late July through September (Connecticut Natural Diversity Data Base, unpublished data). The flowers of *Silene stellata* are perfect, and reproduction is sexual. As stated in the Description section, the species has not been observed to have any methods of vegetative reproduction.

Hickey and King (1988) state that all members of the Caryophyllaceae secrete nectar at the base of the stamens but that only long-tongued insects can reach the nectar of the subfamily Silenoideae because of the long calyx tube. Though no studies have been found that specifically address pollination of *Silene stellata,* nor is it known if the species is self-fertile, there is ample anecdotal evidence that it is visited frequently by a diversity of insects. Kartesz (1999) calls it a "butterfly nectar species" and Schaeffer and Rose (1998) also note it as a plant that attracts butterflies. Niering (1979) states that it is pollinated by "butterflies and many kinds of moths," and Wade (personal communication) reports that his associates at Prairie Moon Nursery in Minnesota have seen many bees — honey bees and smaller unidentified species — on the plants. He has also seen it visited by hummingbirds, attracted probably by nearby plantings of the bright red *Silene regia.*

No information has been found on germination in the wild, but limited observations have been made for nursery grown plants outside Connecticut. Wade (personal communication) reports "good" germination percentages after two months of

moist cold stratification. He has not experimented with different lengths of moist, cold stratification but has noted good results from seed sown outdoors in the fall. He has tried spring sowing of unstratified seed with poor results but found that those same seeds germinated well the following spring, demonstrating at least partial viability in the soil. He acknowledges that his observations are not scientifically rigorous and that many factors, such as storage method and the age of the seed can affect germination rates. He also reports that different seed collections act differently "for no rhyme or reason." Francis Groeters (personal communication), a nursery owner in New York's Catskill Mountains, has noticed little self-sowing of the species, while Wade, in Minnesota, has noticed seedlings germinating spontaneously in bare ground. Perhaps there is a relevant reason for these different observations, but speculation based on only two anecdotal reports seems inadvisable. No research has been performed on seed longevity but investigators in a Midwestern savanna restoration project speculated that *Silene stellata* seeds survived for a considerable time in the seed bank because of the species' spontaneous appearance following restoration efforts (Apfelbaum and Haney 1987).

Wade reports that the plants grow fast and are extremely drought-tolerant. Groeters (personal communication) also noted good drought tolerance in the garden, with plants surviving recent hot dry summers. Wade's plants flower in the second year in the nursery, while plants that have been installed in outdoor mixed-savanna restoration plantings flower in the third year. Individual plants in the nursery have lived up to ten years. He finds the species to be a consistent seed producer and finds that the best seed production is from plants grown in sites with half a day of sun and half of shade. He has not found the plants to be susceptible to disease or die-offs.

No information has been found on herbivory. *Hadena ectypa*, a noctuid moth considered rare by Sullivan and Deutshmann (2001), is reported by the Chicago Academy of Sciences (2000) to have *Silene stellata* as its food plant in the larval stage, though Sullivan and Deutschmann (2001) refer to *Silene stellata* as the "supposed" food plant of the moth larva. *Hadena ectypa* is reported by Dudash (1997) to be a "major herbivore on both flowers and developing fruits of *Silene virginica* in western Virginia," suggesting that the species can have a noticeable effect on plant populations. The relevance of this implication, however, is not clear, since the range of the plant far surpasses the range of the moth, which is restricted to New Jersey, Delaware, Maryland, Virginia, and West Virginia (NatureServe 2002). Furthermore, countless species of plants serve as host plants to Lepidopteran larvae but are still abundant.

Janis Antonovics (University of Virginia, personal communication) suspects that in western Virginia the species may be threatened by deer grazing, of which he has seen evidence, but no other sources mention this possibility. Browsing by deer or other mammals has not been noted by either observer of the two extant New England occurrences.

HABITAT/ECOLOGY

Many sources (Darlington 1837, Greller 1977, Great Plains Flora Association 1986, Gleason and Cronquist 1991, Porcher and Rayner 2001) give a simple designation of "woods" as habitat for *Silene stellata.* Other sources (Torrey 1843, Chapman 1860, Wiegand and Evans 1926, Dobbs 1963, Eisendrath 1978, Yatskievych 2000) are more specific, citing "dry woods," while others (Wiegand and Evans 1926, Dobbs 1963, Niering 1979) cite "open woods."

Oak woods are cited by Bruner (1931) in Oklahoma and Kucera (1952) in Iowa. Almost all of the occurrences listed in the Michigan Natural Features Inventory (unpublished data) are in oak woods. Leoshcke (Iowa Department of Natural Resources, personal communication) cites wood edges, as does Mitchell (1993) in New York. Hanes and Hanes (1947) and Rhoads and Block (2000) mention wooded banks or slopes. Two North Carolina sources (Radford et al. 1964, Justice and Bell 1968) specify rich woods, as do Dobbs (1963) in Illinois and Palmer and Steyermark in Missouri (1935).

In Connecticut, habitat information must be obtained mainly from herbarium specimens, since most occurrences are historic. Of 29 specimens from Connecticut herbaria that provide habitat information on the label, three are from coastal woodlands, six are from rocky, dry or open woods, and three from trap rock woods. Coastal and trap rock woods are generally open and dry, so rocky, dry, or open woods could be considered a common habitat for historic Connecticut specimens.

Tallgrass mesic prairies are a habitat cited by Bray (1957) in Wisconsin, Leoschke (personal communication) in Iowa, Gleason (1912) in Wisconsin, Wade (personal communication) in Minnesota, and Albert (1995) in Michigan. Savanna is another frequently mentioned habitat (McCarty 1993, Pruka 1995, Wade personal communication). The species is also found on less natural habitats such as roadsides and railroad tracks (Gleason 1912, Dobbs 1963, Carleton College 2002, Michigan Natural Features Inventory, unpublished data).

In spite of the several habitats mentioned above, *Silene stellata* seems to have a fairly narrow amplitude. In several studies of large forested areas (Uphof 1922, Turner 1936, Braun 1940, Cobbe 1943, Hotchkiss and Stewart 1947, Cantlon 1953, Kucera 1954, McCoy 1958), where the investigators have identified different forest communities and noted the species in each one, *Silene stellata* is usually only found in one or two of up to a dozen adjacent communities. Cobbe (1943), studying an undisturbed forest tract in southern Ohio, found *Silene stellata* only in the oak/hickory communities dominated by *Quercus rubra, Quercus muehlenbergii, Quercus alba,* and *Carya ovata,* and not in communities dominated by *Fagus grandifolia* or *Acer saccharum.* Braun (1940), in the Cumberland Mountains of Kentucky, recorded *Silene stellata* in communities dominated by *Castanea dentata* or *Quercus alba* but not in those dominated by *Tsuga canadensis, Fagus grandifolia* or *Quercus prinus.* Hotchkiss and Stewart (1947), describing the Patuxent Research Refuge in the Maryland Piedmont, found *Silene stellata* in a community that he called the bluff forest, a well-drained area dominated by *Fagus*

grandifolia and *Quercus alba,* but not in the upland oak forest dominated by *Quercus stellata, Quercus marilandica,* and *Quercus prinus,* or in an oak-pine forest.

Similarly, though *Silene stellata* is a common species in savannas, it does not seem to be found in all kinds of savannas. For instance, a Natural Resources and Conservation Service technical guide (1999) lists *Silene stellata* as a common species only of a type designated as Mesic Savanna, dominated by *Quercus alba* and *Quercus macrocarpa*, not of a type designated Savanna on Claypan Soils, which is dominated by *Quercus bicolor, Quercus stellata, Quercus marilandica* and *Quercus palustris,* or of the type designated Sand Savanna, dominated by *Quercus velutina* and *Quercus marilandica*.

River edges also are mentioned in connection with *Silene stellata.* Studies in Oklahoma (McCoy 1958) and Illinois (Turner 1936) record *Silene stellata* growing in floodplains. Several occurrences in Michigan, both current and historic, are on the edges of rivers or lakes, and of the 29 historic Connecticut records that include habitat information on the herbarium label, nine were collected from river banks. One current Connecticut occurrence, yet to be entered in the state database, is also on a river edge – growing on the "brow," a shelf of soil and vegetation growing above an area where the bank has been undercut by the river.

It is important to distinguish between river banks and floodplains. Only one occurrence (McCoy 1958) seems to be in a classic floodplain and yet the area still is dominated by various species of oak. The site described by Turner (1936) in Illinois seems to have more typical floodplain vegetation – species such as *Ulmus americana* and *Platanus occidentalis* – but is somewhat rocky and is not typical floodplain soil. The Michigan sites are described thus:

- "Dry bank of the Kalamazoo River,"
- "southern floodplain forest rising to rich dry-mesic forest on sandy loam"
- "a sandy black oak bench (levee?) along the edge of a river floodplain/marsh" (Michigan Natural Features Inventory, unpublished data).

The current Connecticut occurrence is on the river edge, not in the floodplain, in a zone where the canopy vegetation consists mainly of *Quercus alba, Quercus borealis, Tilia americana, Carya cordiformis*, *Fraxinus americana,* and *Ostrya virginiana*, along with *Acer saccharinum.* True floodplain – areas dominated by *Acer saccharinum* - does not seem to provide habitat for *Silene stellata.*

In sum, the literature and current records reveal the three prime habitat preferences for *Silene stellata*: dry, open, or rocky woods; river edges; and savannas. It is also occasionally found on roadsides (perhaps some of which are shaded embankments) and in waste places like railroad tracks. The literature also suggests a specificity of habitat requirements, but does not reveal the perhaps narrow parameters that define *Silene stellata* habitat.

Though the overwhelming majority of sources cite woods as the habitat for *Silene stellata,* there are a few hints that the species might have early successional preferences. Turner (1936), studying floodplain communities in the lower Illinois River valley, found *Silene stellata* growing with *Saponaria officinalis* and *Verbascum thapsus*, species more typically found along a roadside or in a disturbed area. Bray (1957) refers to it in passing as one of "two native adventurers or pioneers," the other one being *Ambrosia trifida.* Mark Leoschke (personal communication) considers it a species "that can tolerate a fair amount of disturbance."

As is to be expected from a species that grows from Connecticut to Oklahoma, the associated species are far too numerous to list in their entirety, but certain plants that are mentioned more frequently than others deserve note. In particular, every study of forest communities that links canopy and herbaceous species shows *Silene stellata* growing with oaks (Uphof 1922, Lyon 1927, Braun 1940, Cobbe 1943, Hotchkiss and Stewart 1947, Kucera 1952, McCoy 1958). Iverson et al. (1999) lists *Silene stellata* as occurring in Illinois in the SAF Forest Cover Types of Upland Oak and Bur Oak. Every occurrence in the Michigan Natural Features Inventory that lists associated species lists oaks. The most frequently mentioned species are the upland oaks (*Quercus alba, Quercus coccinea, Quercus rubra, Quercus velutina)* and to a lesser extent *Quercus prinus, Quercus muehlenbergii,* and *Quercus marilandica.* Almost always listed along with the oaks are various hickories – *Carya tomentosa, C. ovata, C. glabra,* and *C. cordiformis.* This observation is consistent with the frequently cited habitat of dry, open or rocky woods. The oaks at the two ends of the moisture spectrum (*Quercus palustris* and *Quercus bicolor* at the hydric end and *Quercus ilicifolia* or *Quercus prinoides* at the xeric end) are infrequently mentioned. Other tree species growing with *Silene stellata* include *Cornus florida, Sassafras albidum, Fraxinus americana, Liriodendron tulipifera, Betula lenta,* and *Celtis occidentalis* (Cantlon 1953, Greller 1977). Pines and hemlocks are rarely mentioned.

Shrubs and vines include *Viburnum acerifolium, Toxicodendron radicans, Parthenocissus quinquefolia, Vaccinium angustifolium, Corylus cornuta, Smilax rotundifolia,* and *Vitis aestivalis* (Hotchkiss and Stewart 1947, Cantlon 1953). Associated herbaceous species are far too many to enumerate but include *Aster divaricatus, Hieracium paniculatum, Eupatorium rugosum, Collinsonia canadensis, Smilacina racemosa,* and *Maianthemum canadense* (Cantlon 1953, Greller 1977), all common understory herbs of rocky open woods.

The habitats mentioned above – dry oak woods, savannas, prairies, and river edges – are broad designations. Are there more specific aspects of *Silene stellata* habitats that can yield clues to its survival requirements or reasons for its rarity in New England? What are the key parameters of *Silene stellata* habitats? Answers to these questions are not easily forthcoming, as very few authors have quantified or even described habitat characteristics, and of those that have, the findings are sometimes contradictory. It should also be noted that most habitat information available is incidental as no studies were found that focused specifically on *Silene stellata.*

Porcher and Rayner (2001), in the South Carolina Piedmont, note the species growing mainly on north slopes. However, Cantlon (1953), studying the relation of vegetation to aspect on a trap rock ridge in northern New Jersey, found *Silene stellata* growing only on the south slope, which he documented as having earlier snow melt, warmer soil temperatures, and greater rates of evaporation than the north slope.

In Cobbe's (1943) study of a forest tract in Ohio, the species was found only on south and west slopes, in oak/hickory communities. Soil testing in this study showed these oak/hickory communities to have the least available soil moisture and to be the most acid (pH 4) of all the communities, also to have a mor humus layer – one usually matted or compacted and not blended into the mineral soil – as opposed to mull, which is blended into the mineral soil. In two Michigan occurrences, soil pH was measured at 5.5 and 6 (Michigan Natural Features Inventory, unpublished data). In terms of soil pH, however, Palmer and Steyermark (1935) list *Silene stellata* as having a circumneutral preference but offer no supporting documentation. Several, though by no means all Connecticut occurrences are on trap rock ridges, which generally produce an alkaline soil. From these contradictory findings, one can either conclude that the species is not dependent on pH or that evidence is insufficient to address the pH question.

Silene stellata occurs on different substrates, growing in areas underlain by limestone (Uphof 1922), sandstone and shale (Braun 1940), and diabase (Cantlon 1953, Connecticut Natural Diversity Data Base, unpublished data), as well as on dunes (Lyon 1927), outwash plains (Michigan Natural Features Inventory, unpublished data), and in Cretaceous sediments (Hotchkiss and Stewart 1947). It grows in deep till (Kucera 1952), sand (Lyon 1927, Michigan Natural Features Inventory, unpublished data,), shallow rocky soil (Uphof 1922, Cantlon 1953, personal observation), and planasols with a claypan (Kucera 1952). In spite of the latter observation, all the Michigan sites were noted as having dry or sandy soil, and most other occurrences seem to be in dry soil. Schaeffer and Rose (1998), in a gardening bulletin, state that the species prefers "well-drained soils," and the Missouri Botanical Garden Web site (2002) states, "excellent drainage is essential for growing this plant." Moorhead (personal communication) feels that high soil fertility is also a factor, noting the species' frequent occurrence on trap rock soils, high-base bedrocks, and forest soils that can be inferred from associated species or alluvial origin to be of higher fertility.

For the Connecticut occurrences, it is interesting to reflect about a commonality between the two most prevalent habitats: dry woods and river banks. At first glance, these two habitats seem quite different, especially in terms of moisture regimes, but one common factor could be filtered or partial light. The species' occasional occurrence on wood edges and roadside banks could also indicate a predilection for partial sun, and in fact, partial sun is a recurring theme in descriptions of *Silene stellata* habitats. For instance, savanna sites where *Silene stellata* is common have a canopy coverage from 10 to 80 percent (Natural Resources Conservation Service 1999). Oaks do not generally cast a deep shade. Wade (personal communication), has found that *Silene stellata*, though tolerant of full sun, produces the most seed when it is grown in a site which receives sun half the day, and the Missouri Botanical Garden (2002) recommends full sun to part

shade for growing the species. In the proceedings of the 1995 Midwest Oak Savanna and Woodland Ecosystem Conference (Pruka 1995), *Silene stellata* is listed as a Category 1 species – one of the best indicators of former savannas and open woodlands. These species "tend to be limited to partial canopy conditions. In more densely wooded sites, these species are usually in a state of declining vigor due to the ever-increasing canopy closure. They typically persist in densely-wooded sites only near canopy openings such as woodlot edges, roadsides, or brushed utility corridors."

Since *Silene stellata* is common in prairie savannas, a community that owes its existence to periodic fires, it is clearly fire-tolerant. Its frequent association with oaks could also be related to fire, since many oak woods in the Northeast originated as a result of early 20th century fires (Crow 1998). Whether it is actually fire-dependent is doubtful, however, given its relative abundance throughout much of its range. It is difficult to conceive that every site where it currently occurs was recently burned, but it is possible that *Silene stellata* grows better or more frequently in sites that have been burned.

Another feature of *Silene stellata* habitat to consider is its almost constant association with oaks. The association could be coincidental, merely reflecting similar habitat requirements of the two taxa, or it could indicate a beneficial influence of the oaks, whether through their light shade, qualities of the leaf litter, acidification of the soil caused by their leaves, or other factors.

THREATS TO *SILENE STELLATA*

In much of its range, *Silene stellata* is not threatened and in fact might be increasing as more savanna restoration projects take place. In Connecticut, with only two recently discovered sites in disparate habitats, it is difficult to generalize about threats.

At CT .051 (Madison), Ken Metzler (Connecticut Natural Diversity Data Base, unpublished data) indicated that widening of the trail would obliterate the few existing plants. Whether this widening is being actively considered is not known. The current trail is narrow and little used, and this particular section of the park where the plant is located is little visited compared to the rest of the site. The author noted considerable herbivory and general lack of vigor in 2002, but whether this is part of a long-term trend bears further examination. Metzler did not indicate other threats, nor were any obvious to the author on a site visit, but the author feels that not enough is known about the species' requirements to identify threats definitively on this site. These plants, which number fewer than ten individuals, could be subject to inbreeding depression.

At CT NEW (Avon, Simsbury), Moorhead (personal communication), the only botanist who has seen this occurrence, has identified several possible threats. One is an increase in invasive species. *Celastrus orbiculatus, Euonymus alatus, Berberis thunbergii, Rhamnus frangula,* and *Rosa multiflora* are present in at least small numbers at all sites and "rampant" very close to some sites. A second potential threat identified by Moorhead is the possibility of hydrologic alterations caused by the upstream flood

control structures installed in the late 1950s. For example, he postulates that floods might be occurring less often but be of longer duration and that this change could be affecting *Silene stellata.*

There is considerable evidence that *Silene stellata* prefers partial sun to dense shade. If this is the case, canopy closure could be a threat, but the plants at CT .051 (Madison) are growing, as the species often does, near the edge of the woods. The woodland in this case is bordered by a salt marsh and therefore not subject to shading or succession. At CT NEW (Avon, Simsbury) canopy closure seems unlikely, with the plants being on a river bank. Herbivory has been noted at both sites, but whether it is a deciding factor is not at all clear.

As elaborated in the following section, *Silene stellata* was formerly more common in Connecticut and the possible reasons for its decline are discussed in that section. In general, canopy closure is the most likely – though unproven – cause for the species' decline. One could generalize that the oak forests of Connecticut and indeed much of the Northeast are becoming more shaded as the forest matures, but at the same time, agents like the gypsy moth and the hemlock wooly adelgid are always creating gaps where new forests are starting and yet *Silene stellata* does not appear. Perhaps these new stands are still too young, or perhaps *Silene stellata* needs the kind of disturbance created by fire rather than one created by insects. Or perhaps the seed source is too diminished and/or dispersal mechanisms too limited.

DISTRIBUTION AND STATUS

General Status

Under The Nature Conservancy's occurrence ranking system (NatureServe 2002), *Silene stellata* has a global rank of G5 and a national rank of N5, indicating that it is secure on a global and national level. Gleason and Cronquist (1991) cite the species' range as Connecticut to Oklahoma and Nebraska, south to Georgia and Texas. Several sources (Fernald 1950, NatureServe 2002) include Massachusetts in its range, but there are no data to support this determination (Paul Somers, Massachusetts Natural Heritage and Endangered Species Program, personal communication, Arthur Haines, New England Wild Flower Society, personal communication). Bruner (1931) and Little (1938) note the species only in the forested, eastern part of Texas, and Fernald (1950) notes eastern Texas as the southwestern edge of its range. Its western boundary coincides roughly with the 98th meridian (NatureServe 2002), the demarcation proposed by Webb (1931) as the beginning of the Great Plains. *Silene stellata* does not grow in the more northern regions of the United States, being found only in the southern part of Minnesota and South Dakota (Great Plains Flora Association 1986) nor does it grow in the shortgrass prairie, the Rocky Mountains, the Pacific Coast, or Florida. Though it seems to be common in the southern Appalachians, it is not found in the Adirondack, White or Green Mountains.

Within Connecticut, a look at the historical distribution — based on herbarium data (see Figure 2) — reveals some information. The species is not clustered in the northwest corner of the state, with its colder temperatures and limestone outcrops, nor is it exclusively clustered along the coast, with milder winters and other coastal influences. Similarly, though some occurrences are on trap rock, it does not seem to be clustered in the trap rock areas. A loose pattern of distribution can be seen along the coast, along the Connecticut River and a few other rivers. In the coastal towns, where habitat data are available, the noted habitat is always dry woods; in the river towns, the habitat when noted is river banks.

Reports vary on the abundance of *Silene stellata.* The fact that the species is not included in several popular wildflower books (Greene and Blomquist 1953, Duncan and Foote 1975, Dwelley 1977, Chapman 1998, Duncan and Duncan 1999) implies that it is not among the more abundant species, even deeper into its range. In Michigan and Louisiana, the species is listed as S2 and it is historic in Vermont. Sources from New York, Michigan, North Carolina, Maryland, Pennsylvania, and Indiana (Young 1871, Wiegand and Evans 1926, Hanes and Hanes 1947, Hotchkiss and Stewart 1947, Schaeffer 1949, Justice and Bell 1968, Weldy 2002) note it as rare or scarce. The Carleton College Arboretum Web site labels the species "uncommon" in Minnesota and Leoschke (personal communication) considers it "infrequent" in the Iowa.

In Cantlon's (1953) New Jersey trap rock ridge study, of 71 herbaceous species tallied, *Silene stellata* ranked 55th in density, with nine plants per 140 square meters (compared for example to the most abundant species, *Aster divaricatus,* which had 1,466 plants in the same area). In the William L. Hutcheson Memorial Forest in south/central New Jersey, *Silene stellata* was one of the rarer species, with fewer than seven individuals (Frei and Fairbrothers 1963).

However, other sources label the plant as common or frequent (but never abundant) over as wide a geographical and temporal range. These sources include Rhoads and Block (2000) in Pennsylvania, Dobbs (1963) in Henry County, Illinois, Torrey (1843) in New York State, and Darlington (1837) in eastern Pennsylvania. In a study of a wooded park in Queens County, New York, *Silene stellata* was rated as common in its habitat of mixed hardwoods (Greller 1977) and Antonovics (personal communication) states that the species "is found quite commonly near Mountain Lake Biological Station" in Giles County, Virginia. Wade (personal communication) notes that it is found often in prairie savannas in the Midwest and it is one of the species expected to reappear and flourish in a successful savanna restoration.

The reasons for the decline of *Silene stellata* are not obvious. Habitat loss, the most frequent cause of species endangerment, seems a low possibility. Of course, vast amounts of land have been lost to development in the last century, and many river banks have been altered, but oak woods still blanket much of the state and many river banks remain relatively undisturbed. Most of the state's trap rock ridges are protected. Indeed, some of the historic locales, such as New Haven's East Rock Park or Guilford's Chaffinch Island, are still undeveloped and protected as park land. Chaffinch Island still supports

state-listed species that were collected at the site over 100 years ago, indicating that the habitat is, in some spots, stable.

Since *Silene stellata* seems to prefer filtered or partial light, one cause could be canopy closure of the maturing forest. This theory could be supported by previously cited observations of growers and savanna restoration practitioners, and by limited inferences of *Silene stellata* being a pioneer species, however, these observations by no means offer conclusive proof.

In Missouri savanna restorations, practitioners have learned the importance of removing and preventing the recurrence of midstory growth (McCarty 1993). Moorhead (personal communication) noted that all the *Silene stellata* sites along the Farmington River are on the edges of mature stands or strips of larger, older trees, and absent from sites with earlier successional forest stands. He noted that the latter stands tend to be weedy with woody invasive shrubs and vines, while the older stands mostly have relatively open shrub layers. These two observations suggest that another related cause could be competition and/or shading from the shrub or sapling layer, although maturing forests generally tend to have a reduced midstory layer. Another possibility, suggested by savanna restoration work, is fire suppression. Since *Silene stellata* is a prime component of fire-dependent savanna communities, perhaps it too is fire-dependent, or at least encouraged by fire. It would be difficult if not impossible to prove that all the sites where it currently occurs were at one time burned, and in fact this possibility seems highly unlikely. However, fire suppression might be one of many interrelated factors.

In the case of river bank populations, William Moorhead (personal communication) has an interesting theory: that flood control projects could have altered flooding regimes to the detriment of the plant by increasing the duration of inundation of lower frequency floods. This hypothesis is quite preliminary but bears consideration. In fact, probably all of Connecticut's rivers have experienced hydrological alteration of some type in the last century, so altered flooding regimes could be a factor in the decline of river bank populations.

Table 2. Occurrence and status of *Silene stellata* in the United States and Canada based on information from Natural Heritage Programs, the USDA, NRCS Plants National Database (2002), and other sources as noted below

OCCURS & LISTED (AS S1, S2, OR T &E)	OCCURS & NOT LISTED (AS S1, S2, OR T & E)	OCCURRENCE REPORTED OR UNVERIFIED	HISTORIC (LIKELY EXTIRPATED)
Connecticut (SU as per NatureServe and Connecticut Natural Diversity Data Base, S1 as per Brumback and Mehrhoff et al. 1996): 2 extant and 50 historic occurrences	Great Smoky Mountains National Park (P4)	Alabama (SR)	Ontario (SEH)
Louisiana (S2)	Illinois (S3S4): reported from 90 out of 102 counties (Kieninger, personal communication)	Arkansas (SR)	Rhode Island (SH): 1 historic occurrence
Michigan (S2): 8 extant (since 1974) and 9 historic occurrences	Iowa (S5)	Delaware (SR)	Vermont (SH): 3 historic occurrences
		District of Columbia (S?)	
		Georgia (SR)	
		Indiana (SR)	
		Kansas (SR)	
		Kentucky (S?)	
		Maryland (SR)	
		Massachusetts (SR)	
		Minnesota (SR)	
		Mississippi (SR)	
		Missouri (SR)	
		Nebraska (SR)	
		New Jersey (SR)	
		New York (SR)	
		North Carolina (SR)	
		North Dakota (SR)	
		Ohio (SR)	
		Oklahoma (SR)	
		Pennsylvania (SR)	
		South Carolina (SR)	
		South Dakota (SR)	
		Tennessee (SR)	
		Texas (SR)	
		Virginia (SR)	
		West Virginia (S?)	
		Wisconsin (SR)	

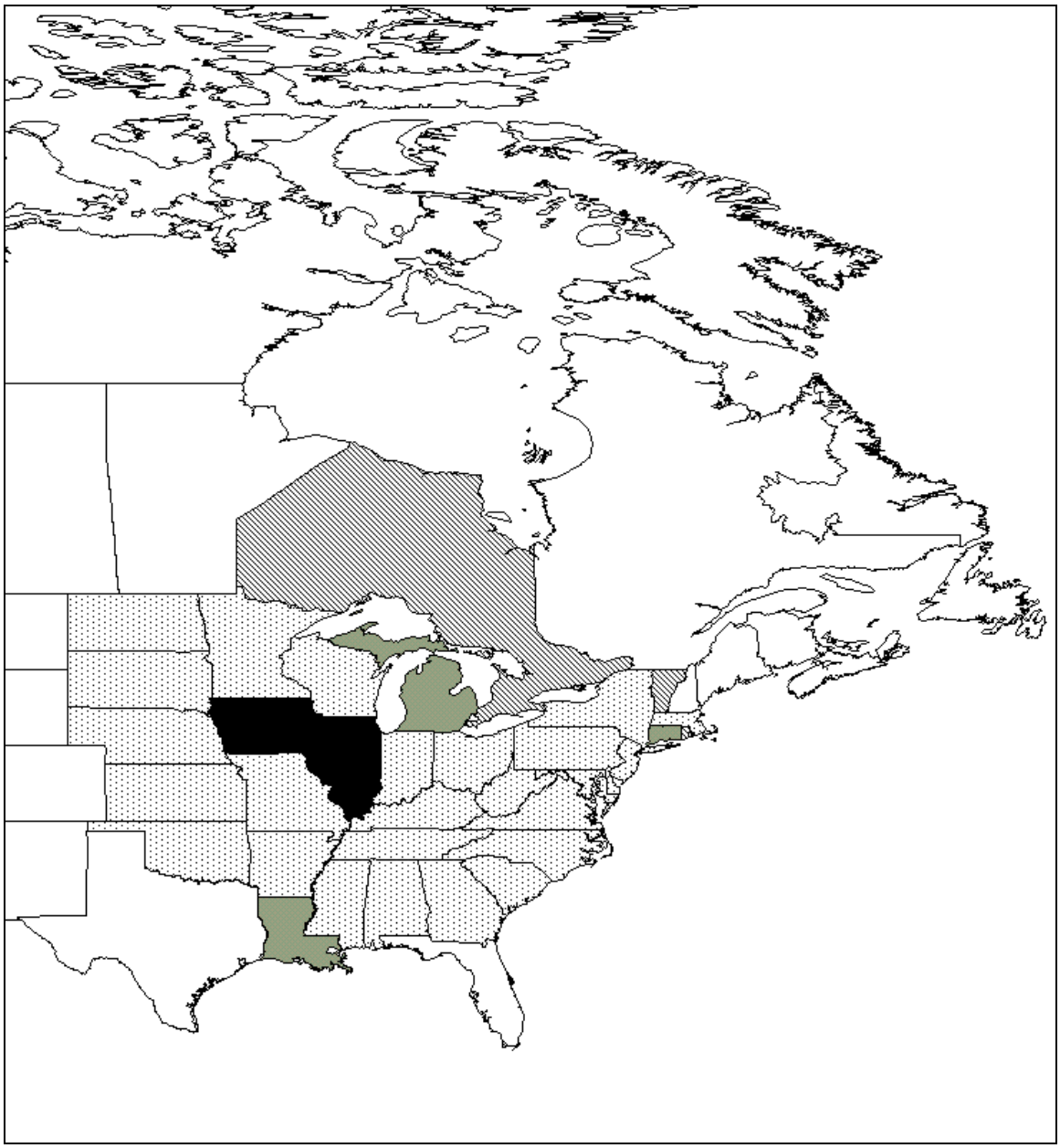

Figure 1. Occurrences of *Silene stellata* in North America. States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. Areas with diagonal hatching are designated "historic," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but without further information on species status). See Appendix for explanation of state ranks.

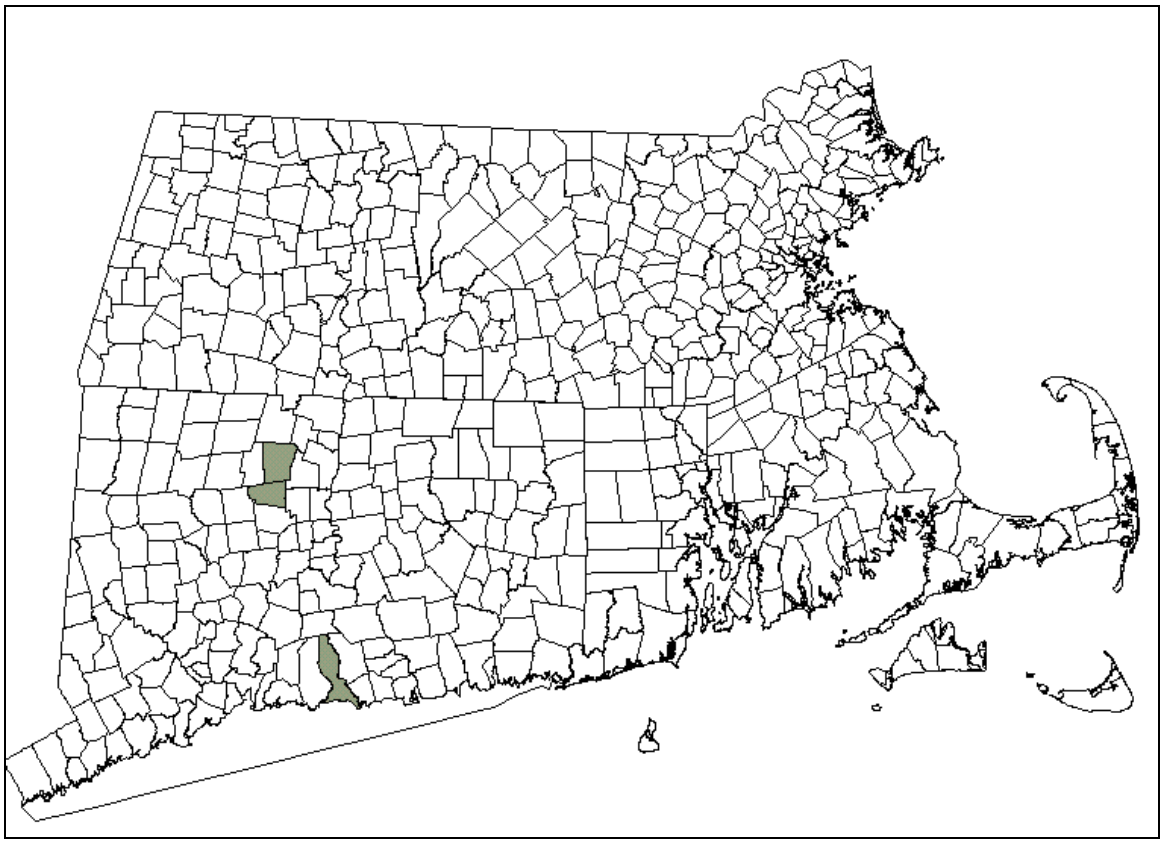

Figure 2. Extant occurrences of *Silene stellata* in New England. Town boundaries for southern New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon.

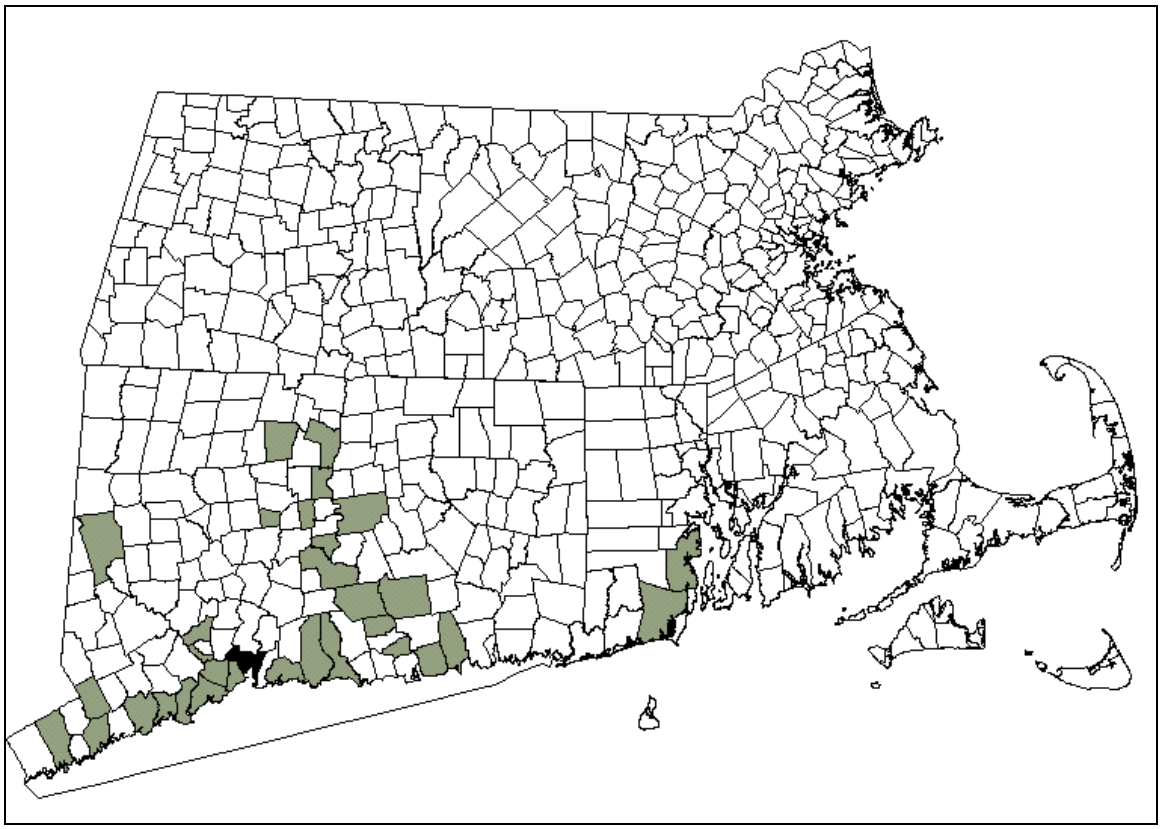

Figure 3. Historical occurrences of *Silene stellata* in New England. Towns shaded in gray have one to five historical records of the taxon.

Table 2. New England Occurrence Records for *Silene stellata.* Shaded occurrences are considered extant.
Information for Connecticut occurrences derived from Connecticut Natural Diversity Data Base unpublished material.

State	EO Number	County	Town
VT	None	Windsor	Windsor
VT	None	Franklin	Franklin
VT	None	Unknown	Unknown
RI	None	Washington	South Kingstown
CT	.001	Hartford	Simsbury
CT	.002	Hartford	Newington
CT	.003	Middlesex	Essex
CT	.004	Middlesex	Middletown
CT	.005	New Haven	Derby
CT	.006	New Haven	Guilford
CT	.007	New Haven	New Haven
CT	.008	New Haven	Milford
CT	.009	New Haven	New Haven
CT	.010	New Haven	New Haven
CT	.011	New Haven	New Haven
CT	.012	New Haven	Orange
CT	.013	Fairfield	Norwalk
CT	.014	Fairfield	Stratford
CT	.015	Hartford	Windsor
CT	.016	Fairfield	Bridgeport
CT	.017	Fairfield	Fairfield
CT	.018	Fairfield	Stamford
CT	.019	Hartford	Hartford
CT	.020	New Haven	Branford
CT	.021	Middlesex	Cromwell
CT	.022	Middlesex	East Haddam
CT	.023	New Haven	Milford
CT	.024	Fairfield	Stratford
CT	.025	Litchfield	New Milford
CT	.026	Middlesex	Haddam
CT	.027	New London	East Lyme
CT	.028	Fairfield	Bridgeport
CT	.029	Hartford	Glastonbury
CT	.030	Fairfield	Norwalk
CT	.031	New Haven	New Haven
CT	.032	New Haven	New Haven
CT	.033	Fairfield	Norwalk

Table 2. New England Occurrence Records for *Silene stellata.* Shaded occurrences are considered extant.
Information for Connecticut occurrences derived from Connecticut Natural Diversity Data Base unpublished material.

State	EO Number	County	Town
CT	.034	New London	Old Lyme
CT	.035	New Haven	West Haven
CT	.036	Hartford	Plainville
CT	.037	New Haven	Seymour
CT	.038	New Haven	Guilford
CT	.039	Hartford	Simsbury
CT	.040	Fairfield	Wilton
CT	.041	New Haven	Seymour
CT	.042	Middlesex	Chester
CT	.043	New Haven	New Haven
CT	.044	Fairfield	Stratford
CT	.045	New Haven	New Haven
CT	.046	New Haven	New Haven
CT	.047	New Haven	West Haven
CT	.048	New Haven	Milford
CT	.049	Fairfield	Bridgeport
CT	.050	Hartford	Windsor
CT	**.051**	**New Haven**	**Madison**
CT	**NEW**	**Hartford**	**Avon, Simsbury**

II. CONSERVATION

CONSERVATION OBJECTIVES FOR *SILENE STELLATA* IN NEW ENGLAND

New England has two extant occurrences of *Silene stellata,* one coastal and one riverine. Though neither seems immediately threatened with extirpation, each one could be quickly eliminated by one event; the coastal population through one pass of the weed-whacker or the backhoe and the river population perhaps by a major flood. In Connecticut, given the potential fragility of these two populations and the relative historical abundance of *Silene stellata*, a goal should be set of maintaining at least five populations in a mix of riverine and coastal habitats. The average count per population should be 100 individual plants, for a total of 500. This goal can be achieved either through rediscovering historic populations, discovering extant populations, through reintroduction, or, at CT .051, through augmentation. In the rest of New England, conservation objectives are more elusive, given the historical – and very vague – status of the species in Rhode Island and Vermont. Unless the species is relocated in these two states, the author feels that conservation efforts are better focused on Connecticut.

III. LITERATURE CITED

Albert, Dennis A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. General Technical Report NC-178. U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota. Available at http://www.npwrc.usgs.gov/resource.1998/rlandscp/S6-2-1.HTM. (Updated June 3, 1998, accessed December 2003).

Apfelbaum, S. I. and A. Haney. 1987. Management of Degraded Oak Savanna Remnants in the Upper Midwest. Preliminary results from three years of study. Report available at www.appliedeco.com/Projects/MgmtDegradedOakSav.pdf (Accessed December 2002).

Braun, L. E. 1940. An ecological transect of Black Mountain, Kentucky. *Ecological Monographs* 10: 193-241.

Bray, J. R. 1957. Climax forest herbs in the prairie. *The American Midland Naturalist* 58: 434-440.

Brumback W. E., L. J. Mehrhoff, R. W. Enser, S. C. Gawler, R. G. Popp, P. Somers, D. D. Sperduto, W. D. Countryman, and C. B. Hellquist. 1996. *Flora Conservanda*: New England. The New England Plant Conservation Program (NEPCoP) list of plants in need of conservation. *Rhodora* 98: 233-361.

Bruner, W. E. 1931. The vegetation of Oklahoma. *Ecological Monographs* 1: 99-188.

Cantlon, J. F. 1953. Vegetation and microclimates on north and south slopes of Cushetunk Mountain, New Jersey. *Ecological Monographs* 23: 241-270.

Carleton College. 2002. Vascular flora of the Cowling Arboretum, Carleton College. Available at http://www.acad.carleton.edu/campus/arb/floralist.html (Accessed December 2002).

Chapman, A. W. 1860. *Flora of the Southeastern United States.* Ivison, Phinney and Co., New York, New York, USA.

Chapman, W. K. 1998. *Wildflowers of New York.* Syracuse University Press, Syracuse, New York, USA.

Chicago Academy of Sciences. 2000. Survey methods and rarity coefficients for 384 prairie and savanna insects in the Chicago region. Available at www.chias.org/biology.insect2000.pdf (Accessed November 2002)

Cobbe, T. J. 1943. Variations in the Cabin Run Forest, a climax area in southwestern Ohio. *The American Midland Naturalist* 29: 89-105.

Committee of the Vermont Botanical Club. 1937. *The Flora of Vermont. An Annotated List of the Ferns and Seed Plants of the State of Vermont.* Third Revised Edition. Free Press Printing Company, Burlington, Vermont, USA.

Crow, T. R. 1998. Reproductive mode and mechanism for self-replacement of northern red oak (*Quercus rubra*) – a review. *Forest Science* 34: 19-40

Darlington, W. 1837. *Flora Cestrica: An Herborizing Companion for the Young Botanists of Chester County, Pennsylvania.* Lindsay and Blakiston, Philadelphia, Pennsylvania, USA.

Dobbs, R. J. 1963. *Flora of Henry County, Illinois.* Natural Land Institute, Rockford, Illinois, USA.

Dudash, M. R. 1997. Multiyear study of pollen limitation and cost of reproduction in the iteroparous *Silene virginica. Ecology* 78: 484-493.

Duncan, W. H. and L. Foote. 1975. *Wildflowers of the Southeastern United States.* University of Georgia Press, Athens, Georgia, USA.

Duncan, W. H. and M. B. Duncan. 1999. *Wildflowers of the Eastern United States.* University of Georgia Press, Athens, Georgia, USA.

Dwelley, M. 1977. *Summer and Fall Wildflowers of New England.* Down East Enterprises, Camden, Maine, USA.

Eisendrath, E. R. 1978. *Missouri Wildflowers.* Missouri Botanical Garden, St. Louis, Missouri, USA.

Fernald, M. L. 1950. *Gray's Manual of Botany.* Eighth Edition, Corrected printing 1970. D. VanNostrand Company, New York, New York, USA.

Flint, R. F. 1971. *The Surficial Geology of the Guilford and Clinton Quadrangles.* State Geological and Natural History Survey of Connecticut. Quadrangle Report No. 28. Hartford, Connecticut, USA.

Frei, K. R. and D. E. Fairbrothers. 1963. Floristic study of the William L. Hutcheson Memorial Forest (New Jersey). *Bulletin of the Torrey Botanical Club* 90: 338-355.

Gleason, H. A. 1912. An isolated prairie grove and its phytogeographical significance. *Botanical Gazette* 53: 38-49.

Gleason, H.A. and A. Cronquist. 1991. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada.* Second Edition. The New York Botanical Garden, Bronx, New York, USA.

Graves, C. B., E. H. Eames, C. H. Bissell, L. Andrews, E. B. Harger, and C. A. Weatherby. 1910. *Catalogue of the Flowering Plants and Ferns of Connecticut.* State of Connecticut Geological and Natural History Survey. Bulletin No. 14, Hartford, Connecticut, USA.

Great Plains Flora Association. 1986. *Flora of the Great Plains.* University Press, Kansas. Lawrence, Kansas, USA.

Greene, J. P. and P. A. Blomquist. 1953. *Wildflowers of the South.* University of North Carolina Press, Chapel Hill, North Carolina, USA.

Greller, A. M. 1977. A vascular flora of the forested portion of Cunningham Park, Queens County, New York, with notes on the vegetation. *Bulletin of the Torrey Botanical Club* 104: 170-176.

Hanes, C. R. and F. N. Hanes. 1947. *Flora of Kalamazoo County, Michigan.* Schoolcraft, Michigan, USA.

Hickey, M. and C. King. 1988. *100 Families of Flowering Plants.* Second Edition. Cambridge University Press. New York, New York, USA.

Hotchkiss, N. A. and R. E. Stewart. 1947. Vegetation of the Patuxent Research Refuge, Maryland. *The American Midland Naturalist* 38: 1-75.

Iverson, L. R., D. Ketzner, and J. Karnes. 1999. Illinois Natural History Survey and USDA Forest Service. Illinois Plant Information Network. Database at http://www.fs.fed.us/ne/delaware/ilpin/ilpin.html (Accessed December 2002).

Justice, W. S. and C. R. Bell. 1968. *Wildflowers of North Carolina.* University of North Carolina Press, Chapel Hill, North Carolina, USA.

Kartesz, J. T. 1999. Synthesis of North American Flora. Compact disc. Version 1.0. North Carolina Botanical Garden, Chapel Hill, North Carolina, USA.

Kucera, C. 1952. An ecological study of a hardwood forest area in central Iowa. *Ecological Monographs* 22: 283-299.

Linnaeus, C. 1753. *Species Plantarum.* p. 414.

Little, E. L. 1938. Flora of Muskogee County, Oklahoma. *The American Midland Naturalist* 19: 369 - 389.

Lyon, M. W. 1927. List of flowering plants and ferns in the Dunes State Park and vicinity, Porter County, Indiana. *The American Midland Naturalist* 10: 245-295.

McCarty, K. 1993. Restoration in Missouri Savannas. Proceedings of the Midwest Oak Savanna Conference. 1993. Chicago. Available at http:www.epa.gov/glnpo/oak/oak93/mccarty.html (Accessed December 2002).

McCoy, D. A. 1958. Vascular plants of Pontotoc County, Oklahoma. *The American Midland Naturalist* 59: 371-396.

Mitchell, R. S. 1993. *Contributions to a Flora of New York State XI. Portulacaceae through Caryophyllaceae of New York State.* Bulletin No. 486. New York State Museum. The University of the State of New York. The State Education Department. Albany, New York, USA.

Missouri Botanical Garden. 2002. Available at http://www.mobot.org/gardeninghelp/plantfinder/codem/M360.shtml (Updated February 2002, accessed October 2002).

Natural Resources Conservation Service. 1999. Restoration and management of declining habitats. Code 643. Illinois Field Office Technical Guide. Available at www.il.nrcs.usda.gov/resources/fotg/section4/643/643.pdf (Accessed November 2002).

NatureServe. 2002. An on-line encyclopedia of life. Web application available at http://www.NatureServe.org. (Updated October 2002, accessed November 2002).

Niering, W. A. 1979. *Audubon Society Field Guide to North American Wildflowers.* Alfred Knopf. New York, New York, USA.

Nieuwland, J. A. 1913. Evactoma. *The American Midland Naturalist* 3: 57-59.

Palmer, E. J. and J. Steyermark. 1935. An annotated catalogue of the flowering plants of Missouri. *Annals of the Missouri Botanical Garden* 22: 375.

Porcher, R. D. and Rayner, D. 2001. *A Guide to the Wildflowers of South Carolina.* University of South Carolina Press, Columbia, South Carolina, USA.

Pruka, B. W. 1995. Indicator plant species of recoverable oak savannas and open woodlands in southern Wisconsin. Proceedings of the 1995 Midwest oak savanna and woodland ecosystems conference. Available at http://www.epa.gov/grtlakes/oak/oak95/app-d/htm (Accessed December 2002).

Radford, A. E., H. E. Ahles, and C. R. Bell. 1964. *Guide to the Vascular Flora of the Carolinas.* Book Exchange, University of North Carolina, Chapel Hill, North Carolina, USA.

Rhoads, A. F. and T. A Block. 2000. *The Plants of Pennsylvania: an Illustrated Manual.* University of Pennsylvania Press, Philadelphia, Pennsylvania, USA.

Schaeffer, C. and M. A. Rose. 1998. Native Plants of Ohio. Bulletin 865, Ohio State University. Available at http://www.Ohioline.osu.edu (Accessed November 2002).

Schaeffer, R. L. 1949. *The Vascular Flora of Northampton County, Pennsylvania.* New Era Printing Company, Lancaster, Pennsylvania, USA.

Sullivan, J. B. and Deutschmann, L. C. 2001. Lepidopteran Studies: the Ravensford Site. Available at http://www.npslandexchange.com/docs.lepidoptera.pdf (Accessed December 2002).

Swink, F. A. 1952. A phenological study of the flora of the Chicago region. *The American Midland Naturalist* 48: 758-768.

Torrey, J. 1843. *A Flora of the State of New-York.* Carroll and Cook, Printers to the Assembly, Albany, New York, USA.

Turner, L. M. 1936. Ecological studies in the lower Illinois River Valley. *Botanical Gazette* 97: 689-727.

Uphof, J. C. Th. 1922. Ecological relations of plants in southeastern Missouri. *American Journal of Botany* 9: 1-17.

USDA (United States Department of Agriculture). 2002. Integrated Taxonomic Information System (ITIS). Available at http://www.itis.usda.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=20127 (Updated August 20, 2002. Accessed November 2002).

USDA, NRCS. 2002. PLANTS National Database. National Plant Data Center, Baton Rouge, Louisiana, USA. Available at http://plants.usda.gov/cgi_bin/topics.cgi (Updated December 23, 2002. Accessed November 2002).

Webb, W. P. 1931. *The Great Plains.* University of Nebraska Press, Lincoln, Nebraska, USA.

Weldy, T., Mitchell, R. and R. Ingalls. 2002. New York Flora Atlas. New York Flora Association, New York State Museum, Albany, New York, USA. Available at http://nyflora.org/atlas/atlas.htm (Updated December 11, 2002, accessed December 2002).

Wiegand, K. M. and A. J. Evans. 1926. *The Flora of the Cayuga Lake Basin.* Cornell University Agricultural Experiment Station, Ithaca, New York, USA.

Yatskievych, K. 2000. *Field Guide to Indiana Wildflowers.* Illinois University Press, Bloomington, Indiana, USA.

Young, A. H. 1871. *Manual of the Botany of Jefferson County.* Prepared for the Second Report of the Geological Survey of Indiana. Indianapolis, Indiana, USA.

IV. APPENDICES

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1. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

1. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis -- that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction -- i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks (the lower the number, the "higher" the rank, and therefore the conservation priority). On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups; thus, G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EOs have received such ranks in all states, and ranks are not necessarily consistent among states as yet.