New England Plant Conservation Program

Calystegia spithamaea (L.) Pursh ssp. *spithamaea* Low Bindweed

Conservation and Research Plan for New England

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Approved, Regional Advisory Council, December 2003

SUMMARY

Low bindweed, *Calystegia spithamaea* (L.) Pursh ssp. *spithamaea*, is a low-growing, rhizomatous perennial plant of the Convolvulaceae. It favors dry, open, sandy to rocky sites throughout its range; in New England, it is found growing in pitch pine/scrub oak barrens, blueberry barrens, sandplain grasslands, scree and talus slopes, sandy roadsides, and power line rights-of-way and riverbanks. *Calystegia spithamaea* is sensitive to competition from other plants and may require disturbance to persist.

Low bindweed ranges from Nova Scotia and Quebec to Maine, west to Manitoba and south to Florida. One of three other species of *Calystegia* present in New England, *C. sepium*, is reported to hybridize with *C. spithamaea*. There are three subspecies of *Calystegia spithamaea* in eastern North America, but only ssp. *spithamaea* grows in New England.

Globally, low bindweed is ranked G4G5, indicating that it is apparently secure. However, in most states at the western and southern limits of its range, it is ranked SR (reported but without persuasive documentation), making it difficult to determine whether its range is shrinking. *Flora Conservanda:* New England lists *C. spithamaea* as Division 2 (Regionally Rare). In New England, it is ranked S1 (critically imperiled) in Massachusetts and Maine, S2 (imperiled) in New Hampshire, and Vermont, SR in Rhode Island, and SH (historic) in Connecticut. The current known distribution is limited to 18 extant stations in Maine, Vermont and Massachusetts, but only twelve populations (5 in Maine, 5 in Vermont, and 2 in Massachusetts) have been confirmed in the past decade to have plants. One unsubstantiated report from Rhode Island lacks specific documentation. Herbarium searches during preparation of this plan located an additional 72 specimens from 31 additional towns in New England, including three hybrids. Of these collections, specimens from Brunswick made by P. Vickery and J. Wells in 1988 and 1989 may represent one or two more extant occurrences, but this requires further verification.

Threats to the taxon in New England include: agricultural, commercial, and recreational land-use; competition from non-native invasive plants; and natural succession. The suppression of fire in fire-dependent communities also appears to be a threat but its ecological role with respect to low bindweed is poorly understood. Conservation efforts consisting of prescribed burning and manual removal of competing vegetation have been initiated at a few stations, but most efforts have not taken place on a regular basis, nor have the results been thoroughly evaluated.

The primary conservation objective for *Calystegia spithamaea* is to protect and maintain the 18 known extant stations. The viability of unranked occurrences in Maine and Massachusetts needs to be assessed through field surveys. Since so little is known about the ecology of *C. spithamaea*, further research, particularly on reproduction and seed germination, is advised. Recommendations also include experimental clearing or burning for site management; surveys of documented extant and historical sites; regular, systematic monitoring; and protection of occurrences through easement and landowner education.

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.

This document should be cited as follows:

Corrigan, Elizabeth. 2004. *Calystegia spithamaea* (L.) Pursh ssp. *spithamaea* (Low Bindweed) Conservation and Research Plan for New England. New England Wild Flower Society, Framingham, Massachusetts, USA.

I. BACKGROUND

INTRODUCTION

Low bindweed, *Calystegia spithamaea* (L.) Pursh ssp. *spithamaea* is low-growing, rhizomatous perennial of the Convolvulaceae. It tends to be upright in habit and unlike most members of the genus, it rarely twines. *Calystegia spithamaea* is sensitive to competition from other plants and apparently requires disturbance that keeps sites open. Throughout its range, low bindweed favors dry, open, sandy to rocky sites. In New England, low bindweed is found growing in the sand and gravel soils of sandplain communities, sandy roadsides, power line rights-of-way, scree and talus slopes, and dry riverbanks.

Low bindweed ranges from Nova Scotia to Maine, west to Manitoba and south to Florida. There are three subspecies of *Calystegia spithamaea* but only *Calystegia spithamaea* ssp. *spithamaea* ranges from Georgia north through New England and eastern Canada, and from here on will be referred to as *Calystegia spithamaea*.

Three other species of *Calystegia* occur in New England. *Calystegia sepium* (L.) R. Br., hedge bindweed, has both a native and Eurasian form and is sympatric with *Calystegia spithamaea*, with which it apparently hybridizes (Appendix 3). *Calystegia silvatica* (Kit.) Griseb. (large bindweed) and *C. pellita* (Leded.) G. Don (hairy bindweed) have been reported as garden escapes.

The status of *Calystegia spithamaea* is questionable in many states, especially at the western and southern limits of its range, thereby making it difficult to determine if its range is contracting. The taxon is listed as SR (reported but without persuasive documentation) in 12 states and in the Canadian province of Quebec, and it is listed as S? (uncertain status) in three states at the center of its range. Globally ranked G4G5, *C. spithamaea* is apparently secure. In New England, it is considered regionally rare and is listed as Division 2 in *Flora Conservanda*: New England (Brumback and Mehrhoff et al. 1996), indicating fewer than 20 documented occurrences since 1970. In Massachusetts and Maine, *C. spithamaea* is listed as S1 (critically imperiled). New Hampshire and Vermont list the taxon as S2 (imperiled). There is only one report from Rhode Island, where it is ranked SR (R. Enser, Rhode Island Natural Heritage Program, personal communication). In Connecticut, the taxon is ranked SH (historic). Twenty-three New England occurrences tracked by New England Natural Heritage Programs can be considered historic or extirpated.

Low bindweed appears to be sensitive to competition from encroaching vegetation and, depending on the community type in which it grows, benefits from fire or other types of disturbance that keep sites open. The sandy and gravelly soils on which the species is found are well-drained and, therefore, at risk for development; they are also favored by all-terrain vehicle (ATV) and mountain bike enthusiasts who can directly

impact plants. Some populations *Calystegia spithamaea* are affected by herbicides, applied to keep utility rights-of-way and blueberry barrens weed free.

Based on information provided in field notes, it is not certain whether New England populations of *C. spithamaea* are capable of successful sexual reproduction; however, this may be an artifact of sampling since reproduction frequently is ignored by surveyors. Seedlings have not been definitively identified at any of the stations, and aborted fruit were documented from others. Some evidence of herbivory, principally by invertebrates, has also been noted but it is not evident if it had any deleterious effect on populations.

Conservation efforts consisting of managing sites by prescribed burning and manual removal of competing vegetation have been initiated at stations in Maine, Vermont and Massachusetts but most efforts have not been performed on a regular basis. In some cases, low bindweed has indirectly benefited from management of this type where it has been implemented for other co-occurring, rare taxa. ATV trails at one site have been blocked off to protect plants; for another, recommendations that the property owner seek alternatives to herbicides were made.

This Conservation and Research Plan evaluates the status of *Calystegia spithamaea* in New England and provides recommendations essential to the recovery and long-term preservation of the taxon. Since so little is known about the ecology and biology of *Calystegia spithamaea*, the need for further research is emphasized.

DESCRIPTION

The following description was compiled from the following sources: Fernald (1950), Lewis and Oliver (1965), Britton and Brown (1970), Crittenden and Telfer (1977), Gleason and Cronquist (1991), and K. Gandhi (Gray Herbarium, personal communication). *Calystegia spithamaea* (Convolvulaceae) is a short, rhizomatous perennial growing 7-50 cm in height. Plants tend to be upright, but larger plants usually sprawl. Unlike most members of the Convolvulaceae, low bindweed does not twine, but according to one source (Britton and Brown 1970), it sometimes twines feebly at the summit. *Calystegia spithamaea* has a single stem, but a few ascending branches may emanate occasionally from its base. Its leaves are alternate and more or less hairy; the uppermost are sessile. Leaves are variable in shape: oblong to obovate-oblong. Leaf bases can be subcordate to subtruncate or even tapering. Leaf tips vary from acute to rounded. Mature blades are 3-8 cm long on petioles much shorter than the blade and the basal leaves are much smaller than the upper ones. One to four solitary, erect, pink to white flowers emerge from May to July from the median to lower leaf axils and can grow to be quite large (3.5-7 cm in length). The corolla is funnel-form in shape and there are five, appressed sepals. The ovary is semi-locular. The two stigmas are thick, oblong and flat. Pollen is spheroidal, pentoporate with 20-40 apertures. The calyx is subtended by two large, leafy bracts that are oblong or ovate in shape. They are inserted immediately

beneath the calyx, thereby concealing it. The fruit is a globose to nearly globose, bilocular capsule; each locule contains two glabrous seeds.

A co-occurring congener, *Calystegia sepium* (hedge bindweed), apparently hybridizes with *C. spithamaea,* but the two are unlikely to be confused in the field (Arthur Haines, New England Wildflower Society, personal communication). Although it also has pink or white flowers, hedge bindweed has a twining growth habit, grows considerably longer – up to 3 m – and has hastate or sagittate leaves. According to Gleason and Cronquist (1991), there is apparently an introduced Eurasian form *of C. sepium*, but it is not clear how the two can be differentiated. Hybrids of *C. sepium* and *C. spithamaea* show subtle pink tingeing of flowers and the lobes on the leaf blades are more exaggerated and pointed (Appendix 3).

Another co-occurring, aggressive species, the non-native field bindweed (*Convolvulus arvensis*), also has similar pink to white flowers but its bracts are minute and are inserted 5-20 mm below the flower. Instead of being upright in habit as *Calystegia spithamaea*, *C. arvensis* climbs and forms tangles. Other differences include freely branching stems which grow considerably longer (up to 1 m in length) than those of low bindweed. Its long-petioled leaves are highly variable in shape, ranging from ovate to almost linear with a cordate, hastate, or sagittate base. Also, the 1.5 to 2 cm-long flowers, which bloom somewhat later in the season (June to September), are considerably smaller than those of *C. spithamaea*.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

The genus *Calystegia* is comprised of 25 species distributed world-wide over temperate to tropical zones; 18 species are found in North America. There are three subspecies of *Calystegia spithamaea* but their ranges do not overlap in New England: *C. spithamaea* ssp. *purshiana* (Wherry) Brummitt occurs from Alabama up the eastern seaboard to Pennsylvania and *C. spithamaea* ssp. *stan*s (Michx.) Brummitt has a scattered distribution, mostly in the upper Midwest (Kartesz 1999). The New England subspecies is *Calystegia spithamaea* ssp. *spithamaea.*

Calystegia spithamaea has undergone several name changes since it was first described by Linnaeus in 1753. The following synonyms have been used (Britton and Brown 1970):

Convolvulus spithamaeus L., *Species Plantarum* 158 (1753)
Calystegia spithamaea Pursh, *Flora America Septentrionalis* Sept. 143 (1814)
Volvulus spithamaeus Kuntze, *Revisio Generum Plantarum* 447 (1891)
Convolvulus camporum Greene, *Pithonia* 3: 328. (1898)

Lewis and Oliver (1965) give the following historical account of some of the nomenclatural changes. The *Calystegia* species were placed in *Convolvulus* until separated by R. Brown in 1810. Bentham questioned the separation, believing it was too

artificial to adopt as a separate genus; in 1876, Bentham and Hooker returned it to *Calystegia*. Gray, in a publication later that year, considered *Calystegia* and *Convolvulus* as one, based on his observations of certain Californian species. Hence, most North American species of *Calystegia* were lumped into *Convolvulus* but elsewhere, the same and other species were recognized under *Calystegia* and *Convolvulus*. The placement and nomenclature of the species was not resolved until years later when Hallier noted distinct morphological differences between the genera: "species of *Calystegia* possess oblong or rarely filiform stigmas, incompletely 1-locular ovaries, and spherical pollen covered with pores, while those of *Convolvulus* have filiform stigmas, 2-locular ovaries and ellipsoid pollen with three longitudinal furrows." More recently, O'Donnell made additional, more detailed observations. He found that the stigmas of *Calystegia* were also flat, the ovaries were semi-locular and the pollen had many evenly distributed pores. O'Donnell noticed that *Convolvulus*, however, had cylindrical, pointed stigmas, bilocular ovaries, and pollen with three pores. He also observed that *Calystegia* possessed larger bracts than *Convolvulus*, which had only reduced bracts.

The genus now rests as *Calystegia*; studies by Lewis and Oliver (1965) dispelled beliefs held by Kuntze, Roberty and MacBride that pollen characteristics of species in the Convolvulaceae could not be used in solving complicated problems due to their variability. Palynological studies conducted by the researchers proved not only that pollen morphology was consistently and distinctly different between species of *Calystegia* and *Convolvulus*, but also that the genera are probably distantly related since those differences were so great. Recent phylogenetic analyses place *Calystegia* within the tribe Convolvuleae (Stefanovic et al. 2003).

SPECIES BIOLOGY

Reproduction

Calystegia spithamaea spreads vegetatively by rhizomes. It blooms from May to July. It is not known whether New England populations are capable of successful sexual reproduction *in situ*. Fruits have been observed at seven stations (ME .005 [Falmouth], VT .001 [Essex], VT .003 [Burlington], VT .005 [Colchester], VT .008 [Orwell], MA .001 [Marlborough],and MA .010 [Groton]). At two of those stations (VT .003 [Burlington] and VT .005 [Colchester]), fruit appeared to be aborted; the cause at either site was not apparent. According to field observations by surveyors, plants at one site (ME .003 [Kennebunk]) were reportedly "reproductive" but it is not known whether this determination was based on presence of flowers or fruit. Interestingly, three specimens were found during herbarium searches that may represent hybrids of *Calystegia spithamaea* and *C. sepium* (Appendix 3). It is not known, however, if hybridization with *C. sepium* or perhaps another species of *Calystegia*, led to production of aborted fruit.

Seeds have not been documented from any Element Occurrence in New England and Natural Heritage Element Occurrence Records (EORs) do not mention whether seedlings have been observed in the field. This, however, may be an artifact of sampling,

as it is not uncommon for surveyors to ignore reproduction. It is also difficult to differentiate seedlings from young shoots that are emerging from rhizomes without digging them up (Corrigan, personal observation; Tim Simmons, Massachusetts Natural Heritage and Endangered Species Program, personal communication). It is equally difficult to determine where one genet ends and the other begins (Haines, personal communication). This difficulty more than likely contributed to inconsistent reporting of population size at some stations (e.g., MA .010 [Groton], VT .001 [Essex], VT .003 [Burlington], VT .009 [Colchester], ME .006 [Wells], ME .003 [Kennebunk] and ME .No EO Number) where surveyors reported the number of plants present based on the number of stems observed. There has been one report of possible seedling recruitment, however. At ME .005 (Falmouth), plants reportedly colonized an area with exposed soil, approximately 4 m away from a parent (ramet) population. According to Georgia Hall (Woodlot Alternatives, personal communication), who made the initial observation, it is very likely that the new colony developed from seed rather than by vegetative spread because the gap between the two colonies lacked stems. Seedlings were not present or noticeable at the time the observation was made in mid-June, probably because they had already matured.

It is difficult to evaluate, without genetic studies, whether a (perceived) lack of sexual reproduction in extant populations is harmful to the viability of *Calystegia spithamaea* populations. Interestingly, *Calystegia collina*, a related rare endemic of serpentine barrens in California, also shows low rates of sexual reproduction (relying heavily on vegetative reproduction like *C. spithamaea*), but may maintain moderate levels of genetic variation through somatic mutation (Wolf et al. 2000). It should also be noted that many herbarium specimens from New England populations have had flowers (although a very small proportion have been collected with fruit).

Pollinators

Little is known about the pollinators of *Calystegia spithamaea* in New England. Tim Simmons (personal communication) suggests that the pollinators might be generalists, such as native flies or bees, or even moths. According to Austin (1997), some species of bees of the genus *Diadasia* use only pollen from *Calystegia* and *Convolvulus* to provision their nests (Austin 1997). One station of *C. spithamaea* from Wisconsin was reportedly visited by honeybees (Wisconsin State Herbarium 2003).

Dispersal

Literature searches provide insufficient information on the possible dispersal vectors and mechanisms of *Calystegia spithamaea*. According to Austin (1997), the specific mode of dispersal of the Convolvulaceae is poorly known but wind, mammals and water are vectors; information regarding the possible relationship between seed morphology and dispersal is not available.

Seed Dormancy and Germination

According to Carol Baskin (University of Kentucky, personal communication), seeds of *C. spithamaea* have impermeable seed coats, indicating physical dormancy, and can probably germinate over a wide range of conditions after the seed coat has been made permeable. Seeds become permeable and imbibe when the water plug, which is a small structure on the seed coat, has been dislodged or removed, thereby creating an entry point for water. Direct heat from fires can dislodge the water plug as can fluctuations between day and night temperatures. Seeds covered by soil or leaf litter are normally protected from large temperature fluctuations but when that cover is removed, the differences between day and night temperatures suddenly become much greater, causing the water plug to move. This response to daily temperature changes may play a role in preventing seeds from germinating under a forest canopy, while enabling germination in gaps. It may also prevent seeds from germinating deep in the soil yet trigger germination when they are moved to the surface. The length of time that the seeds of *Calystegia spithamaea* remain viable in the soil is not known.

Pests, Predators and Pathogens

Literature searches provide little information on the pests of *Calystegia spithamaea*. Beetles of the genus *Megacerus* (Bruchidae) are specialists that feed on the seeds of the Convolvulaceae (Austin 1997), but the literature does not indicate which species, if any, feed specifically on *C. spithamaea*. Pests of the closely-related species, *Calystegia sepium*, have been thoroughly studied and are used as biological control agents against this noxious weed (Kok 1999). In addition to the seed weevil *Megacerus disciodus*, two moths, *Oidaematophorus monodactylus* (Pterophoridae) and *Bedellia somnulentella* (Lyonetiidae), are also used (Kok 1999) but it is not known whether they feed on *C. spithamaea* as well. Three aborted fruits were observed at VT .003 (Burlington), possibly due to such predation, but the cause is not certain. At ME .003 (Kennebunk) and ME .007 (Lyman), there was some evidence of leaf predation, possibly by insects or slugs, but it was unconfirmed and the extent of damage was not noted.

Stagonospora convolvuli (Sphaeropsidaceae) is a fungus known to attack *C. sepium*, causing brown lesions on its leaves and defoliation, but it is not known if it also infects *C. spithamaea* (DeFago 1999). Additionally, a naturally-occurring strain of *S. convolvulli*, known as LA 39, is shown by research to be a potentially effective mycoherbicide that targets *Convolvulus arvensis*, *Calystegia sepium* and other bindweeds that are agricultural pests (Pfirter and DeFago 1998). Tests to determine the pathogen's host range, however, were limited to only a few common species of Convolvulaceae (DeFago et al. 2001) and therefore did not include *C. spithamaea*.

HABITAT/ECOLOGY

In New England, *Calystegia spithamaea* has been documented from pitch pine/ scrub oak barrens, blueberry barrens, sandplain grasslands, scree and talus slopes, sandy roadsides, and power line rights-of-way. It has also been documented on a dry riverbank and a limestone bluff. The specific substrates that low bindweed might favor have not been thoroughly documented. Specific soil type has been recorded only from two stations (ME .003 [Kennebunk], ME No EO Number [Waterboro]), where low bindweed was reportedly growing in Adams/Lyman sandy loam. However, soils maps indicate that Adams/Windsor loamy sand underlies over half of the Vermont sites [VT .001 (Essex), VT .004 (Milton), VT .005 (Colchester), VT .006 (Essex), VT .007 (Colchester), VT. 010 (Colchester)]. In certain regions, the plant is often found in areas overlying circumneutral bedrock. Bedrock geology has been reported from only two stations in New England: at MA .006 (Greenfield), the bedrock is sugarloaf arkose; at VT .003 (Burlington), plants were growing on a limestone bluff.

The taxon apparently favors the dry, open, sunny sites of these sandy to rocky substrates where competition from other plants is limited (e.g., VT .005 [Colchester], ME .005 [Falmouth]) (T. Simmons, personal communication; G. Hall, personal communication). Investigation of its growing conditions at many New England sites indicates that low bindweed requires full sunlight to persist. Plants respond positively to the removal of competing growth either by clearing or burning. For example, flower production and/or stem counts including production of new colonies increased at three of the sites being managed to remain open (ME .003 [Kennebunk], ME .005 [Falmouth], VT .005 [Colchester]). One occurrence in particular, ME .005 (Falmouth), is exemplary in that stem counts have increased into the thousands after clearing was initiated. Flower production also increased and a new colony was discovered. Observations made by G. Hall (personal communication) suggest that if the occurrence is not managed, the number of stems will begin to decline after about three years due to competing vegetation. Hall also states that plants growing under tree cover will produce few, if any, flowers. Plants growing in dappled light (ME .007 [Lyman]) were described as being less vigorous than those that were growing in sun. Plants at ME .006 (Greenfield), which numbered more than two-hundred and were growing in full sun, were reported to be vigorous when they were first discovered. Fifteen years later, when the population was rediscovered, the plants, now growing in dappled shade, had decreased to 140.

Low bindweed appears to benefit from fire, which is used as a management tool at certain sites to keep sites open and free from competing vegetation. In Ontario alvar communities, *Calystegia spithamaea* recruited strongly into burned plots within 100 days post-fire (Catling et al. 2001, 2002). New colonies were observed at three stations (ME .003 [Kennebunk], ME No EO Number [Waterboro], VT .005 [Colchester]) after burning. Also, an increase in flowering was observed at two stations: ME .003 (Kennebunk) and VT .005 (Colchester) (T. Simmons, personal communication). It is not known, however, if these increases were due to additional sunlight reaching the plants — a result from the removal of cover by burning — or perhaps from changes in the substrate that may result from fire, or a combination of the two (Keeley and Fotheringham 2000).

It is important to note that the effects of fire on seed germination has not been documented as seedlings have not been observed after burns, probably because they were not surveyed for. Although EORs suggest that fire may also trigger or stimulate flower production, data on the mechanisms are lacking.

Other types of disturbance, such as slope failures in scree and talus areas, cutting, mowing, or deliberate scarification of the soil may also remove competitors and create suitable areas of for seedling recruitment by exposing soil. The putative new colony of seedlings discovered at ME .005 (Falmouth) had established in exposed soil, for example.

THREATS TO TAXON

The most apparent threats to the long-term survival of *Calystegia spithamaea* in New England include:

- the natural succession of its habitat
- development and habitat conversion
- competition from upland invasive plants such as *Berberis thunbergii* and *Rhamnus cathartica*,
- trampling from recreational vehicles.
- use of herbicides nearby

Many of the historical Element Occurrences (EOs) and specimens found through herbarium searches date back to the 1800s and early 1900s when the landscape was more open, threats from non-native plants were less prevalent, and development was not as extensive as it is today. Some stations (e.g., ME .003 [Kennebunk], MA .010 [Groton], VT .005 [Colchester]) are becoming overgrown and have required some form of management — either burning or cutting — to stave off encroaching vegetation and to keep occurrences open to sunlight. Populations at some stations (e.g., MA .008 [Northampton]) have been impacted by excavation of sand and gravel or by development as sandy soils have good drainage, which is essential for septic systems. Also, the suppression of naturally-occurring fires in sandplain communities, which also helps keep sites open is a threat. ATVs and mountain bikes have been noted to trample plants at ME .003 (Kennebunk), ME No EO Number (Waterboro), VT .003 (Burlington), VT .005 (Colchester), and VT .010 (Colchester). Herbicide use is mentioned as a problem at ME .006 (Wells) and MA .010 (Groton).

Potential threats include overcollection or picking of stems. According to EORs, picking by visitors has impacted plants at ME .003 (Kennebunk). Likewise, numerous herbarium specimens from several Connecticut towns (e.g., New Milford, Southbury, and East Haven; see Appendix 2) indicate possible collection pressure on populations that may no longer exist. Herbivory by insects and/or slugs and deer has been recorded at some sites (e.g., ME .007 [Lyman], ME No EO Number [Waterboro]), but the extent of these threats is not well documented.

DISTRIBUTION AND STATUS

General Status

Calystegia spithamaea (ssp. *spithamaea*) ranges from the eastern half of North America, from Quebec, west to Ontario, and south to Georgia (NatureServe Explorer 2002). Table 1 and Figure 1 summarize the distribution of *Calystegia spithamaea* in North America. County distributions are from USDA, NRCS (2002).

Table 1. Occurrence and status of *Calystegia spithamaea* 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)
Delaware (S1): reported from 35 counties	Ontario (S4S5)	District of Columbia (SR)	Connecticut (SH): 4 historic occurrences
Maine (S1,T): 7 extant and 4 historic occurrences	Kentucky (S?)	Illinois (SR)	
Maryland (S2)	Pennsylvania (S?)	Iowa (SR)	
Massachusetts (S1,E): 2 extant and 8 historic occurrences	West Virginia (S?)	Georgia (SR): reported from 4 counties	
New Hampshire (S2,T): 7 historic occurrences		Indiana (SR)	
New Jersey (S1)		Michigan (SR): reported from 53 counties	
Vermont (S2,T): 9 extant occurrences		Missouri (SR): reported from 9 counties	
		New York (SR)	
		Rhode Island (SR); 1 unsubstantiated report	
		Tennessee (SR): reported from 25 counties	
		Virginia (SR): reported from 32 counties	
		Wisconsin (SR): reported from 48 counties	
		Quebec (SR)	

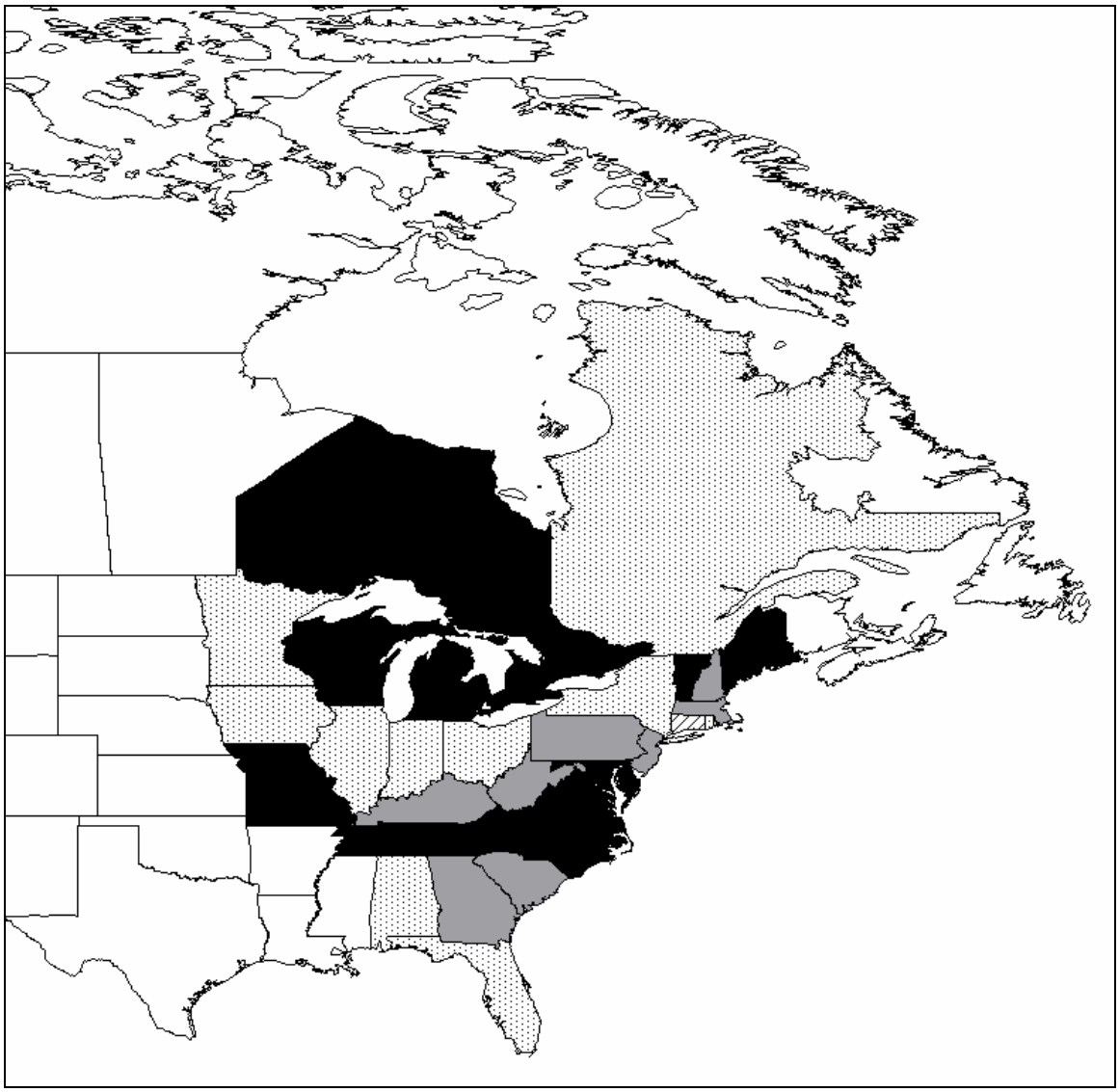

Figure 1. Occurrences of *Calystegia spithamaea* ssp. *spithamaea* in North America. States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. Note: Despite an apparent lack of extant occurrences, New Hampshire is shown in gray because the state rank remains S2. Areas shaded in black have more than five confirmed occurrences. Areas with diagonal hatching are designated "historic," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but without further document; "SR" states with additional information are shaded according to number of occurrences). See Appendix 4 for explanation of state ranks.

Status of All New England Occurrences — Current and Historical

New England Natural Heritage programs have documented 40 Element Occurrences of *Calystegia spithamaea* (Table 2, Figure 2, Figure 3). In addition, one occurrence, ME .No EO Number (Waterboro), is also extant (but has not been entered into the Maine Natural Areas Program database), giving a total of 41 known occurrences. Not all of the occurrences have been ranked by state Natural Heritage Programs, but 18 Element Occurrences can be considered extant and 23 can be considered historic since they have not been seen in 25 years. The taxon reportedly has been observed in two other locations in New England. Tom Rawinski (Massachusetts Audubon Society, personal communication) observed plants in Chapleigh, Maine and in Concord, New Hampshire but due to lack of data, these occurrences will not be discussed any further.

Herbarium searches, sponsored by the Herbarium Recovery Project at New England Botanical Society (NEBC), Connecticut Botanical Society (NCBS), University of Maine (MAINE), G. S. Torrey Herbarium (CONN), and Gray Herbarium (GH) located 72 New England specimens, which are listed in Appendix 2. Due to insufficient locality information on most of the specimen labels, the exact number of unique occurrences is uncertain. However, collections have been made from 31 towns other than the ones tracked by New England Natural Heritage Programs; conservatively, these may constitute 31 or more distinct, historic EOs. Also, a set of herbarium specimens (see Appendix 2) collected from Brunswick, Maine in 1988-1989, may represent one or two more extant occurrences, but the site(s) have not been verified through field survey.

Calystegia spithamaea once occurred in all six New England states (although no specific documentation exists for Rhode Island); the taxon has declined since the late 1800s to early 1900s.

Table 2. New England Occurrence Records for *Calystegia spithamaea.* Shaded occurrences are considered extant.			
State	**EO #**	**County**	**Town**
ME	.001	Oxford	Fryeburg
ME	**.002**	**York**	**Wells**
ME	**.003**	**York**	**Kennebunk**
ME	**.004**	**Oxford**	**Brownfield**
ME	**.005**	**Cumberland**	**Falmouth**
ME	**.006**	**York**	**Wells**
ME	**.007**	**York**	**Lyman**
ME	.008	Lincoln	Monhegan Plantation
ME	.009	Franklin	Chesterville
ME	.010	Androscoggin	Poland
ME	**No EO #**	**York**	**Waterboro**
NH	.001	Cheshire	Hinsdale
NH	.002	Grafton	Lebanon
NH	.003	Carroll	Ossipee
NH	.004	Hillsborough	Manchester
NH	.005	Stafford	Rollinsford
NH	.006	Hillsborough	Merrimack
NH	.007	Hillsborough	Litchfield
VT	**.001**		**Essex**
VT	**.002**	**Chittenden**	**Colchester**
VT	**.003**	**Chittenden**	**Burlington**
VT	**.004**	**Chittenden**	**Milton**
VT	**.005**	**Chittenden**	**Colchester**
VT	**.006**	**Chittenden**	**Essex**
VT	**.007**	**Chittenden**	**Colchester**
VT	**.008**	**Addison**	**Orwell**
VT	**.009**	**Chittenden**	**Colchester**
VT	**.010**	**Chittenden**	**Colchester**
MA	.001	Berkshire	New Marlborough
MA	.002	Franklin	New Salem
MA	.003	Middlesex	Dunstable
MA	.004	Hampden	Westfield
MA	.005	Berkshire	Sheffield
MA	**.006**	**Franklin**	**Greenfield**
MA	.007	Hampden	Wilbraham
MA	.008	Hampshire	Northampton
MA	.009	Hampshire	Granby
MA	**.010**	**Middlesex**	**Groton**
CT	.001	Litchfield	Salisbury
CT	.002	New Haven	Oxford
CT	.003	New Haven	Hamden
CT	.004	Hartford	Southington

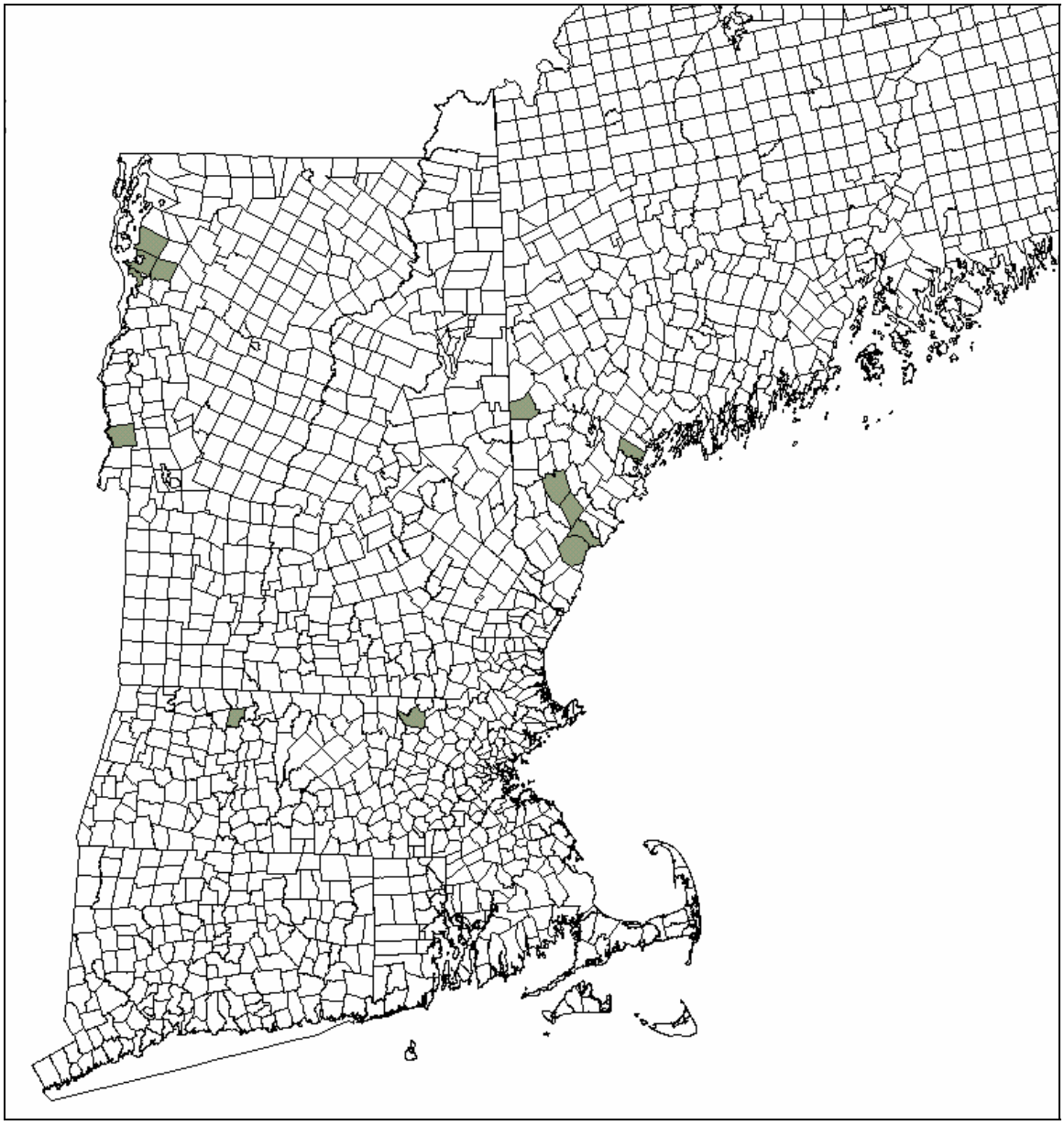

Figure 2. Extant occurrences of *Calystegia spithamaea* in New England. Town boundaries for New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon.

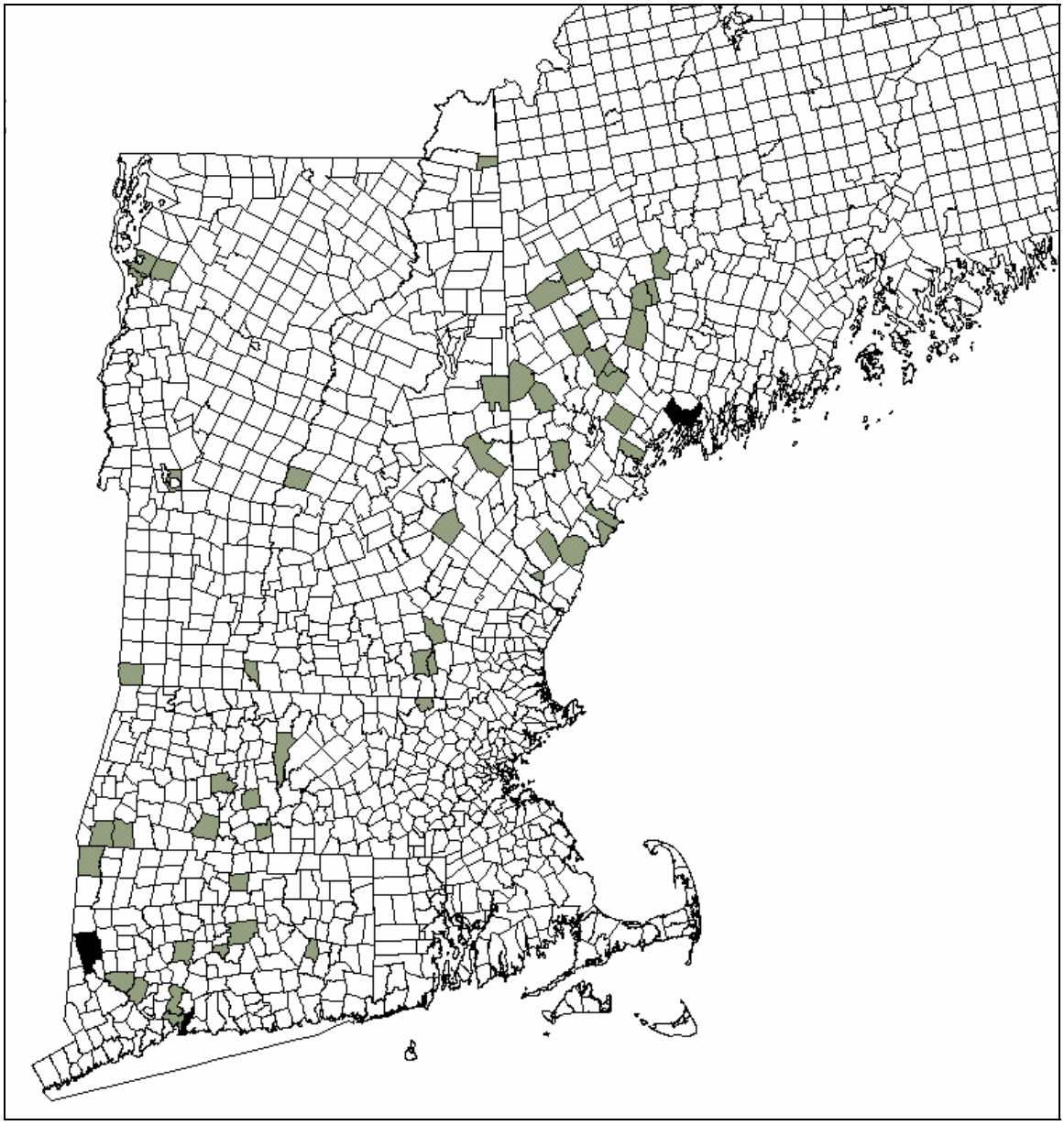

Figure 3. Historical occurrences of *Calystegia spithamaea* in New England. Towns shaded in gray have one to five historical records of the taxon; towns shaded in black have more than five records.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

The primary conservation objectives for *Calystegia spithamaea* are to protect, manage, and study all 18 confirmed, extant stations that currently have plants: seven in Maine, nine in Vermont, and two in Massachusetts. This conservative recommendation is based on the fact that little is known about the current status of New England populations of the taxon. Only 12 occurrences have been visited within the past decade, and more accurate population counts and updated information on the threats facing populations need to be compiled for all occurrences. Occurrences that have not been recently observed must be thoroughly resurveyed to determine their current status, particularly ME .002 (Wells), ME .004 (Brownfield), VT .002 (Colchester), VT .007 (Colchester), NH .001 (Hinsdale), MA .008 (Northampton), and occurrences documented only by herbarium specimens in 1988-89 from Brunswick, Maine. Total population objectives should be revised upward if these and new populations are rediscovered, with the ideal objective of approaching the 40 or more occurrences known historically from five of six New England states. Each population should have a minimum of 200 stems (which is based on the mean numbers per known extant population) to be considered viable, although higher stem counts ranging into the thousands may be preferable for biological studies.

To achieve these objectives, research of historical EO's and *de novo* surveys will be important for understanding the species' actual distribution in New England. Surveys of several historical EOs, particularly CT .001 (Salisbury), NH .003 (Ossipee), MA .005 (Sheffield) may be promising, as abundant natural habitat for the plants remains in these areas. It is very important to determine whether the taxon is capable of sexual reproduction at the New England sites, for we cannot assess the present or future vigor of populations without understanding limits to reproduction and genetic variability. Only aborted fruit have been documented from two stations, VT .003 (Burlington) and VT .005 (Colchester), and reported numbers of flower and fruit production elsewhere have been inconsistent. Consistent monitoring protocols need to be established in order to detect population trends. Management such as clearing, controlled burns, and scarification of the soil should be initiated where necessary and feasible, if research proves that this is an effective tool. Landowner education, rerouting of trails, negotiation of conservation easements and other options for land protection will be needed at several sites to prevent direct harm to the plants.

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IV. APPENDICES

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1. Additional New England Collections of *Calystegia spithamaea* Compiled from Herbarium Searches

2. Hybrids of *Calystegia spithamaea* Found During Herbarium Searches

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

1. Additional New England collections of *Calystegia spithamaea* compiled from herbarium searches

State/Id no	County	Town	Date	Description	Collector	Herbarium
ME .i	Androscoggin	Livermore	No date	Valley of Androscoggin River; flowering	K. Furbish	NEBC
ME .ii	Androscoggin	Mechanic Falls	1897-07-11	Flowering	J. Allen	GH
ME .iii	Androscoggin	Mechanic Falls	1897-07-15	Flowering	J. Allen	MAINE
ME .iv	Androscoggin	Poland	1895	S. Poland, Valley of Androscoggin River; flowering	K. Furbish	NEBC
ME .v	Androscoggin	Poland	1893	S. Poland, Valley of Androscoggin River; vegetative	K. Furbish	NEBC
ME .vi	Androscoggin	Turner	1915-07-07	Sandy roadside, Flowering	R. Bean, F. Bean	NEBC
ME .vii	Cumberland	Brunswick	Collected before 1908	Flowering	K. Furbish	NEBC
ME .viii	Cumberland	Brunswick	1989-07-14	Brunswick Naval Air Station; 20+ stems on sandplain grassland at end of runway; vegetative	P. Vickery	MAINE
ME .ix	Cumberland	Brunswick	1988-07-17	50+ stems on Maquoit Rd, 0.6 mi. SW of junction w/ Mere Pt. Rd.; flowering	P. Vickery	MAINE
ME .x	Cumberland	Brunswick	1989-06-18	Brunswick Naval Air Station; airfield/runway area	J. Wells	MAINE
ME .xi	Cumberland	Brunswick	1989-07-14	Brunswick Naval Air Station; airfield/runway area; 20 plants in sandplain grassland	P. Vickery	MAINE
ME .xii	Cumberland	Brunswick	1988-07-17	Maquoit Bay Rd.; flowering	P. Vickery	MAINE
ME .xiii	Cumberland	Falmouth	1909-07-01	Falmouth Foreside	M. Fernald	NEBC
ME .xiv	Cumberland	Gray	1941-06-18	N. Gray Sandy Barrens; flowering	F. Hyland	MAINE
ME .xv	Cumberland	Standish	1916-08-28	Sandy clearing; Vegetative	M. Fernald, B. Long	NEBC

1. Additional New England collections of *Calystegia spithamaea* compiled from herbarium searches

State/Id no	County	Town	Date	Description	Collector	Herbarium
ME .xvi	Franklin	Chesterville	1900-07	Sandplains, Flowering	L. Eaton	NEBC
ME .xvii	Oxford	Bethel	1929-06-25	Dry roadside NW Bethel sandhill	L. Wheeler	NEBC
ME .xviii	Oxford	Denmark	1974-06-29	Sandy field 2 mi. S of Liberty Corner; flowering	C. Campbell	MAINE
ME .xix	Oxford	Fryeburg	1887-06	Flowering	M. Perley	NEBC
ME .xx	Oxford	Fryeburg	1885-07-02	Flowering	Unknown	MAINE
ME .xxi	Oxford	Norway	1955-06-22	Sandy bank in Norway; flowering	L. Crane	MAINE
ME .xxii	Oxford	Oxford	1907-07-01	Sandy soil Wilchville; flowering	E. Chamberlain	NEBC
ME .xxiii	Oxford	Oxford	1914-07-05	Dry, sandy soil	C. Weatherby	NEBC
ME .xxiv	Oxford	Oxford	1907-07-06	Flowering	A. Norton	MAINE
ME .xxv	Oxford	Oxford	1907-07-02	Woods path; flowering	L. Coburn	MAINE
ME .xxvi	Oxford	Rumford	1890-07-04	Flowering	J. Parlin	GH
ME .xxvii	Oxford	Sweden	1920-07-07	Sandy roadside; flowering	R. Bean	NEBC
ME .xxviii	Oxford	West Paris	1955-06-23	Berry Ledge, Trap Corner	C. Richards	MAINE
ME .xxix	York	Biddeford City	1891-07	Flowering	C. Regester	NEBC
ME .xxx	York	Kennebunk-port	1915-06	Flowering	A. Pier	NEBC
ME .xxxi	York	Limington	1916-08-29	Dry thicket by small pond west of Sand Pond. Valley of the Saco River, in fruit	M. Fernald, B. Long, A. Norton	NEBC
ME .xxxii	York	North Berwick	1896-06	Dry, gravelly bank; flowering	J. Parlin, M. Fernald	GH
ME .xxxiii	York	Wells	1897	Flowering	K. Furbish	NEBC
NH .i	Belknap	Gilmanton	1869-07-01	Upper Gilmanton; flowering	Unknown	MAINE
NH .ii	Carroll	Conway	No date	Flowering	Unknown	GH
VT .i	Bennington	Pownal	1907-07-02	Pasture; flowering	C. Weatherby	NEBC
VT .ii	Chittenden	Burlington	1902-07-10	Dry, sandy soil; flowering	N. Flynn	NEBC

1. Additional New England collections of *Calystegia spithamaea* compiled from herbarium searches

State/Id no	County	Town	Date	Description	Collector	Herbarium
VT .iii	Chittenden	Colchester	1882-07-07	Flowering	F. Horsford	GH
VT .iv	Chittenden	Essex	1896-07-13	Parade ground at Ethan Allen; flowering	E. Brainerd	GH
VT .v	Chittenden	Winooski City	1896-07-13	Flowering	E. Brainerd	GH
VT .vi	Rutland	Rutland City	1909-06-27	Flowering	E. Kent	NEBC
MA .i	Berkshire	New Marlborough	1912-07-16	Sandy hillside, Immature fruit	R. Hoffman	NEBC
MA .ii	Berkshire	Sheffield	1899-09-25	Vegetative	R. Hoffman	NEBC
MA .iii	Berkshire	Sheffield	1901-06-27	Flowering	R. Hoffman	NEBC
MA .iv	Franklin	New Salem	No date	Flowering	G. Pierce	NEBC
MA .v	Middlesex	Dunstable	1928-06-09	Railroad embankment	J. Bill, F. Grigg S. Sanford	NEBC
CT .i	Litchfield	New Milford	1901-05	Dry, open, sandy soil	E. H. Austin	CONN
CT .ii	Litchfield	New Milford	1909-06-17	Dry, open ground	E. B. Harger	CONN
CT .iii	Litchfield	New Milford	1909-06-17	Dry railroad bank	C. H. Bissell	NCBS
CT .iv	Litchfield	New Milford	1909-06-17	No data	R. W. Woodward	NEBC
CT .v	Litchfield	New Milford	No date	Railroad embankment; in flower	Unknown	NCBS
CT .vi	Litchfield	New Milford	1909-06-17	In flower	A. E. Blewitt	NEBC
CT .vii	New Haven	Southbury	1906-06-09	Pomperaug Valley	R. W. Woodward	NCBS
CT .viii	New Haven	Southbury	1906-06-09	Grassy bank of railroad cutting in gravelly soil	C. A. Weatherby	NCBS
CT .ix	New Haven	Southbury	1906-06-09	Railroad bank	H. S. Clark	CONN
CT .x	New Haven	Southbury	1906-06-09	Dry ground near *Phlox pilosa*; in flower	H. S. Clark	NEBC
CT .xi	New Haven	Southbury	1906-06-09	Rocky soil	G. H. Bartlett	NEBC
CT .xii	New Haven	East Haven	1942-06-10	Base of wooded hill in trap talus; in flower	J. J. Neale, B. T. Neale	NCBS

1. Additional New England collections of *Calystegia spithamaea* compiled from herbarium searches

State/Id no	County	Town	Date	Description	Collector	Herbarium
CT .xiii	New Haven	East Haven	1942-06-06	In trap talus at hill, West Bradley street. Place where it grew was later a target area of a gun club and may have been destroyed; in flower	J. J. Neale, B. T. Neale	NCBS
CT .xiv	New Haven	East Haven	1855	Near New Haven	G. Thurber	GH
CT .xv	New Haven	New Haven	1851-07	Dry copses	W. J. Crown	YU
CT .xvi	New Haven	East Haven	1942-06-06	In thin soil among small pieces of trap on southern end of hill	J. Neale	CONN
CT xvii	New Haven	East Haven	1855	No information	G. Thurber	GH
CT .xviii	New Haven	East Haven	1942-06-06	Southern end of hill west of Bradley Street; in trap talus.	J. J. Neale	CONN
CT .xix	Hartford	Southington	1920-06-20	Dry, gravelly waste ground; in flower	C. H. Bissell	NCBS
CT .xx	Hartford	Southington	1898-06-16	Dry hills- not common; in flower	L. Andrews	NEBC
CT .xxi	Hartford	Glastonbury	1892-06-07	Dry hill; in flower	F. Wilson	NCBS
CT .xxii	Hartford	East Windsor	1921-06	Along railroad track	C. V. Vibert	NEBC
CT xxiii	New London	Franklin	1911-06-11	Gravel ridge-Newman Meadow; in flower	R. W. Woodward	NEBC
CT xxiv	New London	Franklin	1919-06-19	Low gravel ridge	R. W. Woodward	GH
CT xxv	New London	Franklin	1908-06-08	Dry knoll at Newman Meadows	R. W. Woodward	NCBS
CT xxvi	Middlesex	Cromwell	No date	No information	No data	GH

2. Hybrids of *Calystegia spithamaea* Found During Herbarium Searches

State	County	Town	Date	Collector	Herbarium
ME	Cumberland	Falmouth	01 July 1909	M. Fernald	NEBC

Notes:
Collected at Falmouth Foreside

Annotated notes:
This specimen shows a pink corolla and more exaggerated, slightly pointed basal lobes on the leaf blades; it is a transition to *Calystegia sepium* and may represent a hybrid.

State	County	Town	Date	Collector	Herbarium
ME	Cumberland	East Chamberlain	01 July 1909	M. Fernald	NEBC

Notes:
Flowering. Edge marsh, near Marine Hospital. Portland or Falmouth.
Convolvulus sepium var. *americanus* x *C. spithamaeus*

Annotated notes:
This specimen shows subtle pink tingeing of flowers and more exaggerated and more pointed basal lobes on the leaf blades.

State	County	Town	Date	Collector	Herbarium
ME	Cumberland	–	01 July 1909	M. Fernald	NEBC

Notes:
Flowering. Field, Underwood Spring.
Convolvulus sepium var. *americanus* x *C. spithamaeus*

Annotated notes:
This specimen shows subtle pink tingeing of flowers and more exaggerated and more pointed basal lobes on the leaf blades.

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 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.