

New England Plant Conservation Program  
Conservation and Research Plan

*Cynoglossum virginianum* var. *boreale* (Fern.) Cooperrider  
Northern Wild Comfrey

Prepared by:  
Elanor Abrams  
214 NE Thompson St.  
Portland, Oregon 97212

in association with

William E. Brumback  
New England Wild Flower Society  
180 Hemenway Road  
Framingham, MA 01701

For:

New England Wild Flower Society  
180 Hemenway Road  
Framingham, MA 01701  
508/877-7630  
e-mail: [conserve@newfs.org](mailto:conserve@newfs.org) ! website: [www.newfs.org](http://www.newfs.org)

Approved, Regional Advisory Council, 2000

## SUMMARY

---

*Cynoglossum virginianum* var. *boreale* (Fern.) Cooperrider (Boraginaceae) (syn. *Cynoglossum boreale*), northern wild comfrey, is found throughout southern Canada, the northern Midwest, and northern New England states. Only six populations are known to exist currently in New England, two in Vermont, one in New Hampshire, and three in Maine. By contrast, between 1880 and 1910, when collection of plants was at its peak, at least 19 populations were recorded in New England, including sites in Massachusetts and Connecticut where *C. virginianum* var. *boreale* is believed to be extirpated.

*Cynoglossum virginianum* var. *boreale* tends to grow on mesic, often calcareous soils of coniferous upland forests. The plants do not reproduce clonally. They are dependent on animals to disperse their seeds to suitable habitat. Seeds are few and large, and may not last long in the soil seed bank. Environmental factors that may restrict population numbers include light availability, interspecific competition, and the availability of nearby, suitable habitat for colonization. The development of roads, paths and parking lots may contribute to the decline of some populations, but some disturbance, including fire, appears to be beneficial. Plants are often located in very rocky soil or on steep slopes and tend to grow in tree-fall gaps, recently burned areas, along road or trail edges, or in other areas where the canopy has been disturbed.

The overall conservation objective for this species in New England is to maintain three to four protected populations in each of the three states where it currently exists (Vermont, New Hampshire, and Maine). The six current sites in New England should be protected. Yearly surveys should be performed at all sites. In Vermont and New Hampshire, these objectives require introducing or reintroducing two to three populations in each state, and managing and stabilizing extant populations. In addition, historic sites in Vermont should be searched by well-trained botanists or volunteers. In Maine, conservation objectives include closely monitoring the three extant populations while searching for other sites. The minimum population size for managed sites should be 200 individuals and 20 flowering plants in a given year, but preferably greater where possible. These are fairly conservative goals, as natural populations tend to be rare, local, and small. These objectives should be updated as more information is gathered concerning species biology and factors that contribute to population stability. Populations should be reintroduced to viable habitat in Vermont and New Hampshire. It should be determined whether Massachusetts and Connecticut contain suitable, protected habitat for reintroduction sites. Management techniques should be developed to maintain populations and management should be performed at sites where populations are declining.

## 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.

NEPCoP is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

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

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

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection. If you require additional information on the distribution of this rare plant species in your town, please contact your state's Natural Heritage Program.

This document should be cited as follows:

Abrams, E. and W. E. Brumback. 2001. *Cynoglossum virginianum* var. *boreale* (Northern Wild Comfrey) Conservation and Research Plan. New England Plant Conservation Program, Framingham, Massachusetts, USA (<http://www.newfs.org>).

© 2001 New England Wild Flower Society

# I. BACKGROUND

---

## INTRODUCTION

In 1996, the New England Plant Conservation Program (NEPCoP) published a comprehensive list of plant species in need of conservation action, and assigned priorities to these species by divisions of rarity (Brumback and Mehrhoff *et al.* 1996). *Cynoglossum virginianum* var. *boreale* (Fern.) Cooperrider (Boraginaceae), commonly known as northern wild comfrey (Gleason and Cronquist 1991), is placed in Division 1 of this list as a globally rare taxon. Throughout its range in Canada and the USA, with the exceptions of New York, Connecticut and Maine, Natural Heritage Programs list this plant as *Cynoglossum boreale*. The geographic range of the two varieties of *C. virginianum*, *C. virginianum* var. *boreale* and *C. v. var. virginianum* (wild comfrey), do not overlap. For the purposes of conservation in the New England region, this plant has a high priority independent of its exact taxonomic classification.

In New England, *Cynoglossum virginianum* var. *boreale* occurs in Vermont, New Hampshire, and Maine. It is considered extirpated in Massachusetts and Connecticut and is not found in Rhode Island. Between 1880 and 1910, a period when forests were sparser and when collection of plants for herbarium specimens was at its peak, 19 populations of *Cynoglossum v. var. boreale* were identified in New England, only one of which still exists. Despite extensive searches, there are currently only six confirmed current populations throughout New England.

## DESCRIPTION

*Cynoglossum virginianum* var. *boreale* is an understory herb that occurs primarily in transitional and disturbed areas of upland forests with mesic, calcareous soils. Vegetative plants of *C. virginianum* var. *boreale* have a basal rosette of one to seven hairy leaves. Flowering plants have an erect inflorescence with up to five branches. Flowers are small, lavender to light blue. For a more detailed identification, see Gleason and Cronquist 1991.

## TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

*Cynoglossum virginianum* var. *boreale* is a member of the Boraginaceae. This taxon is distinguishable from the closely related variety *C. virginianum* var. *virginianum* on the basis of several unique characters. *Cynoglossum virginianum* var. *boreale* is a smaller plant with distinctly petioled lower cauline leaves, whereas the cauline leaves of *C. virginianum* var.

*virginianum* are sessile. Flowers and seeds of *C. virginianum* var. *boreale* are smaller, and corolla lobes are oblong and not overlapping as opposed to broadly rounded and overlapping in *C. virginianum* var. *virginianum* (Gleason and Cronquist 1991). The geographic range of *C. virginianum* var. *boreale* is north of *C. virginianum* var. *virginianum*. Although distinctive when in flower or in fruit, the leaves can be difficult to discern from *Hieracium aurantiacum* (Brett Engstrom, Botanist, *personal communication*).

## **SPECIES BIOLOGY**

*Cynoglossum virginianum* var. *boreale* is a long-lived plant that sexually reproduces every 1 to 4 years. Plants have a taproot that over-winters and foliates in late April. Flowers appear late May to June, and the seeds mature July to August. Flowers produce up to 4 nutlets, which are covered in bristles that attach to animals and clothing and are in this fashion transported to new sites. Closely-related species in the *Cynoglossum* genus are self-compatible and primarily pollinated by bumblebees (*Bombus* spp.) (DeJong and Klinkhamer 1991), although equivalent information is not documented for *C. virginianum* var. *boreale*. *Cynoglossum virginianum* var. *boreale* does not reproduce clonally.

Seed dispersal may be a limiting factor in the colonization of habitat patches, especially on the islands of Lake Champlain where at least two populations occur, one in Vermont and one in New York State. As mammal populations fluctuate naturally and as human occupancy and impacts increase, there may be fewer hosts to transport the seed (though people may also transport the seed) and less viable habitat available.

There is evidence that suggests *Cynoglossum virginianum* var. *boreale* populations follow a metapopulation structure. The site in Moxie Gore, Maine is by far the largest population in New England, and it is organized in at least 5 distinct sub-populations. This organization may contribute to the stability of the population, although it has only been monitored for two years, and continued close surveillance is needed to determine whether a metapopulation structure is contributing to stability. It is important to determine whether metapopulation dynamics play a role in population stability, as this will have a significant impact on the choice of appropriate management practices. .

## **HABITAT/ECOLOGY**

*Cynoglossum virginianum* var. *boreale* populations tend to grow in shallow, calcareous soils, in cedar/hemlock/hardwood forests. Plants are often found in very rocky soil or on steep slopes and tend to grow in tree-fall gaps, recently burnt areas, along road or trail edges, or in other such canopy disturbances. Many *C. virginianum* var. *boreale* populations occur in transitional forest stands where more light is available on the forest floor than under a closed canopy. Shading over time in these forests poses a threat as otherwise suitable habitat

can no longer be successfully colonized. It has been demonstrated that canopy gap formation and closure affect the growth of *C. virginianum* var. *virginianum*, which occurs in deciduous forests throughout the southeastern United States, once as far north as Connecticut. Whigham *et al.* (1993) observed gap and non-gap sub-populations of *C. virginianum* var. *virginianum* and found that reproductive output is highest and seedling survivorship lowest in gap sub-populations. Seedling survivorship may be density-dependent, due to increased plant density in gaps (Cipollini *et al.* 1993). Because these two species are so closely related, it is likely that gaps in the forest canopy also affect *C. virginianum* var. *boreale* populations, possibly affecting different life stages in different ways.

Fire may also play a role in maintaining this species. Notes from an herbarium record from Stockbridge, Massachusetts in 1904 describe the location as a “burnt-over ledge.” *Cynoglossum virginianum* var. *boreale* plants seem to grow in newly disturbed habitat: in clear-cuts and tree-fall gaps, alongside trails, roads and campgrounds. Fire may open up an area in a similar way. At the sites in both Lancaster, NH and Moxie Gore, ME, forest fires have occurred in the last 20-50 years, suggesting that fire may play a role in opening the canopy and creating habitat for *C. virginianum* var. *boreale*.

## **THREATS TO TAXON**

Specific threats to *C. virginianum* var. *boreale* have been little studied to this point, and are largely unknown. Because these plants preferentially grow in mid-successional forests and in areas where disturbance tends to keep the canopy somewhat open, canopy closure could ultimately threaten populations. Fire suppression may also reduce habitat availability. However, logging activities and other large-scale conversions of habitat will also negatively impact these populations (for example, ME .009, last observed in 1988, may have been eliminated by logging).

## **DISTRIBUTION AND STATUS**

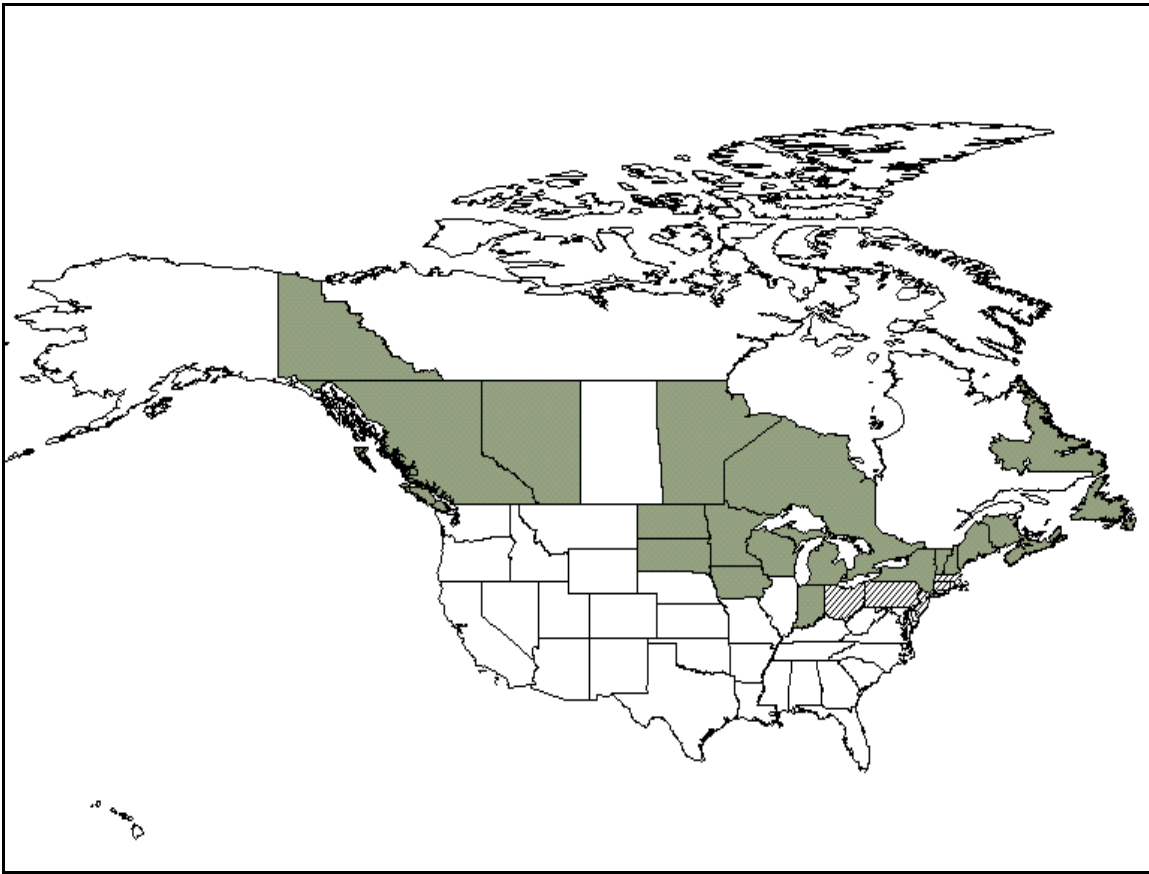
### ***General status***

*Cynoglossum virginianum* var. *boreale* is globally ranked by The Nature Conservancy as G5T4 in the US and Canada. The designation T4 indicates it is widespread, abundant, and apparently secure, though it may be quite rare in parts of its range, especially at the periphery. It is ranked N3? in the United States and N4 in Canada. For a map of the current North American geographic range of *C. virginianum* var. *boreale*, see Figure 1. Although widespread in Canada and many northern states of the U.S., *C. virginianum* var. *boreale* is seemingly retreating northward. There are more historical sites than extant sites in the northern states (The Nature Conservancy and the Association for Biodiversity Information 1999). The species is most common in Minnesota, Wisconsin, and Michigan in the US, and in

Manitoba and Ontario in Canada. It is rare throughout the peripheral parts of its range, including New York, New England, New Brunswick, Quebec, and western Canada (The Nature Conservancy and the Association for Biodiversity Information 1999).

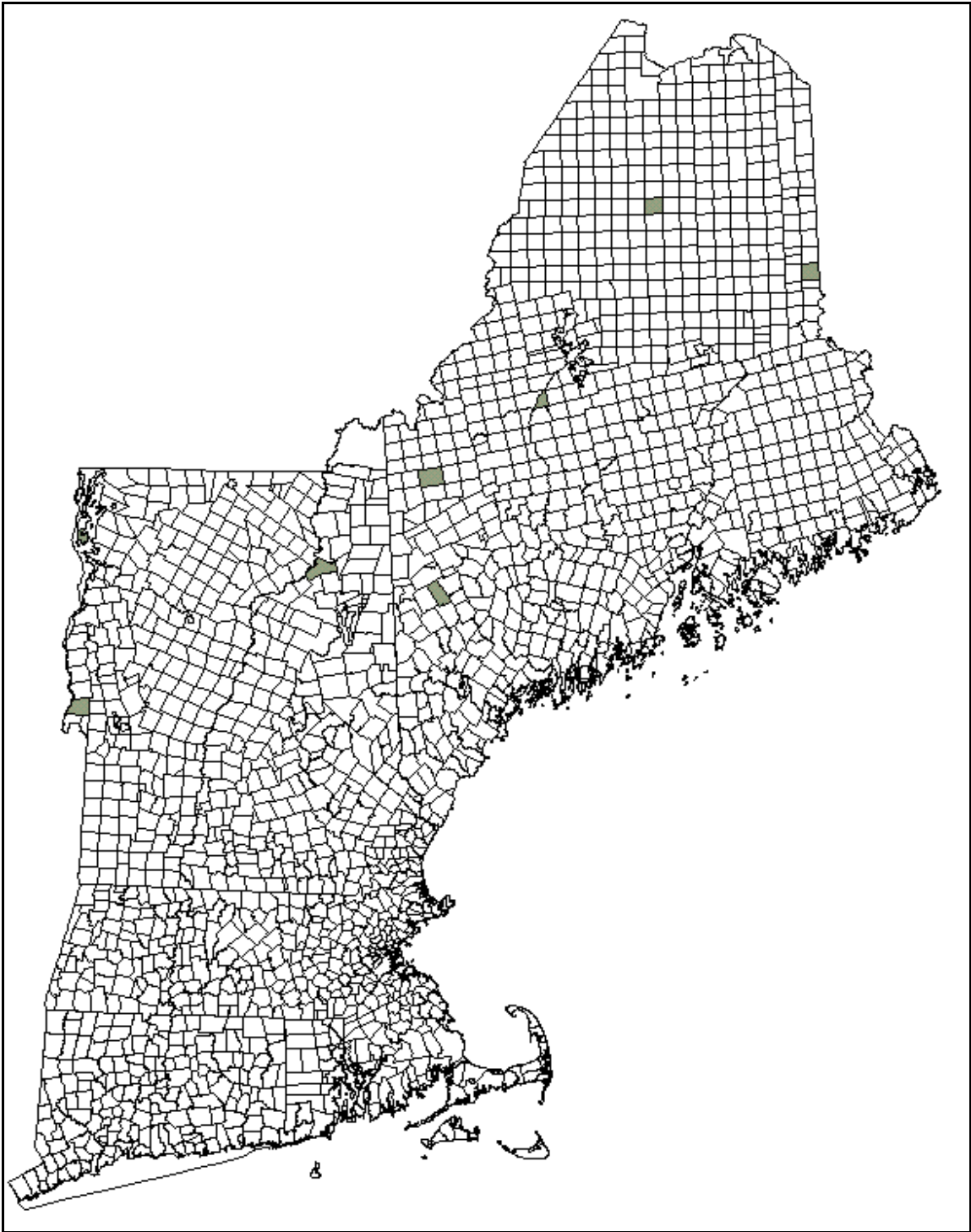
In New England states, where few populations are known to exist, and these populations are small and/or declining in size, *C. virginianum* var. *boreale* is given a State Endangerment Status of Threatened in Vermont and Endangered in New Hampshire. It was listed as historic in Maine until two populations were located, one in 1997 and one in June 1999. *Cynoglossum virginianum* var. *boreale* is listed as extirpated in Massachusetts and Connecticut. Table 1 lists the range-wide status of *C. virginianum* var. *boreale*. Figure 2 shows the current occurrences of *C. virginianum* var. *boreale* in New England, and Figure 3 shows the historic occurrences of the taxon.

<b>Table 1. Occurrence and status of <i>Cynoglossum virginianum</i> var. <i>boreale</i> in the United States and Canada based on information from Natural Heritage Programs.</b>			
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURS &amp; NOT LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURRENCE UNVERIFIED</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Maine (S1): 3 current and 9 historic occurrences	Manitoba (S3?)	British Columbia (SR)	Massachusetts (SX): 6 historic occurrences
New Hampshire (S1): 1 current and 5 historic occurrences	Ontario (S4)	Iowa (SR)	Connecticut (SH): 4 historic occurrences
Vermont (S1): 2 current and 8 historic occurrences	Michigan (S3)	Indiana (SR)	New Jersey (SH)
Alberta (S1)		Kentucky (SRF)	Ohio (SH)
New York (S1)		Minnesota (SR)	Pennsylvania (SH)
South Dakota (S1)		New Brunswick (SR)	
		Newfoundland (SR)	
		North Dakota (SR)	
		Nova Scotia (SR)	
		Quebec (SSYN)	
		Saskatchewan (S?)	
		Wisconsin (SR)	
		Wyoming (SRF)	
		Yukon Territory (SR)	

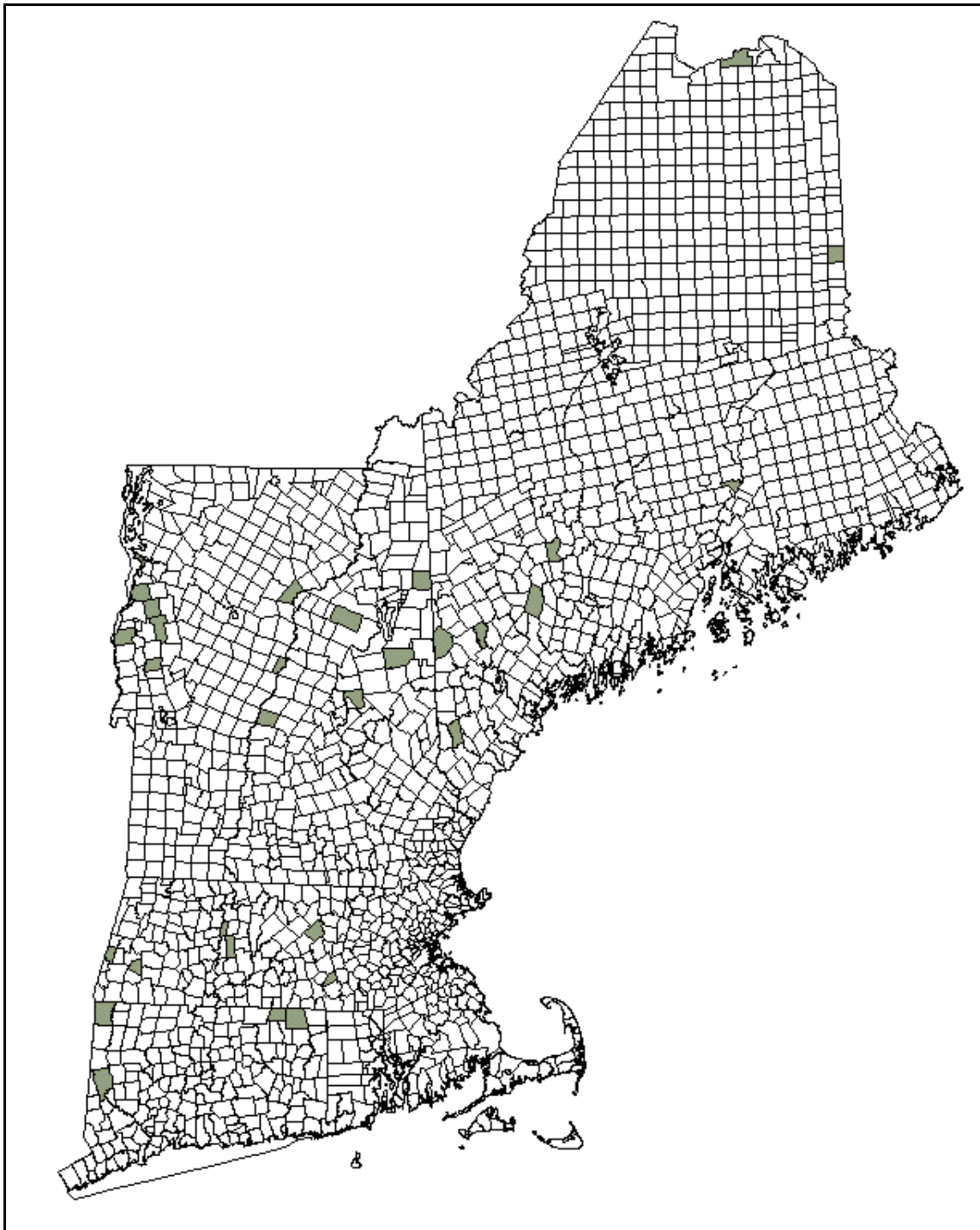


**Figure 1. Occurrences of *Cynoglossum virginianum* var. *boreale* in North America.** Shaded states and provinces have 1-5 confirmed, extant occurrences. States and provinces with diagonal hatching are designated “historic” or “presumed extirpated” (see Table 1), where *Hypericum adpressum* no longer occurs.





**Figure 2.** Extant occurrences of *Cynoglossum virginianum* var. *boreale* in New England. Town boundaries for New England are shown. Shaded towns have extant 1-5 occurrences.



**Figure 3. Historic occurrences of *Cynoglossum virginianum* var. *boreale* in New England.** Town boundaries New England are shown. Shaded towns have 1-5 historic occurrences.

**Table 2. New England Occurrence Records for *Cynoglossum virginianum* var. *boreale* based on data from State Natural Heritage Programs. Shaded occurrences are considered extant.**

State	EO #	County	Town
ME	.001	Aroostook	Fort Kent
ME	.002	Aroostook	Houlton
ME	.003	Penobscot	Orono
ME	.004	Franklin	Chesterville
ME	.005	Androscoggin	Turner
ME	.006	York	Shapleigh
<b>ME</b>	<b>.007</b>	<b>Piscataquis</b>	<b>T09 R10 WELS</b>
<b>ME</b>	<b>.008</b>	<b>Somerset</b>	<b>Moxie Gore</b>
<b>ME</b>	<b>.009</b>	<b>Aroostook</b>	<b>Hodgdon</b>
<b>ME</b>	<b>.010</b>	<b>Oxford</b>	<b>Greenwood</b>
<b>ME</b>	<b>.011</b>	<b>Franklin</b>	<b>Rangeley</b>
ME	none	Oxford	Fryeburg
ME	none	Cumberland	Harrison
<b>NH</b>	<b>.001</b>	<b>Coos</b>	<b>Lancaster</b>
NH	.002	Coos	Shelburne
NH	.003	Grafton	Franconia
NH	.004	Grafton	Lebanon
NH	.005	Carroll	Albany
NH	.006	Grafton	Holderness
VT	.001	Orange	Fairlee
VT	.003	Addison	Salisbury
VT	.004	Addison	Addison
VT	.005	Addison	Bristol
VT	.006	Addison	Monkton
<b>VT</b>	<b>.007</b>	<b>Grand Isle</b>	<b>South Hero</b>
VT	.008	Caledonia	Barnet
VT	.009	Chittenden	Burlington
VT	.010	Chittenden	Charlotte
<b>VT</b>	<b>.012</b>	<b>Rutland</b>	<b>Benson</b>
MA	None	Hampshire	Amherst
MA	None	Worcester	Millbury
MA	None	Berkshire	Tyringham
MA	None	Berkshire	Stockbridge
MA	None	Franklin	Sunderland
MA	None	Worcester	Princeton
CT	None	Litchfield	New Milford
CT	None	Litchfield	Salisbury
CT	None	Tolland	Union
CT	None	Windham	Woodstock

## II. CONSERVATION

---

### CONSERVATION OBJECTIVES FOR TAXON IN NEW ENGLAND

It is likely that *Cynoglossum virginianum* var. *boreale* has always been rare in its native New England range. However, the number of populations in this region has declined in the past century, and those populations that have been surveyed for a number of years are declining rapidly. The main objective for this taxon is to establish and maintain three to four protected populations in each of the northern New England states (Vermont, New Hampshire and Maine), where the plant still occurs and additional potential habitat still exists.

While the parameters of a population size needed to maintain viability require additional research, populations should consist of more than 200 individual plants with at least 20% flowering. In order to restore the New England populations to a more stable (yet still rare) status, current populations need to be closely monitored and managed, and introduction or reintroduction to the historic ranges in Vermont and New Hampshire is necessary. Reintroduction to the southern historic range through Massachusetts and Connecticut may be possible, but further research is necessary to determine whether viable, protected habitat exists. The major actions needed to ensure conservation of this taxon in the New England region are listed below, and are prioritized in order of importance:

- C Inform and work cooperatively with landowners to ensure protection of all current sites in New England.
- C Research management techniques and perform management at declining sites.
- C Re-survey historic sites in Vermont by well-trained botanists/volunteers.
- C Augment existing populations as necessary after demonstrating that existing habitat can be successfully managed.
- C Introduce or reintroduce the species to viable habitat (if additional historic or new populations are not located), to establish new populations in Vermont and New Hampshire.
- C Determine whether there is suitable, protected habitat for reintroduction sites in Massachusetts and Connecticut. If so, establish new populations.

### III. LITERATURE CITED

---

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

Campbell, D. R. and K. J. Halama. 1993. Resource and pollen limitations to lifetime seed production in a natural plant population. *Ecology* 74: 1043-1051.

Cipollini, M. L., D. F. Whigham and R. J. O'Neill. 1993. Population growth, structure, and seed dispersal in the understory herb *Cynoglossum virginianum*: a population and patch dynamics model. *Plant Species Biology* 8: 117-129.

De Jong, T. J. and P. G. L. Klinkhamer. 1991. Early flowering in *Cynoglossum officinale* L. constraint or adaptation? *Functional Ecology* 5: 750-756.

Fischer, M. and D. Matthies. 1998. Effects of population size on performance in the rare plant *Gentianella germanica*. *Journal of Ecology* 86: 195-204.

Gleason, H. A. and A. Cronquist. 1991. *Manual of Vascular Plants of Northeastern United States and adjacent Canada*. 2<sup>nd</sup> Edition. New York Botanical Garden, Bronx, USA.

Groom, M. J. 1998. Allee effects limit population viability of an annual plant. *American Naturalist* 151: 487-496.

Jackson, J. 1894. *A Catalogue of the Phaenogamous and Vascular Cryptogamous Plants of Worcester County, Massachusetts*. Franklin P. Rice, Worcester, Massachusetts, USA.

Seymour, F. C. 1969. *The Flora of New England: a Manual for the Identification of all Vascular Plants, Including Ferns and Fern Allies and Flowering Plants Growing Without Cultivation in New England*. C. E. Tuttle Company, Rutland, Vermont, USA.

The Nature Conservancy and the Association for Biodiversity Information. 1999. Natural Heritage Central Databases, Arlington, VA. U.S.A.

Whigham, D. F., R. J. O'Neill and M. L. Cipollini. 1993. The role of tree gaps in maintaining

the population structure of a woodland herb: *Cynoglossum virginianum* L. *Plant Species Biology* 8: 107-115.

## IV. APPENDICES

---

1. **Conservation Biology of a Rare New England Plant: *Cynoglossum virginianum* var. *boreale* (abstract only).**
2. **Calculating size class transitions from 1998 to 1999 for *Cynoglossum virginianum* var. *boreale* at three sites.**
3. **An explanation of conservation ranks used by The Nature Conservancy and the Association for Biodiversity Information**

## **Appendix 1. Conservation Biology of a Rare New England Plant: *Cynoglossum virginianum* var. *boreale***

### **ABSTRACT**

*Cynoglossum virginianum* var. *boreale* Fern. (Boraginaceae), northern wild comfrey, is one of the twenty-one threatened plant taxa identified by the New England Plant Conservation Program (NEPCoP) for initial regional conservation plans. *Cynoglossum virginianum* var. *boreale* is an iteroparous herb that grows primarily in coniferous upland forests with mesic, calcareous soils. There are only five populations in New England; however, it used to be found throughout the region. This study establishes baseline demographic data with which to study life history stages and distinguish those stages most sensitive to environmental factors.

The effects of soil characteristics, competition, and population size on growth and reproductive parameters of *C. virginianum* var. *boreale* were investigated at three of the known New England populations during the summer of 1998. Size classes (small, medium, large, and reproductive) were established based on number of leaves and longest leaf length parameters, and assigned to individual plants. In all three populations, the small size class contained the largest percentage of individuals. Soil characteristics did not explain variation in population status. The removal of competition increased growth in large and reproductive size classes. To examine whether pollinators limit reproduction in small populations, the relationships between population size and seed set, flower production, seeds per flower, and seed weight were examined. Results indicated positive, weakly significant relationships between sub-population size and both seed set and seeds per flower. Flower production and seed weight were independent of population size.

Management suggestions include the use of controlled fires to create new habitat, the removal of co-occurring plant species around large and reproductive plants, hand-pollination to increase cross-pollination and decrease pollinator limitation, and hand-sowing of seeds to increase seedling establishment and population size. Information about population location should additionally be kept confidential in order to protect sites from potential human impact. Research suggestions include investigating potential metapopulation dynamics, seedling establishment in controlled burns, sensitive life history stages, optimal light availability, and outcrossing effects on seed set. A comparison of current, declining New England sites to historical locations and healthy and stable Midwestern populations would additionally contribute to a more comprehensive understanding of the conservation biology of this species across its geographical range.

Conservation and management suggestions are aimed at increasing the growth, survival and fitness of individual plants in declining populations. For example, hand-pollination may increase seed set in small populations. Sowing seeds by hand within populations may increase seedling establishment and sowing seeds in new patches could increase colonization rates in a



metapopulation structure. From reported research and field observations, I suggest that the number of *C. virginianum* var. *boreale* populations are declining across the New England region, and that each population has a high probability of extinction due to small population size whether or not the populations are steadily declining. Both general and site-specific conservation and management techniques are suggested for the region. Conservation occurs on the population scale, however, and it is necessary to assess each site and determine the most effective measures for each population and its habitat. At all sites environmental impacts of each technique should be considered before application. Suggested management techniques are only meant to increase the population size and fitness of *C. virginianum* var. *boreale* populations in New England where the general habitat is already undeveloped and protected. At sites threatened with habitat loss or degradation, the area must be secured and habitat left intact before suggested management techniques are applied.

**Appendix 2. Calculating size class transitions from 1998 to 1999 for *Cynoglossum virginianum* var. *boreale* at three sites.**

Size class definitions are as follows:

**Dead:** No trace of plant at marker from 1998 season

**Small:** 1 to 3 leaves, longest leaf length (LLL) <120 mm

**Medium:** 2 to 5 leaves, LLL 120 mm to 200 mm

**Large:** 3 to 6+ leaves, LLL > 200 mm

**Reproductive:** In flower or seed

<b>Number of individuals marked and found in both years: Number (% of 1998 size class)</b>			
<b>Transition</b>	<b>South Hero</b>	<b>Lancaster</b>	<b>Moxie Gore</b>
Small to Dead	4 (18.0)**	2 (8.3)	
Small to Small	3 (14.0)	21 (87.5)	
Small to Medium	15 (68.0)	1 (4.2)	
Small to Large			
Small to Reproductive			
Medium to Dead			2 (3.3)
Medium to Small			2 (3.3)
Medium to Medium		4 (100.0)	43 (70.5)
Medium to Large			12 (19.7)
Medium to Reproductive			2 (3.3)
Large to Dead			5 (9.8)
Large to Small		1 (11.1)	
Large to Medium		2 (22.2)	4 (7.8)
Large to Large		1 (11.1)	20 (39.2)
Large to Reproductive		5 (55.6)	22 (43.1)
Reproductive to Dead		1 (12.5)	1 (3.4)
Reproductive to Small			
Reproductive to Medium		3 (37.5)	
Reproductive to Large		2 (25.0)	9 (31.0)
Reproductive to Reproductive		2 (25.0)	19 (65.5)

\*\* Subject to interpretation. Of the small plants located and tagged in 1998 and re-located in 1999, four did not grow in the 1999 season (18% of the small plants tagged in 1998).

### **Appendix 3. 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 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 been made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EO's have received such ranks in all states, and ranks are not necessarily consistent among states as yet.