

New England Plant Conservation Program  
Conservation and Research Plan

*Carex polymorpha* Muhl.  
Variable sedge

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## SUMMARY

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*Carex polymorpha* Muhl. (Cyperaceae), variable sedge, is a rare sedge that occurs from Virginia to Maine. This sedge was formerly considered for inclusion on the federal list of endangered and threatened species but was withdrawn due to the discovery of additional sites. The Nature Conservancy ranks it G3; its NEPCoP rank is Division 1. It is listed as S1 in all states but Virginia where it is listed as S2. Outside of New England, *Carex polymorpha* occurs in Virginia, West Virginia, Pennsylvania, and New Jersey. There are 15 extant populations in New England: five each in Connecticut and Maine, one each in Rhode Island and New Hampshire, and three in Massachusetts. Thirteen of these occurrences have been found since 1985.

The population size estimates range from hundreds of ramets in six of the occurrences, thousands of ramets in two of the occurrences and ten thousand to a million ramets in four of the occurrences. Population size information does not exist on three of the populations. Most of the populations cover a small area. However, one Massachusetts population and the New Hampshire and Maine populations are spread over many acres in separated sub-populations; these may represent three formerly large and widespread populations that have been separated by modern land use.

*Carex polymorpha* is a perennial, rhizomatous sedge that grows in sandy, acidic soil. Although the sedge persists in shade, its growth and flowering are increased in the absence of shade. In New England most sites where *Carex polymorpha* is found have a seasonally high water table or lateral seepage and are often situated near wetlands. There is no reliable method for germinating achenes of this species, but transplantation of individual plants or mats of rhizomes has been successful.

The proposed conservation goals for *Carex polymorpha* over the next five to ten years are:

- C to increase the number of occurrences by finding new sites
- C to protect part or all of at least three occurrences
- C to increase the population density and area covered by plants at five of the sites.

The result of this activity would not change the G3 status but might change the state ranking from S1 to S2 in several states and change the status from endangered to threatened in those states.

## PREFACE

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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.

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## I. BACKGROUND

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### INTRODUCTION

*Carex polymorpha* (variable sedge) is a rare, rhizomatous, perennial member of the sedge family (Cyperaceae). The species is considered threatened or endangered in all states in which it occurs in New England. *Flora Conservanda: New England*, a list of plants in need of conservation in the region, lists the taxon as Division 1 or globally rare (Brumback and Mehrhoff *et al.* 1996). *Carex polymorpha* was considered for listing under the Federal Endangered Species Act of 1973 as amended, but was dropped when more populations were discovered. The taxon's current distribution in New England includes Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island. Thirteen of the fifteen New England occurrences have been found since 1985. Outside of New England, the species is restricted to the eastern states, occurring in a relatively narrow band stretching from New England south to New Jersey, Pennsylvania, West Virginia and Virginia.

### DESCRIPTION

*Carex polymorpha* Muhl. is placed in the section *Panicea* of the genus *Carex*. This group is characterized by three parted stigmas and three sided achenes, a terminal male spike, usually erect female spikes, a sheathing bract subtending the most basal female spike, dark scales, glabrous perigynia and leaves, and rhizomatous growth. In the section, *Carex polymorpha* is distinguished by a beaked perigynium, densely flowered female spikes, and bladeless basal leaves. More than one male spike on flowering stalks and the presence of male flowers at the apex of female spikes has been observed in the field (M. Everett, *personal observation*); this agrees with Standley and Dudley's (1989) description. Leaves are 2.5 to 5.0 mm wide. Flowering shoots can be 60 cm high. There can be 0 to 3 pistillate spikes 1.5 to 3.5 cm long on upright peduncles. The scales are purplish and shorter than the perigynia. The perigynia are 4.0-5.5 mm long and have a beak with an oblique apex (Standley and Dudley 1989).

Five species in the *Panicea* group now occur in New England. *Carex panicea* is a naturalized weed of lawns, fields and meadows and was introduced from Europe (Gleason and Cronquist 1991). The remaining four species, *C. polymorpha*, *C. vaginata*, *C. livida*, and *C. tetanica*, are rare in New England and threatened or endangered in one or more New England states (Brumback and Mehrhoff *et al.* 1996). *Carex vaginata*, *C. livida*, and *C. tetanica* are described as occurring in wet, calcareous habitats (Fernald 1950, Magee and Ahles 1999); this provides an explanation for the rarity of these species in New England. *Carex polymorpha* is found growing in acidic soils in habitats described by several New

England floras as dry, open woods (Fernald 1950, Seymour 1969, Gleason and Cronquist 1991, Magee and Ahles 1999). This adequately describes some of the habitats of *Carex polymorpha*, but many New England populations are found in mesic to wet-mesic acidic soils in lowland habitats at wetland ecotones.

A common, rhizomatous sedge, *Carex vestita*, is often found growing in the vicinity of *Carex polymorpha*. Superficially, the two sedges appear similar and both flower in May. When in flower, the two species are easily distinguishable. *Carex vestita* has hairy perigynia, and the bract below the lowest spike has no sheath; *Carex polymorpha* has glabrous perigynia and a sheathed lower bract. Standley and Dudley (1989) have provided a table of vegetative features to permit the identification of the two species when they are not flowering. Rawinski (1991) finds that *Carex polymorpha*'s "over-wintering perennating shoots bend rather than stab under gentle finger pressure," and this feature can be used to distinguish the two species in winter. *Carex vestita* has been consistently observed growing on drier sites than *Carex polymorpha* (M. Everett, *personal observation*).

## **SPECIES BIOLOGY**

*Carex polymorpha* can reproduce either vegetatively or sexually. Standley and Dudley (1991) observed more vigorous production of shoots from rhizomes in plants growing in open conditions than in shade. However, there was no indication of any increase in the area covered by the plants. A single, upright, vegetative shoot persists a growing season or less, but the rhizome from which the shoots arise can survive for at least eight years (Standley and Dudley 1989). Additionally, plants occurring in open conditions seem to produce more meristems per node of rhizome; these meristems can produce additional rhizomes or vegetative or flowering shoots (Standley and Dudley 1989). Populations of *Carex polymorpha* growing under favorable conditions for rhizome expansion exhibit an increased density of vegetative and flowering shoots, and rhizomes can extend into adjacent habitat if it is suitable. Vegetative propagation may be possible by collecting plants or dormant rhizomes from vigorous populations and using these to establish new populations. The feasibility of vegetative propagation was demonstrated in Maine, where employees of Woodlot Alternatives successfully transplanted *Carex polymorpha* in mats or as individual plants when a population was threatened by construction (Standley 1992, Woodlot Alternatives, Inc. 1998).

If transplantation were to be used to increase populations of *Carex polymorpha*, information about the genetic diversity of the species would be useful. Lack of genetic diversity could also explain the rarity of this sedge. Standley and Dudley (1989), using plants from Maine, Massachusetts, and Pennsylvania, investigated enzyme polymorphism using electrophoresis. It was revealed that diversity was highest in the largest populations. The Duxbury, Massachusetts population consisted of one genotype and appears to be a single clone. However, there was sufficient variability among the larger populations examined that Standley and Dudley concluded that genetic diversity had not been lost in *Carex polymorpha*

despite the small number of extant populations. Their study points out that individual clones might be adapted to specific microsites in their habitat; such adaptation could complicate efforts at transplantation.

Sexual reproduction, through seed production, provides another way to expand a population or to establish a population at a new site. Seeds can provide greater genetic diversity and are more easily stored and preserved than the living material described above. Standley and Dudley (1989) found that in vigorous populations growing in open conditions, 1.5% of the shoots produced flowering stems, although seed set was low. The study also found that cross- or self-pollination produces apparently viable seed. Predators were implicated in the removal of seeds in germination studies performed at sites in Maine and Massachusetts. When these sites were protected with covers, no germination was observed. There are no observations of seed germination in the wild in the literature surveyed for this report. Attempts to germinate seeds *ex-situ*, at the New England Wild Flower Society, using a variety of methods including stratification, scarification, and gibberellic acid, have been largely unsuccessful (Chris Mattrick, NEWFS, *personal communication*). It appears that populations of *Carex polymorpha* can be manipulated by transplantation, but that the use of seeds to increase existing or to establish new populations is not feasible at this time. Because this sedge ranges from Virginia to Maine, it is logical to assume that the dispersal and germination of seeds was responsible for expansion of existing populations and establishment of new populations. Further investigation of seed germination and population establishment is needed.

## **HABITAT/ECOLOGY**

Standley and Dudley (1989, 1991) and Rawinski and Sneddon (1991) have documented the ecology of *Carex polymorpha*. Unless otherwise noted, the following information comes from these resources. *Carex polymorpha* is found growing in acidic, oligotrophic soils that are sandy and friable and support the rhizomatous growth pattern. The seven soils tabulated by Rawinski and Sneddon (1991) are moderately permeable to water and vary in water-holding capacity from low to high but are described as seasonally saturated. The vegetation associated with *Carex polymorpha* populations is varied. *Quercus* sp., *Pinus* sp., *Acer rubrum*, and ericaceous shrubs frequently form the canopy, and *Lygodium palmatum* is often associated with the Pennsylvania populations (Rawinski and Sneddon 1991). No single species serves as a habitat indicator in New England, but *Acer rubrum*, *Quercus* spp., *Pinus strobus*, and *Osmunda cinnamomea* are frequent associates. Although the taxon persists in shade, its growth and flowering are more vigorous with an open canopy. Standley and Dudley (1991) collected information on populations growing in shaded versus open habitats. Their data suggest that shoot density, rhizome length, number of flowering shoots, number of perigynia, and number of achenes increase with increasing light penetration through the canopy. These observations are supported by results from two management projects for *Carex polymorpha*. In Maine, removal of shading and competing vegetation from plots containing

*Carex polymorpha* resulted in more leafy shoots and perigynia in the two years after treatment (Woodlot Alternatives, Inc. 1998). In 1998, the New England Wild Flower Society under contract from the Massachusetts Division of Fisheries and Wildlife undertook a project to reduce the canopy density at the Duxbury, Massachusetts site. Prior to the management in 1998, there were 96 flowering stems in three areas. In 1999, 338 flowering stems were counted in the same three areas.

The hydrology of the sites where *Carex polymorpha* occurs in New England varies considerably. All of Connecticut's documented occurrences are associated with rivers. Rhode Island's population is located on a slope above a wetland. Two of Massachusetts populations are found near wetlands and the third is on a slope separated from nearby wetlands. Some New Hampshire sub-populations of *Carex polymorpha* are adjacent to wetlands and a brook; others may have been previously associated with wetlands but are now separated from them by development. Two of the Maine populations are associated with lateral seepage or seasonally saturated soils. The habitats are often described as mesic and occasionally as dry. However, as noted above, the populations are usually never far from water bodies or wetlands. Rawinski, in field reports, describes several sites as ecotones between wetlands and dry uplands. He also mentions lateral seepage as important for sites on slopes. Therefore, the "dry woods" habitat description for *Carex polymorpha* given in the various floras of New England does not always apply in New England. In many cases, the species is associated with lateral seepage, seasonally high water table, wetlands or water bodies.

*Carex polymorpha* grows most vigorously in open conditions and seems to respond favorably to cutting or mowing involved in right-of-way maintenance. Rawinski (1988) reports that fires have occurred at the Pennsylvania and West Virginia populations and observes that the continued growth of the plants in these areas suggests that *Carex polymorpha* can withstand the effects of fire. The apparent adaptation of this species to growth in more open habitats indicates that it may have been more abundant and widespread in the past when New England contained more open and agrarian habitats. All the Maine populations may be remnants of a previously much larger contiguous population. The fragmented New Hampshire and Brookfield, Massachusetts, populations may also each have been contiguous under previous land use conditions. Prior to European colonization of New England, *Carex polymorpha* probably persisted in scattered populations in areas prone to fire. Fire- and storm-damaged areas provided the necessary habitat conditions for this species to flower vigorously and undergo dramatic population expansions until these habitats once again reverted to a forested state. Today, habitat fragmentation and control of wildfires may limit or prevent such expansion and may be a factor in the rarity of this species.

## **DISTRIBUTION AND STATUS**

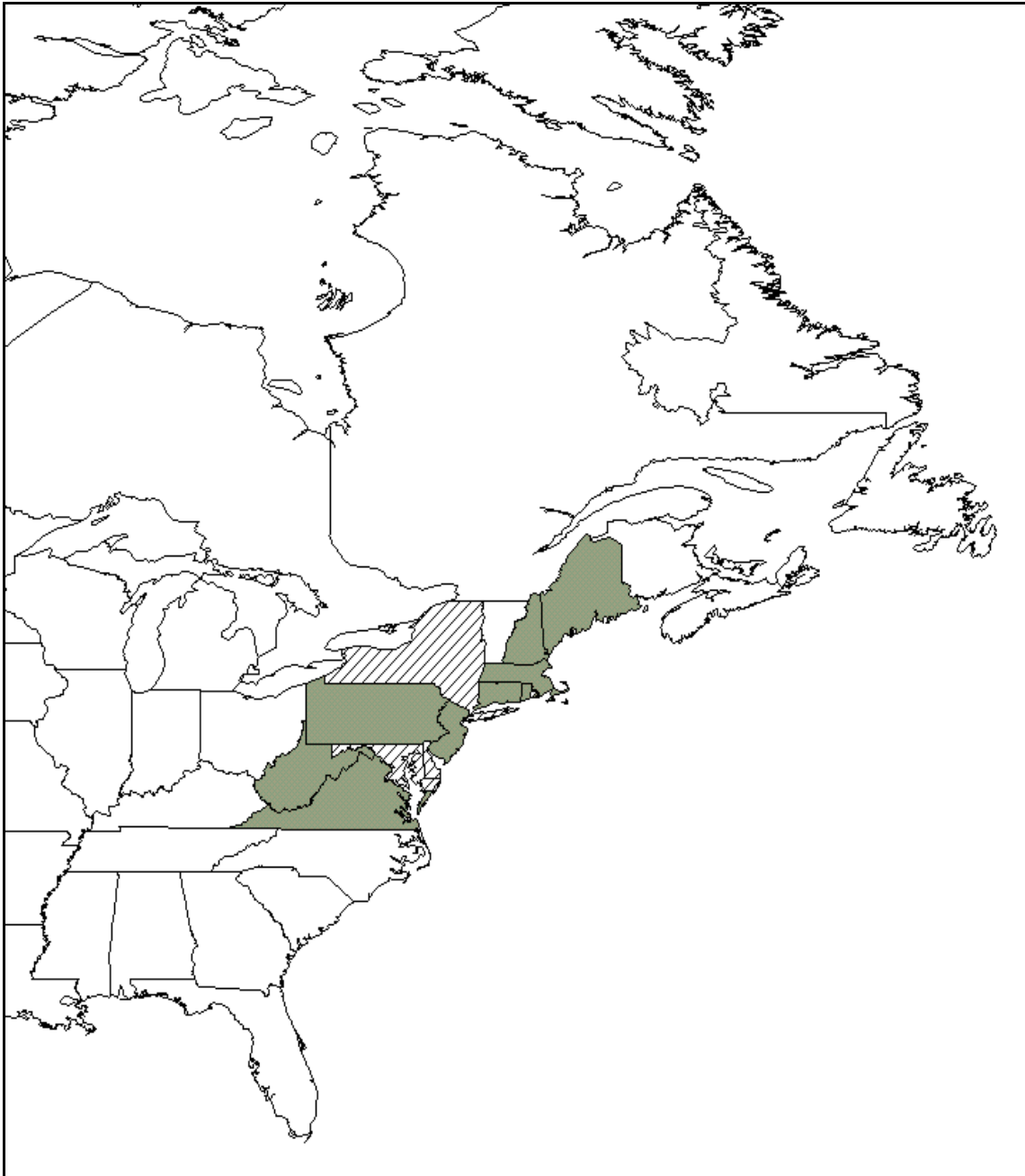
### ***General status***

*Carex polymorpha* is locally distributed in northeastern North America, occurring in a narrow band stretching from Virginia to Maine (see Figure 1, Table 1). It has a global rank of G3, indicating it is rare or uncommon throughout its range (The Nature Conservancy and the Association for Biodiversity Information 1999). *Carex polymorpha* is ranked S1, critically imperiled (one to five occurrences) in eight of the states in which it currently occurs, and S2, imperiled (6 to 20 occurrences) in Virginia. It is considered historic in Delaware, Maryland, and New York (Rawinski 1988). Outside of New England, extant populations occur in New Jersey, Pennsylvania, Virginia, and West Virginia. New Jersey has three populations, growing along an abandoned railroad track, with numbers of ramets in the hundreds (The Nature Conservancy and the Association for Biodiversity Information, 1999). Seven populations are located in Pennsylvania, all in the Pocono Mountains. Estimated numbers of ramets at these sites range from hundreds at one site to several thousand at others. There are 14 populations in Virginia and five in West Virginia. The numbers of ramets in Virginia's populations range from hundreds to thousands. The single largest occurrence of this taxon, millions of individuals, is located in West Virginia on property mostly owned by The Nature Conservancy. Like the Pennsylvania populations, most Virginia and West Virginia occurrences are located in mountainous regions. The elevation of the West Virginia populations is 4000 to 4600 ft (1200 to 1400 m); in Virginia the elevation of most populations is 3200 to 4200 ft (975 to 1300 m); in Pennsylvania it is 1800 to 2000 ft (550 to 600 m) (Rawinski 1991). No New England populations are located in mountainous areas; in fact several populations, including the most northerly populations in Maine, occur close to sea level. Additional information on the distribution and habitats of *Carex polymorpha* is available at the NatureServe web site (<http://www.natureserve.org>).

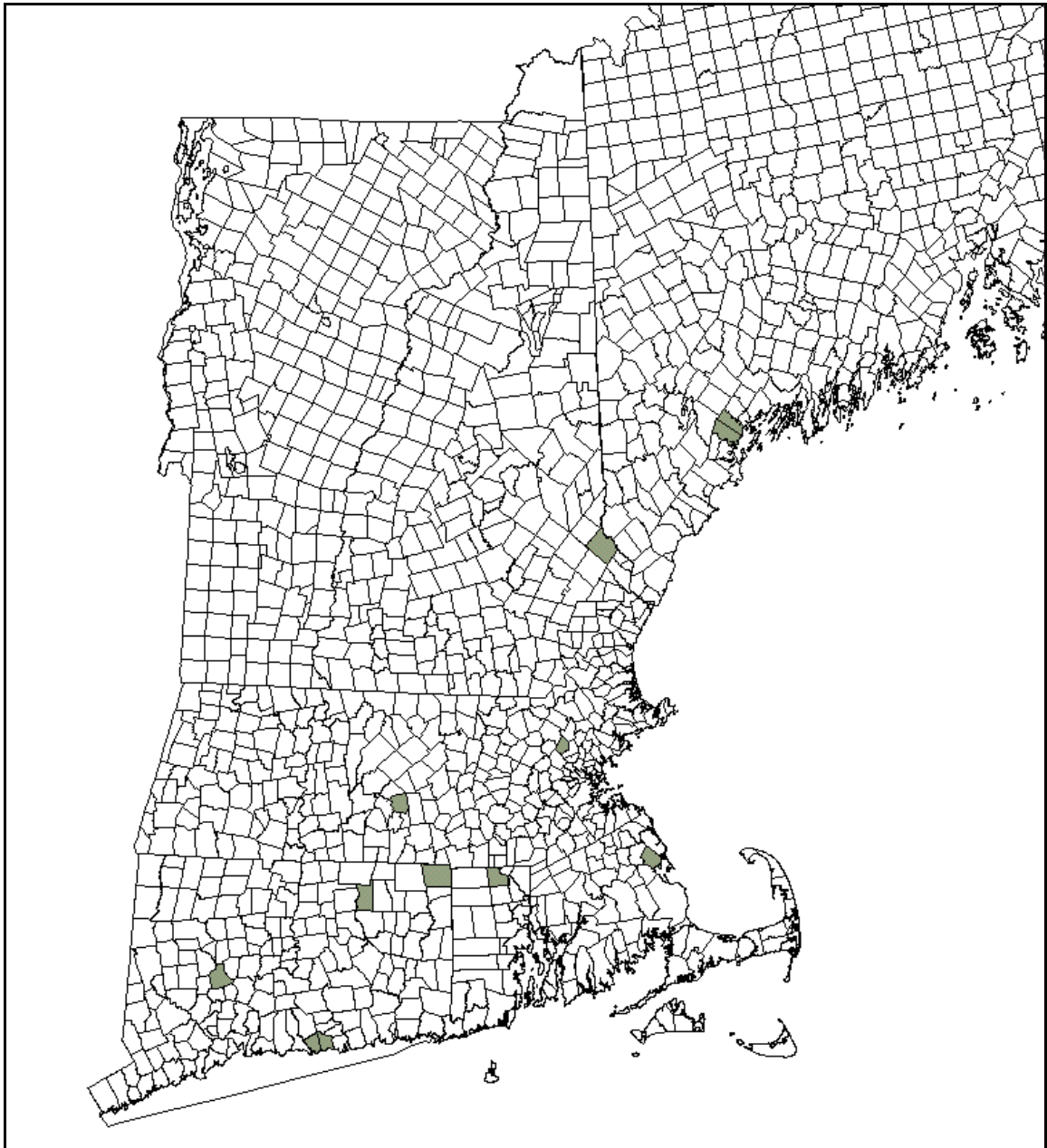
In New England *Carex polymorpha* occurs in Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island (see Figure 2), and it is listed as threatened or endangered in each of these states. Historic localities are shown in Figure 3. Rhode Island has a single population, discovered in 1988, consisting of hundreds of ramets. Five populations occur in Connecticut; two are recent discoveries that lack field forms or additional data. The three additional Connecticut sites consist of hundreds to thousands of ramets each. In Massachusetts, three populations have been discovered since 1987. Two of the populations consist of thousands of ramets each while the most recently located population has an estimated several hundred thousand ramets. New Hampshire's single extant population, found in 1989, consists of thousands to a million individuals scattered over approximately one square mile (259 hectares) in several disjunct groups. Investigators found five populations in Maine between 1985 and 1992. All populations occur within a few miles of each other; they range in size from a few hundred to several thousand ramets.



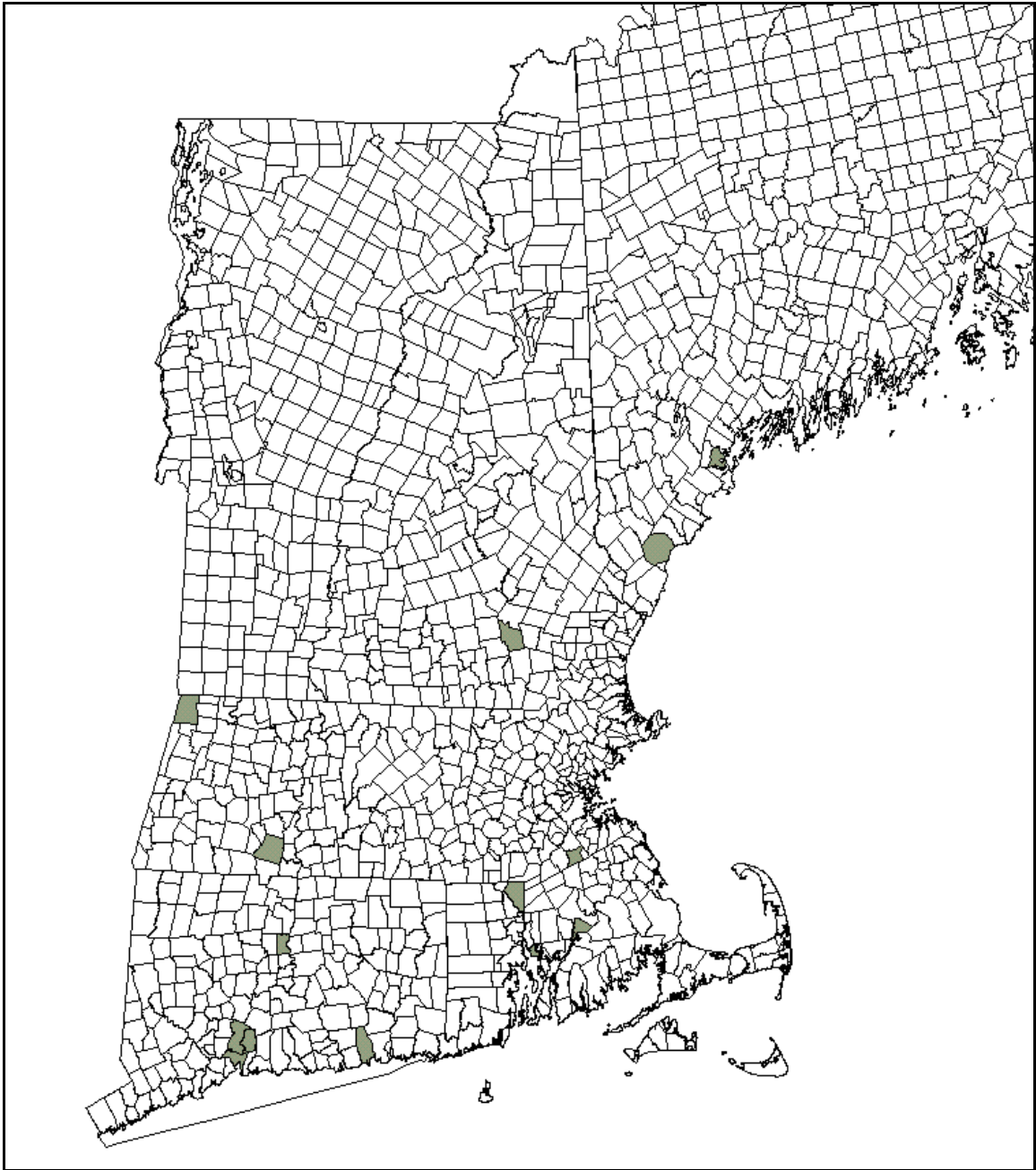
<b>Table 1. Occurrence and status of <i>Carex polymorpha</i> in the United States and Canada based on information from Natural Heritage Programs.</b>	
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp;E)</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Connecticut (S1):5 extant and 5 historic occurrences	Delaware (SX)
Maine (S1): 5 extant and 3 historic occurrences	Maryland (SH)
Massachusetts (S1): 2 extant and 4 historic occurrences	New York (SX)
New Hampshire (S1): 1 extant and 1 historic occurrence	
New Jersey (S1)	
Pennsylvania (S2)	
Rhode Island (S1): 1 extant and 2 historic occurrences	
Virginia (S2)	
West Virginia (S1)	



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



**Figure 2. Extant occurrences of *Carex polymorpha* in New England.** Town boundaries for New England are shown. Shaded towns have 1-5 extant occurrences.



**Figure 3. Historic occurrences of *Carex polymorpha* in New England.** Town boundaries New England are shown. Shaded towns have 1-5 historic occurrences.

**Table 2. New England Occurrence Records for *Carex polymorpha* based on data from State Natural Heritage Programs. Shaded occurrences are considered extant.**

State	EO #	County	Town
ME	<b>.001</b>	<b>Cumberland</b>	<b>Falmouth</b>
ME	.003	York	Wells
ME	<b>.004</b>	<b>Cumberland</b>	<b>Falmouth</b>
ME	<b>.005</b>	<b>Cumberland</b>	<b>Cumberland</b>
ME	<b>.006</b>	<b>Cumberland</b>	<b>Falmouth</b>
ME	.008	Cumberland	Portland
ME	.009	Cumberland	Portland
ME	<b>.011</b>	<b>Cumberland</b>	<b>Falmouth</b>
NH	.001	Hillsborough	Manchester
NH	<b>.002</b>	<b>Strafford</b>	<b>Rochester</b>
MA	.001	Bristol	Berkley
MA	.002	Berkshire	Williamstown
MA	.003	Norfolk	Stoughton
MA	<b>.004</b>	<b>Plymouth</b>	<b>Duxbury</b>
MA	.005	Hampden	Westfield
MA	<b>.006</b>	<b>Middlesex</b>	<b>Burlington</b>
MA	New	<b>Worcester</b>	<b>Brookfield</b>
RI	.001	Bristol	Bristol
RI	.002	Providence	Providence
RI	<b>.003</b>	<b>Providence</b>	<b>North Smithfield</b>
CT	None	Hartford	Hartford
CT	None	New Haven	New Haven
CT	None	New Haven	Hamden
CT	<b>.001</b>	<b>Windham</b>	<b>Thompson</b>
CT	.002	New London	East Lyme
CT	.003	New Haven	North Haven
CT	<b>.004</b>	<b>New Haven</b>	<b>Waterbury</b>
CT	<b>.005</b>	<b>Tolland</b>	<b>Willington</b>
CT	<b>.009</b>	<b>Middlesex</b>	<b>Westbrook</b>
CT	New	<b>Middlesex</b>	<b>Clinton</b>

## II. CONSERVATION

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### CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

There are 15 current occurrences of *Carex polymorpha* in New England; 13 of these are new records located since 1985. At least half of these populations cover less than 2 acres and are ranked C (containing about a thousand ramets and covering 2 to 5 acres) or D (containing many fewer than a thousand ramets and covering less than 2 acres) in the Element Occurrence Specifications of The Nature Conservancy.

A reasonable goal for this taxon in New England in the next five to ten years would be to maintain and protect the fifteen extant populations of *Carex polymorpha* in the region, to augment certain populations, and to continue searching for new occurrences of the taxon. Since thirteen new populations have been found in the past fifteen years, it is anticipated that new sites for *Carex polymorpha* could be found in the five states in which it occurs now. Land protection is imperative for at least three of the extant populations. Furthermore, the size and density of most of the populations should be increased through habitat management and/or transplantation since at present only four of these populations are large, consisting of hundreds of thousands of individuals (*i.e.* vegetative or reproductive shoots) covering several acres. Such actions will not result in a change in the global rank of G3 for this species, but may change some state rankings from S1 to S2 and could raise the site Element Occurrence ranking for some smaller populations.

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## **Appendix I. 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.