New England Plant Conservation Program

Desmodium cuspidatum (Muhl.) Loudon
Large-bracted Tick-trefoil

Conservation and Research Plan
for New England

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SUMMARY

Desmodium cuspidatum (Muhl.) Loudon (Fabaceae) is a tall, herbaceous, perennial legume that is regionally rare in New England. Found most often in dry, open, rocky woods over circumneutral to calcareous bedrock, it has been documented from 28 historic and eight current sites in the three states (Vermont, New Hampshire, and Massachusetts) where it is tracked by the Natural Heritage programs. The taxon has not been documented from Maine. In Connecticut and Rhode Island, the species is reported but not tracked by the Heritage programs. Two current sites in Connecticut are known from herbarium specimens. No current sites are known from Rhode Island. Although secure throughout most of its range in eastern and midwestern North America, *D. cuspidatum* is Endangered in Vermont, considered Historic in New Hampshire, and watch-listed in Massachusetts. It is ranked G5 globally.

Very little is understood about the basic biology of this species. From work on congeners, it can be inferred that there are likely to be no problems with pollination, seed set, or germination. As for most legumes, rhizobial bacteria form nitrogen-fixing nodules on the roots of *D. cuspidatum*. It is unclear whether there have been any changes in the numbers or distribution of rhizobia capable of forming effective mutualisms with *D. cuspidatum*. In the Midwest, *Desmodium cuspidatum* has been identified as an indicator species for frequently burned oak savannas and open oak woodlands. This precise community type does not seem to exist in New England. However, if *D. cuspidatum* is adapted to colonizing areas subject to occasional disturbances, especially fire, the decline of the taxon in New England may be due to increased fire suppression. A factor that has clearly contributed to the decline of the taxon is the intensive development of some of its former range, especially in the greater Boston area.

The primary conservation objectives for *Desmodium cuspidatum* are to protect and study the plant in the region and to understand and protect its habitat. Several actions should be undertaken to effect these objectives: protection of all current occurrences; thorough inventories and regular survey updates for all New England occurrences, historic and current, including in Connecticut and Rhode Island; *de novo* searches in suitable habitat for as-yet unreported populations; species biology research on a variety of topics; management of known occurrences; establishment of *ex situ* collections, for research and sources of plants for reintroductions; augmentation and reintroductions to current, historic, and other suitable sites, to approach historic levels in the region; and education of landowners and field biologists.

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

Desmodium cuspidatum (Muhl.) Loudon (Fabaceae) is a tall, herbaceous, perennial legume, considered rare in New England (Brumback and Mehrhoff et al. 1996). While the extent of the plant's current distribution in New England is unclear, apparently it is more common in southern New England. The species is not known from Maine, while its status is Historic in New Hampshire, with only three known occurrences, none more recent than 1906. Vermont lists *D. cuspidatum* as Endangered, with three extant sites. In Massachusetts, the species is "watch-listed," meaning it has no legal protected status, but is considered to be uncommon enough to be tracked by the state Natural Heritage and Endangered Species Program. There are five current and 25 historic occurrences of the plant in Massachusetts. The taxon is known from Connecticut and Rhode Island, but is neither listed nor tracked by the Heritage programs in those states. There are two current occurrences in Connecticut, known from herbarium specimens.

Outside New England, *Desmodium cuspidatum* ranges over the central and eastern United States, west to Iowa and Oklahoma, and south to Florida and Texas. In Canada, it is known from Ontario, where it is listed as S3. The plant is Status Historic in Delaware and the District of Columbia, S2 in Nebraska and Virginia, and S2S3 in North Carolina (see Appendix 7 for an explanation of S-ranks). Its global rank is G5.

Desmodium cuspidatum is listed as Division 2 in the New England Plant Conservation Program's (NEPCoP) *Flora Conservanda*, meaning that fewer than twenty current occurrences were known for the plant as of the time of writing (Brumback and Mehrhoff et al. 1996). Notes on the frequency of occurrence in all floras consulted indicate that the plant is now and has mostly been considered occasional to rare throughout New England (except Maine, where it is not known). It seems to be somewhat more common south and west of New England.

Desmodium cuspidatum has declined in at least those states (Vermont, New Hampshire, Massachusetts) where sufficient data exist to draw appropriate conclusions. While development can be blamed for many extirpations, much suitable habitat still exists in these states. This conservation plan will examine New England occurrences in detail, summarize known life history data, and suggest actions to be taken to prevent further erosion of this species' status in the region.

DESCRIPTION

The perennial, herbaceous legume *Desmodium cuspidatum* grows one to two meters tall, with glabrous or nearly glabrous stems and leaves in var. *cuspidatum*, the variety found in New England. The flowering panicle can be finely pubescent. The petioled leaves are divided into three leaflets, each six to 12 cm long. The leaflets are ovate to ovate-lanceolate and conspicuously acuminate. Each leaflet is subtended by a semi-persistent, lanceolate or subulate stipule, about eight to 17 mm long. The bracts of the leaves and, especially, of the flower buds are conspicuous, usually caducous, and cuspidate. The flowers are purple, with the calyx four to five mm long and the corolla six to 12 mm long, on pedicels four to eight mm long in a branched inflorescence. The fruit is a loment, with three to seven articles. Each uncinate-pubescent article is rhomboidal, about nine to 11 mm long and half as wide. The top edge of each article is slightly convex; the bottom edge is obtusely angled. (This description compiled from Britton and Brown 1897, Gambill 1953, Isely 1990, and Gleason and Cronquist 1991.)

In New England, *Desmodium cuspidatum* is sometimes confused with *D. canescens*. Seymour (1982) points out that, "When bracts and stipules have fallen, *D. canescens* and *D. cuspidatum* can be distinguished by glabrous petioles and faint veinlets of *D. cuspidatum* and densely hairy petioles and prominent veinlets of *D. canescens*."

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Desmodium cuspidatum (Muhl.) Loudon is a member of the legume family Fabaceae (Leguminosae), subfamily Papilionoideae, tribe Desmodieae, subtribe Desmodiinae (summarized in Bailey et al. 1997). Older taxonomies (summarized in Polhill 1981) place *Desmodium* species in the tribe Desmodieae; however, recent molecular and cladistic studies suggest affinities to the tribe Phaseoleae (summarized in Doyle 1994). The Desmodieae are largely an Old World tribe, with *Desmodium* the largest genus within the tribe, consisting of about 300 species. In Canada and the United States, there are about 49 species (NatureServe 2001), with 13 of these found in the six New England states (Gleason and Cronquist 1991).

Synonyms for *Desmodium cuspidatum* include (Schubert 1950):

Hedysarum cuspidatum Muhl. ex Willd.
Hedysarum bracteosum Michx.
Hedysarum grandiflorum Walt.
Desmodium bracteosum (Michx.) DC.
Desmodium grandiflorum (Walt.) DC.
Desmodium bracteatum Loud.
Meibomia bracteosa (Michx.) Ktze.
Meibomia grandiflora (Walt.) Ktze.
Meibomia cuspidata (Muhl. ex Willd.) Schindl.

Two varieties have been identified: *cuspidatum*, with glabrous stems and leaves, and *longifolium*, with pubescent leaves. Variety *cuspidatum* is the only variety found in New England. Variety *longifolium* tends to have a more western distribution. These varieties are not especially distinct; as Isely (1990) states, "The amount of pubescence, however, is quantitative and correlates unsatisfactorily with other features assigned to the ideal type; hence, much material is ambiguous."

SPECIES BIOLOGY

Very little is known about the basic biology of *Desmodium cuspidatum*. It has a long blooming and fruiting time of late July through September in New England (Seymour 1982; Weatherbee 1996; Magee and Ahles 1999). No descriptions have been found for such life history characteristics as: pollinator species, rhizobial species, insect pests, susceptibility to deer browsing, vegetative spread, seed dispersal, or population size variation over time, among others. Where known, *D. cuspidatum* biology is summarized below. Where no data exist for *D. cuspidatum* itself, research on related species is summarized in the expectation that these data may prove relevant.

Self-compatibility and Seed Set

Kalin Arroyo (1981) summarized known examples of self-incompatible legumes. For *Desmodium*, four species (out of about 300 in the genus) have been tested and none showed self-incompatibility. As Kalin Arroyo pointed out, tropical herbaceous legumes (*Desmodium* is largely a tropical genus) often inhabit savannas and other open areas prone to fire. These same legumes tend to have a high frequency of self-compatibility. She speculated that high frequencies of self-compatibility are an adaptation to unstable habitats. The degree of self-incompatibility in *Desmodium cuspidatum* is unknown. Although the species is probably self-compatible, if it does prove to be self-incompatible, the small and localized populations currently extant in New England would be likely to face severe problems in setting viable seed.

To make matters more complex, Desmodieae tend to have explosive pollen delivery systems triggered by "tripping" of the anthers (Kalin Arroyo 1981). Tripping systems evolved in cadence with bee pollination; other possible pollinators are excluded (Kalin Arroyo 1981). Kalin Arroyo summarizes a few cases in which, apparently, fewer bee species are visitors on temperate papilionates than on tropical ones. If *Desmodium cuspidatum* requires tripping by bees for out-crossing, it may be adversely affected by declines in number or diversity of native bees (Spira 2001). Thus, while *Desmodium cuspidatum* may be physiologically able to self-fertilize, it may not do so in natural conditions, where bee visits may be necessary for fertilization. On the other hand, different bee-pollinated legumes are often visited by the same bee species (Kalin Arroyo 1981), which may help mitigate the effects of decline in any one

pollinator species. The pollinator species for *D. cuspidatum* are unknown. Further research into self-incompatibility, pollination mechanisms, and pollinator species are needed for a fuller understanding of *Desmodium cuspidatum* life history.

There appear to be no data on seed set percentages in *Desmodium cuspidatum*. Observations at three sites in New England in the fall of 2001 showed what appeared to be reasonably high percentages of viable seeds being set, perhaps 30% to 50% of flowers, at all sites (MA #1 [North Adams], MA #6 [Holyoke], VT .001 [West Rutland]), although viability was gauged by the plumpness of ripe articles, not by examining the seeds within the articles (personal observation). In a study of *Desmodium nudiflorum*, a common congener in New England, 22 percent of the flowers produced fruit (Schaal and Smith 1980). In this taxon, pollination is effected by bumblebees largely, with out-crossing predominant.

For another legume, *Lupinus texensis*, Schaal (1980) demonstrated that of the approximately 2000 ovules each lupine plant produced, only 2.5% ever developed into seeds. This low seed set was then reduced further by abortion and seed predation. Schaal suspected that lack of successful pollination resulted in the low seed set and speculated that *L. texensis* may be producing large numbers of flowers over a long flowering period to ensure pollination in the face of scarce pollinators. As *Desmodium cuspidatum* has a very long flowering period (possibly as much as two months for an individual plant), it may also be adapted to a scarcity of pollinators. With the reduction in numbers and species of native pollinators in North America in the past few centuries (summarized in Spira 2001), successful out-crossing and pollination in *D. cuspidatum* may be even less likely currently than in the past. It is worth noting that the long flowering period of *Desmodium cuspidatum* represents a very large investment of energy on the part of each plant towards ensuring out-crossing. Observations of the percentage of viable seed set in the wild by *Desmodium cuspidatum* would be useful in understanding the causes of rarity of this species.

Seed Germination

Martin et al. (1975) demonstrated high germination (76% to 81%) of *D. cuspidatum* under three scenarios in laboratory settings: a control; moist heat; and dry heat. Two other *Desmodium* species used in the same study, *D. ciliare* and *D. fernaldii*, showed even higher germination percentages – between 91% and 100% – under all three regimes. Wulff (1986a, 1986b, 1986c), in an extensive series of experiments on the effects of seed size in *Desmodium paniculatum* on various life history traits, generally observed very high germination rates. Germination trials for *D. sessilifolium* at the New England Wild Flower Society (NEWFS) found 24% to 90% germination over seven attempts, using both cold stratification and warm germination, and both fresh and dry seed. The lowest germination percentage was for dried seeds sown warm. The highest germination percentage was for dried seeds with cold stratification (Christopher Mattrick, NEWFS, personal communication). Although these data

are not conclusive, it seems there is likely to be no particular problem with germination for *Desmodium cuspidatum* in the wild.

Population Genetic Structure

For *Desmodium nudiflorum*, a relatively common component of the New England flora, Schaal and Smith (1980) demonstrated that genetic variability of the species appears to reside mainly among populations, rather between subpopulations, in contrast to many other plant species. Schaal and Smith (1980) attribute this to three reasons: 1) small population size and low plant density, which are likely to result in population bottlenecks, during which genetic variation is lost; 2) faithfulness of bee pollinators to a plant species, yielding complete gene flow among individual plants in small populations (but see Kalin Arroyo 1981); and 3) founder effects. Schaal and Smith investigated five *D. nudiflorum* populations in Ohio and Michigan, where, they note, suitable habitats are currently distant from each other, as a result of the destruction of almost all forested areas over the past few centuries. Such factors are almost certainly restricting the within-population genetic variability of *D. cuspidatum* in New England at this time, as well. As for many rare plants, it would be useful to understand further the population genetic structure of *Desmodium cuspidatum*.

Interactions with Rhizobial Bacteria

Desmodium cuspidatum forms a mutualistic association with rhizobial bacteria (Allen and Allen 1981). Parker (1999a) demonstrated that three co-occurring legumes (*D. glutinosum*, *Apios americana*, and *Amphicarpaea bracteata*) in New York harbor overlapping bradyrhizobial symbiotic bacteria species. He points out that, "if plants cause local proliferation of symbiotic bacteria in their vicinity…, then a site occupied by one plant may become a favorable microhabitat for invasion by a second host" (Parker 1999a: 4919). However, not all rhizobial species were equally effective in enhancing plant growth for all three legumes. One bacterial isolate was found in both *Apios*, where it functioned effectively as a symbiont, and in *Amphicarpaea*, where it was ineffective. As Parker (1999a) notes, "…one legume may potentially create an ecological burden for a second species by serving as a source for bacteria that are inferior-quality symbionts" (p. 4919). Given Parker's results and the fact that rhizobia seem able, at least in some cases (Wilkinson et al. 1996), to form effective nodules on a broad range of legume hosts, it may be helpful to try re-establishment experiments for *Desmodium cuspidatum* only where there are flourishing populations of other legumes already occurring.

Rhizobacteria are not obligate symbionts (Young and Johnston 1989) and can live in soil separately from legumes. However, it is unknown whether seeds apparently adapted for relatively long-distance dispersal, such as those of *Desmodium* species, can be sure of finding an effective strain of bacteria wherever the seeds end up.

Parker (1999b) theorizes that mutualistic systems such as those of legumes and rhizobia may well form stable geographic mosaics of plants and bacteria, each polymorphic for the ability to form effective mutualisms. This may indicate that the decline in several legume plants across the Northeast (six *Astragalus*, five *Desmodium*, two *Lespedeza*, *Lathyrus ochroleucus*, *Lupinus perennis*, *Oxytropis campestris* var. *johannensis*, *Phaseolus polystachios*, *Strophostyles umbellata* [Brumback and Mehrhoff et al. 1996]) is related to a decline or shift in their symbiotic bacterial flora. While there is no direct evidence for rhizobacteria limiting *Desmodium* populations, this complicated mutualistic landscape of plants and bacteria, as with plants and pollinators, must be kept in mind throughout planning for recovery of *Desmodium cuspidatum*.

HABITAT/ECOLOGY

Current descriptions of the habitat of *Desmodium cuspidatum* in New England generally agree that it is found in dry, rocky, open woods (Upham 1959, Domville and Dunbar 1970, Seymour 1982, Weatherbee 1996, Magee and Ahles 1999). Other habitats noted in New England are: rich woods (Harris 1975); woodland borders and roadsides (Magee and Ahles 1999); woods and banks (Newcomb 1977); and thickets and shaded roadsides (Upham 1959).

Older literature also characterized *D. cuspidatum* habitat as dry, rocky, open woods and thickets (Deane 1896, Britton and Brown 1897, Brainerd et al. 1900, Bissell and Andrews 1902, Dole et al. 1937). Wiegand and Eames (1925) describe the habitat as the borders of dry woods, in rich sandy non-calcareous loams. Bissell and Andrews (1902) say that *D. cuspidatum* prefers "hard soils," by which they mean trap rock.

The habitat outside New England seems to be much the same, with the addition of moister habitats and ruderal areas (Burnham 1913, Gambill 1953, McVaugh 1958, Mohlenbrock and Voight 1959, Domville and Dunbar 1970, Bare 1979, Voss 1985, Mohlenbrock 1986, Lange 1998, Isely 1990, Isely 1998). Clewell (1985) describes the habitat in the Florida panhandle as pine-oak-hickory woods.

In the Midwest, *Desmodium cuspidatum* has been identified as a moderate indicator species for frequently burned oak savannas and open oak woodlands (Pruka 1995). Pruka lists 152 species as best, moderate, or weak indicators of this natural community; of the 107 of these plants found in New England, 63% are listed or tracked in one or more states in New England (Appendix 2). Thus, *Desmodium cuspidatum* may be one among many rare plants that are declining in New England because the natural community supporting these plants is disappearing, possibly due to fire suppression and subsequent succession to closed-canopy forest. New England is not likely to have a natural community identical to the frequently burned oak savannas and woodlands of the midwestern prairie-forest ecotone, but it seems possible

that New England has, or had, a northeastern analogue to this community type. Rawinski (2000) documented fire-maintained oak woodlands in Worcester, Massachusetts, which appeared to support a different flora from other oak forest types. *Desmodium cuspidatum* was not among those plants found in the Worcester sites, nor were many of Pruka's midwestern indicators. This is not very surprising, given the generally acidic bedrock underlying much of the City of Worcester, compared to the circumneutral to calcareous bedrock of current *D. cuspidatum* sites in New England.

Further indication of *Desmodium cuspidatum* habitat comes from midwestern coefficients of conservatism, which are measures of the degree to which a species is faithful to high-quality habitats. The coefficient ranges from one to ten, with a value of ten demonstrating complete faithfulness. Summarized by Packard and Ross (1997), the coefficient for *D. cuspidatum* ranges from four for Ohio and Missouri, to five in Michigan, to six in Illinois and the Chicago region in particular, to ten in Ontario. Rankings over four indicate a relatively high degree to which a species is ordinarily found only in high-quality, unimpacted, natural communities. In these five states and one province, *D. cuspidatum* appears to be mainly restricted to savannas and open woodlands.

Examination of Natural Heritage field forms from New England gives a clearer picture of the habitat of *Desmodium cuspidatum* in this region. Of the eight current New England populations tracked by the Natural Heritage programs, three (VT .001 [West Rutland], MA #1 [North Adams], and MA #29 [Stockbridge]) are found in forb-dominated power or gas line clearings, on dry, rocky, steep, rich slopes. Another (MA #6 [Holyoke]) is in a similar situation on the side of a gravel road.

Two Vermont occurrences (VT .002 [Benson] and VT .003 [West Haven/Benson]) and one Massachusetts site (MA #30 [New Marlborough]) are in rich woods on the slopes of a hill or mountain. The eighth occurrence (MA #7 [Greenfield]) is on a woodland border of a circumneutral rocky ridge.

Associated forbs, vines, and shrubs for these current occurrences include *Aster* spp., *Aureolaria flava, A. pedicularia, Ceanothus americanus, Desmodium glutinosum, D. nudiflorum, D. paniculatum, D. rigidum, Diervillea lonicera, Elymus hystrix, Eupatorium purpureum, Helianthus divaricatus, Panax quinquefolius, Panicum clandestinum, Parthenocissus* sp., *Polystichum acrostichoides, Pycnanthemum tenuifolium, P. incanum, Rhamnus frangula, Rhus radicans, Rosa multiflora, Rubus* sp., *Satureja vulgaris, Solidago* spp., and *Vitis* sp. Trees in the vicinity of these sites include *Pinus strobus, Quercus rubra,* and *Betula populifolia*.

While several of these occurrences are sited in human-maintained open habitats, none appear to be associated with other kinds of disturbances, such as fire, windthrow, logging, grazing, or major erosion.

THREATS TO TAXON

Loss of Habitat Due to Development

Given the large number of historic Massachusetts occurrences in or near Boston, it is very likely that many sites for *Desmodium cuspidatum* were destroyed by development. Historic sites in other New England states (where data are more incomplete than for Massachusetts) have also very likely succumbed to development pressure.

However, development has also opened up many of what would appear to be suitable habitats for *Desmodium cuspidatum*, such as roadsides, power lines and other linear disturbances, or ski areas and other outdoor recreation needing open areas. Forest edges opened up by clearing for new buildings might also be suitable for colonization.

Disruption of Disturbance Regimes

Given that the taxon has disappeared from several historic sites that have been protected from development for decades or, indeed, a century or more, habitat destruction by development cannot be the only reason *D. cuspidatum* is disappearing from the New England flora. More likely, the plant cannot survive the succession to closed-canopy forests as has occurred over much of New England following the large-scale clearing of the early and mid-1800s. Suppression of fire, the decline in dependence on local wood for heating and building, and the decline in agriculture all contribute to forests across New England regenerating to a relatively mature state.

Of interest to this point, Hainds et al. (1999) document the presence of 43 species of herbaceous legumes, including *Desmodium* species (not specified to a particular species), in a frequently burned longleaf pine-wiregrass community in Georgia. Gradients of soil moisture, pine basal area (as a measure of light available to forbs), and bivalent base cations (such as calcium) did not account for a high percentage of variation in species composition. Rather, Hainds et al. (1999) hypothesize that the frequent disturbance by fire (no less frequently than every three years) on their site prevented competitive exclusion by similar legume species and allowed a high number of legumes to co-exist. Given that *Desmodium cuspidatum* is only one among 13 congeners and numerous other legumes in New England, the lack of frequent natural disturbance, whether fire-induced or not, might lead to *D. cuspidatum* being excluded from its preferred habitat by more robust species. To this point, the area immediately around two of the largest current populations in New England (MA #1 [North Adams] and MA #6 [Holyoke]) is somewhat open mineral soil, without aggressive colonizers such as goldenrods or grasses. Perhaps *D. cuspidatum* can only survive to maturity and persist where it is not overrun by other, more vigorous forbs or grasses. On the other hand, neither fire nor any other natural disturbance appears to be associated with any of the current New England sites.

Other Threats

With so little known about the life history of this taxon, it is difficult to rule out other possible threats. These possibilities include:

- **reduction in species and abundances of pollinators** with the destruction of much nesting and feeding habitat for native bees;
- **decrease in abundances or species of effective rhizobia**; and
- **loss of sufficient genetic diversity in the taxon.**

It is interesting to speculate on the shifting dynamics of a plant that may be adapted to live in the oft-changing community of frequently burned oak woodlands, and at the same time, forms mutualisms with rhizobia and pollinators, both of which have their own geographic mosaics and possible declines with increased development. However, every other *Desmodium* species in New England, many of which are quite common, also form rhizobial and pollinator mutualisms. Most New England *Desmodium* species are also found in somewhat open or early-successional habitats. Thus, it is unlikely that changes in rhizobial populations, or in pollinators, or in disturbance type or frequency, alone or together, can explain the rarity of *Desmodium cuspidatum* in New England today.

DISTRIBUTION AND STATUS

General Status

Desmodium cuspidatum is given a G5 rank by the Association for Biodiversity Information and The Nature Conservancy (NatureServe 2001), meaning that on a global scale the taxon is secure and not threatened with extinction.

Brumback and Mehrhoff et al. (1996) list *D. cuspidatum* as Division 2 (regionally rare). They give the status within each New England state as follows:

- **Maine:** no current occurrences, no state status or rank;
- **New Hampshire:** no current occurrences, state rank – SH (historic);
- **Vermont:** three current occurrences, state status – Endangered, state rank – S1;
- **Massachusetts:** three current occurrences, state status – WL, state rank – S1;
- **Rhode Island:** no current occurrences, no state status or rank;
- **Connecticut:** no current occurrences, no state status, state rank SU (status unknown).

Note that this summary reflects the status of the taxon as known in 1996, when *Flora Conservanda* (Brumback and Mehrhoff et al. 1996) was published. Currently, it is more accurate to describe the status of *Desmodium cuspidatum* in New England as:

- **Maine:** taxon not reported from this state; no state status or rank;
- **New Hampshire:** no known current occurrences; three historic occurrences; state rank – SH (historic);
- **Vermont:** three current occurrences; no historic occurrences; state status – Endangered, state rank – S1;
- **Massachusetts:** five current occurrences; 25 historic occurrences; state status – WL, state rank – S1;
- **Rhode Island:** taxon reported from this state, but no tracked occurrences (either current or historic); no state status or rank;
- **Connecticut:** taxon reported from this state, but no tracked occurrences (either current or historic); two current occurrences (known from herbarium specimens); no state status; state rank SU (status unknown).

Desmodium cuspidatum is known from 31 other states and provinces outside New England (Table 1). It is apparently secure in most of these areas, except Delaware and the District of Columbia, where it is Status Historic; Nebraska, North Carolina, and Virginia, where it is S2 or S2S3; and Illinois, Iowa, Kentucky, Michigan, New Jersey, Pennsylvania, Ontario, and West Virginia, where it is S3, S4, or S?. Note that *D. cuspidatum* is rare not only on the edges of its range, but in several states towards the middle of its range.

Table 1. Occurrence and status of *Desmodium cuspidatum* 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 REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
Nebraska (S2)	Illinois (S?)	Alabama (SR)	Delaware (SH)
Vermont (S1): 3 current EOs	Iowa (S4)	Arkansas (SR)	District of Columbia (SH)
Virginia (S2)	Kentucky (S?)	Connecticut (SR): no sites are tracked	New Hampshire (SH): 3 historic EOs
	Massachusetts (S?): 5 current EOs, 25 historic EOs, "watch-listed"	Florida (SR)	
	Michigan (S?)	Georgia (SR)	
	New Jersey (S?)	Indiana (SR)	
	North Carolina (S2S3)	Kansas (SR)	
	Pennsylvania (S?)	Louisiana (SR)	
	Ontario (S3)	Maryland (SU)	
	West Virginia (S?)	Minnesota (SR)	
		Mississippi (SR)	
		Missouri (SR)	
		New York (SR)	
		Ohio (SR)	
		Oklahoma (SR)	
		Rhode Island (SR): no sites known to Heritage program	
		South Carolina (SR)	
		Tennessee (SR)	
		Texas (SR)	
		Wisconsin (SR)	

Note: The ranks reported in Table 1 refer to *D. cuspidatum*, not to *D. cuspidatum* var. *cuspidatum* or *D. cuspidatum* var. *longifolium*. Ranks from NatureServe (2001).

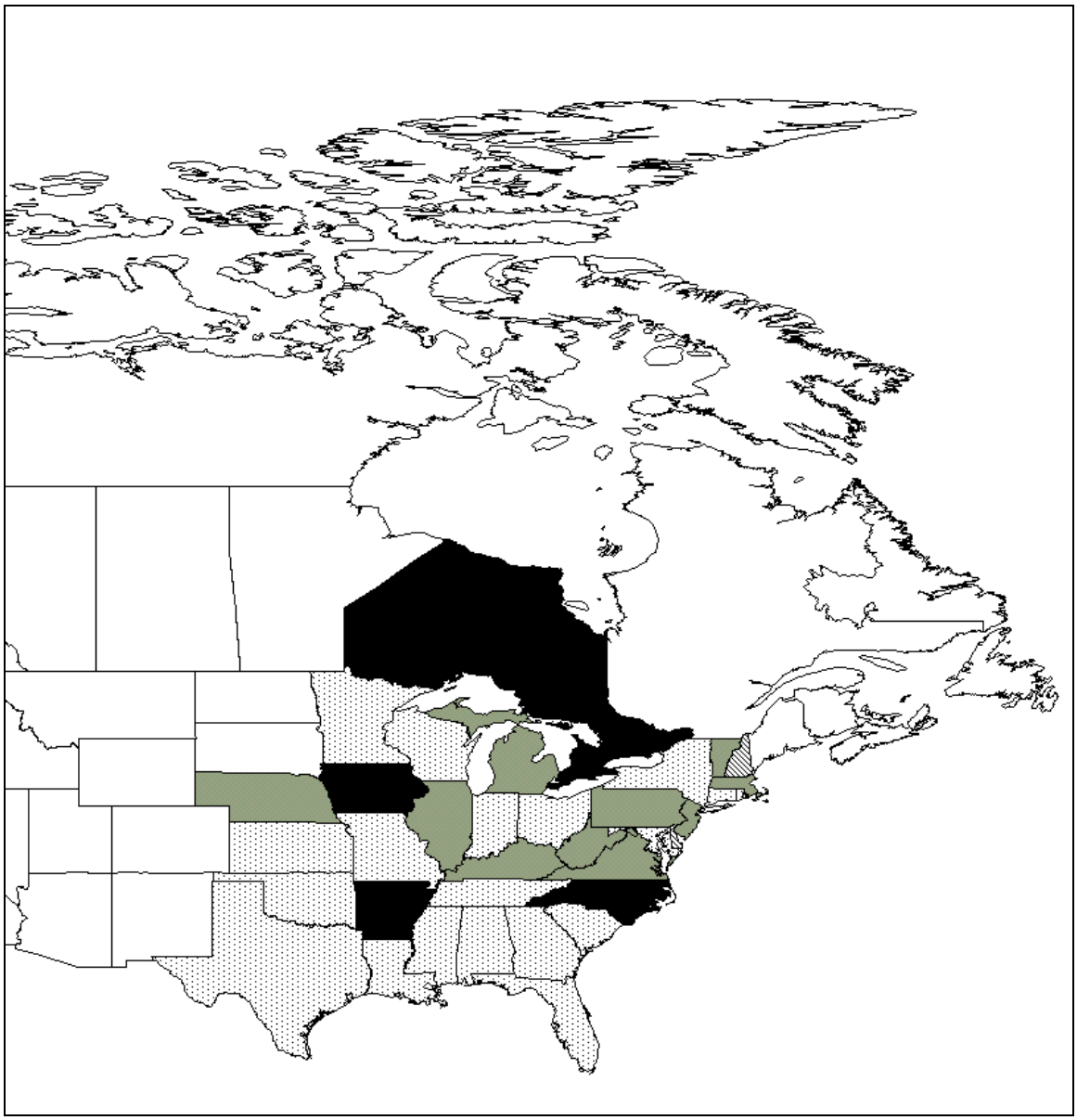

Figure 1. Occurrences of *Desmodium cuspidatum* in North America. States and provinces shaded in gray have one to five current occurrences of the taxon. Areas shaded in black have more than five confirmed occurrences. States with diagonal hatching are designated "historic" or "presumed extirpated," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but not necessarily verified). See Appendix 7 for explanation of state ranks.

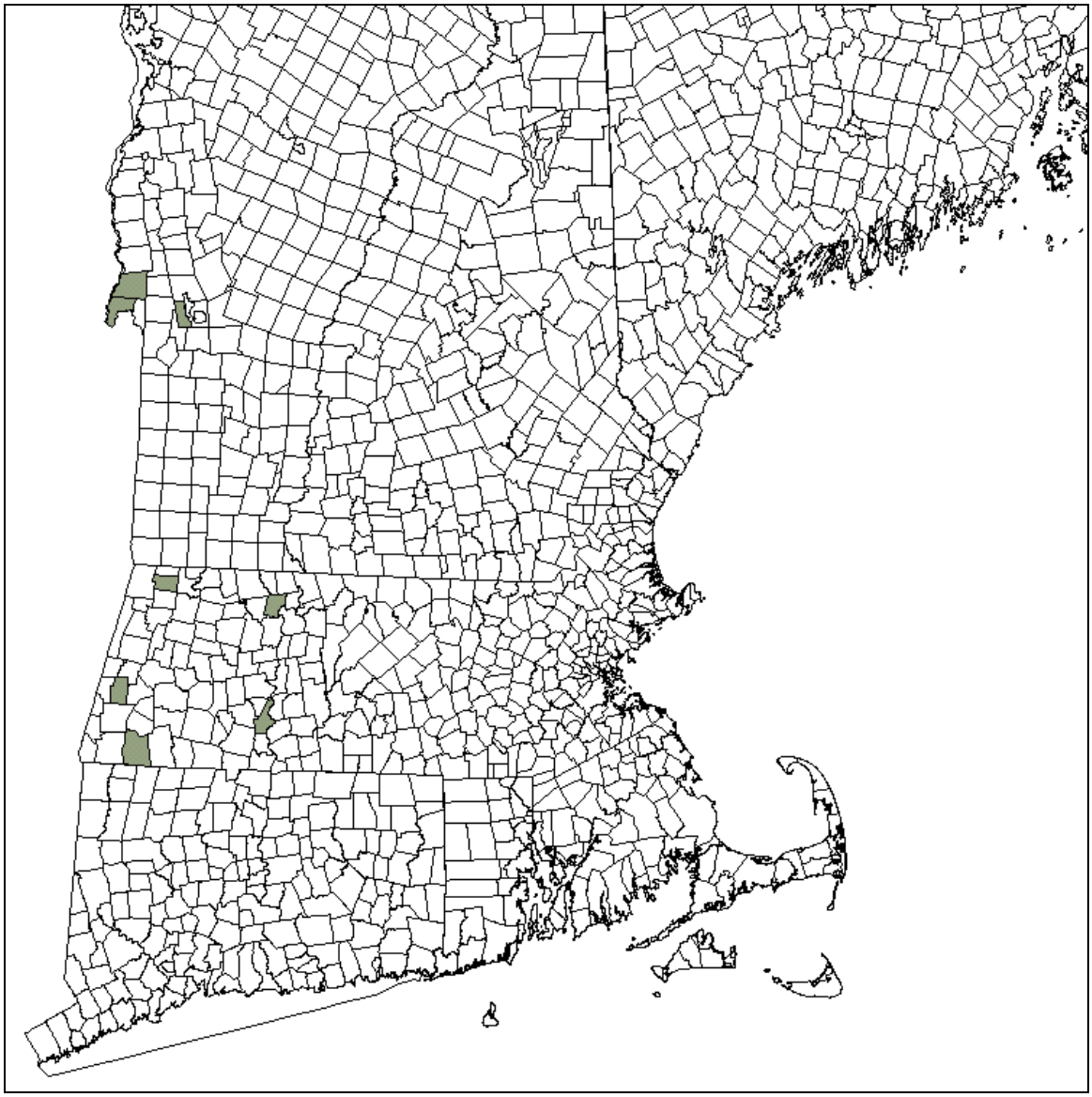

Figure 2. Extant occurrences of *Desmodium cuspidatum* in New England. Town boundaries for southern New England states are shown. Towns shaded in gray have one to five confirmed, extant occurrences of the taxon.

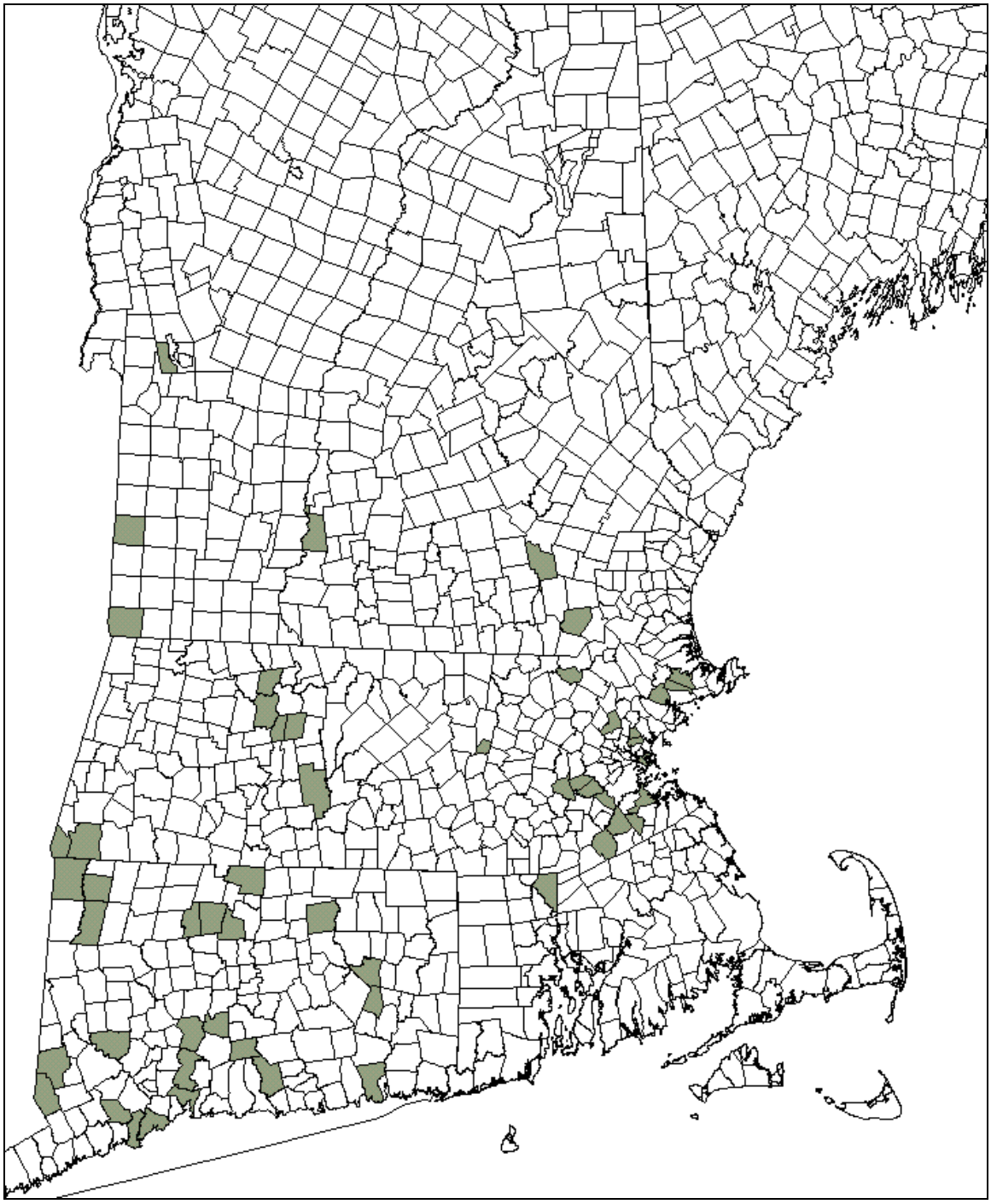

Figure 3. Historic occurrences of *Desmodium cuspidatum* in New England. Towns shaded in gray have one to five historic records of the taxon.

Current and historic floras and other botanical literature generally describe the taxon as rare to occasional in New England (Appendix 3). Connecticut seems to be the only state in New England where *D. cuspidatum* has been described as frequent. *Desmodium cuspidatum* also seems to be noted as uncommon in much of the rest of its range (Appendix 4).

Status of All New England Occurrences -- Current and Historical

See Table 2 for occurrences that have been tracked by the Natural Heritage programs in New England.

Table 2. New England Occurrence Records for *Desmodium cuspidatum.* Shaded occurrences are considered extant.

State	EO #	County	Town
NH	.001	Cheshire	Walpole
NH	.002	Hillsborough	Manchester
NH	.003	Rockingham	Windham
VT	**.001**	**Rutland**	**West Rutland**
VT	**.002**	**Rutland**	**Benson**
VT	**.003**	**Rutland**	**West Haven/ Benson**
MA	**#1**	**Berkshire**	**North Adams**
MA	#2	Suffolk	Boston
MA	#3	Norfolk	Canton
MA	#4	Berkshire	Sheffield
MA	#5	Franklin	Sunderland/ Leverett
MA	**#6**	**Hampden**	**Holyoke**
MA	**#7**	**Franklin**	**Greenfield**
MA	#8	Hampshire	Belchertown
MA	#9	Norfolk	Sharon
MA	#10	Norfolk	Milton
MA	#11	Norfolk	Wellesley
MA	#12	Franklin	Deerfield
MA	#13	Berkshire	Sheffield
MA	#14	Middlesex	Woburn
MA	#15	Suffolk	Boston
MA	#16	Essex	Danvers
MA	#17	Essex	Wenham
MA	#18	Middlesex	Lowell
MA	#19	Middlesex	Malden

Table 2. New England Occurrence Records for *Desmodium cuspidatum.* Shaded occurrences are considered extant.			
State	**EO #**	**County**	**Town**
MA	#20	Middlesex	Melrose
MA	#21	Middlesex	Natick
MA	#22	Middlesex	Woburn
MA	#23	Suffolk	Boston
MA	#24	Norfolk	[Canton/ Milton/ Quincy/ Randolph?]
MA	#25	Norfolk	Dedham
MA	#26	Norfolk	Needham
MA	#27	Norfolk	Canton
MA	#28	Franklin	Deerfield
MA	**#29**	**Berkshire**	**Stockbridge**
MA	**#30**	**Berkshire**	**New Marlborough**

Because two states in New England do not track *D. cuspidatum* and so few occurrences are tracked in the three other states where it is known, it is useful to examine occurrences of this taxon known from herbarium specimens or which were noted in floras and other literature. Appendix 5 lists the New England *Desmodium cuspidatum* specimens from three herbaria. Specimens supporting four additional historic occurrences were found, two each in Vermont and Massachusetts. Appendix 6 gives the New England occurrences reported in the literature surveyed.

Table 3 below summarizes the current and historic occurrences of *Desmodium cuspidatum* in New England, using Heritage Element Occurrence Records, herbarium specimens, and reports in the literature. While this summary is not complete, as not all New England specimens were examined, nor every local flora or field trip report consulted, at a minimum it is possible to say that there may be only ten current sites for the taxon throughout New England. Historically there may have been at least 61 additional occurrences in the region, about six times as many sites as currently extant.

No data exist for population sizes before records from the 1980s and 1990s. Population size for current occurrences, where known, range from one plant to 119 plants.

Table 3: Summary of Current and Historic *Desmodium cuspidatum* Occurrences: Heritage Element Occurrences, Herbarium Specimens, and Literature Reports			
Source	**State**	**Number of Historic Occurrences (pre-1976)**	**Number of Current Occurrences (1976 – 2001)**
Natural Heritage Programs Element Occurrences (Table 2)	New Hampshire	3	0
	Vermont	0	3
	Massachusetts	25	5
	Rhode Island	Not tracked	Not tracked
	Connecticut	Not tracked	Not tracked
Herbarium specimens for additional sites (Appendix 5)	New Hampshire	0	0
	Vermont	2	0
	Massachusetts	2	0
	Rhode Island	2	0
	Connecticut	20	2
Literature reports for additional sites (Appendix 6)	New Hampshire	0	0
	Vermont	1	0
	Massachusetts	4	0
	Rhode Island	0	0
	Connecticut	2	0
Total sites known: 61 historic, 10 current	New Hampshire	3	0
	Vermont	3	3
	Massachusetts	31	5
	Rhode Island	2	0
	Connecticut	22	2

Note: These are minimum counts of occurrences. If an occurrence was both historic and current, it was counted only as current. Herbarium specimens were only counted if they clearly were different sites (different towns, for example) than those tracked by the Heritage Programs. Similarly, literature reports were counted only if the sites were not accounted for by an Element Occurrence Record (EOR) or an herbarium specimen. Literature reports were counted as current if the report appeared post-1976. No reports of any kind were found for Maine.

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

New Hampshire

Desmodium cuspidatum is Status Historic in New Hampshire. The New Hampshire Natural Heritage Inventory has no ongoing conservation actions in place for this taxon.

Vermont

Desmodium cuspidatum is Endangered in Vermont, protected from taking under the 1981 Vermont Endangered Species Law 10 V.S.A. Chapter 123. Aside from the limited protection this legislation affords the plant, monitoring of the three current populations is the only conservation action being undertaken at this time. One (VT .002 [Benson]) and possibly another (VT .003 [West Haven/Benson]) occurrence are on land owned by a conservation organization; however, it does not appear that any management of the site for *Desmodium cuspidatum* is currently underway.

Massachusetts

Desmodium cuspidatum is "watch-listed" in Massachusetts, meaning the taxon is afforded no legal status, but is tracked to some degree by the Natural Heritage and Endangered Species Program because the status of the species is unclear. Some of the historic occurrences (MA #3 [Canton], MA #4 [Sheffield], and MA #5 [Sunderland/ Leverett]) have been searched for in recent years by the Plant Conservation Volunteer Program of the New England Wild Flower Society. No other conservation actions benefiting the plant appear to be in progress at this point. It is likely that the Natural Heritage Program will propose listing this taxon in the next few years.

Connecticut and Rhode Island

Desmodium cuspidatum is neither listed nor tracked by the Natural Heritage programs in Connecticut and Rhode Island. No conservation measures are being taken in these states.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR TAXON IN NEW ENGLAND

Apparently, *Desmodium cuspidatum* has always been and certainly is today a somewhat rare element of the flora of New England. However, it is obvious that, at least in Vermont, New Hampshire, and Massachusetts, the species is even more rare today than it was about a century ago. Even in Connecticut and Rhode Island, where the taxon is not tracked, apparently the species has declined drastically as well. Therefore, conservation actions must be undertaken to ensure the continued survival of the taxon in New England at historic levels.

The primary conservation objectives for *Desmodium cuspidatum* in New England are to protect and study the plant in the region and to understand and protect its habitat. Success of these objectives will be measured by maintenance or long-term improvement of the state ranks in those states where the species is known, and by attainment of the specific conservation actions listed below.

The overall goal for each occurrence of *Desmodium cuspidatum* is the establishment and persistence over at least five years of vigorous populations. "Vigorous" has yet to be defined for this taxon; for immediate purposes, a vigorous population may be defined as one which has at least 50 plants, 75% of which bear viable seed each year.

Once a more complete picture of the status of *Desmodium cuspidatum* in New England is obtained, serious consideration should be given by the Natural Heritage programs to listing the taxon in Massachusetts, Connecticut, and Rhode Island.

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IV. APPENDICES

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1. **Oak Savanna/Oak Woodland Indicator Species and Their Status in New England (Pruka 1995)**
2. **Literature Descriptions of *Desmodium cuspidatum* Frequency in New England**
3. **Literature Descriptions of *Desmodium cuspidatum* Frequency outside New England**
4. **Occurrences of *Desmodium cuspidatum* in New England from Herbarium Specimens**
5. **Occurrences of *Desmodium cuspidatum* in New England as Reported in the Literature**
6. **An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe**

Appendix 1:
Oak Savanna/Oak Woodland Indicator Species and Their Status in New England (*sensu* Pruka 1995)

Species	Indicator Status	ME	NH	VT	MA	CT	RI
Agastache nepetoides	Best					SC, believed extirpated	
Agastache scrophulariifolia	Best			T	SH (S1) (1 extant occurrence)	E	
Anemone virginiana	Best						SH
Asclepias purpurascens	Best		SH		T (S1)	SC, believed extirpated	SH
Astragalus canadensis	Best			T			
Aureolaria pedicularia	Best	SC (S2)	E (var. *intercedens*)	not listed (S1)			
Blephilia ciliata	Best			SH	E (S1)	SC, believed extirpated	
Bromus kalmii	Best	SH	SH	not listed (S2S3)			
Castilleja coccinea	Best	SX	SX		SH (SX)	E	SH
Ceanothus americana	Best	T (S1)					
Ceanothus ovatus (C. herbaceus)	Best			E (S1)	considered introduced		
Convolvulus spithamaeus (Calystegia spithamaea)	Best	T (S1)	T	T	E (S1)	SC, believed extirpated	
Cypripedium pubescens	Best		T		WL (S?)		ST
Elymus villosus	Best			not listed (S1)	T (S1)		C
Eupatorium sessilifolium	Best		E	E			
Hypoxis hirsuta	Best	SX	T	SH			
Krigia biflora	Best					SC	
Lilium philadelphicum	Best			not listed (S3)			C
Oxalis violacea	Best			SH	T (S1)	SC	SE
Polygala senega	Best	E		not listed (S2S3)	SH (SX)	E	
Prenanthes alba	Best				WL (S?)		

Appendix 1:
Oak Savanna/Oak Woodland Indicator Species and Their Status in New England (*sensu* Pruka 1995)

Species	Indicator Status	ME	NH	VT	MA	CT	RI
Ranunculus fascicularis	Best	T (S1)	E	SH	WL (S?)		
Silene stellata	Best			SH		SC	SH
Solidago hispida	Best				SH		
Taenidia integerrima	Best			T		E	SH
Tephrosia virginiana	Best		E				C
Triosteum aurantiacum	Best	E (S1)	E	not listed (S3)			not listed (5 extant)
Triosteum perfoliatum	Best				E (S1)		not listed (4 extant)
Veronicastrum virginicum	Best			E	SC (S2)		
Zigadenus elegans	Best			SX (ssp. *glaucus*)			
Zizia aurea	Best						C
Anemone cylindrica	Moderate		SH				
Anemonella thalictroides	Moderate		T	not listed (S1)			not listed (5 extant)
Arenaria lateriflora (Moehringia lateriflora)	Moderate			not listed (S3)			
Asclepias amplexicaulis	Moderate		T	T			C
Asclepias exaltata	Moderate			not listed (S3)			C
Asclepias tuberosa	Moderate	SH	E	T (SH)	WL (S4)		C
Asclepias viridiflora	Moderate					SC, believed extirpated	
Aster laevis	Moderate			not listed (S3)			C
Bouteloua curtipendula	Moderate					E	
Cacalia suaveolens	Moderate					E	SH
Carex brevior	Moderate			not listed (S2S3)			
Desmodium cuspidatum	Moderate		SH	E	WL (S?)		
Eupatorium purpureum	Moderate			not listed (S2)			

Appendix 1:
Oak Savanna/Oak Woodland Indicator Species and Their Status in New England (*sensu* Pruka 1995)

Species	Indicator Status	ME	NH	VT	MA	CT	RI
Galium boreale	Moderate			not listed (S3)	E (S1)		
Gentiana quinquefolia	Moderate	SH	SH	T	WL (S?)	E	
Helianthemum bicknellii	Moderate			T			
Helianthemum canadense	Moderate			not listed (S2S3)			
Hystrix patula (Elymus hystrix)	Moderate	T (S2)					
Lobelia spicata	Moderate		SH (var. *hirtella*)				
Penstemon pallidus	Moderate			SH			
Potentilla arguta	Moderate			not listed (S3)		SC	
Pycnanthemum virginianum	Moderate		E				
Solidago speciosa	Moderate				WL (S?)		
Sorghastrum nutans	Moderate	E		not listed (S3)			C
Sporobolus heterolepsis	Moderate				SH	E	
Agropyron trachycaulum (Elymus trachycaulus)	Weak			not listed (S3)	WL (ssp. *trachy-caulus*)		
Amphicarpa bracteata	Weak		T (S2, var. *comosa*)				
Lathyrus ochroleucus	Weak			not listed (S2)			
Lechea intermedia	Weak				WL (var. *juniperina*)		
Lechea tenuifolia	Weak	SX	E (SH)				
Panicum oligosanthes var. *scribnerianum*	Weak			not listed (S2)			
Polygala sanguinea	Weak			not listed (S2S3)			
Solidago rigida	Weak				SH	E	SH
Solidago ulmifolia	Weak	SX		E (S1)			
Uvularia grandiflora	Weak		E (S1)		WL	E	

Appendix 1:
Oak Savanna/Oak Woodland Indicator Species and Their Status in New England (*sensu* Pruka 1995)

Species	Indicator Status	ME	NH	VT	MA	CT	RI
Viola pedata	Weak		T (S2, var. *linear-iloba*)				

Note: Best, moderate, and weak indicator species for oak savannas and open oak woodlands from Pruka (1995). Indicator species not found in New England (15 best, 21 moderate, and nine weak indicators) are not shown here. Indicator species found in New England, but not listed or tracked in New England, are not shown here (includes 12 best, 15 moderate, and 13 weak indicators). Names are given as in Pruka (1995), with synonyms in parentheses.

Appendix 2:
Literature Descriptions of *Desmodium cuspidatum* Frequency in New England

Source	Area Covered	Frequency
Seymour (1982)	New England	Occasional
Hoffman (1922)	Berkshire County, MA	Occasional in the southern part of the valley
Weatherbee (1996)	Berkshire County, MA	Occasional, meaning appearing in less than half of the suitable habitat and occurring in five or fewer towns, or in more towns but in very few locations
Harris (1975)	Essex County, MA	Rare
Dame and Collins (1888)	Middlesex County, MA	Rare
Jackson (1927)	Worcester County, MA	Rare
Bishop (1885)	Connecticut	Rare
Conn. Bot. Soc. (1910)	Connecticut	Occasional or frequent in the Connecticut Valley and in the southwestern part of the state; rare or absent elsewhere
Upham (1959)	Connecticut	Rare or missing, except in southern area, where it is at least occasional
Bishop (1901)	Connecticut	Noted as known from four towns: Oxford (where it was described as rare), Milford, Trumbull, Stratford
Berzelius Society (1878)	Within 30 miles of New Haven, CT	Rare
Bissell and Andrews (1902)	Southington, CT, and vicinity	Frequent
Blewitt (1926)	Waterbury, CT	Frequent
Tucker (1995)	Southeastern CT	Occasional
George (1995)	Rhode Island	Rare
Gould et al. (1998)	Rhode Island	Present (meaning from common to fairly common to uncommon)

Appendix 3:
Literature Descriptions of *Desmodium cuspidatum* Frequency outside New England

Source	Area Covered	Frequency
Great Plains Flora Assoc. (1986)	Great Plains	Locally common in rich woodlands, less common in thickets and roadsides
Mohr (1901)	Alabama (SR)	Rare; never observed in the low country
Smith (1978)	Arkansas (SR)	Specimens seen or reported from 14 of 75 counties
Tatnall (1946)	Delaware (SH) and Eastern Shore	Infrequent on the Piedmont; one specimen from the Coastal Plain
Jones and Coile (1988)	Georgia (SR)	Specimens from 8 of 159 counties
Mohlenbrock (1986)	Illinois (S?)	Occasional throughout the state
Gambill (1953)	Illinois (S?)	Throughout the state
Swink and Wilhelm (1994)	Chicago region, Illinois (S?)	Occasional
Mohlenbrock and Voight (1959)	Southern Illinois (S?)	Recorded from 2 counties
Deam (1984)	Indiana (SR)	Infrequent to frequent possibly throughout the state
Ownbey and Morley (1991)	Minnesota (SR)	Eight sites reported for var. *longifolium*
Stone (1973)	Southern New Jersey (S?)	Rather common in the northern counties, but very rare within our limits
Domville and Dunbar (1970)	Ulster Co., NY (SR)	Infrequent
McVaugh (1958)	Columbia Co., NY (SR)	Infrequent or rare, perhaps increasing in abundance southward
Dudley (1886)	Cayuga, NY (SR)	Not common
Wiegand and Eames (1925)	Cayuga Lake Basin, NY (SR)	Infrequent
Zenkert (1934)	Niagara Frontier Region, NY (SR)	Rare

Appendix 3:
Literature Descriptions of *Desmodium cuspidatum* Frequency outside New England

Source	Area Covered	Frequency
Wofford (1989)	Blue Ridge area of North Carolina (S2S3)	Occasional
Wofford (1989)	Blue Ridge area of South Carolina (SR)	Occasional
Correll and Johnston (1979)	Texas (SR)	Not common, but known from rich woods in 4 counties in n. e. Tex.
Wofford (1989)	Blue Ridge area of Virginia (S2)	Occasional

Appendix 4: Occurrences of *Desmodium cuspidatum* in New England from Herbarium Specimens

State	Locality	Town	County	Date	Notes/Comments	EO #	Collector	Herbarium
NH	West slope, Fall Mt.	Walpole	Cheshire	July 30, 1900	"West slope"	.001	M. Fernald #434	NEBC
VT	--	Arlington *	Bennington *	Aug. 21, 1903	--	--	W. Blanchard #98	Gray
VT	--	Arlington *	Bennington *	Aug. 28, 1903	--	--	E. Brainerd	Gray
VT	--	Pownal *	Bennington *	Sept. 8-11, 1899	--	--	W. Eggleston #1106	Gray
VT	South Pownal	Pownal *	Bennington *	Aug. 12, 1902	--	--	W. Blanchard	Gray
VT	--	West Rutland	Rutland	Aug. 17, 1897	--	.001?	A. Driggs #21	Gray
VT	Twin Mt.	West Rutland	Rutland	July 25, 1913	--	.001	George L. Kirk	Tufts, at Univ. of Mass. at Amherst
MA?	--	[no town noted]	--	Aug. 29, 1872	"See *Botanical Gazette* 78, 278. 1924" – this note on the specimen refers to Blake 1924, a descriptive review of some *Desmodium* species.	--	H. G. Jesup (of Amherst, MA)	Amherst College #44907, at Univ. of Mass. at Amherst
MA	Roadside, Bash Bish Falls	Mount Washington *	Berkshire	Aug. 1, 1908	--	--	Stewart H. Burnham	Torrey
MA	--	Sheffield	Berkshire	July 29, 1914	"Rich, moist woods"	MA #4	R. Hoffman	NEBC
MA	Near Housatonic River	Sheffield	Berkshire	Aug. 14, 1914	"Rich woods"	MA #13	R. Hoffman	NEBC
MA	--	Deerfield	Franklin	Aug. 6, 1953	"Old abandoned field"	MA #12	R. Poland	NEBC
MA	--	Deerfield	Franklin	Aug. 6, 1967	--	MA #12?, or MA #28?	Roberta G. Poland	Torrey

Appendix 4: Occurrences of *Desmodium cuspidatum* in New England from Herbarium Specimens

State	Locality	Town	County	Date	Notes/Comments	EO #	Collector	Herbarium
MA	Conn. River Rd., near Sunderland bridge, upper level field	Deerfield	Franklin	Sept. 3, 1967	--	MA #28	Roberta G. Poland #830	Univ. of Mass. at Amherst # 301925
MA	--	Greenfield	Franklin	Aug. 1879	--	MA #7?	C. H. K. Sanderson	Amherst College #72174, at Univ. of Mass. at Amherst
MA	**Woodland border, Temple Woods**	**Greenfield**	**Franklin**	**Sept. 8, 1978**	--	**MA #7**	**H. E. Ahles #86414**	**Univ. of Mass. at Amherst**
MA	So. slope about ½ way to summit, Mt. Toby	[no town noted]	Franklin	July 20, 1921	--	MA #5	L. S. Woodworth	Univ. of Mass. at Amherst #22434
MA	South side, Mt. Toby	Sunderland	Franklin	Sept. 4, 1922	--	MA #5	F. C. Seymour	Amherst College #71408, at Univ. of Mass. at Amherst
MA	--	Belchertown	Hampshire	Aug. 1872	"Perennial, common in woods"	MA #8	L. W. Goodell	Amherst College #58340, at Univ. of Mass. at Amherst
MA	--	Lowell	Middlesex	Aug. 26, 1885	--	MA #18	C. Swan	NEBC
MA	--	Lowell	Middlesex	Aug. 26, 1885	Duplicate specimen	MA #18	C. Swan	NEBC
MA	--	Malden	Middlesex	Sept. 3, 1887	--	MA #19	C. Faxon	NEBC
MA	--	Melrose	Middlesex	Aug. 19, 1894	"Rocky woods"	MA #20	W. Rich	NEBC
MA	--	Natick	Middlesex	Sept. 16, 1906	"Dry woods"	MA #21	C. Knowlton	NEBC
MA	Woburn Hills	Woburn	Middlesex	Aug. 27, 1866	"At rocky brook"	MA #22	Unknown, but likely to be William Boott	NEBC
MA	Woburn Hills	Woburn	Middlesex	Sept. 18, 1866	--	MA #22	Unknown, but likely to be William Boott	NEBC
MA	Woburn Hills	Woburn	Middlesex	Sept. 18, 1866	--	MA #22	W. Boott	Gray

Appendix 4: Occurrences of *Desmodium cuspidatum* in New England from Herbarium Specimens

State	Locality	Town	County	Date	Notes/Comments	EO #	Collector	Herbarium
MA	Hill above Round Pond	Woburn	Middlesex	Sept. 11, 1870	"Hill"	MA #14	W. Boott	Gray
MA	Blue Hills	[not given]	Norfolk	Aug. 11, 1894	--	MA #24	W. Manning	NEBC
MA	Muddy Pond woods	Dedham	Norfolk	Sept. 8, 1887	"Woods"	MA #25	C. Faxon	NEBC
MA	Muddy Pond woods	Dedham [? – inferred from NEBC specimen by A. Haines]	Norfolk [? – inferred from NEBC specimen by A. Haines]	Sept. 8, 1887	"Woods"	MA #25	E. Faxon	Gray
MA	Near [thoghton's] Pond	Milton	Norfolk	July 22, 1889	Probably Houghton's Pond.	MA #10	N. Kidder	NEBC
MA	Ridge Hill	Needham	Norfolk	Aug. 1, 1886	--	MA #26	T. Fuller	NEBC
MA	--	Sharon	Norfolk	Sept. 14, 1919	"Rocky woods"	MA #9	F. Hunnewell #641[1]	NEBC
MA	--	Wellesley	Norfolk	Aug. 12, 1894	"Woods"	MA #11	F. Hunnewell	NEBC
MA	--	Wellesley	Norfolk	Aug., 1911	--	MA #11	F. Hunnewell	Gray
MA	Hyde Park	Boston	Suffolk	[not given]	--	--	B. P. [Higgius] #10891	NEBC
MA	Stony Brook Reservation	Boston	Suffolk	Sept. 6, 1894	"Rocky woods"	MA #2	W. Rich	NEBC
MA	West Roxbury	Boston	Suffolk	Sept. 13, 1896	"Open rocky woods"	MA #2	W. Rich	NEBC
MA	Stony Brook Reservation	Boston	Suffolk	Sept. 13, 1896	"Low woods"	MA #2	E. Williams	Gray
MA	Stony Brook Reservation, West Roxbury	Boston	Suffolk	Sept. 13, 1896	--	MA #2	S. Harris	NEBC
MA	Stony Brook Reservation	Boston	Suffolk	Sept. 13, 1896	"Open woods"	MA #2	E. Williams	NEBC

Appendix 4: Occurrences of *Desmodium cuspidatum* in New England from Herbarium Specimens

State	Locality	Town	County	Date	Notes/Comments	EO #	Collector	Herbarium
MA	Blue Hill	Clinton *	Worcester *	Aug. 16, 1889	Sheet 2 of 2.	If in the town of Canton, in Norfolk County, it may be MA #3	J. Churchill	Gray
RI	Near Diamond Hill	Cumberland *	Providence *	July 25, 1942	"Thickets, rocky ground"	--	E. Palmer #46310	NEBC
RI	Path west of railway north of Quinsnicket Station	Lincoln *	Providence *	Aug. 30, 1927	--	--	J. Franklin Collins	Torrey
CT	--	Tarrifville [? – no such town in CT]	--	Aug., 1901	--	--	A. Driggs	Gray
CT	--	Danbury *	Fairfield *	Aug. 8, 1934	"Dry calcareous soil on open hill"	--	E. H. Eames	Torrey
CT	--	Ridgefield *	Fairfield *	Aug. 18/Sept. 9, 1936	"Border of open swamp"	--	E. H. Eames	Torrey
CT	--	Stratford *	Fairfield *	Aug. 17, 1892	--	--	E. H. Eames	Torrey
CT	--	Trumbull *	Fairfield *	Sept. 2, 1895	"Rocky woods", "Rare and local"	--	Edwin H. Eames	Univ. of Mass. at Amherst #84290
CT	--	Trumbull *	Fairfield *	Sept. 26, 1901	"Thinly wooded rocky slope"	--	E. Eames	Gray
CT	--	Trumbull *	Fairfield *	Sept. 26, 1901	"Rocky woods"	--	E. Eames	NEBC
CT	--	Bloomfield *	Hartford *	Sept. 17, 1906	"Open rocky woods" Sheet 1 of 2.	--	C. Weatherby #467	NEBC
CT	--	Bloomfield *	Hartford *	Sept. 17, 1906	"Open rocky woods" Sheet 2 of 2.	--	C. Weatherby #467	NEBC
CT	--	Canton *	Hartford *	Aug. 14, 1901	--	--	A. Driggs	Gray

Appendix 4: Occurrences of *Desmodium cuspidatum* in New England from Herbarium Specimens

State	Locality	Town	County	Date	Notes/Comments	EO #	Collector	Herbarium
CT	--	Canton *	Hartford *	Aug. 14, 1901	--	--	A. Driggs	Gray
CT	--	Suffield *	Hartford *	Aug. 5, 1921	"Dry open woods"	--	C. Weatherby #4994	NEBC
CT	[Mt.? Nt.?] Slope of Canaan Mt.	Canaan *	Litchfield *	Aug. 14, 1901	--	--	S. W. Driggs	Torrey
CT	**Road bank on Route 4, about 2 miles west of Cornwall Bridge**	**Cornwall ***	**Litchfield ***	**July 27, 1980**	--	--	**H. E. Ahles #89650**	**Univ. of Mass. at Amherst**
CT	Grasslands	Salisbury *	Litchfield *	Aug. 18, 1905	"Dry woods" Grasslands is a former farm, now owned by The Nature Conservancy, on Hammertown Rd.	--	Orra A. Phelps	Torrey
CT	--	Killingworth *	Middlesex *	Sept. 3, 1874	--	--	F. Hall	NEBC
CT	"Pisgah"	[not given]	New Haven *	Aug. 8, 1886	--	--	E. Harger #638	NEBC
CT	West Cheshire	Cheshire *	New Haven *	Sept. 6, 1914	"Dry rocky hillside, trap soil"	--	A. Blewitt #1974	NEBC
CT	**Pistapaug Mtn.**	**Durham ***	**New Haven ***	**Sept. 9, 1983**	**"Woods at foot" of mountain**	--	**Leslie J. Mehrhoff #9219**	**Torrey**
CT	Mt. Carmel	Hamden *	New Haven *	Aug. 30, 1933	"Light shade, rocky woods"	--	E. H. Eames	Torrey
CT	--	Meriden City *	New Haven *	Aug. 23, 1899	"Rocky soil and woods"	--	L. Andrews #779	NEBC
CT	--	Milford *	New Haven *	Sept. 9, 1904	"Dry woods"	--	E. Harger #4679	NEBC
CT	West Rock	New Haven City *	New Haven *	Aug. 31, 1903	--	--	R. Woodward	NEBC
CT	--	New Haven City *	New Haven *	Aug. 31, 1903	"Dry woods"	--	R. Woodward	Gray

Appendix 4: Occurrences of *Desmodium cuspidatum* in New England from Herbarium Specimens

State	Locality	Town	County	Date	Notes/Comments	EO #	Collector	Herbarium
CT	Near Housatonic River	Southbury *	New Haven *	Aug. 10, 1919	"Dry thicket"	--	E. Harger #7091	NEBC
CT	Great Hill woods	Franklin *	New London *	Aug. 20, 1906	"Woods"	--	R. Woodward	NEBC
CT	Great Hill woods	Franklin *	New London *	Aug. 20, 1906	"Woods"	--	R. Woodward	NEBC
CT	--	Franklin *	New London *	Aug. 31, 1906	"Dry woods"	--	R. Woodward	Gray
CT	--	Franklin *	New London *	Aug. 31, 1906	"Dry woods"	--	N. Woodward	Gray
CT	Fells near Cedar Swamp	Waterford *	New London *	Aug. 28, 1892	"Fells" Fells are hilly, rocky areas	--	C. Graves	Gray
CT	Near Cedar Swamp	Waterford *	New London *	Sept. 16, 1901	"Dry woods"	--	C. Graves #226	Gray
CT	Near Cedar Swamp	Waterford *	New London *	Sept. 16, 1901	"Dry woods" "Prostrate"	--	C. Graves #226	Gray
CT	--	Tolland City *	Tolland *	Aug. 6, 1922	"Border of dry woods"	--	C. Weatherby #5091	NEBC
CT	Obwebetuck Hill	Windham *	Windham *	Aug. 11, 1934	"Moist wood" near hill	--	K. P. Jansson	Torrey

Note: **Bolded** specimens are current. An asterisk (*) after a town or county indicates a range expansion beyond that tracked by the Natural Heritage programs. Localities are as noted on the specimens, except additions in brackets [ ]. Element Occurrence numbers are only reported for those specimens where the locality data for the specimen match the locality data as reported by the relevant Natural Heritage program. NEBC is the New England Botanical Club collection, housed at Harvard University.

Appendix 5: Occurrences of *Desmodium cuspidatum* in New England as Reported in the Literature

State	Locality/Town	County	Comments	Source
ME			No reports found in the literature	
NH			No reports found in the literature	
VT	Not given	Bennington *	Probably based on specimens	Magee and Ahles (1999)
VT	Not given	Bennington *	Probably based on specimens	Seymour (1982)
VT	Arlington (?) * - "Arlington Gap, where the Baterkill [sic] River cuts through the Taconic Range, near Arlington and Manchester"	Bennington *	With *Arabis canadensis*, *Viola sororia*, and *Collinsonia canadensis*, generally. No specimen taken.	Flynn (1903)
VT	Arlington *	Bennington *		Dole et al. (1937)
VT	Pownal *	Bennington *		Dole et al. (1937)
VT	North Pownal, Town of Pownal *	Bennington *		Brainerd, Jones, and Eggleston (1900)
VT	North Pownal, Town of Pownal *	Bennington *		Dole et al. (1937)
VT	Not given	Rutland	Probably based on specimens	Magee and Ahles (1999)
VT	Not given	Rutland	Probably based on specimens	Seymour (1982)
VT	Wells *	Rutland		Dole et al. (1937)
VT	West Rutland	Rutland		Dole et al. (1937)
MA	Not given	Berkshire	Based on specimens	Sorrie and Somers (1999)
MA	Not given	Berkshire	Probably based on specimens	Magee and Ahles (1999)
MA	Great Barrington *	Berkshire	Dry thickets.	Hoffman (1922)
MA	Mount Washington *	Berkshire	Dry thickets.	Hoffman (1922)
MA	New Marlborough	Berkshire	Based on specimens	Weatherbee (1996)
MA	North Adams	Berkshire	Based on specimens	Weatherbee (1996)
MA	Sheffield	Berkshire	Dry thickets.	Hoffman (1922)
MA	Sheffield	Berkshire	Probably based on specimens	Seymour (1982)
MA	Sheffield	Berkshire	Based on specimens	Weatherbee (1996)

Appendix 5: Occurrences of *Desmodium cuspidatum* in New England as Reported in the Literature

State	Locality/Town	County	Comments	Source
MA	Not given	Essex	Based on specimens	Sorrie and Somers (1999)
MA	Danvers	Essex	Rich woods. Specimen given as Cole, 1906.	Harris (1975)
MA	Wenham	Essex	Dry open woods, rare. "All represented by identifiable specimens"	Knowlton and Deane (1918)
MA	Wenham Swamp	Essex	Rich woods. Specimen given as Sears, 1887.	Harris (1975)
MA	Not given	Franklin	Probably based on specimens	Magee and Ahles (1999)
MA	Not given	Franklin	Based on specimens	Sorrie and Somers (1999)
MA	Not given	Hampshire	Probably based on specimens	Magee and Ahles (1999)
MA	Not given	Hampshire	Based on specimens	Sorrie and Somers (1999)
MA	Not given	Middlesex	Probably based on specimens	Seymour (1982)
MA	Not given	Middlesex	Probably based on specimens	Magee and Ahles (1999)
MA	Not given	Middlesex	Based on specimens	Sorrie and Somers (1999)
MA	Lowell	Middlesex	Rare	Dame and Collins (1888)
MA	Lowell	Middlesex	Dry open woods, rare. "All represented by identifiable specimens"	Knowlton and Deane (1918)
MA	Malden	Middlesex	Dry open woods, rare. "All represented by identifiable specimens"	Knowlton and Deane (1918)
MA	Middlesex Fells Reservation (rocky open woods near Black Rock) - Melrose	Middlesex	"Specimens in the Reservation Herbarium"	Deane (1896)
MA	Melrose	Middlesex	Dry open woods, rare. "All represented by identifiable specimens"	Knowlton and Deane (1918)
MA	Natick	Middlesex	Moist oak woods. "Represented by specimens in my herbarium".	Knowlton (1907)
MA	Natick	Middlesex	Dry open woods, rare. "All represented by identifiable specimens"	Knowlton and Deane (1918)

Appendix 5: Occurrences of *Desmodium cuspidatum* in New England as Reported in the Literature

State	Locality/Town	County	Comments	Source
MA	Oak Island, Revere *	Middlesex	Wooded island in salt marsh. Rich (1902) noted that *D. cuspidatum* was missing from Oak Island in 1883 (H.A. Young, Bull. Essex Inst.) & 1901. This may be the same site as Oak Island in Chelsea.	Rich (1902)
MA	Woburn	Middlesex	Rare	Dame and Collins (1888)
MA	Horn Pond Mt., Woburn	Middlesex	Open woods. "Represented by specimens in my herbarium".	Knowlton (1907)
MA	Woburn	Middlesex	Dry open woods, rare. "All represented by identifiable specimens"	Knowlton and Deane (1918)
MA	Not given	Norfolk	Probably based on specimens	Seymour (1982)
MA	Not given	Norfolk	Probably based on specimens	Magee and Ahles (1999)
MA	Not given	Norfolk	Based on specimens	Sorrie and Somers (1999)
MA	Canton	Norfolk	Dry open woods, rare. "All represented by identifiable specimens"	Knowlton and Deane (1918)
MA	Blue Hills Reservation (south slope of Great Blue Hill and near Hawk Hill) – Canton/Milton	Norfolk	"Specimens in the Reservation Herbarium".	Deane (1896)
MA	Needham	Norfolk	Dry open woods, rare. "All represented by identifiable specimens".	Knowlton and Deane (1918)
MA	Wood road at Welch's Farm, Stoughton *	Norfolk	Specimen collected by Blake (#3294).	Blake (1929)
MA	Not given	Suffolk	Probably based on specimens.	Seymour (1982)
MA	Not given	Suffolk	Probably based on specimens.	Magee and Ahles (1999)
MA	Not given	Suffolk	Based on specimens.	Sorrie and Somers (1999)
MA	Stony Brook Reservation (rocky woods) - Boston	Suffolk	Either reliable reports or specimen in private herbarium.	Deane (1896)
MA	W. Roxbury, Boston	Suffolk	Dry open woods, rare. "All represented by identifiable specimens".	Knowlton and Deane (1918)
MA	Oak island, Chelsea *	Suffolk	Woods. This may be the same site as Oak Island in Revere.	Bigelow (1840)
MA	Not given	Worcester *	Based on specimens.	Sorrie and Somers (1999)

Appendix 5: Occurrences of *Desmodium cuspidatum* in New England as Reported in the Literature

State	Locality/Town	County	Comments	Source
MA	"east shore of Lake; White City to Lincoln Street"	Worcester*	Specimen described as deposited at the Gray Herbarium.	Jackson (1927)
RI	Not given	Providence *	Probably based on specimens.	Seymour (1982)
RI	Not given	Providence *	Rare. Dry open upland woods.	George (1995)
RI	Not given	Providence *	Probably based on specimens	Magee and Ahles (1999)
CT	Trumbull *	Fairfield *		Bishop (1901)
CT	Stratford *	Fairfield *		Bishop (1901)
CT	Not given	Fairfield *	Probably based on specimens	Seymour (1982)
CT	Not given	Fairfield *	Probably based on specimens	Magee and Ahles (1999)
CT	Not given	Hartford *	Probably based on specimens	Seymour (1982)
CT	Not given	Hartford *	Probably based on specimens	Magee and Ahles (1999)
CT	Southington and vicinity *	Hartford *	Specimen described as deposited at the Gray Herbarium, #779 collected by Andrews	Bissell and Andrews (1902)
CT	Not given	Litchfield *	Probably based on specimens	Magee and Ahles (1999)
CT	Not given	Middlesex *	Probably based on specimens	Magee and Ahles (1999)
CT	Killingworth *	Middlesex *	Probably based on specimens	Seymour (1982)
CT	Not given	New Haven *	Probably based on specimens	Seymour (1982)
CT	Not given	New Haven *	Probably based on specimens	Magee and Ahles (1999)
CT	Not given	New London *	Probably based on specimens	Magee and Ahles (1999)
CT	Milford *	New Haven *		Bishop (1901)
CT	Oxford *	New Haven *	Rare.	Bishop (1901)
CT	Waterbury *	New Haven *	Dry and usually rocky woods and thickets. Frequent.	Blewitt (1926)
CT	Franklin *	New London *	Probably based on specimens	Seymour (1982)
CT	Not given	Tolland *	Probably based on specimens	Magee and Ahles (1999)
CT	Tolland *	Tolland *	Probably based on specimens	Seymour (1982)
CT	Not given	Windham *	Probably based on specimens	Magee and Ahles (1999)

Appendix 5: Occurrences of *Desmodium cuspidatum* in New England as Reported in the Literature

State	Locality/Town	County	Comments	Source
CT	Obwebetuck Hill, Windham *	Windham *	Wooded hill with dry soil. Noted as occasional and as not occurring in the central and northern sections of the county. With *D. glabellum, D. canescens, Eupatorium sessilifolium, Acalypha digyneia, Geum flavum, Polygonum virginianum, Agrimonia mollis, Panicum boscii* var. *molle*.	Upham (1933)
CT	Windham *	Windham *	Dry woods, thickets and shaded roadsides. Rare or missing except in southern area, where it is at least occasional.	Upham (1959)
CT	Windham *	Windham *	Probably based on specimens.	Seymour (1982)

Note: An asterisk (*) after a town or county indicates a range expansion beyond that tracked by the Natural Heritage programs.

6. 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.