New England Plant Conservation Program

# *Scutellaria integrifolia* L.
# Hyssop Skullcap

## Conservation and Research Plan for New England

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# SUMMARY

In New England, *Scutellaria integrifolia* L. (Lamiaceae), or Hyssop Skullcap, is known to exist in only two populations, both in Connecticut. Overall, *Scutellaria integrifolia* currently appears to be more secure in most of its southern and western range: south from New Jersey to Florida, west to Texas and inland to southern Ohio, Missouri, and Kentucky. It is ranked "SR" for many of those states – reported but not locally reviewed. It fares least well at its northern and western/midland reaches: extirpated in Massachusetts, and critically imperiled (S1) in Connecticut, New York and Oklahoma.

One population in Connecticut is relatively small, although it appears to be stable or even growing. While recent mowing should have removed encroaching vegetation as a threat, potential sale of the property for development warrants concerted and immediate attention. The other population is larger and more isolated, though subject to deer browse; protection for the property is being sought.

Within its distribution *S. integrifolia* occupies a variety of habitats that range from pine barrens to bogs. Common features of preferred habitat include, but are not limited to: sandy, acid and low nutrient soils with variable soil moisture and sometimes, clay subsoils; wetlands and xeric sites near wetlands; meadows, edges and border areas; high to medium light availability; and periodic disturbance. In New England, *S. integrifolia* has been found in fields, wet meadows, and the borders of wood and thickets, often in sandy soils and often near wetlands. Historical records in Connecticut indicate concentrations along the Connecticut River Valley and the shoreline.

The species has a variable habit, growing from 30-60 cm high, with single or multiple square stems that are covered in short hairs. Upper leaves are oblong to lanceolate of a light green color, and lower leaves are somewhat crenate. It is noted for its conspicuous July blooming of large purple-blue flowers, the lower lip of which have a white band, and for the distinctive hump in the corolla that characterizes all skullcaps. Also characteristic are the calyces, the bottom portion of which form small, persistent "spoons" after ripening. It is a perennial that reproduces sexually and perhaps asexually from rhizomes, and occurs in populations of low density and variable size.

The bulk of proposed conservation measures will focus on Connecticut, where the plant appears to have always been more common than in its northernmost reaches in Massachusetts. Objectives are to: 1) ensure the viability of 5 populations with 50 genets (80% flowering) and 100 stems, with two populations having one subpopulation each of 20 genets (80% flowering) and 40 stems, 2) protect against catastrophic events by establishing a seed bank of wild seed, and 3) conduct biological studies to inform management and introduction measures. The goal of five populations, two with one subpopulation each, will be reached by a) protecting existing populations, b) conducting *de novo* searches of targeted areas (informed by historical records and habitat requirements), and c) establishing new populations (introductions).

# PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Because they contain sensitive information, full plans 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.

NEPCoP 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. If you require additional information on the distribution of this rare plant species in your town, please contact your state's Natural Heritage Program.

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# I. BACKGROUND

## INTRODUCTION

*Scutellaria integrifolia* L. (Lamiaceae), most commonly referred to as Hyssop Skullcap, is a summer perennial with a terminal raceme of purple-blue flowers. The flower is characteristic of the skullcaps, with its humped corolla, but is larger than most, earning the species one of its many common names, Large Skullcap (Britton and Brown 1913).

Massachusetts has at least two historical occurrences (Sorrie 1987), and represents the northernmost reaches of the species' distribution (Fernald 1950). Connecticut is the northernmost state of a current distribution that spans from Texas to the west, to Florida in the south and inland to southern Ohio, Missouri, Kentucky and Tennessee (Gleason and Cronquist 1963). To the south and west, the species appears to be more common, with a number of historical and current subspecies or varieties.

*Scutellaria integrifolia* inhabits a wide range of habitats throughout its distribution, ranging from pine barrens to wet meadows. A closer look indicates that many sites include the following: sandy soils with low nutrient levels, variable soil moisture, and clay subsoils; ecotones between xeric and mesic systems; medium to high light; and edges of clearings or fields and woods or shrublands.

In New England, *S. integrifolia* is most commonly a plant of roadsides and woodland borders, fields and wet meadows, often near wetlands and often in sandy soils. While its conspicuous floral display has assured that it is noticed, there is some evidence to suggest it is more likely to grow in small, scattered populations. In Connecticut, it has never been recorded as common, though there are numerous historical records of the plant, particularly between 1880 and 1929.

Like many in its family, it may be able to reproduce asexually. It is unlikely to establish a persistent seed bank, and is limited by light availability. While hybridization is known to the genus, and perhaps to this species in its southern range (Epling 1942), there is no indication that it will hybridize with species with overlapping distribution in Connecticut, such as *S. lateriflora* or *S. galericulata*. There is also no indication that the populations in Connecticut represents a unique gene pool; the species is considered to have great natural environmental plasticity (Collins 1976).

Its persistence in New England currently rests on two known populations in Connecticut. One is under threat by potential development and by invasive species, *Solidago* stands, and encroaching saplings. The other appears less vulnerable and perhaps more robust. Two occurrences, especially with one at risk, are insufficient to ensure the species' persistence in the region. Additional populations need to be identified and protected or established through introduction.

## DESCRIPTION

*Scutellaria integrifolia* is a perennial herb, averaging from 30-60 cm tall. Its stem is slender from a subligneous base (Fernald 1950) and covered with upwardly curled or short spreading hairs that may be glandular (Epling 1942). The stem may be simple or with arched-ascending branches, often with shorter axillary branches above (Fernald 1950). Individual plants may be single or multi-stemmed (Collins 1976).

Leaves occur in pairs, 3-8 below the flowers (Fernald 1950). Basal leaves are ovate or oval, frequently entire, and usually longer than 2 cm. Leaves are borne on subequal, slender petioles (Epling 1942, Fernald 1950), and are often quickly deciduous (Gleason and Cronquist 1963). Lower leaves may be crenate (Fernald 1950).

Flora descriptions reflect potential variability in width of median leaves from oblong to narrowly elliptical (Epling 1942, Fernald 1950); they are obtuse, sometimes subcordate and often crenate-dentate at the base (Britton and Brown 1913). The leaves generally become narrower further up the stem (Epling 1942, Fernald 1950). They are entire and hirtellous (various guides alternately describe the plant as "downy;" e.g., Mathews 1902), and average 35 mm long and 10 mm wide (Epling 1942). They may have petioles 2-10 mm long (Epling 1942) or be sessile above (Gleason and Cronquist 1963), and can be obtuse at the apex (Britton and Brown 1913).

Flowers are borne in terminal racemes 5-10 cm long or on a leafy elongate panicle, often with a pair of short auxiliary branches at the bases (Epling 1942, Fernald 1950). All but the lowest flowers are found in the axils of small, leaf-like bracts (Epling 1942), the uppermost equal in length to the calyx (Gleason and Cronquist 1963). Pedicels are short, supporting a calyx that is 2.5-3.5 mm then becoming 5-7 mm long and minutely pubescent. The corolla is 2-2.5 cm long, with large subequal lips (Fernald 1950) and is ascending or suberect (Gleason and Cronquist 1963). The upper lip is crested on its back; the lower is broad and spreading, and slightly notched in the middle. Pairs of flowers apparently start opposite one another while in the bud, and then swing around during development until they are somewhat alongside each other (Keeler 1917). Corollas are closed-lipped (Keeler 1917), and villosulous-puerant or rarely glabrate, 18-28 mm long (Gleason and Cronquist 1963). The lower lip cleft displays a white central band bisected lengthwise by a blue stripe extending into the tube, with occasional latitudinal stripes (Collins 1976). Corolla color is most commonly identified as a purplish-blue, light purple (Mathews 1902), or purple-blue and whitish (Fernald 1950). References to other colors, such as "rose-pink and whitish" (Rickett 1963) or "pale to bright blue, sometimes pinkish" (Godfrey and Wooten 1981) seem to refer to plants in the southern or western portion of the range. The four stamens beneath the "hood" are in two unlike pairs (Rickett 1963).

The ovary is split into four sections, each developing into a rough, one-seeded nutlet (Keeler 1917). Nutlets are 1.0-1.5 mm wide (Collins 1976), dark brown, and covered with thick scales (Epling 1942, and personal observation).

The species is considered polymorphic (Collins 1976). Herbarium specimens demonstrate a wide range of characteristics with regard to stems, branches, leaves, and flower color (personal observation).

The flowers of *S. integrifolia* are scentless (Lounsberry 1899) and the leaves are non-aromatic (Magee and Ahles 1999). *Scutellaria integrifolia* sometimes exhibits short rhizomatous branches (Collins 1976), which is usual for the genus (Epling 1942), and which was evident in two specimens at the University of Connecticut Herbarium (personal observation).

At the CT .001 (Glastonbury) site, leaves were still green during the unseasonably warm and dry fall of 2001, with some turning a deep shade of red/purple at the edges. Stems appeared to become more ligneous into the late summer and fall (personal observation).

Most characteristic of the species are: its narrow medium-to-light green leaves; its thin square stem with short hairs; its large purplish-blue flowers with a distinctive raised hump on the upper corolla; and its calyx, a distinct, closed, curving, rounded box, the style feature of which persists as a small "spoon." The unusual shape and light beige color of this feature persist into the late fall, aiding in identification without flowers. These characteristics alone should be sufficient for identification of the plant in New England.

Other *Scutellaria* that range into southern New England include: *S. lateriflora*, easily distinguishable by significantly smaller flowers, somewhat bushy habit and larger, shinier, veined leaves; *S. leonardi* Epling (much smaller) and *S. elliptica* Muhl., according to ranges defined by Epling (1942); and *S. galericulata* (represented by two voucher specimens at University of Connecticut herbarium [CONN]). At the only population examined for this report, a stand of *S. lateriflora* was found approximately 350 m away, in wetland conditions.

## TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

*Scutellaria integrifolia* belongs to a large genus found throughout the old and new worlds, though notably absent from many island groups. In the New World, the *Scutellaria* genus is the third largest group within the family Lamiaceae, with greatest diversity in the Central Mexican plateau, the southeastern U.S., and the northern Andes. This genus is considered the most sharply defined of the Lamiaceae, its most characteristic feature the humped corolla. *Scutellaria integrifolia* L. is included in the Annulatae section of the species, most closely related to *S. elliptica* Muhl., as well as to *S. arenicola* Sm. and *S. altamaha* Sm. (Epling 1942).

There is evidence of hybridization within the genus (Gill and Morton 1987), as well as within the section Annulatae, most especially in the Gulf and South Atlantic states (Epling 1942). There are some subspecies listed for *S. integrifolia*, restricted to the southern portion and western portions of its range (e.g., Cronquist 1981), though not all have stood the test of time (e.g., Penland 1924, Collins 1976). The species seems to be polymorphic (Collins 1976). On close examination, some of what were considered subspecies are now identified as synonyms. Those listed by the Atlas of Florida Vascular Plants (Institute for Systematic Botany 2000), include *S. caroliniana* Poir, *S. hyssopifolia* L. var. hispida (Benth) Reveal, *S. hyssopifolia* L. var. major Chapm., *S. integrifolia* L. forma rhodantha Fernald, *S. integrifolia* L. var. hispida Benth, *S. integrifolia* L. subsp. hispida (Benth.) Epling, *S. integrifolia* L. subsp. typica Epling, *S. integrifolia* L. var. hyssopifolia (L.) Pursh, *S. polymorpha* A. Ham., *S. polymorpha* A. Ham. var. hyssopifolia (L.) A. Ham and *S. teucriifolia* Sm. Additional synonyms cited by The Scutellaria Group (see references for internet address), include *S. integrifolia* var. floridana, *S. integrifolia* var. glabriuscula, *S. integrifolia* var. integrifolia, *S. integrifolia* var. integrifolia , *S. integrifolia* var. multiglandulosa Kearney, and *S. intermedia* M. Pop.

Epling identifies two variant "races" of *S. integrifolia*: *typica* (distinguished by capitate glands on calyces and inflorescences), and *hispida* (with a hairy or glabrous palate). The subspecies identified for Connecticut is *typica*, and as with all *typica* north of Florida, it is eglandular (Epling 1942). These distinctions are not noted elsewhere in the literature, and these terms do not appear to be in use.

The species is consistently referred to as *Scutellaria integrifolia* L. in New England, with no subspecies in this part of its range. This consistency belies a history of misapplication of names for specimens, at least one specimen that included more than one species, and misidentification of species type as documented by Reveal (1986) and described by him as "exceedingly complex". The confusion begins with Linnaeus' identification in 1753, includes (among others) Smith in 1815 and Epling in 1942, and ends with Reveal's 1989 proposal to maintain the current nomenclature, despite its checkered past (for details see Reveal 1986 and Reveal 1989). The current proposal is to maintain the *Scutellaria integrifolia* name, as identified by Linnaeus, Sp. Pl. 599, 1753 using Clayton 105 (BM) as the type. *Scutellaria hyssopifolia* L. remains a synonym.

*Scutellaria integrifolia* goes by many common names, including:

- Hyssop Skullcap (most common, especially in floras covering northern species)
- Large Skullcap (referring to the relatively large size of the flowers; Britton and Brown 1913)
- Larger Skullcap (Mathews 1902)
- Rough Skullcap (due to down on stem)
- Helmet Skullcap (Wunderlin 1998)
- Narrow-leaved Skullcap (having narrow leaves relative to others in the genus; Duncan and Duncan 1999).

The *Scutellaria* refers to the "dish" shaped form of the fruiting calyx (Keeler 1917). The species epithet "*integrifolia"* translates roughly into "plain-edged leaf" (Rickett 1963). The common name, "skullcap," refers to the hump of the upper lip of the corolla.

## SPECIES BIOLOGY

Most members the *Scutellaria* genus are herbaceous, variable as to underground parts, and perennial (Epling 1942).

References to blooming times are variable, ranging from May to August. Occurrence records in Connecticut, where specified, indicate July. Graves in Connecticut (1910) puts flowering in July; Seymour (1969) is more specific, with flowering times in Massachusetts and Connecticut identified as July 10-20. A longer flowering period is identified for plants in the southern portion of its range; for example, Wunderlin (1998) identifies flowering from spring to fall in Florida. The blooms are large and numerous (e.g., Frei and Fairbrothers 1963).

Interestingly, in the southern portion of its range, different species within the section (e.g., *S. integrifolia* and *S. alabamensis*), may flower at the same time when the they are allopatric, but flower a month or more apart when sympatric (Collins 1976). When sympatric with 8 of the 15 species identified in a revision of the Annulatae section, *Scutellaria integrifolia* will bloom before the others (Collins 1976).

Information is lacking regarding pollination for the species. However, the family exhibits flowers that are hermaphrodite, dioecious, or gynodioecious (fairly commonly), and is most often pollinated by insects, (hymenoptera, lepidoptera, or diptera). In an experiment in which phenotype information was collected from plants raised from seed in a growth chamber, "abundant" fruit was formed by cleistogamous flowers, indicating that cleistogamy may occur to some extent in the wild (Collins 1976).

Experiments exploring both intra and interspecific crossing of *Scutellaria* species were conducted by Collins (1976). In intraspecific crosses, pollen was applied to the stigma of different plants from the same natural population. The maximum possible number of seeds formed was based on 4 mature nutlets per fruiting calyx (i.e., 100% seed formation for 100 calyces is 400). Seed formation for *S. integrifolia* in the wild (presumably in Tennessee), as based on the random sampling of fruiting racemes in 5 populations, was 85%-93%. It was also high (76%-89%) for 3 other species in the section Annulatae. Experimental intraspecific crosses resulted in only 40% seed set; this low rate was attributable in part to mechanical damage and misapplication of pollen. Interspecific crosses of *S. integrifolia* and *S. mellicharpi*) resulted in 0% seed set. Interspecific crosses of other *Scutellaria* sp. yielded seed set rates of 0-5%, some of which may represent accidental self-crossing.

In cultivation, the species is considered self-sowing if it is not dead-headed (i.e., removal of flowers before they go to seed; Riverview Flower Farms 2001). It is available from many native species seed catalogues and nurseries. Seeds have been germinated at NEWFS with success; of ten seeds sown without stratification outside in regular potting soil, three germinated and the resulting plants may persist in the garden (Chris Mattrick, New England Wild Flower Society, personal communication). At Norcross Wildlife Sanctuary, seeds purchased from North Carolina (We-Do Nursery) were subjected to moist, cold stratification and yielded germination of 20-30%. Plants did not fair well in the garden, and survival is not confirmed (Leslie Duthie, Norcross Wildlife Sanctuary, personal communication). Seeds are non-endospermic (Watson and Dallwitz 1992).

Germination experiments conducted by Collins (1976) on more than 1,800 seeds from southern populations of *S. integrifolia* and three other species in the Section indicate the likelihood of the presence of an inhibitor(s), and hence, dormancy. Tests were done by germinating seeds in covered petri dishes with filter paper moistened with distilled water in refrigerated, programmed incubators. Seeds were exposed to 12 hours light (at $76^{o}$ F) and 12 hours dark (at $63^{o}$ F). Treatments included soaking in water for 3 days (with water changes), removing pericarps, and adding gibberellic acid (GA) to stimulate germination. The results indicate that germination rates after 150 days in all cases ranged from a low of 70% to a high of 98%. The greatest germination rates after 20 days were with both fruit coats removed and application of GA (70%-88%). Soaking in water improved germination rates after 90 days (60%-84%), as did removing coats (70%-88%). Thus, it seems there is the potential to improve upon germination rates experienced in New England so far. Based on this information, it seems likely that *S. integrifolia* seeds in the wild in New England will remain dormant until the following spring.

After pollination, the calyx body expands. The enclosed nutlets may take from two to six weeks to mature. Nutlets are released when the upper calyx lobe abscises from the pedicel and lower lobe (Collins 1976). Some plants at the CT .001 (Glastonbury) site could be found with both flowers and maturing and mature seeds. A small number of entire calyces remained intact into the fall, with a seed or seeds enclosed; for most, the bottom portion (the "spoon") persisted into late fall (personal observations). The largest plant at the CT .001 (Glastonbury) site had a branching stem with approximately 64 calyces, all containing seeds (personal observations); 29 calyces were found on a single-stemmed specimen from CONN (voucher #11008).

Information on the ecology and life cycle for *S. parvula*, which shares a portion of *S. integrifolia's* range in middle Tennessee, may provide some information relevant to the species in New England. According to Baskin and Baskin (1982) *Scutellaria parvula* grows in soil that is 5 – 25 cm deep and exhibits seasonal water availability, from saturation to xeric. Flower buds are formed in early spring and flowering is acropetal. On most of the plants, the first few flowers on each inflorescence are cleistogamous. In spring, one to three underground stems are produced at nodes on the belowground base of the shoot, developing into moniliform tubers with numerous swollen internodes. Leafy shoots rise from terminal buds from each tuber, usually in September and October, but sometimes earlier depending on moisture conditions. They may mature and produce seeds during the growing season. Seeds are initially dormant, but show an increased capacity to germinate a month or two after ripening. If moisture and temperature conditions are not right, they may remain dormant for one or two years, germinating when conditions are favorable. All the plants overwinter as small rosettes, with tubers that will decompose.

*Scutellaria parvula* may reproduce asexually from tubers, which give rise to one plant then decay. Shoot emergence from tubers is slow and depends on long periods of adequate soil moisture, usually occurring in partially shaded edges of open glades where soil is 15-25 cm deep (Baskin and Baskin 1982).

Some of these observations are consistent with my observations in 2001 of plants at the CT .001 (Glastonbury) site. Mature fruiting plants were found singly or with one or two other smaller, immature plants within as little as 6 cm of the base of the mature stem. Some of these plants are likely to have arisen from rhizomes within the season, and were not reproductive. Mature individual plants and plant clusters occurred anywhere from .5 m to nearly 2 m apart. The largest of the plants was found closest to the wood's edge, with relatively deeper soil and litter. Removal of the litter layer at its base revealed evidence of what could be additional stems or asexual reproduction. Approximately six somewhat ligneous stems, some with dry stem and seed pod intact, rose from the base of a thickening stem at and just below ground. In addition, small purplish stems with medium/light green leaves ranging from 2 mm to 15 mm, crenate on petioles up to10 mm long, rose from the ground around this stem. There were nine such clusters, which presumably will continue growth in the spring.

A few of the CONN herbarium specimens also contained belowground parts. In one (dated 10/14/27), there were small leaf groupings similar to those I saw in the field. They appear to have sprung up at intervals, from a slender reddish subligneous rhizome that extends from the main stem. The rhizome turns sharply horizontal at the point where discoloration indicates the stem probably entered the ground. Other specimens with belowground parts dated earlier in the year (July) had no rhizomes, only a single fibrous root, occasionally with some with fine roots.

A growth chamber study of *S. integrifolia* and a potential variety (*S. integrifolia* var. Major) indicates that polymorphism responding to variations in environmental conditions may be responsible for differences in habit mistakenly attributed to subspecies genetic variation. An experiment conducted by Collins (1976) showed that seeds from a mostly uniform population can produce noticeably different plants depending on soil conditions, and that seeds from noticeably different parents can produce similar plants when grown in similar conditions.

This claim to polymorphism is supported by the variety of forms displayed by voucher specimens at CONN. Specimens from within Connecticut and outside the region (Louisiana, New Jersey, Florida, Pennsylvania, and Tennessee) show a wide variety of a number of characteristics including the degree to which lower leaves are crenate (vs. entire or more lobed), the shape (single stemmed vs. multi-branching vs. very bushy), the roots or shoots coming from the rhizome, the size of flowers, the color of flowers (distinctly blue vs. bluish purple vs. purple), the size of leaves, the point at which (ascending up the stem) they become lanceolate (vs. crenate) and the spacing of the leaf groups along the stem.

Some seeds identified as *S. integrifolia* grown at the Garden in the Woods grew into plants that behaved like annuals. However, these potentially misidentified *Scutellaria*, as well as others of the genus grown there, may provide some information applicable to *S. integrifolia*. The plants were pollinated by bumblebees, and were eaten by larvae of tiny, tortoise shell-colored moths that staff were unable to identify (Bill Cullina, New England Wild Flower Society, personal communication). *Scutellaria integrifolia* may also be preyed on by deer (Bill Moorhead, personal communication).

The genus contains many members with historical or potential human use for medicinal or anti-pest properties. Examples include isolates from *S. galericulata* that may deter pest feedings (e.g., Rodriguez et. al. 1993), and attributes of *S. baicalensis* with the potential for pharmacological application (e.g., Baylor et. al. 1992). There are records of medicinal herbal use of *Scutellaria* sp., primarily *S. lateriflora*. For example, the King's American Dispensatory identifies S. *lateriflora* as being "tonic, nervine and antispasmodic". *Scutellaria integrifolia* is thought to have similar properties, though it is considered more bitter (King 1898).

## HABITAT/ECOLOGY

*Scutellaria integrifolia* can grow in a variety of habitats (see Table 1). It is found in full sun or light shade. Soil is often, though not always, low nutrient, acid, and sandy. It may have clay subsoils and seasonal variability with regard to moisture levels. It is often, though not always, found in or near wetlands such as swamps, wet meadows and bogs. Other habitat types include dry woods and wood/field edges, and wetland/upland ecotones. It is tolerant of periodic disturbance such as flooding, fire, and mowing. *Scutellaria integrifolia* is more common in the southern and western reaches of its range. In the north, it is historically noted because of its showy flowers, but appears to have always been scarcer. It forms populations of scattered plants (i.e., of low density). There is little census information from which to estimate population size; however, it appears that populations are larger in the south and west than in the north.

There are numerous references to wetland habitats and mention of moist soils (e.g., Penland 1924), though with numerous exceptions it is difficult to call this a wetland plant. At the Patuxent Research Refuge in Maryland, *S. integrifolia* is termed a "characteristic wet meadow species" and is found in an area of post agricultural fields with compact clay subsoil (Hotchkiss and Stewart 1947). In New Jersey, it is found in wet depressions of acid soil (Montgomery 1963). In Louisiana, it occurs in a wet pine site with seasonal variability (Haywood and Grelen 2000). Of the seven CONN vouchers of Connecticut plants with habitat notes, six were found in moist areas; of the ten historical and current occurrences with habitat information in New York, seven are in or near wetlands (three in uplands). *Scutellaria integrifolia* is listed as both FACW (facultative wetland species; i.e., with a 67-99% probability of occurrence within a wetland; Resource Management Group 1993) and FAC (facultative species; i.e., equally likely to occur in wetland and upland habitats; Institute for Systematic Botany 2000).

Its presence in a damp meadow near a salt marsh in Long Island (Ferguson 1925), and near the gulf coast in Tallahassee Florida (Gano and McNeill 1917), as well as occurrence records from New York and Connecticut, indicate some salt tolerance. Two historic populations in New York were in a salt marsh (New York Natural Heritage occurrence records); at least 1 extant and 2 historical populations in Connecticut were on or near the coast in Milford and Lyme (data from CONN specimens).

At least as frequent as the references to wetlands are the references to dry or sandy conditions: e.g., "dry ground" (Mathews 1902), and "plants growing in sandy soil" (Lounsberry 1899). In some cases, the sandy soils do not mean that the sites are consistently dry, such as those with clay subsoils. For example, *Scutellaria integrifolia* was found in abandoned agricultural fields in a region characterized by alluvial and sandy loams with clay subsoils (Oosting 1942) and in a Louisiana study area with "clayey lower subsoils" (Haywood and Grelen 2000).

The ability to populate sandy soils is supported by an analysis of three soil samples from within the area of the CT .001 (Glastonbury) population done by the Connecticut Agricultural Experiment Station. Two were found to be sandy loam; the third was loamy sand. The topsoil was as thin as 4 cm at this site, overlying bedrock. The surficial geology of the CT .005 (Lyme) site is alluvium overlying undifferentiated coarse deposits (Stone et. al. 1992). Many of the voucher specimens from CONN are from coastal areas (e.g., Milford, Lyme) or the Connecticut River Valley (e.g., S. Windsor, E. Windsor), where sandy soils would be likely.

*Scutellaria integrifolia* seems to prefer low-nutrient soils. Samples from the CT .001 (Glastonbury) site were analyzed by the Connecticut Agricultural Experiment Station using the Morgan Soil Testing System, which provides estimates on nutrient availability and is intended to determine crop growing conditions and make soil amendment recommendations (Greg Bugbee, Connecticut Agricultural Experiment Station, personal communication). Nutrient availability from the three samples was most notable for low nitrogen levels and somewhat high calcium levels (nitrate nitrogen ~3ppm-6ppm; ammonium nitrogen ~12ppm; calcium ranging from ~500ppm to ~1200ppm).

| Table 1: Habitat types in which *Scutellaria integrifolia* has been found | | |
|---|---|---|
| **Region** | **Habitat description** | **Source** |
| Northern North America | Fields<br>Borders of woods, thickets and clearings<br>Fields and open wood, especially on the coastal plain<br>Moist borders of fields and wood along roadsides | Seymour (1969)<br>Fernald (1950)<br>Gleason and Cronquist (1963)<br>Keeler (1917) |
| Massachusetts | Fields, meadows<br>Adventive (pioneering ruderal areas) | Sorrie (1987)<br>Coddington & Field (1987) |
| Connecticut | Shrubby swamp, wet meadow, moist sandy grounds, dry roadside, Wood's edge near wet swale<br>Sandy fields and in woodland, either dry or moist | CONN voucher notes Personal observations (2001)<br>Graves et. al. (1910) |
| New York | Damp meadow, woods' edge, oldfield next to boggy opening, swamp, dry oak woods<br>Dry hilly woods; damp meadow near salt marsh | New York Natural Heritage Program Element Occurrence records<br>Ferguson (1925) |
| New Jersey | Along edge and within forest in piedmont plain<br>Undrained depressions of acid soil<br>Meadow along river<br>Roadsides and wetlands<br>Slough next to abandoned railroad | Frei and Fairbrothers (1963)<br>Montgomery and Fairbrothers (1963)<br>Monachino (1947)<br>Karl Anderson (1995)<br>CONN voucher |
| Pennsylvania | Rich woods near stream | CONN voucher |
| Maryland (Patuxent Research Refuge) | Characteristic wet meadow species | Hotchkiss and Stewart (1947) |
| Southeastern seaboard (VA To FL) | Savannahs, pine barrens, low meadows and roadsides | Radford et al. (1968) |
| Southeast | Woods, pastures, thickets | Small (1933) |
| Georgia | Drier, more open woods | Harper (1900) |
| Florida | Sandhills, flatwoods, and hammocks;<br>Upland mixed forests, flatwoods, sandhill, marshes, cypress swamps, ruderal areas<br>Moist rich ground near Jacksonville | Wunderlin (1998)<br>Biological Research Associates (2000)<br>CONN voucher |
| Tennessee | Low sandhill with scrub oak and pine | Gano (1917) |
| Kentucky | *Liquidambar styraciflua* temporarily flooded forest alliance | Foti et al. (1994) |
| Louisiana | Low black soil near bayou<br>Very common; loblolly pine woods, wet area | CONN vouchers |
| Texas | Deciduous woodlands on uplands; eastern oak association<br>Eastern edge of state; pineywoods, gulf prairies and marshes | Oberholser (1925)<br>Biota of North America Program (2002) |
| Wetlands | Bogs, meadows, wet thickets | Godfrey and Wooten (1981) |

Naturally low nutrient levels are characteristic of many of the sites where *S. integrifolia* is found (e.g., pine barrens, bogs); other sites were also found to have low natural fertility (e.g., Haywood and Grelen 2000). There are no references in the literature to indicate that the species is more likely to occur in areas with higher calcium levels, such as those with limestone bedrock. In Connecticut, for example, not one of the 21 historical or current occurrences is located in Connecticut's "marble valley."

There are references in the literature to acidic soil (e.g., Montgomery 1963, Foti et al. 1994). The soil at the CT .001 (Glastonbury) site was also acidic with pH values that ranged from 4.8 to 5.2.

*Scutellaria integrifolia* appears to be tolerant of, and indeed may prefer, periodic disturbance. It has occurred in a site where there were common occurrence cycles of fire, frost and storms (Gano and McNeill 1917) and in burned plots (Haywood and Grelen 2000). At the CT .001 (Glastonbury) site it occurs in an area regularly mowed (Kile Neilson, Algonquin Gas, personal communication). One of the sites in New York is also adjacent to a utility right-of-way (New York Heritage Program occurrence records). At the CT .005 (Lyme) site it occurs in an area that is probably flooded in the spring and hosts deer (Bill Moorhead, personal communication). There is no indication that it requires disturbance for germination; disturbance may serve to remove competitors for light or space.

The majority of habitat types listed in Table 1 refer to some kind of moist or wetland conditions; most of the others indicate especially dry conditions. While it seems to have a preference for moist habitats, and can tolerate xeric conditions (perhaps due to reduced competition), a study conducted in a portion of the Great Dismal Swamp found it present on 2 of 4 transects crossing a transition zone from wetland to upland (Carter et. al. 1994). *Scutellaria integrifolia* was also found in the ecotone between granite outcrops and surrounding mesic vegetation on Arabia Mountain in Georgia (Houle 1987).

*Scutellaria integrifolia* appears to have been rare in New England at least since the late 1800's (Britton 1881, Ferguson 1925, Seymour 1969). There is evidence to indicate that the species is present at low densities, in some cases in small populations. This is particularly so in the northern portion of its range, where populations may include ten to fifty scattered plants (e.g., Steve Young, New York Natural Heritage Program, personal communication). At the CT .001 (Glastonbury) site plants are found over a relatively defined area in small clumps. A vascular plant list for the Great Smoky Mountains National Park (Great Smoky Mountains National Park 2001) identifies the plant as inhabiting low to mid elevations (850 ft to 4,500 ft [280 m to 1,500 m]) and in "several locales or scattered small populations." A trend toward small populations of low density is also supported by results from a study conducted in Piedmont North Carolina, which looked at species frequency and density in post agricultural fields abandoned for one, two and three years (Oosting 1942). In this study, *Scutellaria integrifolia* was found in oldfield habitat of variable stages of succession and with variable dominant vegetation and plant community composition, at consistently low frequencies and densities. In his field surveys of Tennessee, Paul Somers of the Massachusetts Natural Heritage and

Endangered Species Program did not observe *S. integrifolia* in large numbers (personal communication).

Most references are to habitats that have high (e.g., ruderal) to medium (e.g., light woods) light levels; very rarely is it found in dense woods. Preferred habitats may have an overall lower herbaceous canopy (personal observation; Bill Moorhead, personal communication). While light availability may be a limiting factor, *S. integrifolia* may also be efficient at making use of available light. For example, Hirose and Werger (1994) conducted a study to evaluate nitrogen concentrations and photosynthetic capacity in a community of mixed herbs of different heights in a floating fen area with low soil fertility in the Netherlands. *Scutellaria galericulata* was one of the understory herbs they found that was highly efficient at both absorbing fluctuating light and using available nitrogen.

## THREATS TO TAXON

In considering current threats to the taxon in New England, it may be helpful to first explore potential reasons for the reduction in populations over the last century. Changes in the level of forest cover (most of Connecticut was deforested at the turn of the last century) will have affected habitat type availability, and competition. Development and changes in land use may have destroyed populations or altered habitats; many of the towns listed by Graves (1910) as having populations have seen significant development. The taxon often occurs in or near wetlands, which have been subject to filling and draining, especially during the first half of the last century, though this continues at an alarming rate even within the past few decades (Metzler and Tiner 1991). Previous ecotone areas have thus probably developed into more xeric ecosystems. Agriculture may have displaced *S. integrifolia* from areas with alluvial soils (such as in West and East Windsor). Additionally, lowland habitats may have increasingly received run-off containing fertilizers. Its presence in conditions with low nutrient levels may indicate that higher nutrient levels may favor its competitors. In New York, most historical populations were extirpated by development, and human activity remains the main threat, as plants "live in man-made habitats" (Steve Young, personal communication).

I have visited one Element Occurrence (EO) where disturbance was evident, and the plant was absent. It is an historical occurrence in South Windsor, in an agricultural area adjacent to the Connecticut River. While potential habitats do exist, there have been many changes subsequent to the original report: different property layout due to the creation and decay of irrigation ditches; changes to usage and cover; different crops and farming methods; development on borders; decades of alluvial amendment; and pesticide and fertilizer applications.

At the only site I visited with an extant population (CT .001 [Glastonbury]) the most uncertain and potentially catastrophic of threats are sale of the property and subsequent development and disturbance of the site by a utility for routine or emergency maintenance. Three vegetative threats were readily apparent: a spreading population of *Celastrus orbiculatus*; encroachment of tree saplings; and an expanding stand of goldenrod. The most immediate and significant effect would be decreasing light levels and possibly competition for water. An additional threat is management of the area by ill-timed mowing – mostly likely to be deleterious during the "big bang" blooming period.

Plants at this site showed signs of pests (presumably insect predation, though limited). Plants at the other known extant population in Lyme (CT .005) showed sign of deer browse in one of the two years of surveys. This population may also be threatened by succession (e.g., shrubs and saplings) if the property is not regularly mowed at an appropriate time. Although the site is likely to be seasonally flooded, this is not likely to present a threat.

In sum, most likely threats to historical populations are development (habitat destruction) and land use (habitat conversion). To extant populations (CT .001 (Glastonbury) and CT .005 (Lyme), threats include: potential development (habitat destruction); invasive species and changes to vegetative community due to succession (competition); management (e.g., mowing); and potential deer browse. It is unclear whether or not inbreeding is a problem for these populations. At least in the last century it appears that the species has a pattern of small, isolated populations in Connecticut, Massachusetts and New York (and possibly in other parts of its range; Steve Young, personal communication; Oosting 1942; Great Smoky Mountains National Park 2001), and appears to be polymorphic (Collins 1976; CONN voucher specimens). Barring evidence of genetic uniqueness in current populations, outcrossing may serve to protect populations from the effects of undetected, deleterious inbreeding. Alternatively, it may be unnecessary.

## DISTRIBUTION AND STATUS

### General Status

*Scutellaria integrifolia* is known to occur in two extant populations in Connecticut, and is now considered extirpated from Massachusetts. Historical accounts of the plant in Massachusetts indicate that state as the northernmost in its range; this is supported by various field guides and floras (e.g., Fernald 1950, Gleason and Cronquist 1963). There are other references, however, that cite Connecticut as the northernmost state with populations (Lounsberry 1899, Epling 1942). A 1909 map of occurrences identifies three counties in Connecticut (Fairfield, New Haven and Hartford; this is the only reference to a population in Fairfield county) and one in Massachusetts (Magee and Ahles 1999). Verified records in Massachusetts indicate its historical presence in Plymouth and Bristol counties; these date back to 1900. An additional, though unverified, population was identified in Worcester County (Coddington and Field 1978). It appears that the species has always been more rare in Massachusetts; it may have been ephemeral during timber harvest and farming (Paul Somers, personal communication).

Known extant populations of the species now range from Connecticut in the north, all along the eastern seaboard south to Florida, inland to southern Ohio, Kentucky, Tennessee, and west to Oklahoma and Texas (Gleason and Cronquist 1963). See Figure 1 for its North American distribution.

Clues can be gleaned from the literature regarding the distribution and corresponding population ecology of *S. integrifolia*. Seymour (1969) refers to the species as "rare" in New England. In a survey of South Amboy in Middlesex County, New Jersey it is listed as somewhat rare (Britton 1881), and is listed as "uncommon to, in some instances, very rare" in a study of the flora of Long Island (Ferguson 1925). The species has a prominent, noticeable inflorescence, which may be responsible for its listing in many flora despite rarity, scarcity or small populations. For example, a listing of eastern Texas flora identifies it as a "most conspicuous plant" (Oberholser 1925). A study done in the William L Hutcheson forest of New Jersey included *S. integrifolia* in a list of taxa "which were the greatest quantitatively in the number of flowers they produced both along the edge and within the forest" (Frei and Fairbrothers 1963).

It appears to be more common in parts of the southern and western range. For example, Wunderlin (1998) identifies it as "frequent" in its habitats of Florida, and in the southeastern seaboard it is seen "throughout" (Radford et al. 1968).

The NatureServe/Natural Heritage Programs rank *S. integrifolia* as G5, and its national ranking is N5 (demonstrably secure). In many of the states that make up its range along the eastern seaboard south of Delaware to Florida and west to Texas, it is reported but not reviewed locally. However, other information indicates the species is more common in these states, including the number of counties where the plant is reported to have populations, and references to its status as common, or frequent. It is ranked as S3, S5 and S? in six locations, and is falsely reported (SRF) in Rhode Island. It is ranked as S1 (critically imperiled) in 3 states: Connecticut, New York, and Oklahoma. *Scutellaria integrifolia* is listed as Endangered by Connecticut and New York. Table 2 below summarizes the distribution and conservation status of the taxon.

**Table 2. Occurrence and status of *Scutellaria integrifolia* in the United States and Canada based on information from Natural Heritage Programs.**

| OCCURS & LISTED (AS S1, S2, OR T &E) | OCCURS & NOT LISTED (AS S1, S2, OR T & E) | OCCURRENCE UNVERIFIED | HISTORIC (LIKELY EXTIRPATED) |
|---|---|---|---|
| Connecticut (S1); 2 counties[4] | District of Columbia (S?) | Alabama (SR) | Massachusetts (SX) |
| New York (S1); at least 2 counties[5] | Great Smoky Mountain National Park (P3) | Arkansas (SR); 20 counties[3] | |
| Oklahoma (S1) | Kentucky (S?) | Delaware (SR) | |
| | North Carolina (S5) | Florida (SR); 51 of 69 counties[2] | |
| | Ohio (S3) | Georgia (SR) | |
| | West Virginia (S?) | Louisiana (SR) | |
| | | Maryland (SR) | |
| | | Mississippi (SR) | |
| | | Missouri (SR) | |
| | | New Jersey (SR) | |
| | | Pennsylvania (SR) | |
| | | Rhode Island (SRF) | |
| | | South Carolina (SR) | |
| | | Tennessee (SR); 34 of 95 counties; mostly east[1] | |
| | | Texas (SR) | |
| | | Virginia (SR) | |

[1]University of Tennessee Herbarium (TENN); [2]ISB 2000; [3]The Biota of North America program 2002; [4]Connecticut occurrence records; [5]New York occurrence records

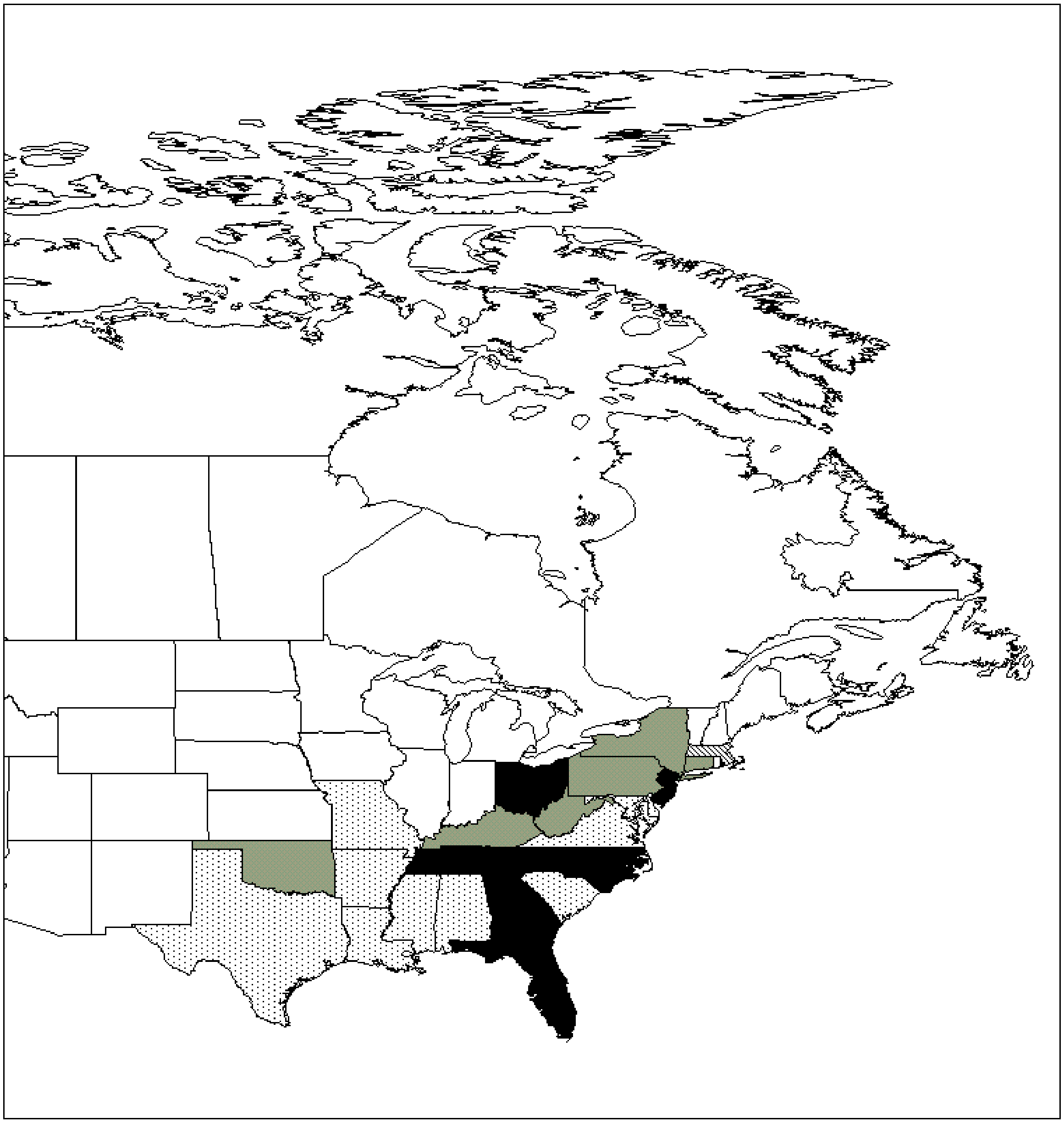

**Figure 1. Occurrences of *Scutellaria integrifolia* in North America.** States and provinces shaded in gray have one to five current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. States with diagonal hatching are designated "historic" or "presumed extirpated," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but not necessarily verified). See Appendix 3 for explanation of state ranks).

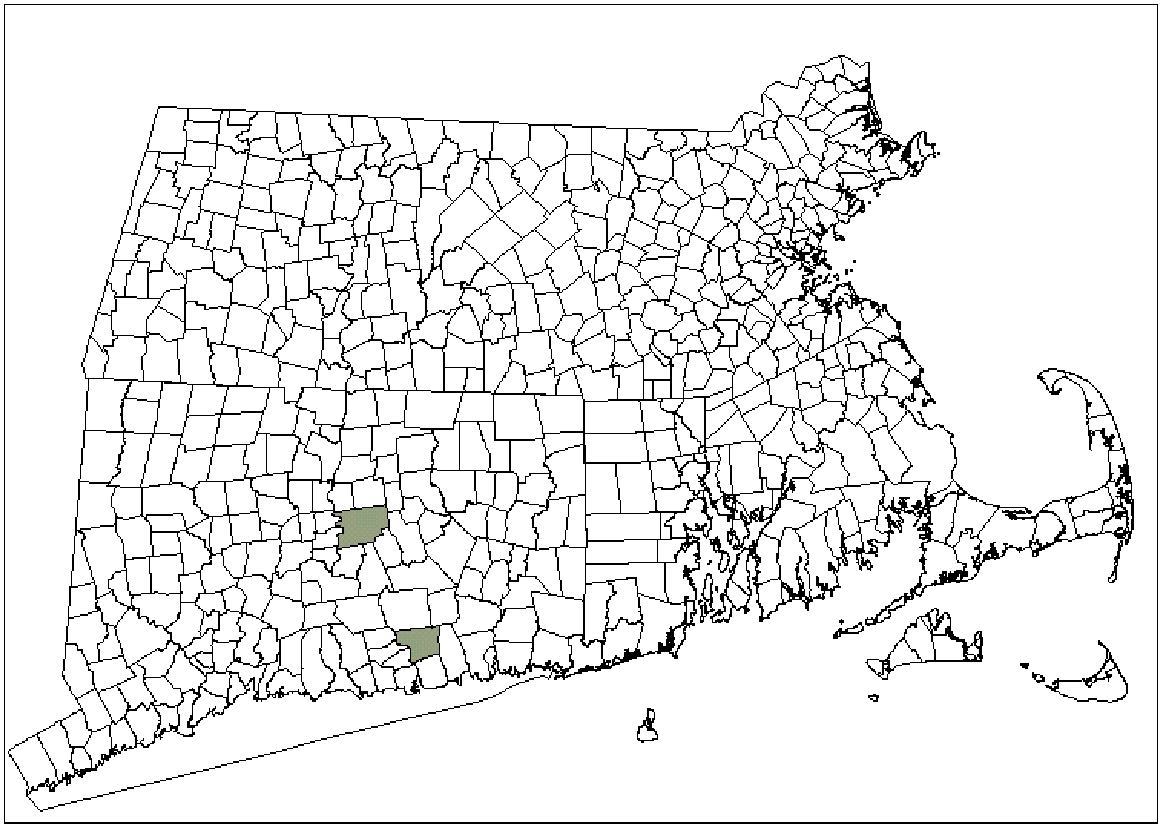

**Figure 2. Extant occurrences of *Scutellaria integrifolia* in New England.** Town boundaries for Connecticut, Massachusetts, and Rhode Island are shown. Towns shaded in gray have one to five current occurrences of the taxon.

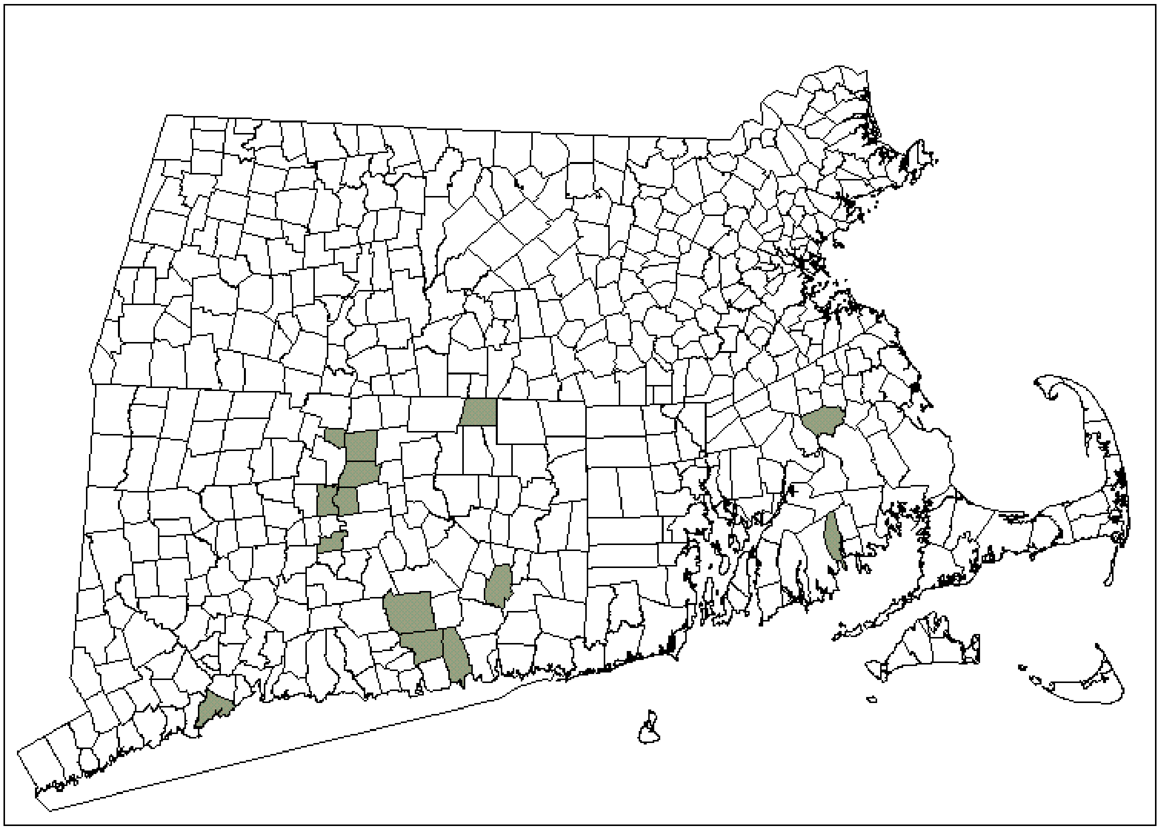

**Figure 3. Historic occurrences of *Scutellaria integrifolia* in New England.** Town boundaries for Connecticut, Massachusetts, and Rhode Island are shown. Towns shaded in gray have one to five historic records of the taxon.

**Other New England and Regional Occurrence Records**

In Massachusetts, *S. integrifolia* is considered extirpated. There are two historical occurrences dated 1900 in the towns of Bridgewater and New Bedford, in Plymouth and Bristol Counties, respectively (Sorrie 1987). These are substantiated with voucher specimens (Paul Somers, personal communication). The species is also listed as present in Worcester and Bristol Counties in 1970 by Coddington and Field (1978). However, this listing is not supported by a specimen record, and an examination of specimens at the herbaria at Clark University, University of Massachusetts, Harvard University and the Ecotarium in Worcester, as well as several published sources, has not turned up any specimens of this species or references to it (Robert Bertin, Holy Cross University, personal communication).

In New York, where the species is present but also ranked S1, there are four extant and 20 historical occurrences. Extant populations are in fair to poor condition (two are ranked C, one CD and the fourth D). See Appendix 2 for the New York Element Occurrence list.

## CURRENT CONSERVATION MEASURES IN NEW ENGLAND

No conservation measures are being undertaken, or are planned, for *S. integrifolia* by the Connecticut Department of Environmental Protection (CT DEP), the Massachusetts Natural Heritage and Endangered Species Program, or the New York Heritage Program at this time. The New England Wild Flower Society currently has four seeds collected from the CT .001 (Glastonbury) population in October 2001, and is planning to germinate them. There are no known seed banks of seeds collected from New England populations.

**Table 3. New England Occurrence Records for *Scutellaria integrifolia.* Shaded occurrences are considered extant.**

| State | EO # | County | Town |
|---|---|---|---|
| **CT** | **.001** | **Hartford** | **Glastonbury** |
| CT | .002 | New London | East Lyme |
| CT | .003 | Hartford | South Windsor |
| CT | .004 | New London | Lyme |
| **CT** | **.005** | **New London** | **Lyme** |

# II. CONSERVATION

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## CONSERVATION OBJECTIVES FOR TAXON IN NEW ENGLAND

The conservation objective for this taxon is to ensure the viability of five populations of at least 50 genets (80% flowering) and 100 stems, two with one subpopulation each of 20 genets (80% flowering) and 40 stems. This objective will be accomplished through protection of existing or newly identified populations, *de novo* searches, and introductions; establishment of a seed bank at least for the short term; and by gathering additional information about the species' biology and ecology in order to ensure population viability. Reassessment of these goals should be done when there is new information about the species, and when five populations have been established. Efforts will be focused on Connecticut, but will include *de novo* searches in likely habitats of historic sites in Massachusetts. The objectives and the actions proposed to achieve them should be sufficient to ensure the species' persistence in New England.

The target number was chosen based, in part, on what may be logistically feasible. Achieving the goal will require the protection and monitoring of two known populations and the identification or introduction of three others. Historical records and voucher specimens from1880-1910 (Graves et. al. 1910; CONN specimens) indicate as many as 16 populations in Connecticut; at the same time (1900) two were recorded in Massachusetts. Reestablishing this level would be unrealistic at this time, not only because of resource limitations, but also because of changes to habitat availability.

There is little census information available to inform proposals for target population size. The current size of the CT .001 (Glastonbury) population is approximately 38 genets (personal observation), the CT .005 (Lyme) population has approximately 50-100 ramets (Bill Moorhead, personal communication), and New York populations may include from 10-50 stems (Steve Young, personal communication). Fifty genets may be an ambitious, though achievable, goal for a robust population. Observations of the CT .001 (Glastonbury) population and information indicating stems arising from rhizomes (Collins 1976) support the goal of a greater number of stems than genets. Accounts of conspicuous blooms, and seed set and/or flowers on all mature plants in Glastonbury indicate that all genets should flower; the target percentage for flowering indicates 20% immature genets. As known populations are inventoried and monitored, and new populations discovered, these goals should be reassessed. It may be, for example, that smaller populations are viable, especially if augmented with subpopulations.

The proposal to establish subpopulations for two of the populations is not supported by any explicit information indicating the presence of subpopulations, but rather by a surmise that subpopulations may exist in the wild, and may serve to improve the viability of a population. References in the literature to the scattered nature of populations may indicate the presences of subpopulation(s). In addition, there are historical data indicating multiple populations within a town. The greatest number of populations was reported around the turn of the century (1893-1910; see Appendix 1), with 16 populations in Connecticut. Of these, 4 occurred in Milford, 2 in E. Windsor, and 2 in E. Haddam. In addition, there is both an historical and current EO in Lyme. Multiple records from the same town may be due to multiple vouchers from the same population, the same population visited over time, different but unrelated populations, or related populations (sub or meta populations). In both Milford and Lyme, populations were located near water, which may have helped to transport seeds. Thus it seems reasonable to establish subpopulations for at least two of the five populations.

*De novo* searches (concentrating on areas that meet habitat and other requirements) are preferable to introductions, which require greater resources. Searches for new populations have been successful for numerous species; for some, sufficient populations have been found to consider a change in state status, as is the currently the case for *Agrimonia parviflora* (Nancy Murray, Connecticut Natural Diversity Data Base, personal communication; Bill Moorhead, personal communication). Introduced populations will be used to help reach the goal; how many will depend on the results of *de novo* searches and on the results of germination and biological studies.

The emphasis for searches should be in Connecticut. *Scutellaria integrifolia* has been extirpated from Massachusetts; there are confirmed historical occurrences in only two towns (Sorrie 1987). The species appears to have always been more common in Connecticut than Massachusetts, which represents the extent of its northern range. However, it is recommended that *de novo* searches be conducted along utility right-of-ways in counties with historical occurrences (Bristol and Plymouth).

The CT .001 (Glastonbury) occurrence has been assigned an EO rank of C, and is threatened by development, competition, utility maintenance and mowing activities that are ill-timed or cover plants with debris. The CT .005 (Lyme) population appears more robust, and is threatened overall to a lesser degree, by deer browse and succession.

Both populations are isolated. It is not known, and unknowable without genetic and greenhouse studies, whether either population represents a gene pool significantly distinct from other populations, or conversely, one that has been weakened by inbreeding. Morphologically, plants from the CT .001 (Glastonbury) population do not appear to have characteristics that differ significantly from the range of characteristics represented by CONN herbarium voucher specimens from Connecticut and other states along the eastern seaboard or from descriptions in various floras. Collins (1976) has demonstrated the polymorphism of the species, producing variability from somewhat uniform specimens, and uniformity from variable specimens, depending on environmental conditions. Many previously identified subspecies or varieties have ultimately been rejected. There is no evidence to suggest that the gene pools of existing populations are unique. Since the species exhibits such plasticity, even if there were a demonstrable difference in genotype, it is not clear that it would warrant protection; rather, it may indicate the need for crossing with other populations. An influx of genes made available through pollen from the other population in Connecticut, or by New York plants, may benefit the populations' viability. Greenhouse studies that seek to document morphological differences in plants from seeds of different populations may provide more guidance.

A reassessment of the target goals should be conducted when new information is available from studies and when the population goals have been met. Much will depend on the results of *de novo* searches. Ideally, resources would be focused on ensuring the viability of existing populations, and possibly introducing subpopulations, with no need for establishing new populations. This may be unrealistic. Alternatively, introductions might be attractive because of ideal sites unearthed by *de novo* searches and study results that indicate the species will be easy to introduce. In this case new populations may be established despite the success of *de novo* searches.

Based on the factual information available about the species, comments and suggestions by those experienced in the field of conservation, and the reasoning above, the following are the recommended conservation objectives for *Scutellaria integrifolia* in New England. Actions required to achieve the objectives are explained in subsequent sections.

**1. Ensure the viability of five populations of at least 50 genets (80% flowering) and 100 stems, two with one subpopulation each of at least 20 genets (80% flowering) and 40 stems.** Initially, this requires protection and management of the two extant populations in Connecticut, CT .001 (Glastonbury) and CT .005 (Lyme). The second priority will be to conduct *de novo* searches, targeting towns with historical occurrences and areas where public or private non-profit ownership exists. The third step will be to introduce new populations into similar areas. The last step will be to establish and/or identify subpopulations for at least two populations.

**2. Protect against catastrophic events by establishing a seed bank of wild seed.** There is no evidence to indicate that annual banking of small quantities of seed from existing populations, at least until the target goal of five populations is established, will have any impact on the population viability or rate of growth. The disparity between apparently high seed set and new genets at the CT .001 (Glastonbury) site indicate that at least a portion of mature seeds may not be germinating. Since this population may currently be at risk, banking seeds from this site is a prudent step. Additional seed banking will depend on information from the other extant population (re: viability, seed set and new plants, threats, and potential to expand), germination rates for banked seeds, and the achievement of the target goal of five populations.

**3. Conduct biological studies, including germination, to inform management and introduction measures.** Studies will provide information necessary to assess the health of extant populations, project population viability, determine habitat requirements, and establish new populations. In addition, studies may help determine whether to mitigate potential inbreeding with cross-pollination using pollen from plants of other populations in Connecticut or New York.

# III. LITERATURE CITED

Anderson, C. 1995. Field report notes: Pine Barrens, Burlington County, New Jersey, 6/18/95. *Bulletin of the Torrey Botanical Club* 122: 326.

Anonymous. Field Trip Reports. March-April 1947. *Bulletin of the Torrey Botanical Club* 74: 186-187.

Anonymous. 1995. Field Trip Reports: 6/19/95. *Bulletin of the Torrey Botanical Club* 122: 325-327.

Baskin, J. M. and C.C. Baskin. 1982. Ecological life cycle and temperature relations of seed germination and bud growth of Scutellaria parvula. *Bulletin of the Torrey Botanical Club* 109: 1-6.

Baylor, N. W., T. Fu, Y. D. Yan and F.W. Ruscetti. 1992. Inhibition of human T cell leukemia virus by the plant vlavonoid baicalin (7-glucuronic acid, 5,6-dihydorixyflavone). *Journal of Infectious Diseases* 165: 433-437.

Biological Research Associates, Florida. 2000. Available at http://www.biolresearch.com/plants/web_html/s/scute_int.html. (Accessed 12/13/01).

Biota of North America Program. 2002. Herbarium specimen browser. Available at http://www.csdl.tamu.edu/FLORA/tracy/main1.html. (Accessed 12/13/01).

Britton, N. L. 1881. Notes on the Middlesex County New Jersey Flora. *Bulletin of the Torrey Botanical Club* 8: 7.

Britton, N. L. and A. Brown. 1913. *An Illustrated Flora of the Northern United States, Canada and the British Possessions.* Volume III. Charles Scribner's Sons, New York, New York, USA.

Carter, V., P. T. Gammon and M. K. Garrett. 1994. Ecotone dynamics and boundary determination in the Great Dismal Swamp. *Ecological Applications* 4: 189-203.

Coddington, J. and K. G. Field. 1978. *Rare and Endangered Vascular Plant Species in Massachusetts*. New England Botanical Club in conjunction with the United States Fish and Wildlife Service. Region 5, Newton Corner, Massachusetts, USA.

Collins, J. L. 1976. A revision of the Annulatae *Scutellaria* (Labiatae). Ph.D. Dissertation, Vanderbilt University, Nashville, Tennessee, USA.

Cronquist, Arthur. 1981. A new species of *Scutellaria* (Lamiaceae) from California. *Brittonia* 33: 449-450.

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

Epling, C. 1942. The American species of *Scutellaria*. *University of California Publications in Botany* 20: 1-146.

Ferguson, W. C. 1925. Contributions to the flora of Long Island, New York, third paper. *Bulletin of the Torrey Botanical Club* 52: 133-136.

Fernald, M. L. 1950. *Gray's Manual of Botany*. American Book Company, New York, New York, USA.

Foti, T. X. Li, M. Blaney and K. G. Smith. 1994. A classification system for the natural vegetation of Arkansas. *Proceedings of the Arkansas Academy of Science* 48: 50-62.

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

Gano, L. and J. McNeill. 1917. Evaporation Records from the Gulf Coast. *Botanical Gazette* 64: 318-329.

Gleason, H. A. and A. Cronquist. 1963. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. D. Van Nostrand Company, Inc., Princeton, New Jersey, USA.

Gill, L. S. and J.K. Morton. 1978. *Scutellaria chruchilliana* – Hybrid or Species? *Systematic Botany* 3: 342-348.

Godfrey, R.K. and J.W. Wooten. 1981. *Aquatic and Wetland Plants of Southeastern United States Dicotyledons*. University of Georgia press, Athens, Georgia, USA.

Graves, C. B., E. H. Eames, C. H. Bissell, L. A., E. B. Harger, and C. A. Weatherby. 1910. *Catalogue of the Flowering Plants and Ferns of Connecticut Growing without Cultivation*. State Geological and Natural History Survey. Hartford, Connecticut, USA.

Great Smoky Mountains National Park. 2001. Vascular plant list. Available at http://www.discoverlife.org/nh/cl/GSMNP/plant_Dicotyledoneae_GSMNP.html. (Accessed 12/13/01).

Harper, R. M. 1900. Notes on the flora of Middle Georgia. *Bulletin of the Torrey Botanical Club*, 27: 320-341.

Haywood, J. D. and H. E. Grelen. 2000. *Southern Journal of Applied Forestry,* 24: 86-91.

Hirose, T. and M. J. A. Werger. 1994. Photosynthetic capacity and nitrogen partitioning among species in the canopy of an herbaceous plant community. *Oecologia* 100: 203-212.

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

Houle, G. 1987. Vascular Plants of Arabia Mt. Georgia. *Bulletin of the Torrey Botanical Club* 114: 412-418.

Institute for Systematic Botany. 2000. Atlas of Florida Vascular Plants. Available at http://www.plantatlas.usf.edu/

Keeler, H. L. 1917. *The Wayside Flowers of Summer: A Study of the Conspicuous Herbaceous Plants Blooming Upon our Northern Roadsides During the Months of July and August*. Charles Scribner's Sons, New York, New York, USA.

King, J. 1898. *King's American Dispensatory / by Harvey Wickes Felter and John Uri Lloyd: entirely rewritten and enlarged.* Ohio Valley Co., Cincinnati, Ohio, USA.

Lounsberry, A. 1899. *A Guide to the Wild Flowers*. Frederick A. Stokes Company, New York, New York, USA.

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

Mathews, F. S. 1902. *Field Book of American Wild flowers*. G. P. Putnam's Sons, New York, New York, USA.

Metzler, K. J. and R. W. Tiner. 1991. *Wetlands of Connecticut*. Pages 82-85. State Geological and Natural History Survey of Connecticut, Hartford, Connecticut, USA.

Monachino, J. 1947. Field trip reports: August 4, Singac, New Jersey. *Bulletin of the Torrey Botanical Club* 74: 186-187.

Montgomery, J. D. 1963. A floristic comparison of the vascular plants of two sphagnous wetlands in New Jersey. *Bulletin of the Torrey Botanical Club* 90: 87-99.

Oberholser, H. C. 1925. The relations of vegetation to bird life in Texas. *American Midland Naturalist* 9: 564-594.

Oosting, H. J. 1942. An ecological analysis of the plant communities of Piedmont NC. *The American Midland Naturalist* 28: 1-126.

Penland, C. W. 1924. Notes on North American *Scutellarias*. *Rhodora* 26: 75-76.

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

Resource Management Group. 1993. *National List of Plant Species that Occur in Wetlands: Region 1, Northeast*. Resource Management Group, Inc., Grand Haven, Michigan, USA.

Reveal, J. L. 1986. Additional comments on Linnaean types of Eastern North American plants. *Botanical Journal of the Linnaean Society* 92: 161-176.

Reveal, J. L. 1989. Proposal to conserve *Scutellaria integrifolia* L. (Lamiaceae) with a conserved type. *Taxon* 28: 517-519.

Rickett, H. W. 1963. *The New Field Book of American Wild Flowers*. G. P. Putnam's Sons, New York, New York, USA.

Riverview Flower Farms. 2002. Florida Friendly Plants: Rough skullcap. Available at http://www.floridafriendlyplants.com/PLANT_LIST/ROUGH_SKULLCAP/rough_skullcap.html. Accessed on 4/12/02.

Rodgers, J. 1985. *Bedrock Geological Map of Connecticut*. Connecticut Geological and Natural History Survey, Hartford, Connecticut, USA.

Rodriquez, M. C. de la Torre, B. Rodriquez, M. Bruno, F. Piozzi, G. Savona, Monique S. J. Simmonds, W. M. Blaney and A. Perales. 1993. Neo-clerodane insect antifeedants from *Scutellaria Galericulata*. *Phytochemistry* 33: 309-315.

Seymour, F. C. 1969. *The Flora of New England*. The Charles E. Tuttle Company, Rutland, Vermont, USA.

Small, J.K. 1933. *Manual of the Southeastern Flora*. J. K. Small, New York, New York, USA.

Sorrie, B. A. 1987. Notes on the rare flora of Massachusetts. *Rhodora* 89: 113-196.

Stone, J. R., J. P. Schafer, E. H. London, and W. B. Thompson. 1992. *Surficial Materials Map of Connecticut*. Connecticut Geological and Natural History Survey, Hartford, Connecticut, USA.

The Scutellaria Group. 2001. *Scutellaria* species information and images. Available at: http://sphosting.com/cactus/page2gl.html. Accessed on 12/13/01.

University of Tennessee Herbarium. 2001. University of Tennessee (TENN). Available at www.bio.utk.edu/botany/herbarium/index.html. (Accessed on 12/13/01).

Watson, L and M. J. Dallwitz. 1992. Delta: Description Language for Taxonomy. The Families of Flowering Plants: Descriptions, Illustrations, Identification, and Information Retrieval. Version: 14th December 2000. Available at: http://biodiversity.uno.edu/delta/

Wunderlin, R.P. 1998. *Guide to the Vascular Plants of Florida*. University Press of Florida, Gainesville, Florida, USA.

# IV. APPENDICES

1. **Sixteen Additional Historical Occurrences of *Scutellaria integrifolia***
2. **New York Element Occurrence Records**
3. **An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe**

## Appendix 1. Sixteen Additional Historical Occurrences of *Scutellaria integrifolia*

| County | Town | Date | Source | ID | Reported by | Quotes from voucher sheets |
|---|---|---|---|---|---|---|
| New Haven | Milford | 7/24/1928 | Herbarium | 10665 | E. H. Eames | "Low, moist, somewhat acid meadow on coast" |
| New Haven | Milford | 10/14/1927 | Herbarium | 10532 | E.H. Eames | "Low, mossy meadow on coastal plain. Plentiful in our locality" |
| New Haven | Milford | 8/13/1929 | Herbarium | 11008 | | "Very wet shrubby swamp on coast" |
| New Haven | Milford | 7/12/1928 | Herbarium | 10652 | E. H. Eames | "Low meadow on coast" |
| Hartford | E. Windsor Hill | 7/13/1880 | Herbarium | | Rosa B. Watson | |
| Hartford | E. Windsor | 7/13/1902 | Herbarium; Graves | | C. H. Bissel | "Moist, sandy grounds" |
| Hartford | S. Windsor | 7/7/1906 | Herbarium | | CAW | "Roadside in dry ground no. of …" (undecipherable; ? Barber hire?) |
| Hartford | Hartford | 7/10/1898 | Herbarium; Graves | | H. S. Clark | Site: South Meadows |
| Hartford | E. Hartford | | Graves | | Weatherby | |
| Hartford | Rocky Hill | | Graves | | Bissell | |
| Hartford | Windsor Locks | | Graves | | Miss A. E. Carpenter | |
| Tolland | Union | | Graves | | G. Towne | |
| Middlesex | E. Haddam | 7/22/1893 | Herbarium | | Emma J. Thompson | |
| Middlesex | E. Haddam | | Graves | | W. E. Nichols | |
| New London | E. Lyme | | Graves | | Graves | |
| New London | Norwich | | Graves | | Mrs.E. E. Rogers | |

These records are in addition to those in the Element Occurrence Log Sheet of the CT Natural Diversity Database. KEY: Herbarium = UCONN, Graves = Graves et. al., 1910, ID# = herbarium specimen number

## Appendix 2: New York Element Occurrence Records

| EO Number | EO Rank | County | Habitat |
|---|---|---|---|
| .018 | H | Bronx | No data |
| .003 | F | Nassau | Damp meadow near salt marsh |
| .007 | F | Nassau | No data |
| .004 | H | Nassau | Damp meadow at salt marsh |
| .006 | H | Nassau | No data |
| .008 | X | Nassau | No data |
| .024 | C/D | Orange | Plants found along the open grassy/herbaceous patches along the south shore of a small, artificial lake. Most of the vegetation surrounding lake is shrubby and shaded by trees with broad crowns. South side of lake is much less disturbed than other sections. Some areas along the east shore were also less disturbed, but no plants found here. Associated species: *Aster lateriflorus, Erigeron strigosus, Prunella vulgaris,* various grasses, few sedges, other common forbs. |
| .015 | H | Richmond | No data |
| .016 | H | Richmond | No data |
| .013 | X | Richmond | No data |
| .011 | X | Richmond | No data |
| .014 | X | Richmond | No data |
| .012 | X | Richmond | No data |
| .022 | D | Rockland | Grassy area between woods and river, south of a power line |
| .001 | H | Suffolk | No data |
| .002 | H | Suffolk | Hilly dry oak woods |
| .005 | H | Suffolk/Nassau | No data |
| .020 | C | Ulster | In an old field next to woods but fairly close to a boggy opening in woods. The soil is Oquaga-Arnot-rock outcrop complex, sloping. Grass-sedge-forb cover continuous by sparse. One *Platanthera lacera* was seen. |
| .023 | C | Ulster | Fragment of an old field between road and lawn, partial shade, level, well-drained, |

| EO Number | EO Rank | County | Habitat |
|---|---|---|---|
| | | | among common forbs and graminoids |
| .019 | F | Ulster | No data |
| .021 | H | Ulster | Swamp, growing with *Ilex verticillata*, *Rhus glabra,* and blueberry |
| .009 | F | Westchester | Edge of woods |
| .017 | X | Westchester | Bog on high ground. Rare in Westchester County |
| .010 | X | Westchester | No data |

## 3: 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 als 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.