

New England Plant Conservation Program
Conservation and Research Plan

Pedicularis lanceolata Michx.
Swamp Wood-betony

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Approved, Regional Advisory Council, May 2001

SUMMARY

Pedicularis lanceolata Michx. (Scrophulariaceae), Swamp wood-betony, is a hemiparasitic, short-lived perennial member of the Scrophulariaceae family. It ranges from Massachusetts to Georgia on the east coast, and west to North Dakota and Missouri, and is also present in the Canadian provinces of Saskatchewan, Manitoba, and Ontario. Although *P. lanceolata* is common in some mid-western states and is not considered to be rare on a global scale, it is rare in most eastern states in which it occurs, and is known only from historic records in Delaware and Kentucky. In New England, *P. lanceolata* is currently present at six sites in Connecticut, and two sites in Massachusetts. Despite regular field visits, the species has not been observed since the mid-1990's at one of the sites; but it was relocated at the other site in 2001. It has not been found in other New England states, but was known historically from nine other locations in Massachusetts and approximately 30 in Connecticut (herbarium specimen data are not precise enough to determine the exact number of historic locations). *Pedicularis lanceolata* populations in New England appear to be disappearing or declining due to habitat loss, habitat modification, exotic species invasion, and ecological succession.

Nearly all habitat requirements for *Pedicularis lanceolata* reported in the literature and on herbarium specimen labels indicate that it grows in open, non-forested areas with calcareous soils that are wet but not saturated year-round. In the east, *P. lanceolata* occurs in wet meadows that are usually calcareous and in other open wetlands such as stream banks. In the Midwest, it is a component of wet fens as well as of other open wetlands. *Pedicularis lanceolata* is not host-specific, although the relative benefits to the species of different hosts has not been investigated.

The conservation objectives for *Pedicularis lanceolata* in New England include protection and maintenance of all extant populations in Massachusetts and Connecticut, and a search for new populations through *de novo* surveys in wet meadows in southern Vermont and New Hampshire, throughout Massachusetts and Connecticut, and in western Rhode Island. If new populations have been located, every attempt should be made to achieve protection through purchase or easements. Historic sites should be surveyed to determine the extent of population loss. Since most of the existing known populations are on land that is in private ownership, continued landowner contact will be essential. In order to maintain viable populations, active management should include control of woody vegetation and elimination of invasive species, including *Rhamnus* sp., *Lythrum salicaria*, *Microstegium vimineum*, and *Phragmites australis*. Twice-yearly demographic monitoring should take place for at least three consecutive years, providing data on environmental factors, population size, flowering, and seed set success. These data will later be used for population viability analysis. Studies should also examine pollination ecology, methods of dispersal, and host plant requirements, since all of these aspects of the species biology of *Pedicularis lanceolata* may influence its survival in New England.

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) 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:

Allard, Dorothy J. 2001. *Pedicularis lanceolata* Michx. (Swamp Wood-betony) Conservation and Research Plan. New England Wild Flower Society, Framingham, Massachusetts, USA.

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I. BACKGROUND

INTRODUCTION

Pedicularis lanceolata Michx. (Scrophulariaceae) is a hemiparasitic, short-lived perennial member of the Scrophulariaceae family. In the United States, it ranges from Massachusetts to Georgia on the east coast, and west to North Dakota and Missouri. It also occurs in Saskatchewan, Manitoba, and Ontario. In the eastern U.S., it occupies wet meadows and other open wetlands such as stream banks. In the mid-west it is a component of wet fens as well as other open wetlands.

Although *P. lanceolata* is common in some mid-western states and is not considered to be rare on a global scale, it is rare in most eastern states in which it occurs, and is known only from historic records in Delaware and Kentucky. *Pedicularis lanceolata* populations in New England appear to be disappearing or declining due to habitat loss, habitat modification, exotic species invasion, and ecological succession.

A conservation plan is needed to pinpoint actions essential to maintenance of viable populations in New England. This plan summarizes existing knowledge of the species biology and habitat requirements of *P. lanceolata*, identifies knowledge gaps, and proposes conservation actions necessary to maintain New England populations. These actions include active management at most extant sites, *de novo* surveys for the species, and demographic and environmental studies to aid in population viability analysis.

DESCRIPTION

The following descriptive account was compiled from several taxonomic references (Fernald 1950: 1299, Steyermark 1963: 1367, Radford et al. 1968: 962, Strausbaugh and Core 1978: 864-5, Holmgren 1998, Gleason and Cronquist 1991: 487). Measurements given for plant parts differed slightly among the various treatments.

Pedicularis lanceolata is a hemiparasitic perennial with stems 3-8 dm in height. The stems are glabrous or slightly hairy, and simple or few-branched. The leaves are opposite to sub-opposite, elliptic-lanceolate, sessile or short-petioled, 5-10 cm long, and pinnately lobed less than half way to the mid-vein, with each lobe crenate. The flower spikes are terminal as well as from the upper leaf axils. The calyx is two-lobed and 1 cm long, each lobe bearing near its lower side a foliaceous, oblong or ovate, entire or crenate appendage. The corolla is 1.5-2.5 cm, yellow to cream-colored, with a galea about as long as the lower lip, arched, truncate or very shallowly notched at the tip, and otherwise entire. The lower lip is erect, so that the throat is nearly closed. The capsule is ovate, about the same length as the calyx or a little longer. Numerous small seeds are

produced.

Gleason and Cronquist (1991: 487) indicate that *P. lanceolata* is a short-lived perennial. No mention is made of the number of years that individual plants survive, nor of whether the species is monocarpic or polycarpic.

Three other species of *Pedicularis* occur in the region: *P. furbishiae* S. Wats., *P. canadensis* L., and *P. palustris* L. Of the four species, *P. lanceolata* is the only opposite-leaved *Pedicularis*. In flower, it can be distinguished by its entire galea; the other species have galeas that are toothed. Differences in habitat requirements and/or geographic distribution between *P. lanceolata* and the other species make it unlikely that it would be misidentified in the field.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Pedicularis lanceolata was originally described by Michaux in 1803. There are three named synonyms: *P. auriculata* Sm., *P. virginica* Poir., and *P. pallida* Herb. Banks ex Pursh. In addition to these synonyms, one variety from the mid-western U. S. has been named: *P. lanceolata* var. *hirsuta* Farw. (The Plant Names Project 1999). None of these names, including the varietal designation, is in current use.

SPECIES BIOLOGY

Pedicularis lanceolata is a hemiparasite (Piehl 1965, Lackney 1981), like all other species of *Pedicularis* that have been studied for this characteristic (Sprague 1962). Suction-cup-shaped protuberances on its roots, called haustoria, connect the phloem of *Pedicularis* with that of the host plant. Root parasites like *P. lanceolata* are able to draw compounds through their roots by maintaining transpiration rates that are higher than those of their hosts (Marvier and Smith 1997). In *P. lanceolata*, haustoria form on the fine roots away from the center of the plant, and not on the larger roots near the crown (Piehl 1965). Haustoria average 1.5 mm in diameter (Piehl 1965).

Like most other studied species of *Pedicularis*, *P. lanceolata* is not host-specific. In a study conducted near Ann Arbor, Michigan, Piehl (1965) found haustoria of *P. lanceolata* attached to graminoids, broad-leaved flowering herbs, woody plants, horsetails, and ferns. Other species of *Pedicularis* have been known to develop haustorial attachments to inanimate objects (L. Macior, University of Akron, personal communication; Marvier and Smith 1997). Nonetheless, some host plant species may provide a better source of nutrients than others. Potential host plants that are deep-rooted may not have roots accessible to the roots of *Pedicularis* seedlings, for example (Marvier and Smith 1997), although the rooting depth of *P. lanceolata* seedlings has not been investigated under natural conditions.

In order to determine host-parasite relationships during the life cycle of *P. lanceolata*, plants were grown alone or with either wheat or clover (Lackney 1981). Seeds germinated and seedlings grew rapidly, at first, in any of the three growing conditions. Then, after growing for three weeks, plants grown without potential hosts became chlorotic and began to weaken and die. All plants grown without hosts were dead after 81 days, whereas 35% survival was achieved among plants grown with hosts. While plants grown with clover, a nitrogen-fixer, had a lower survival rate than those grown with wheat, the survivors grown with clover were larger and more luxuriant at the end of the growing season.

The length of time that it takes *P. lanceolata* to achieve sexual maturity has not been studied. In Lackney's (1981) study of host-parasite relationships in *P. lanceolata*, he showed photographs of plants grown for one growing season until dormancy. The plants did not flower during that first season. In my field observations of *P. lanceolata*, made at the end of the growing season in 2000, I found plants that had not flowered. Either plants do not flower every year, or more than one year is necessary to achieve sexual maturity, or both. Plants may also regulate their flowering to amounts of available nutrients, either supplied through host plants or through photosynthesis. *Pedicularis furbishiae* field studies have shown that three years of growth are necessary before flowering and seed set occur (Menges et al. 1986). My own ongoing studies of an un-described species of *Pedicularis* in Nepal indicate that plants need to grow for at least two growing seasons before they flower.

Despite the rather large latitudinal and longitudinal geographic range of *P. lanceolata*, all state and regional floras that I investigated reported the same flowering time of from August to September (Fernald 1950: 1299, Steyermark 1963: 1367, Radford et al. 1968: 962, Strausbaugh and Core 1978: 864-5, Gleason and Cronquist 1991: 487, Voss 1996: 214). *Pedicularis lanceolata* flowers contain no nectar and are not self-pollinating (Macior 1969). Pollination is achieved by pollen-foraging species of bumblebees, primarily *Bombus vagans*, as demonstrated in northeastern Ohio by Macior (1969). No pollination studies of *P. lanceolata* have been completed in New England, although *Bombus vagans* is common (Williams 2000) and is a likely pollinator. *Bombus vagans* is also known to pollinate *Pedicularis furbishiae* (New Brunswick Museum 2000).

Seed set occurs in September and October (Radford et al. 1968: 962). In my field studies, I observed that most capsules had dehisced by early November of 2000, but capsules still contained many seeds.

Dispersal in *P. lanceolata* has not been studied. Seeds of *P. lanceolata* are winged (personal observation), indicating possible dispersal by wind. No particular method should be assumed for *P. lanceolata* without further study, however, since various dispersal mechanisms have been documented in other *Pedicularis* species. For instance, *P. sylvatica* is dispersed by ants (Berg 1954, as cited in van der Pijl 1982) that harvest elaisomes that form from a "protruding endosperm-haustorium" (van der Pijl 1982: 49). The seeds of *P. furbishiae* are thought to be

dispersed by actions of wind and water after capsule dehiscence (Menges et al. 1986).

Known herbivores include white-tailed deer (*Odocoileus virginianus*), which graze on *Pedicularis lanceolata* in both Massachusetts and Connecticut. Elizabeth Farnsworth (New England Wild Flower Society, *personal communication*) reported seed predation by an unidentified chrysomelid flea beetle in one Connecticut population.

Pedicularis lanceolata does not have any known diseases, but a number of species of rusts have been found to infect other species of *Pedicularis* (Savile 1967).

HABITAT/ECOLOGY

Though the habitat of *Pedicularis lanceolata* varies somewhat across its range, it mainly grows in wet areas at lower elevations that have little woody vegetation. In the eastern states, it grows primarily in wet meadows. In the mid-west, it is a component of a variety of wetland types: fens and other wetland habitats in Iowa (Pearson and Leoschke 1992); "calcareous and spring-fed swampy meadows and swales in valleys and lowland, occasionally on moist limestone ledges" in Missouri (Steyermark 1963: 1367); and "borders of marshes, swamps, ponds, and lakes; river banks, thickets, and springy slopes; fens (even in *Sphagnum*), meadows, and wet prairies" in Michigan (Voss 1996: 214). Since extant occurrences of *P. lanceolata* in New England occupy such areas as power line and gas line right-of-ways, it can apparently withstand a certain amount of disturbance, and may benefit from activities that maintain open vegetation.

According to various floristic accounts, *P. lanceolata* is found mainly in areas with calcareous soils. This observation was first made by Pennell in 1935, who reported that *P. lanceolata* occurred in calcareous sites with a pH of 7 or higher. Nonetheless, it has been found in non-calcareous wetlands in Connecticut (N. Murray, Connecticut Geological and Natural History Survey, *personal communication*). In addition, Lackney (1981), when growing *P. lanceolata* without host plants in sterile cultures with low mineral content media in which the pH was adjusted to varying levels between 5.5 and 8, found that the highest pH levels produced stunted seedlings, whereas a pH of 6.2 produced seedlings that developed to the same extent as attached seedlings grown in soil. He suggested that in the low mineral content media, the phosphorus may have gone out of solution at a high pH, thus producing stunted plants.

The main activities that could negatively affect *P. lanceolata* include draining of wetlands and allowing wet meadows to succeed to wet shrub lands or woodlands.

THREATS TO TAXON

Possible or probable threats to *P. lanceolata*'s survival in New England include habitat

loss, habitat modification, ecological succession, herbivory, competition from invasive species, and host plant limitation.

Habitat Loss

Several populations of *P. lanceolata*, which were documented decades ago with herbarium specimens, have been lost to development. Many more may have been lost, but they have not been re-surveyed. Another form of habitat loss that may occur in New England, although it has not been documented, is the conversion by humans of wet meadows to ponds, as has happened with a number of Iowa fens (Pearson and Leoschke 1992). Beaver flooding of wet meadows along streams could also eliminate *P. lanceolata* populations, but this has not been documented.

Habitat Modification

Mowing, grazing and livestock pasturage, herbicide spraying, and drainage of wetlands may all affect populations of *P. lanceolata*. While there is no documented evidence that mowing effects populations of *P. lanceolata*, it is hypothesized that mowing may be either a help or a hindrance. The seasonal timing and frequency of mowing must be balanced in regards to three factors: the direct effect on *P. lanceolata*, the effect on its competitors, and the effect on its host plants. *Pedicularis lanceolata* sets seed late in the growing season, and mowing just before seed set would effectively eliminate that year's seed production. Mowing after seed set (e.g., in mid-October), however, could act to reduce competition from woody plants or exotic invasive species and might also serve as a means of seed dispersal. Mowing early in the growing season might control competition from other species and still allow *P. lanceolata* time to flower and fruit. Because mowing can influence host plant reproduction and growth, knowledge of which species are acting as hosts, and the life cycles of these species, is essential to understanding the indirect effects of mowing on *P. lanceolata*.

Grazing, as well, may help or hinder the species. One historic site in Mansfield, Connecticut was apparently destroyed as a habitat for *P. lanceolata* by heavy grazing and pasturage of horses, although ditching and draining has also occurred there. Light grazing, on the other hand, may possibly enhance populations by reducing competition from other species. Light grazing has not been investigated as a management technique for *P. lanceolata*.

Herbicide spraying, used as a vegetation control measure under a power line, has been reported for a Bloomfield, Connecticut location of *P. lanceolata*. Surveys done in the same year, later in the season, did not show a reduction in *P. lanceolata* plants. More study needs to be conducted to determine if herbicide spraying has a negative influence on populations.

Since *P. lanceolata* is limited to wetland sites, ditching and draining of wet meadows,

perhaps done to make lands cultivable or available for haying, is likely to eliminate or reduce populations of *P. lanceolata*.

Ecological Succession

The succession of herbaceous wet meadows to wet shrub thickets has been a major problem in the maintenance of existing populations of *P. lanceolata*. Succession is occurring both in relatively natural open habitats, and in disturbed habitats that have been maintained by human activity to control woody growth. Open wetlands that formed post-glacially are undergoing long-term succession to wooded wetlands through the process of isostatic rebound, as well as through sedimentation (Pielou 1991), so that the natural habitat available for supporting *P. lanceolata* is gradually shrinking. On the other hand, abandonment of flooded areas by beavers could potentially provide temporary habitat for the species as beaver ponds succeed to wet meadow vegetation. *Pedicularis lanceolata* has not yet been found in areas known to have been manipulated by beavers.

Herbivory

Deer herbivory has been documented in New England populations of *P. lanceolata*, and both deer and rabbit herbivory negatively affect populations of *P. furbishiae* (Menges et al. 1986). The current decline in hunting as a sport and the increasing size of deer herds in New England are a possible long term threat to *P. lanceolata*.

Flea beetle seed predation was documented in one population of *P. lanceolata* and needs further research. Predation of *P. furbishiae* by the plume moth caterpillar (*Amblyptilia pica*) has been observed and quantified (Menges et al. 1986). This possibly could be a problem for *P. lanceolata* as well, but it has not been observed.

Competition from Invasive Species

Even though *P. lanceolata* is hemiparasitic and therefore must grow where its roots can contact the roots of other species, it may be negatively affected by competition for light from tall herbaceous growth in wet meadows and in disturbed habitats. Invasive species that occur with *P. lanceolata* include purple loosestrife (*Lythrum salicaria*), Japanese stilt grass (*Microstegium vimineum*), and common reed (*Phragmites australis*). The impact of these species on the reproduction and survival of *P. lanceolata* has not been investigated.

DISTRIBUTION AND STATUS

General Status

Pedicularis lanceolata is distributed in various types of wetlands in 26 eastern and mid-western United States and in south-central Canada. It is listed as a Division 2 species in *Flora Conservanda* (Brumback and Mehrhoff et al. 1996), which is defined as a regionally rare taxon with fewer than 20 occurrences within New England. Its global rank is G5, and both its US and Canadian national ranks are N?. It is relatively common in most mid-western states, and rare in most eastern states. The North American distribution of *P. lanceolata*, both historic and extant, is presented in Figure 1. The current distribution in New England is shown in Figure 2, while Figure 3 depicts the historic New England distribution.

The distribution and current state and sub-national ranks of *P. lanceolata* are presented in Table 1.

| Table 1. Occurrence and status of <i>Pedicularis lanceolata</i> in the United States and Canada based on information from Natural Heritage Programs | | | |
|--|--|------------------------------|-------------------------------------|
| OCCURS & LISTED (AS S1, S2, OR T & E) | OCCURS & NOT LISTED (AS S1, S2, OR T & E) | OCCURRENCE UNVERIFIED | HISTORIC (LIKELY EXTIRPATED) |
| Arkansas (S1) | Illinois (S?) | Indiana (SR) | Delaware (SH) |
| Connecticut (S1): 6 extant EOs | Iowa (S4) | Minnesota (SR) | Kentucky (SH) |
| Georgia (S1) | Michigan (S?) | Missouri (SR) | |
| Maryland (S1) | New Jersey (S3) | North Dakota (SR) | |
| Massachusetts (S1): 2 extant EOs | Virginia (S3) | Ohio (SR) | |
| Nebraska (S2) | Manitoba (S4) | Rhode Island (SRF) | |
| New York (S2) | Ontario (S4) | South Dakota (SR) | |
| North Carolina (S1) | Saskatchewan (S?) | Wisconsin (SR) | |
| Pennsylvania (S1S2) | | | |
| Tennessee (S1) | | | |
| West Virginia (S2) | | | |

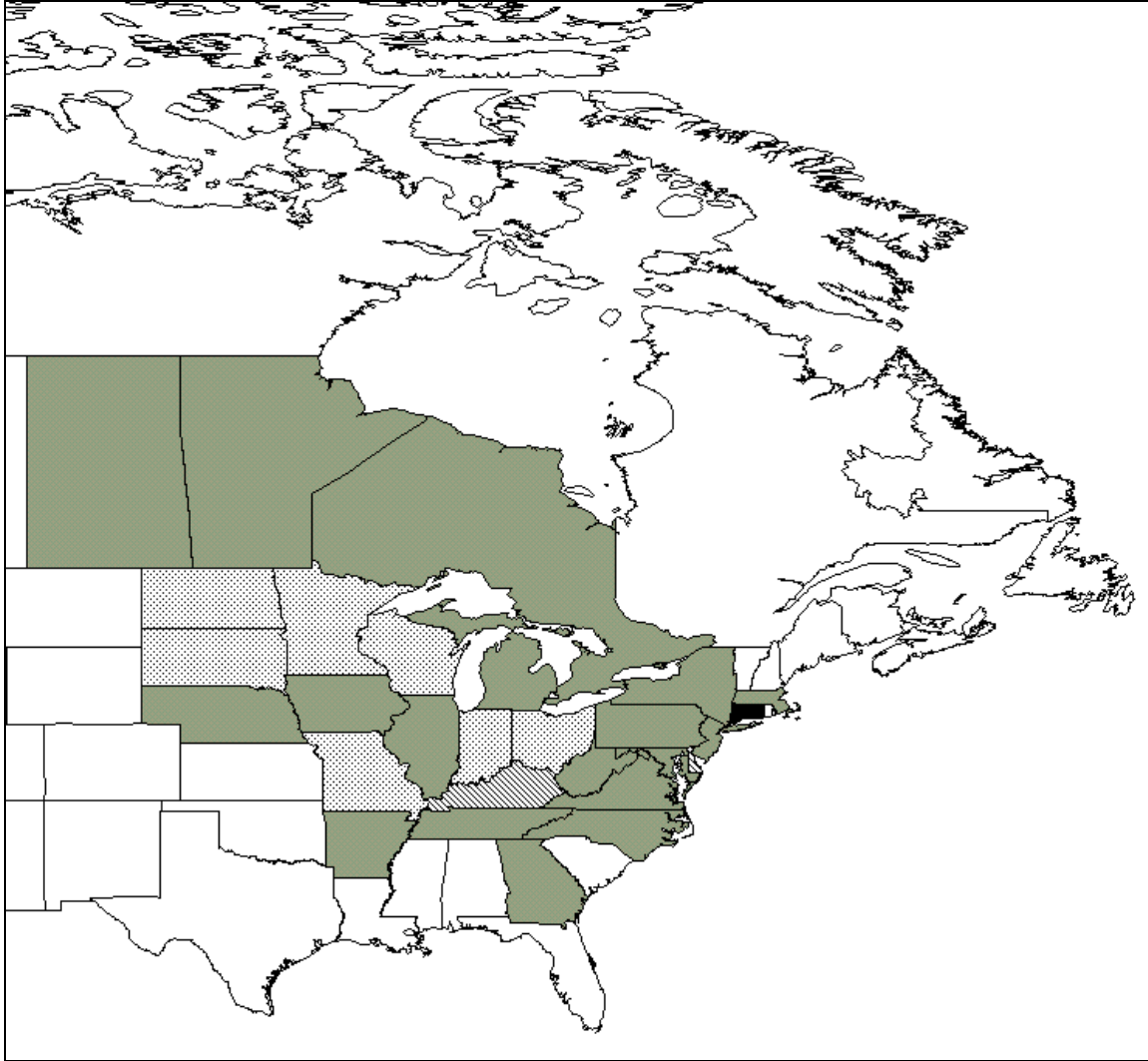


Figure 1. Occurrences of *Pedicularis lanceolata* in North America. States and provinces shaded in gray have known occurrences of the taxon. Connecticut, shaded in black, has more than five confirmed, extant occurrences. States with diagonal hatching are considered 'historic' (SH; see Appendix for definitions of state ranks), where the taxon no longer occurs. Stippled states are ranked ASR.

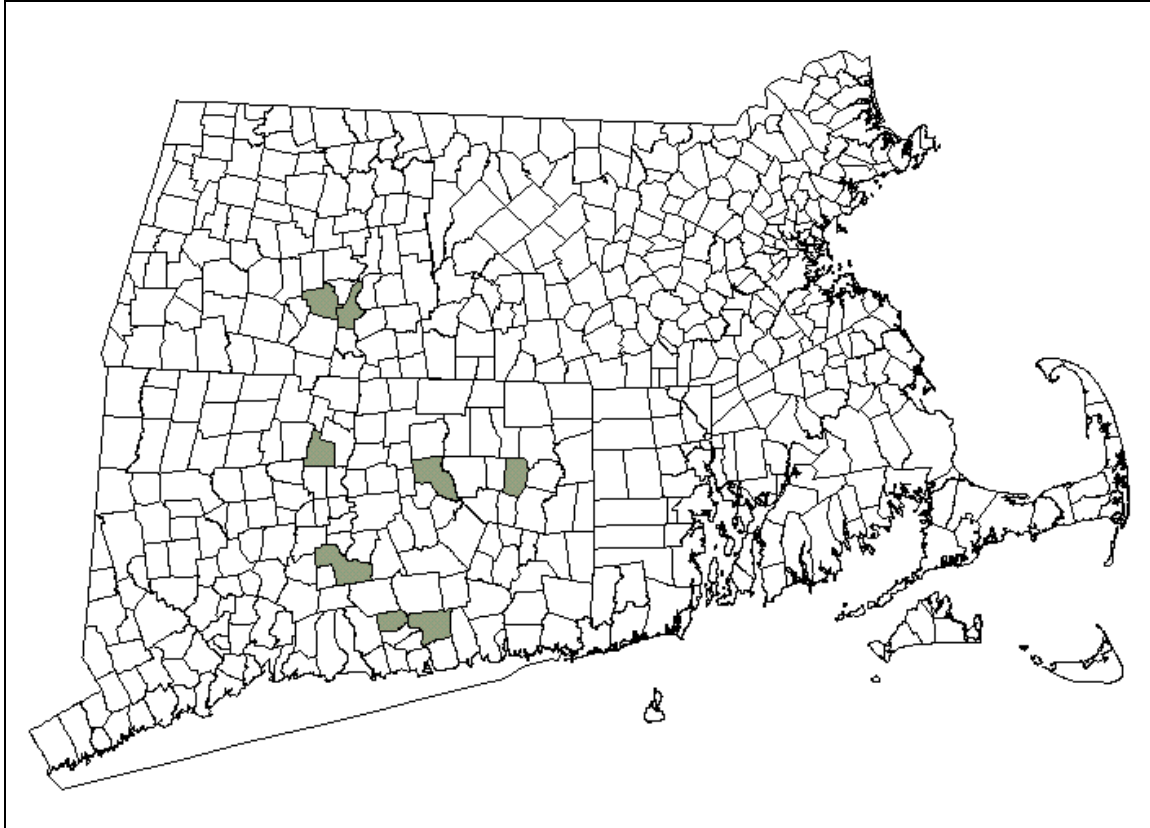


Figure 2. Extant occurrences of *Pedicularis lanceolata* in New England. Town boundaries for Connecticut, Massachusetts, and Rhode Island are shown. Towns shaded in gray have one to five confirmed, extant occurrences.

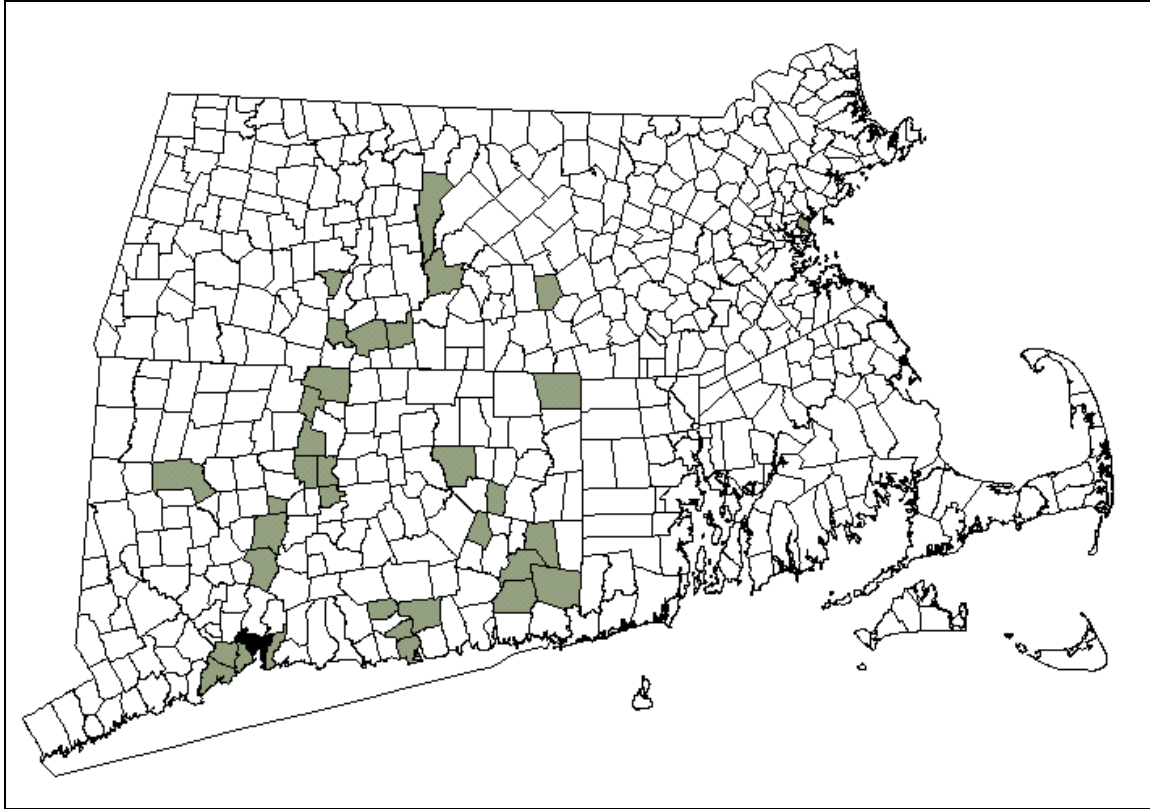


Figure 3. Historic occurrences of *Pedicularis lanceolata*. Towns shaded in gray have one to five historic records of the taxon, while towns shaded in black have more than five historic records.

Status of all New England occurrences B current and historic

Pedicularis lanceolata has been identified at 11 stations in Massachusetts and 60 stations in Connecticut. It has not been found in the other New England states (Table 2), although it was reported falsely from Rhode Island. Of the Massachusetts occurrences, nine are historic records from herbarium specimens, and two are extant, although no plants have been found at one site since the mid-1990's. Of the 60 Connecticut occurrences, six are extant, and 54 are historic records mainly from herbarium specimens. One of these historic records was field checked in the year 2000, but no plants were found. Many of the other specimens may have been collected at the same location by different botanists, but there appear to be at least 30 historic locations.

Element occurrence ranks are given in Table 2. These ranks are assigned by the state Natural Heritage programs for each population, and are developed from an assessment of population size and productivity, condition, viability, and site defensibility. Ranks range from excellent (A) to poor (D). A rank of E is given when an occurrence is known to be extant but there is not enough information to assign a more specific rank. A rank of H is given for sites in which individuals of the population have not been observed for more than 20 years.

While the number of known populations of *P. lanceolata* in New England has declined substantially, it is difficult to determine accurate population trends for *P. lanceolata*. Monitoring of population size and health must be done during the flowering season or early in the fruiting season. However, *P. lanceolata* is not a showy plant, and is difficult to observe in the field in the tall, thick vegetation that usually accompanies it. New populations may be easily overlooked by field biologists (L. Mehrhoff, Torrey Herbarium, personal communication). It is easiest to find after it has fruited and after a frost, since its capsules can be seen on stiff brown stalks sticking up above other vegetation that has died back (W. Moorhead, Botanist, personal communication). At this time of year, however, the stalks become brittle, and some may break off. Thus, estimates of population size or numbers of occurrences are likely to be low.

In both Massachusetts and Connecticut, not every population has been visited on a yearly basis. Only a small proportion of historic records have been checked for the possibility of extant populations.

Even with these limitations, some trends concerning populations of *P. lanceolata* can be observed in New England. Massachusetts populations seem to be in worse condition than those in Connecticut. Only eleven populations have ever been observed. The habitat of one of the nine historic populations has been destroyed, and six more have not been surveyed. Two other historic locations have been inventoried with no success. Inventory in 1998-2000 did not uncover any plants in either of the two extant populations (P. Somers, Massachusetts Natural Heritage and Endangered Species Program, personal communication). Only one population (MA .004 Southampton) appears vigorous.

Pedicularis lanceolata appears to be in better shape in Connecticut. There are four extant populations that are being monitored by the Connecticut Natural Heritage Program, and although each one has threats and management problems, *P. lanceolata* seems to thrive at these sites. An additional site was discovered in 2000 (N. Murray, Connecticut Geological and Natural History Survey, *personal communication*). Further searches of sites represented by herbarium records and literature references may reveal more populations in Connecticut. On the other hand, if all historic populations are determined to be extirpated, Connecticut's number of populations has declined precipitously.

One site in Chester deserves specific mention. *Pedicularis lanceolata* was observed there in 1981 during a field trip of the Connecticut Botanical Society, Inc., and the siting was published in their Yearbook (W. Moorhead, *personal communication*). By definition, it is an extant population, but it has not been documented with a specimen, nor has it been re-surveyed.

**Table 2. New England Occurrence Records for *Pedicularis lanceolata*.
Shaded occurrences are considered extant.**

| * | | | |
|-----------|---------------------------|-------------------|--------------------|
| State | Element Occurrence Number | County | Town |
| MA | .001 | Hampshire | Easthampton |
| MA | .002 | Hampden | Springfield |
| MA | .003 | Hampden | Wilbraham |
| MA | .004 | Hampshire | Southampton |
| MA | .005 | Hampden | Springfield |
| MA | .006 | Hampshire | Ware |
| MA | .007 | Worcester | Leicester |
| MA | .008 | Suffolk | Revere |
| MA | .009 | Hampden | Holyoke |
| MA | .010 | Franklin | New Salem |
| MA | .011 | Hampden | West Springfield |
| CT | .001 | New London | Lyme |
| CT | .002 | Hartford | Bloomfield |
| CT | .003 | Tolland | Coventry |
| CT | .004 | Windham | Hampton |
| CT | .005 | New London | Lyme |
| CT | .006 | New Haven | New Haven |
| CT | .007 | New Haven | New Haven |
| CT | .008 | Middlesex | Chester |
| CT | .009 | Middlesex | Middletown |

**Table 2. New England Occurrence Records for *Pedicularis lanceolata*.
Shaded occurrences are considered extant.**

| * | | | |
|-------|---------------------------|------------------|----------------|
| State | Element Occurrence Number | County | Town |
| CT | | Hartford | Bloomfield |
| CT | | Hartford | East Granby |
| CT | | Hartford | Hartford |
| CT | | Hartford | Plainville |
| CT | | Hartford | Plainville |
| CT | | Hartford | Southington |
| CT | | Hartford | Southington |
| CT | | Hartford | Southington |
| CT | | Hartford | Southington |
| CT | | Hartford | Suffield |
| CT | | Hartford | Suffield |
| CT | | Hartford | Suffield |
| CT | | Hartford | West Hartford |
| CT | | Hartford | Wethersfield |
| CT | | Litchfield | Litchfield |
| CT | | Middlesex | Chester |
| CT | | Middlesex | Chester |
| CT | None | Middlesex | Chester |
| CT | | Middlesex | Essex |
| CT | | Middlesex | Old Saybrook |
| CT | | New Haven | Cheshire |

**Table 2. New England Occurrence Records for *Pedicularis lanceolata*.
Shaded occurrences are considered extant.**

*

| State | Element Occurrence Number | County | Town |
|-------|---------------------------|------------|------------------|
| CT | | New Haven | East Haven |
| CT | | New Haven | East Haven |
| CT | | New Haven | Milford |
| CT | | New Haven | near New Haven |
| CT | | New Haven | New Haven |
| CT | | New Haven | New Haven |
| CT | | New Haven | New Haven |
| CT | | New Haven | New Haven |
| CT | | New Haven | New Haven |
| CT | | New Haven | Orange |
| CT | | New Haven | West Haven |
| CT | | New London | Franklin |
| CT | | New London | Franklin |
| CT | | New London | Franklin |
| CT | | New London | Griswold |
| CT | | New London | Griswold |
| CT | | New London | Ledyard |
| CT | | New London | North Stonington |
| CT | | New London | Preston |
| CT | | New London | Preston |
| CT | | Tolland | Mansfield |

**Table 2. New England Occurrence Records for *Pedicularis lanceolata*.
Shaded occurrences are considered extant.**

*

| State | Element Occurrence Number | County | Town |
|--------------|--|---------------|-----------------|
| CT | | Tolland | probably Storrs |
| CT | | Windham | Scotland |
| CT | | Windham | Scotland |
| CT | | Windham | Scotland |
| CT | | Windham | Thompson |
| CT | | Windham | Thompson |
| CT | | Windham | Thompson |
| CT | | Windham | Thompson |
| CT | | Unknown | Unknown |

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

Massachusetts

Pedicularis lanceolata is listed as endangered in Massachusetts and is protected under the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). "Endangered" species in Massachusetts are native species that are in danger of extinction throughout all or part of their range, or which are in danger of extirpation from Massachusetts, as documented by biological research and inventory (Massachusetts Natural Heritage and Endangered Species Program 2000). The law protects species from take and sale.

Ongoing conservation measures by staff of the Massachusetts Natural Heritage and Endangered Species Program include landowner contact, monitoring of extant populations (MA .004 and .009), removal of woody growth and invasive species, and erecting a deer enclosure (MA .009). The New England Wild Flower Society has done seed collection and seed banking of seeds from occurrence MA .009.

Connecticut

Pedicularis lanceolata is listed as a species of special concern in Connecticut and is protected under Connecticut law. "Species of Special Concern" in Connecticut means any native plant species or any native non-harvested wildlife species that has been documented by scientific research and inventory to have a naturally restricted range or habitat in the state, to be at a low population level, to be in such high demand by man that its unregulated taking would be detrimental to the conservation of its population, or to have been extirpated from the state (Connecticut Department of Environmental Protection 2000).

Ongoing conservation measures in Connecticut by the Connecticut Natural History Survey and the New England Wild Flower Society include active monitoring of extant populations, landowner contact, and seed collection and banking. The Connecticut Natural History Survey has monitored four extant occurrences (CT .001, .002,.003, and .009) during the last ten years, although monitoring has not taken place on an annual basis. Seed banking by the New England Wild Flower Society has also been attempted with seeds from these four populations.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Pedicularis lanceolata is a rare and declining species in New England. Only eight sites have extant populations, and plants were not found at two of these sites since the mid-1990's.

The primary conservation objective for this species in New England is protection of the eight existing occurrences for the species in Massachusetts and Connecticut, and maintenance of a stable or increasing population at each site. Based upon current knowledge of plant numbers and year-to-year fluctuations at extant occurrences, it is estimated that 200 plants per site should suffice to provide enough seeds to maintain a stable population, given proper management of the sites. Consideration must also be given to maintenance of host plants. Determination of the life history characteristics of the species, as detailed in the next section of the plan, and subsequent population viability analysis, will allow for more accurate, quantitative objectives for population numbers and sizes to be set. Protection and management of occurrences will be an ongoing activity.

A second objective is completion of an inventory of sites with historic records for the species in Massachusetts and Connecticut, and of new sites with appropriate habitat in Massachusetts, Connecticut, Vermont, New Hampshire, and Rhode Island. Since numerous historic occurrences exist that have not been recently surveyed, and since this species is easily overlooked in the field, the potential is great for the discovery of new populations. If new populations are found, monitoring and management should begin immediately. Inventory of historic records should be accomplished within the next three years, and *de novo* surveys completed within the next five years.

A final objective is completion of an inventory of potential habitat for the species. Knowledge of potential habitat can be used to choose sites for introduction, in the case that protection measures fail at existing locations, or in the case that metapopulation viability analysis indicates the need for more populations. Completion of this inventory should take place within the next five years, and can be accomplished concurrently with *de novo* surveys.

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Appendix 1. An explanation of conservation ranks used by The Nature Conservancy and the Association for Biodiversity Information

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 or refine 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 been 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.