New England Plant Conservation Program

Rhynchospora capillacea Torr.
Capillary Beak Rush

Conservation and Research Plan
for New England

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SUMMARY

Rhynchospora capillacea Torr. (capillary beak-rush) is a small, caespitose, perennial herb of the Cyperaceae. It is an obligate calciphile found in rare New England community types such as calcareous fens, calcareous rivershore seeps, and seeping calcareous cliffs. It is a shade-intolerant species that thrives in small, wet patches of exposed soil or along edges of pools in peatlands, or in the cracks and turfy patches of ledges of wet rock outcrops. Because it has a specific habitat affinity for rare community types, it is commonly associated with other rare species also restricted by habitat.

Soon to be globally ranked G4 (apparently secure), this North American species is most common in the Midwestern states and provinces, where it is not tracked. However, despite its abundance in the Great Lakes region, it is very rare throughout most of its range. In fact, 25 of the 33 states or provinces where *R. capillacea* occurs track this species as a rarity. The species is considered rare (Endangered) in all the New England states where it occurs, each but Rhode Island, where it has never been documented. It is ranked Division 2 (Regionally Rare) in New England, where only nine occurrences are currently extant. Eight historic occurrences are also known from the region.

While most of the current New England occurrences of *R. capillacea* are apparently viable, several are threatened by shrub succession, invasive exotic species, and alterations to local hydrology. Where threatened, this species and its associated rarities should be managed primarily at the community level.

The main conservation objective recommended for *R. capillacea* in New England is to increase the number of known current occurrences from 9 to 17 separate populations in the next 20 years. Most population sizes should be over 300 genets in most years. At least four populations should average over 2,000 genets each year. Most occurrences should be should be permanently protected by conservation organizations and land trusts.

In order to achieve the goal of sustaining 17 known populations in New England, maintenance of the nine current populations is essential. Careful regular monitoring, land protection, management, and scientific study will be important conservation actions necessary to maintain these nine current occurrences. In order to increase the number of known populations from 9 to 17, searches of historically documented locations in Vermont, New Hampshire, Connecticut, and Maine are recommended. *De novo* searches of appropriate habitat will likely reveal new locations of this species. Finally, as a last resort, reintroduction of *R. capillacea* to historic locations, or introduction to new, suitable locations should be considered.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Full plans with complete and sensitive information are made available to conservation organizations, government agencies, and individuals with responsibility for rare plant conservation. This excerpt contains general information on the species biology, ecology, and distribution of rare plant species in New England.

The New England Plant Conservation Program (NEPCoP) of the New England Wild Flower Society is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

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

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

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection.

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I. BACKGROUND

INTRODUCTION

Rhynchospora capillacea Torr. (capillary beak-rush) is a small, caespitose, perennial herb with threadlike stems and leaves. Although the capillary beak-rush and the other beak-rushes in the genus *Rhynchospora* may superficially resemble the group of plants called "rushes," they do not belong to the Rush Family (Juncaceae), but are in fact members of the Sedge Family (Cyperaceae).

Rhynchospora capillacea is a plant of calcareous wetlands and seeping calcareous ledges. The species is nearly always found in open conditions with limited competition from taller forbs, shrubs, or trees. In areas where succession is regularly halted by disturbance or inhospitable growing conditions (as on ledges), the species may persist for many years. One New England population of *R. capillacea* has been known to persist since 1859.

The range of this species extends from Newfoundland in the north, to Virginia and skipping to Alabama in the Southeast, west to British Columbia and south through the Dakotas, Oklahoma, and Texas (Kartesz and Meacham 1999). Although the range of this species is quite large, it is rare or uncommon throughout much of its range, probably due to its habitat specificity for wet, calcareous substrate in open situations. As one might expect, the species is thought to be secure throughout most of the relatively calcareous Great Lakes region, including Ontario, Michigan, New York, Ohio, Indiana and Wisconsin. Because the species is secure in the heart of its range, the global rank for *R. capillacea* is currently G5 (demonstrably secure) (NatureServe 2001), although it will be changed to G4 (apparently secure) in 2002. It has not been ranked on a national level in either the U.S. or Canada. On a sub-national level, the species is tracked as a rare species in no less than 25 of the of the 33 states or provinces in which it is found, sixteen of which list the species in the most rare category of S1 (Natureserve 2001).

In New England, only nine occurrences of *R. capillacea* have been confirmed since 1975 ("current"). In addition, eight sites in New England were documented prior to 1975 ("historic"). The species is considered to be rare throughout the New England region, and hence bears the regional rank of Division 2 (Brumback and Mehrhoff et al. 1996). The species is listed as Endangered (and is ranked S1) in every New England state except Rhode Island, where it has never been documented. Explanations of regional conservation ranks and of global, national, and state conservation ranks are provided in Appendices 4 and 5, respectively.

Threats to this species include both anthropogenic and natural factors. Habitat destruction (through development or conversion to forage grasses), landscape fragmentation (and subsequent introduction of non-native species), alteration of hydrological regime

(anthropogenic or by beaver), and alteration of disturbance regime (and subsequent natural succession) all pose threats to the continued existence of populations of *R. capillacea* in New England.

A Conservation and Research Plan is necessary to ensure the continued existence of this regionally-rare species in New England. Because this species is so rare in so many of the states in which it occurs, the danger for the range of the species to shrink appears quite serious. The New England states must take responsibility for this corner of the species' range.

The purpose of this plan is twofold. The first objective, addressed in the opening section of this plan, is to compile existing information about this species in New England, and to some extent throughout its range. The second objective is to use this compiled information to inform a specific plan for long-term conservation of this species in New England. The specific plan, including conservation objectives and the actions required to achieve those objectives, comprises the second section of this document.

DESCRIPTION

Rhynchospora capillacea is a caespitose, perennial herb of the Cyperaceae, which may grow to be 0.9 to 4 decimeters in height (Gale 1944). It is quite delicate in appearance, and may easily be overlooked. It has a capillary, flexuous-erect stem and thread-like leaves. Like most other members of the genus *Rhynchospora*, the inflorescence is an axillary spikelet with imbricate scales, the lower few being empty, the upper subtending perfect florets. In *R. capillacea*, each stem bears a single, long-peduncled, ovoid cluster of 1-10 fusiform spikelets. Each floret is subtended by a papery, light or dark brown scale, and bears a perianth of 6 retrorsely barbed or smooth bristles that may just fall short of or slightly exceed the length of the tubercle, and a style deeply cleft into two stigmatic branches. The achene is fusiform, lenticular, oblong-elliptic, and quite narrowed to the base; it is crowned by a long, attenuate tubercle (Gale 1944).

Two congeners that have repeatedly been reported to co-occur with *R. capillacea* in the field are *R. alba* (in fens) and *R. capitellata* (along river shores). *Rhynchospora capillacea* differs from *R. alba* in having fewer perianth bristles (six, as opposed to eight to fourteen in *R. alba*) that are not feathery at the base (plumose at the base in *R. alba*). To the naked eye, *R. capillacea* has a more narrow, ovoid cluster of spikelets that is brownish, and *R. alba* has broader-tipped cluster of spikelets that is white or tawny-colored. *Rhynchospora capillacea* differs from *R. capitellata* in having a more narrow achene (only one half as wide as long, compared to equally wide as, or wider than long in *R. capitellata*) and many fewer spikelets per cluster. To the naked eye, the one or two clusters of spikelets are narrow in *R. capillacea*. In *R. capitellata*, there are usually several hemispheric clusters of spikelets.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

The genus *Rhynchospora* is well-represented in North America. Like the common-name "beak-rush," the genus takes its name from the tubercle, an indurated and persistent style base, atop each achene. The root "*Rhynch*" is Greek for "snout" or "beak," and "*spora*" is Greek for "seed." *Rhynchospora capillacea* falls into the subgenus *Distylis* Pax., in which the styles are divided into two stigmatic branches equal to the length of the undivided portion (Gale 1944). Within the subgenus *Distylis*, the species is in the Section *Eurhynchospora* Griesb (with scales thin and papery, bristles usually present). Within the Section, this species falls within the Series *Glomeratae* Small, emend., with a caespitose habit, leaves thinner than 5 mm wide, and bristles usually retrorsely barbellate.

The species itself is a distinct taxon (Gale 1944), and while several synonyms do exist, they primarily represent controversy at the generic and not the specific level. The species was first described as *Schoenus setaceus* by Muhlenberg in 1817. *Rhynchospora capillacea* has been neither merged nor divided into other species of *Rhynchospora*. A variety of this species with smooth bristles was reported by Gray for Hill, named *Rhynchospora capillacea* var. *leviseta,* later revised to *Rhynchospora capillacea* forma *leviseta* by Fernald (Gale 1944).

Synonymy

Rhynchospora capillacea Torr. has been recognized in the scientific literature under many different synonyms. As described above, most of the nomenclatural controversy surrounding the various synonyms relates to dissension at the generic level. However, a few synonyms for the species do exist within the genus *Rhynchospora*. All synonymy uncovered by this author is reported as follows:

Rhynchospora capillacea Torr. Comp. 41 (1826)
Phaecocephalum capillaceum Farwell (1920)
Rhynchospora smallii Britt. (1903)
Triodon capillaceus Farwell (1913)
Rhynchospora setacea (Muhl.) MacMillan (1892)
Schoenus setaceus Muhl. (1817)
Rhynchospora capillacea var. *levisita* E.J. Hill ex Gray (1876)
Rhynchospora capillacea forma *leviseta* (E.J. Hill) Fernald

SPECIES BIOLOGY

General Biology

Very little is specifically known about the species biology of *R. capillacea*. It is an obligate calciphile, found only in areas influenced by the presence of carbonate or other calcium-rich bedrock. It is a caespitose perennial with very short rhizomes, and hence is not known to spread clonally. The species flowers in mid-summer and fruits in late summer. Seymour (1969) reports that mature achenes were found from New England herbarium specimens collected between June 11 though September 17.

Although little is known specifically about the biology *R. capillacea*, there is some information in the scientific literature pertaining to the biology of the genus *Rhynchospora*. For example, many members of *Rhynchospora* are susceptible to infection by smut fungi. Tropical *Rhynchospora* species are infected by the smut genera *Cintractia* and *Trichocintractia*, which inhibit floral development and inflorescence development, respectively (Piepenbring 1995). Certain temperate species of *Rhynchospora* are also prone to smut infection, such as *R. alba*, *R. capitellata*, *R. fusca*, *R. macrostachya*, *R. nitens*, and *R. scirpoides* (Fischer 1953). To this authors' knowledge, smut infection of *R. capillacea* has not been documented; however, the host ranges of these smut species are wide, and may also include *R. capillacea* (D. Lambert, University of Maine, personal communication).

Some members of *Rhynchospora* exhibit Kranz anatomy and the C_4 photosynthetic pathway, which is a mechanism that has evolved independently in several different angiosperm lines (Takeda et al. 1980, Soros and Dengler 2001). The C_4 pathway allows efficient photosynthesis in hot, arid climates by reducing photorespiration and improving water use efficiency over the C_3 pathway (Taiz and Zeiger 1991). Other members of *Rhynchospora* retain the C_3 pathway, such as *R. alba*. Although the leaf anatomy of *R. capillacea* has not been examined, it is not expected to posses Kranz anatomy, because of its relation to *R. alba* (both in the Series Glomeratea) and because the selection pressure for the C_4 pathway is not strong in the cool, temperate wetlands where *R. capillacea* grows.

Reproductive Biology

Rhynchospora capillacea, like other members of the genus, has very reduced, perfect flowers. Pollination is anemophilous (by wind); hence, floral adaptations to attract pollinators are not present. The fruit is a smooth achene, crowned by a subulate tubercle.

Nothing is reported in the literature regarding fruit dispersal mechanisms of *Rhynchospora*. However, it is reasonable to assume that the presence of barbs on the perianth bristles may aid in fruit dispersal by animals. Fruits may possibly be water-dispersed. Whether or not the tubercle has a role in dispersal is unknown.

Most wetland members of the Cyperaceae in New England require damp, exposed soil to germinate (William Cullina, New England Wild Flower Society, personal communication), which may be related to a requirement for light or temperature fluctuation, or both. The seed of *R. capillacea* is contained within the small achene, which is an indehiscent, dry fruit. Because small seeds, such as those of *R. capillacea*, have limited food reserves, it is usually critical that they germinate near the soil surface. Light is an important indicator that a seed is positioned at or near the soil surface (Grime 1979), and hence light may be a requirement to break dormancy or stimulate germination in *R. capillacea* seed.

Wide temperature fluctuations also act as a cue that a seed is near the soil surface and free of insulating vegetative cover. Wetland species are particularly stimulated to germinate by fluctuating temperatures (Thompson and Grime 1983). Seed germination tests on herbaceous calcareous fen species in Southern Germany indicated that constant temperature inhibited germination, and temperature fluctuation increased germination in members of the Cyperaceae (Maas 1989).

Rhynchospora capillacea seed germination trials have been conducted by the New England Wild Flower Society, although the results of these tests have not yet been formally evaluated or reported (Chris Mattrick, New England Wild Flower Society, personal communication). It appears that some seeds (approximately 50%) collected in late summer or fall and air-dried for two months, then cleaned, are able to germinate in spring if surface-sown in early January and placed outside in flats with a light sand cover. Under this treatment, seeds would have experienced both a winter period of prechilling, followed by springtime exposure to light and temperature fluctuations. Treatments that did not include winter prechilling, or that substituted refrigerator chilling for outdoor stratification, followed by placement in a greenhouse under relatively constant temperatures, exhibited no or very low levels of germination.

In summary, it is suspected that seed of *R. capillacea* requires a bare soil surface to germinate (Anton Reznicek, University of Michigan, personal communication). If so, soil disturbance followed by gap indicators such as light or temperature fluctuation are likely necessary to stimulate germination. Gap detection serves to indicate soil exposure and a lack of competition that would be favorable for seedling establishment (Fenner 1985). Seedling establishment has not been studied specifically for *Rhynchospora capillacea*; however, reduction in competition may be important. Competition was the main factor limiting the establishment of four herbaceous fen species, including common *R. capillacea* associate *Carex flava*, in a fen restoration study conducted in Switzerland (Ramseier 2000).

Population Biology

Because of its caespitose habit, this species is not thought to spread extensively via long rhizomes to form large colonies. Instead, it is expected that the species spreads through seed

dispersal, and hence recruitment of new seedling cohorts into the population may be the primary method of population growth. If so, disturbance that provides suitable germination safe sites (moist areas of exposed soil) may need to occur if population sizes are to increase.

Small population sizes are not typical of this species, either in the heart of its range, or in New England. In suitable microhabitat, it is actually a dominant species in some New England communities. A resultant conservation implication may be that this species is not inherently well-adapted to cope with small population size, and small populations may be vulnerable to negative genetic effects such as inbreeding depression and drift, as well as stochastic events (Barrett and Kohn 1991).

HABITAT/ECOLOGY

General Habitat

Outside of New England, and especially in the Midwest, *R. capillacea* habitat has been described by various botanists as: calcareous fens; marl fens; fen-like seepage communities; sedge meadows; calcareous lakeshores (cobble beaches, wet sandy or stony shores, boggy beach pools); shoreline meadows; interdunal meadow depressions; limy seeps; seepages of limestone and dolomite cliffs; seepy, shelving rock ledges; moist areas of calcareous quarries and gravel pits; and alvars (limestone pavements) (Sean Blaney, Atlantic Canada Conservation Data Centre; Erika Choberka, Michigan Natural Features Inventory; Allison Cusick, Division of Natural Areas and Preserves, Ohio Department of Natural Resources; Anton Reznicek, University of Michigan; Welby Smith, Minnesota Department of Natural Resources Information Center; and Kristen Westad, Wisconsin Department of Natural Resources; personal communication).

Within New England, *R. capillacea* is present in three general habitat types: calcareous peatlands; calcareous riverside seeps; or dripping calcareous cliffs. As mentioned above, the species is calciphilic, and hence is found only in areas with underlying calcium-rich bedrock or surficial deposits. The species also requires an open situation with minimal competition from surrounding vegetation. In keeping with its ruderal life-history strategy (*sensu* Grime 1979), the species is occasionally found in disturbed, cultural habitats, as is the case of one population growing along the exposed banks of a channeled stream in Connecticut.

Most New England populations of *R. capillacea* grow in calcareous peatland communities, which are uncommon in New England. They have been described as Forested Fens (Weatherbee and Crow 1992), Calcareous Sloping Fens (Swain and Kearsley 2000), and Shrubby Cinquefoil-Sedge Circumneutral Fens (Gawler 2001). These wetland communities are strongly influenced by the movement of calcareous groundwater, and groundwater seepage is actually often apparent as small rivulets (Swain and Kearsley 2000). The vegetation structure is usually low and open, dominated by graminoids, but with scattered

shrubs and stunted, small trees. Characteristic species found in these fen communities in southern New England include *Pentaphylloides floribunda*, *Larix laricina*, *Parnassia glauca*, *Carex flava*, *C. sterilis*, *Salix serissima* and *S. candida*. Northern New England fens also include several of the above-listed species, as well as *Thuja occidentalis*, *Myrica gale*, *Carex livida*, and *Carex exilis*. *Rhynchospora capillacea* is usually found in what is referred to as the "harsh" portion of a fen, which is an area of very low, stunted vegetation adapted to low levels of nitrogen and phosphorous (T. Rawinski, Massachusetts Audubon Society, personal communication).

Several more New England populations of *R. capillacea* are found growing within calcareous riverside seep communities (Thompson and Sorenson 2000, Gawler 2001). Like calcareous fens, this community type is defined by the presence of seeping calcareous groundwater, which flows out of the river bank and over and through the shoreline substrate (Thompson and Sorenson 2000). Rocky ledge outcrops typically support this community, and plants are found growing in pockets of soil and peat in fissures and cracks of the ledges, or in small areas of accumulated alluvial soil. Annual disturbance by spring ice scour maintains the low, open character of this community. Graminoids and low herbs are the plants most often found within this rare community type, and include *Carex garberi*, *Triantha glutinosa*, *Parnassia glauca*, *Lobelia kalmii*, *Juncus dudleyi*, *Equisetum variegatum*, and *Carex flava*. A New England Conservation and Research Plan for two of the above-listed species, *Carex garberi* and *Triantha glutinosa*, addresses the conservation concerns of this community type in detail (Brumback 2002).

Finally, one population of *R. capillacea* is growing within a boreal calcareous cliff community (Thompson and Sorenson 2000). This community type is characterized by near-vertical calcareous bedrock, dripping, mineral rich groundwater, and cold temperatures. Vegetation is usually quite sparse in these communities; however, several species are found inhabiting moist, seepy areas, including *Lobelia kalmii*, *Carex scirpoidea*, *Eleocharis pauciflora*, *Cryptogramma stelleri*, *Campanula rotundifolia*, *Pinguicula vulgaris*, and several species of *Saxifraga* (Thompson and Sorenson 2000).

The three general community types described above share several characteristics in common, other than the presence of *R. capillacea*. They are each strongly influenced by seepage of calcareous groundwater, and have areas of open substrate with low competition. Due to association with carbonate bedrock, which is scarce in most of New England, they are each very rare natural community types in this region (Appendix 1). In addition, each of these community types contain concentrations of rare plant species.

Concentrations of rare species within these communities relates to high habitat-specificity for the shared environmental conditions described above. As a result, a relatively predictable and rare vegetation association is found among these three community types (T. Rawinski, personal communication). This association has been described by Motzkin (1994) in his classification of the vegetation associations of calcareous fens Western New England and

adjacent New York. He calls the association the *Carex interior-C. leptalea-C. flava* Type, and lists other members of the association (in part) as *Larix laricina, Pentaphylloides floribunda, Salix serissima, Juncus dudleyi, Juncus nodosus, Muhlenbergia glomerata, Parnassia glauca, Solidago uliginosa* (as *Solidago purshii)* and *Solidago patula*. The National Vegetation Classification describes similar associations as *Triantha glutinosa-Carex garberi* Herbaceous Vegetation along large river shores (ranked G3?), or as *Pentaphylloides floribunda/Carex (sterilis, hystericina, flava)* Shrub-Herbaceous Vegetation in calcareous seepage fens (ranked G2) (Natureserve 2001).

Based on species lists and plot data from the New England populations, those species most often co-occurring with *R. capillacea* in this vegetation association include: *Eleocharis pauciflora, Pentaphylloides floribunda, Lobelia kalmii, Carex flava, Carex sterilis, Solidago uliginosa, Parnassia glauca, Juncus dudleyi, Salix serissima, Triantha glutinosa,* and *Carex garberi*. Many members of this association are present at all *R. capillacea* sites; a few are present only in the peatland or outcrop communities.

Microhabitat

Much observational information has been recorded regarding the microhabitat requirements of the species in New England fens. Several surveyors have reported that *R. capillacea* occurs only in openings where soil is exposed and competition is very reduced. Specific microhabitat descriptions include: "small, muddy openings" (Sorrie 1987: 138); "muddy, bare openings" (Weatherbee and Crow 1992: 204); and "only where most open with least competition" (Clark, field form to Massachusetts Natural Heritage and Endangered Species Program). Mehrhoff (1989: 135) reported that the species in Connecticut was "known from two disturbed localities. The clue to locating additional stands may be to look in disturbed wetlands with exposed calcareous soils."

Natural causes of soil exposure within New England fens are attributable to at least two known factors: ground seepage and deer trails. Motzkin (1994: 62, 64) reports that seepage discharge was clearly and frequently visible as rivulets, and that "in areas of heavy discharge, mineral soil is typically exposed." One Element Occurrence (EO) record from a Massachusetts fen indicates *R. capillacea* in "a harsh section with open channels that have exposed, wet soil." Deer trails have been cited as important microhabitat in at least one New England fen. A surveyor notes " deer trails go east to west exposing mucky soils" and another writes "*Rhynchospora capillacea* seems to prefer low areas (deer paths)." Moose may also create important areas of disturbed microhabitat in peatlands, especially in northern New England.

Other reports relating to the microhabitat of the species within fens describes its tendency to be found within the wettest sections. Bruce Sorrie reports in an EO record that one Massachusetts *R. capillacea* occurrence "occupied the wettest, most open places along [the] outlet creek and around holes and depressions." A Minnesota botanist observes "it seems that

R. capillacea occurs in the wettest parts of fens, usually at the edge of pools" (Welby Smith, personal communication).

THREATS TO TAXON

Because *R. capillacea* is restricted to very specific and rare habitat types, the greatest threat to this species in New England is habitat destruction. Interruption or alteration of the natural processes within the calcareous riverside seep and fen communities would be most detrimental to the populations of *R. capillacea* in this region. Because this species is also commonly associated with other rare habitat specialists, a community-based, rather than species-specific, protection and management approach should be taken.

The major threats to the communities are threats to the environmental factors that best characterize them, and to which *R. capillacea* and its associates are adapted. Hence, the greatest threats would be altering groundwater flow, groundwater quality (high calcium, low nitrogen and phosphorous), and the open, low-competition environment in which the plant thrives.

Alterations to Hydrology

Rhynchospora capillacea is nearly always associated with calcium-rich groundwater seepage. Alterations of seep hydrology, including flow and ground water quality, would seriously threaten the integrity of the seep-driven community types where this species is found. Because of their agricultural and commercial potential, large river shore and calcareous landscapes in New England are often fragmented by agricultural, commercial and residential development. These types of land uses may be detrimental by lowering the water table (through wells or irrigation), which may reduce volume of groundwater flow, and secondarily reduce surface seepage. In addition, agricultural fertilizer, livestock waste, or septic systems could possibly contribute to eutrophication of groundwater sources (*sensu* Panno et al. 1999). Gravel extraction operations can also interrupt groundwater recharge and discharge processes (T. Simmons, Massachusetts Natural Heritage and Endangered Species Program, personal communication). Impoundment of sloping fens for water supply purposes may alter hydrology, as well. The invasive exotic species *Phragmites australis* has been observed to alter local hydrology at a Massachusetts fen by reducing flow (F. Lowenstein et al., unpublished data).

In addition to alterations to groundwater seepage, flooding is also a serious threat to fen communities containing *R. capillacea*. An increase in New England's beaver population over the past few decades has resulted in the creation of impoundments and subsequent flooding in landscapes throughout the region (Tim Simmons, personal communication). The effects of beaver flooding on wetland vegetation has been addressed in two New England studies, both of which document resultant vegetation change (Rawinski and Lapin 1990, Mitchell and Niering

1993). Coincidentally, one of these studies took place at the location of an historic Connecticut *R. capillacea* occurrence. In this fen study, species richness was reduced following prolonged beaver floods (Rawinski and Lapin 1990). The authors speculate that sustained flooding at one New England fen might "eliminate rare species, damage peat mats, and allow exotics to invade" (Rawinski and Lapin 1990: 244). One surveyor directly observed the impact of beaver on *R. capillacea*, stating "apparently due to beaver, high water levels in the area where the sedge was quite abundant last year have reduced the population again to a level below what it was in years prior" (S. Shaw, The Nature Conservancy, personal communication).

Permanent or sustained anthropogenic flooding by dams may threaten *R. capillacea* in riparian areas. One historic population of this species in Maine is considered extirpated due to permanent submersion of its habitat by damming (S. Rooney, Josselyn Botanical Society, and S. Gawler, Gawler Conservation Services, personal communication).

Loss of Natural Disturbance Regime and Subsequent Competition

A shade-intolerant plant of very small stature, *R. capillacea* requires an open situation in order to compete successfully. Hence, it is usually only directly associated with other low herbs, such as *Carex flava, Lobelia kalmii*, and *Eleocharis pauciflora*. In a study of Iowa fens, *R. capillacea* was found to prefer mats of very low vegetation (Nekola 1994). Succession to taller herbaceous vegetation, shrubs, or trees would threaten populations of *R. capillacea*.

The low, open quality of *R. capillacea* habitat is maintained differently, depending on community type. Within boreal calcareous cliffs and calcareous riverside seeps, areas remain inherently open due to the inhospitable nature of bare rock ledges, and plants are only found growing in small crevices and turfy patches among the rock. However, in rivershore communities, annual ice scour plays a critical role in keeping these rocky shores free of soil buildup and competing, weedy vegetation. River dams are thought to reduce natural ice damming and subsequent shoreline ice scour (Gawler 1983). Interruption of springtime ice scour may allow early-successional rarities, such as *R. capillacea*, to be outcompeted by colonizing weedy species.

Disturbance regimes within fens are more varied, and often relate to land–use history. Some areas of fens (termed "harsh") remain in low herbaceous vegetation without disturbance, due to the low nitrogen and phosphorous content of the soils and water which are not sufficient to support many shrubs and trees. Water movement also contributes to maintaining open areas in fens. Grazing by moose and elk was probably instrumental in curbing shrub populations and creating disturbances in fens during pre-colonial times. An unpublished paleoecological pollen study of one Massachusetts fen discovered extensive charcoal deposits, indicating that frequent fire was another factor keeping fens open before European colonization (T. Simmons, personal communication).

Grazing by deer or moose may play an important role in keeping fens open, both by grazing taller vegetation, and by creating important microhabitat in the form of trails. Since small rills that form in areas of heavy groundwater seepage are also important small-scale disturbances, interruption of this process could threaten *R. capillacea* at some sites.

Grazing by livestock and controlled burning are two methods known to have kept Massachusetts fens open in the more recent past (T. Simmons, personal communication). While helpful in curbing succession, livestock may be harmful by increasing soil compaction or site eutrophication.

In addition to threats posed by succession of native vegetation, the threat of competition from invasive exotic species is present in both New England riparian (Nislow et al. in press) and fen (Richburg et al. 2001) communities. Invasive species often thrive in open environments with disturbed soil, as does *R. capillacea*. Invasive species have been documented at six of the nine current occurrences of *R. capillacea*.

Habitat Conversion or Destruction

Some ecologists speculate that much of the historic habitat of *R. capillacea* was converted to forage grass meadows during the height of agricultural activity in New England. While only eight historic occurrences have been documented, it is possible that many more populations existed in the abundant calcareous sedge meadows present in Berkshire County, Massachusetts prior to European settlement (Tim Simmons, personal communication). For example, hundreds of acres of rich graminoid fen that were present in the town of Stockbridge, Massachusetts prior to European contact have all subsequently been converted to European forage grasses or buried.

Development may also be responsible for the loss of appropriate habitat for *R. capillacea* in our region. While direct development of wetland areas is usually regulated in the present day, in the past, much calcareous wetland was filled for development into schools or residences.

Recreational Pressure

An oft-perceived threat to river shore communities is trampling by excessive recreation along river shores. Because this is a disturbance-adapted plant community, this threat is not considered as serious as those discussed above (T. Rawinski, personal communication).

DISTRIBUTION AND STATUS

Distribution

The current range of *R. capillacea* extends from Newfoundland south to Virginia and skipping to Alabama in the Southeast, west to British Columbia and south through the Dakotas, Oklahoma, and Texas (Gleason and Cronquist 1991). It is most common in the heart of its range, which includes the Midwestern states and Ontario. Its phytogeographic floristic affinity is "Alleghanian" or "Alleghanian-Ozarkian" which reflects the supposition that it had refugia in the Appalachian and Ozark mountains during glaciation in the Quaternary Period (Weatherbee and Crow 1990). Like other species with an Alleghanian affinity, its range is centered in the glaciated region with extensions south into the Appalachians. Figure 1 shows the distribution of *R. capillacea* in North America.

Status

Rhynchospora capillacea is currently globally ranked G5 (demonstrably secure) (Natureserve 2001). However, this rank was assigned in 1984, has no associated justification comments, and has not been reviewed since that time (Gwen Davis, Natureserve, personal communication). During the preparation of this plan, the Global rank responsibility for this species was transferred to the Massachusetts Natural Heritage and Endangered Species Program. Based on the distribution and rarity information gathered for this plan, the G-rank will be changed to G4 (apparently secure) in 2002. The rank will be changed because the species is rare throughout such a large portion of its global range, and as such, the potential for the range (and perhaps genetic diversity) to shrink is great. This species has not been ranked on a national level in Canada or the United States.

The species is most common in the Great Lakes region, where calcareous bedrock is abundant. Several states or provinces there rank *R. capillacea* as SR (reported) or S? (undetermined). Because such ranks do not communicate much information about the actual abundance of the species in those states, Natural Heritage Program botanists were interviewed, and the resulting comments on status of *R. capillacea* in these states are reported in Appendix 2. Interestingly, despite the relative abundance of suitable habitats in the Midwest, no states or provinces estimated the rank of the species to be an S5 (demonstrably secure). Because of the

sensitive nature of fen communities, most states estimated the rank of *R. capillacea* to be S4 (apparently secure).

The regional rank for *R. capillacea* in New England is Division 2, or regionally rare, with fewer than 20 occurrences in New England (Brumback and Mehrhoff et al. 1996). Only seventeen populations have ever been documented in New England, and only nine of these are considered current. The species is ranked S1 (critically imperiled) and Endangered in all of the New England states except Rhode Island, where it does not occur, because each has well under 5 occurrences.

In fact, most states or provinces that contain populations of *R. capillacea* rank it S1 and Endangered (Table 1) (Natureserve 2001). Out of the total of 33 states or provinces where the species occurs, no less than 16 of them (48%) rank the species in the most rare category. An additional two states or provinces list the species as S1S2, and 6 others rank it as S2 (Threatened). One state lists the species as historic. A total of 25 states or provinces (76%) rank this species as Endangered, Threatened or Historic.

The type of rarity exhibited by *R. capillacea* has been categorized by Rabinowitz (1981); the type is characterized by having a large geographic range, local population sizes that can be large and dominant in some areas, and a narrow habitat-specificity. Such species are "predictable" in location, and tend to be precarious as a result of habitat destruction (Rabinowitz 1981). In the Northeast, the precarious status of *R. capillacea* is more the result of the inherent scarcity of the habitat type than habitat destruction, *per se* (Appendix 1). For example, the community type in which *R. capillacea* is found in Massachusetts, Sloping Calcareous Fen, is ranked S2 (Swain and Kearsley 2000). The corresponding community in Maine, Shrubby Cinquefoil-Sedge Circumneutral Fen, is also ranked S2 in that state (Gawler 2001). Similarly, calcareous rivershore seep communities are ranked S1 in New Hampshire. Clearly, habitat protection will be a key factor in the conservation of this species, as well as the other rarities of uncommon calcareous habitats, in New England.

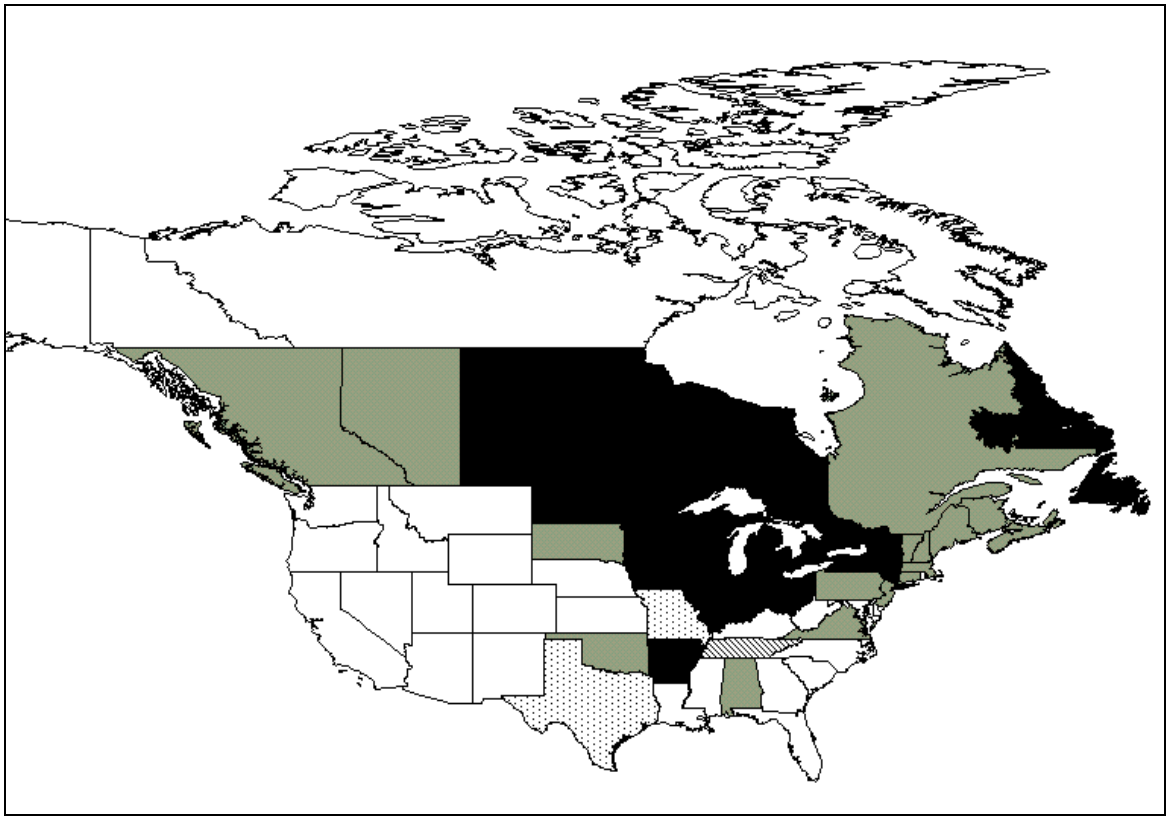

Figure 1. Occurrences of *Rhynchospora capillacea* in North America. States and provinces shaded in gray have one to five current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. States with diagonal hatching are designated "historic" or "presumed extirpated," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but not necessarily verified). See Appendix 4 for explanation of state ranks).

Table 1. Occurrence and status of *Rhynchospora capillacea* in the United States and Canada based on information from Natural Heritage Programs.			
OCCURS & LISTED (AS S1, S2, OR T &E)	**OCCURS & NOT LISTED (AS S1, S2, OR T & E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
Alabama (S1)	New York (S?) [S4]	Indiana (SR)	Tennessee (SH)
Alberta (S1)	Michigan (S?)	Missouri (SR)	
British Columbia (S1)	Ontario (S4?)	Ohio (SR)	
Connecticut (S1, E) 2 current and 1 historic occurrence		Texas (SR)	
Maine (S1, E) 2 current and 4 historic occurrences		Wisconsin (SR)	
Massachusetts (S1, E) 2 current occurrences and 0 historic occurrences			
New Hampshire (S1, E) 1 current and 1 historic occurrence			
New Brunswick (S1)			
New Jersey (S1)			
Nova Scotia (S1)			
Oklahoma (S1)			
Pennsylvania (S1)			
Quebec (S1)			
South Dakota (S1)			
Vermont (S1) 2 current and 1 historic occurrence			
Virginia (S1)			
Illinois (S1S2)			
Newfoundland (S1S2)			
Arkansas (S2)			
Iowa (S2)			
Manitoba (S2)			
Minnesota (S2)			
North Dakota (S2)			
Saskatchewan (S2)			

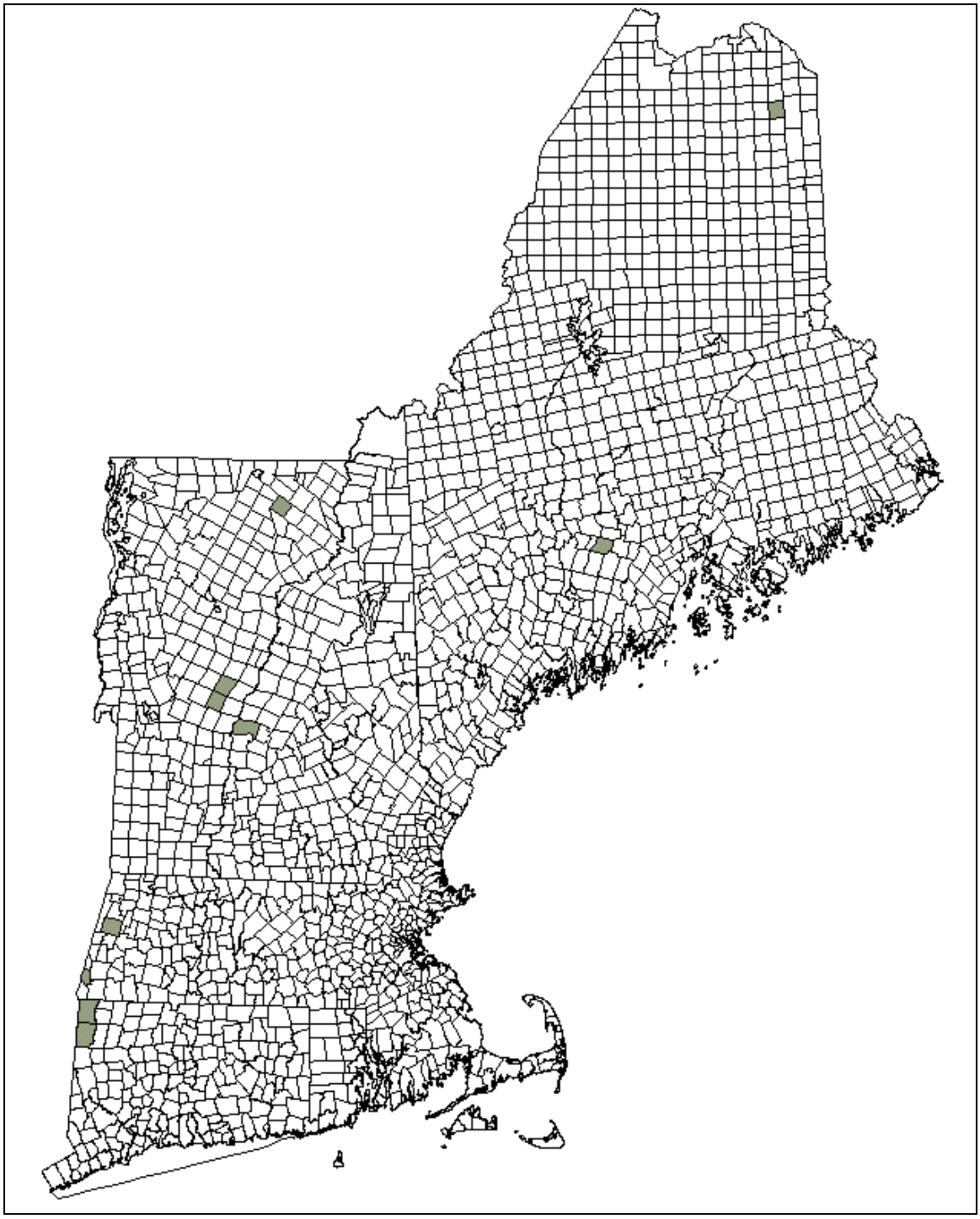

Figure 2. Extant occurrences of *Rhynchospora capillacea* in New England. Town boundaries for New England states are shown. Towns shaded in gray have one to five confirmed, extant occurrences of the taxon.

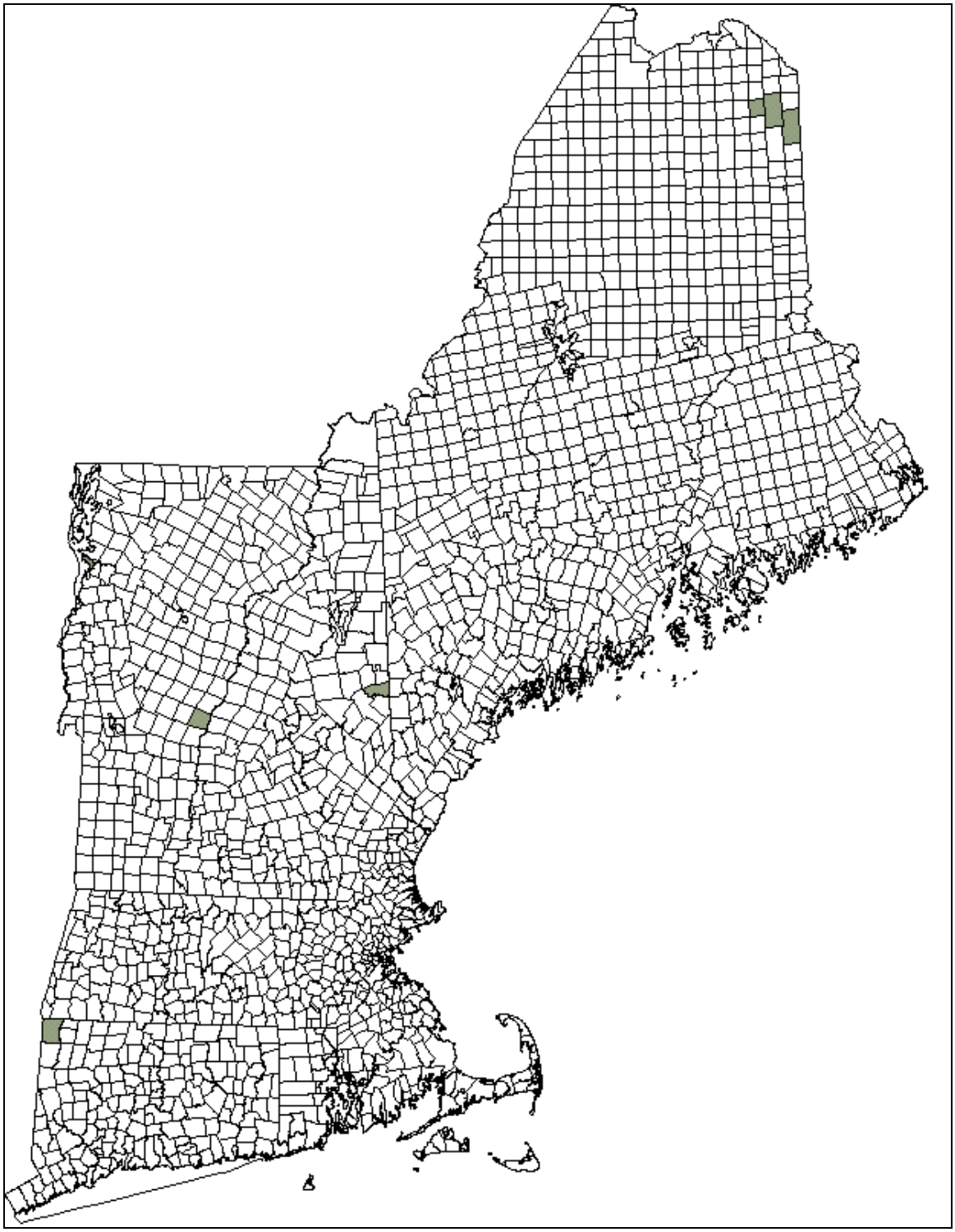

Figure 3. Historic occurrences of *Rhynchospora capillacea* in New England. Towns shaded in gray have one to five historic records of the taxon.

Table 2. New England Occurrence Records for *Rhynchospora capillacea.* Shaded occurrences are considered extant.

State	EO #	County	Town
ME	**.001**	**Kennebec**	**Winslow**
ME	.002	Aroostook	Caribou
ME	.003	Aroostook	Fort Fairfield
ME	**.004**	**Aroostook**	**Woodland**
ME	N/A	Aroostook	Fort Fairfield
ME	N/A	Aroostook	Fort Fairfield
NH	**.001**	**Sullivan**	**Plainfield**
NH	.002	Carroll	Freedom
VT	**.001**	**Orleans**	**Westmore**
VT	**.002**	**Windsor**	**Sharon/ Pomfret**
VT	.003	Windsor	Hartford
VT	.004	Chittenden	Burlington
MA	**.001**	**Berkshire**	**Pittsfield**
MA	**.002**	**Berkshire**	**Egremont**
CT	**.001**	**Litchfield**	**Salisbury**
CT	.002	Litchfield	Salisbury
CT	**.003**	**Litchfield**	**Sharon**

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

State Rare Species Legislation

The Natural Heritage Network equivalents in Maine, New Hampshire, Vermont, Massachusetts, and Connecticut each list *R. capillacea* as "Endangered" on their official list of rare species. Official "listing" by a state results in varying levels of protection for a rare species, depending upon the state in question. In Maine, populations of *R. capillacea* are protected under the Maine Revised Statutes Annotated 5 MSRA C, 3833, sub C. III, article 1-A. This statute does not prevent the plant from being collected or destroyed by landowners, or by others with the permission of landowners. In the state of New Hampshire, *R. capillacea* is protected under the 1987 State Law RSA 217-A:3, III. In Vermont, populations of *R. capillacea* are protected under the 1981 Vermont Endangered Species Law (10 V.S.A. Chapter 123). Under this law, plants may not be taken unless permit is granted by Secretary of the Vermont Agency of Natural Resources. While take of listed plants, including damage, possession, and sale, is prohibited, the law states that these rules should not unduly interfere with agricultural or forestry practices. *Rhynchospora capillacea* is also protected under Criteria 8A of Act 250, Vermont's state land use law, which protects state-Endangered and

Threatened species and significant wildlife habitat. In Massachusetts, *R. capillacea* is protected under the 1992 Massachusetts Endangered Species Act (MGL c. 131A and its implementing regulations (321 CMR 10.00). Under this act, rare species are protected from "take" (picking, collecting, killing) or sale. Rare species habitat is usually protected as well. Permits for collection may be obtained under special circumstances. In Connecticut, *R. capillacea* is protected under the State Endangered Species Act (Connecticut General Statute § 26-303). As an Endangered species, *R. capillacea* is protected from "any action authorized, funded or performed by [state] agencies." It is also illegal to for any person, including landowners, to take an endangered species "for the purpose of selling offering for sale, transporting or for commercial gain or exporting such specimen."

Finally, since populations of *R. capillacea* are usually found in wetland or riparian habitats, the species may be indirectly protected by wetland protection regulations, such as the Wetlands Protection Act in Massachusetts, and parallel acts in other states.

Land Acquisition and Protection

Four of the nine New England natural communities harboring current occurrences of *R. capillacea* already have been purchased by conservation agencies or organizations. Protected occurrences include the populations in Woodland, Maine (ME .004), Westmore, Vermont (VT .001), Sharon/Pomfret, Vermont (VT .002), and Egremont, Massachusetts (MA .002). In addition, one historic site for this species has also been protected in Salisbury, Connecticut (CT .001).

One site is voluntarily protected by a private landowner. The owner of the Pittsfield, Massachusetts occurrence (MA .001) is a member of the TNC Natural Areas Registry Program. Under this program, landowners agree to notify TNC of changes in ownership or of threats to the community. The Pittsfield, Massachusetts site was enrolled in this progressive program in the 1980's.

Monitoring

Semi-regular monitoring of several sites has occurred for most of the current New England populations of *R. capillacea*. Most monitoring work has been conducted by Natural Heritage Program staff or their contractors. Such is the case for the populations in: Winslow, Maine (ME .001); Plainfield, New Hampshire (NH .001); Sharon/Pomfret (VT .002) and Westmore, Vermont (VT .001); Sharon (CT .003) and Salisbury (CT.001), Connecticut. Volunteers of the New England Plant Conservation Program (NEPCoP) have monitored the sites at Egremont (MA .002) and Pittsfield, Massachusetts (MA .001).

Species Biology Research and Community Research

No specific, controlled experiments focusing on the biology of *R. capillacea* were found in a thorough literature search. For observational data collected on this species in New England, refer to the Habitat and Ecology section in the Background of this report.

While no species-specific studies have been performed, research into the general communities types that support *R. capillacea* have been conducted in New England. Study topics have included the effects of dam impoundment on flooding regimes along river shore communities (Nislow et al., in press), effects of road salt and invasive species on a fen community (Richburg et al. 2001), and the influence of beaver flooding on species composition and diversity of a fen community (Rawinski and Lapin 1990).

Habitat Management

Management has taken place, and continues to take place, at the Egremont, Massachusetts population (MA .002), which is threatened by invasive species, shrub succession, and beaver flooding. Management to control levels of invasive *Phragmites australis* and *Lythrum salicaria* by herbicide and hand-pulling, respectively, has taken place from 1998 to present. To continue to halt encroachment of *Phalaris arundinacea, Pinus strobus*, and *Typha latifolia* into the harsh fen area, a controlled burn plan is nearly complete for the site. As mentioned previously, a wildfire that spread through the site in April of 1999 helped achieve these management goals. Beaver activity at the site was managed in 1999 by hunting beaver and removing a beaver lodge in the area. The beaver quickly recolonized the area, however. All types of management will be ongoing at this site (T. Simmons, personal communication).

Potential management also is currently under discussion for the Plainfield, New Hampshire community (NH .001), which is threatened by nearby invasive species (W. Brumback, personal communication). The management activity may not encompass the exact area occupied by *R. capillacea*, however.

Seed Banking, Germination Research and Propagation

Seeds have been collected from four of the New England populations through the NEPCoP Seed Bank program. The purpose of this program is to collect and store seeds of New England populations of regionally and globally rare species in order to increase knowledge of species habitat and cultural requirements, scientific research, or augmentation, reintroduction, or introduction to the wild (New England Wild Flower Society 1992). Some seed germination tests have been conducted by NEPCoP. However, the results of these tests have not yet been

formally evaluated or reported (Chris Mattrick, personal communication). For observational results of these germination trials, see the Species Biology section of this report.

Education

Rare plant "Fact Sheets" developed by Natural Heritage programs endeavor to educate the public about the status, distribution, ecology and conservation concerns of rare plant species. Fact sheets for *R. capillacea* are available through the Maine Natural Area Program, the Massachusetts Natural Heritage and Endangered Species Program, and Connecticut Natural Diversity Database.

Signage exists near the Plainfield, New Hampshire site to alert the public to the sensitivity of the plant community underfoot and in nearby areas. While the sign does not directly mention *R. capillacea*, it educates visitors about the fragile plant community the species helps comprise.

A recently published field guide to the Natural Communities of Vermont (Thompson and Sorenson 2000) educates the public about a variety plant habitats, including those inhabited by *R. capillacea*. Its discussion of boreal calcareous cliff communities, calcareous riverside seeps, and rich fens not only describes the communities and their component species, but also informs the reader of their conservation status and management concerns.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR TAXON IN NEW ENGLAND

Rhynchospora capillacea has only ever been documented at 17 locations in the New England region. Because it is limited by specificity to rare habitat types, it is unrealistic to expect that this species will ever be common in our region. However, we may use the total number of current and historically known sites to gauge what we may hope to achieve in conservation of this species. Therefore, one conservation objective for this species is to increase the number of current occurrences from 9 to 17 separate, known populations in the next 20 years. Increase of known populations will rely most heavily on upon searches of historic sites and appropriate habitats, however introduction may be considered at fens that have undergone ecological restoration. Most population sizes should be over 300 genets in most years. At least four populations should average over 2,000 genets each year. Population recovery numbers are based on current best population sizes in New England. Most of the 17 occurrences should be permanently protected by conservation organizations and land trusts.

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IV. APPENDICES

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1. Rarity Status of Community Types Supporting *Rhynchospora capillacea* in New England.

2. Research Into SR and S? Ranks

3. An Explanation of Conservation Ranks Used by the New England Plant Conservation Program

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

1. Rarity status of community types supporting *Rhynchospora capillacea* in New England.
Based on Thompson and Sorenson (2000), Gawler (2001b), and Swain and Kearsley (2000).

General Community Type	Maine	New Hampshire	Vermont	Massachusetts	Connecticut
Calcareous Sloping Fen	**S2** Shrubby cinquefoil-sedge circumneutral fen	**S1** Circumneutral calcareous flark	**S2** Rich Fen	**S2** Calcareous Sloping Fen	Not ranked *Carex sterilis*/*Potentilla fruticosa* community
Calcareous Riverside Seep	**S2** Circumneutral Riverside Seep	**S1** Calcareous Riverside Seep	**S1** Calcareous Riverside Seep	**S2** Riverside Seep (calcareous and acidic)	Not described
Boreal Calcareous Cliff	**S2** Boreal Circumneutral Open Outcrop	**S3S4** Cliff Seep	**S2** Boreal Calcareous Cliff	Not present	Not present

2. Research into SR and S? Ranks

In order to clarify the actual status of *R. capillacea* in states where the S-rank was ambiguously reported as S? or SR (occurrence unverified) by Natureserve, appropriate Heritage Programs were contacted. The "occurrence unverified" category can be misleading, since species that are ranked SR are often common in those states, and not unverified at all.

Indiana

The Natureserve website reports the rank for *R. capillacea* in Indiana as "SR" (Natureserve 2001). According to the botanist with the Indiana Natural Heritage Data Center, the species is fairly common, and is not tracked or on a watch list. The species is present at approximately 50 to 100 sites in that state (Michael Homoya, Indiana Natural Heritage Data Center, personal communication).

New York

The Natureserve website reports the rank for New York as "S?" (Natureserve, 2001). However, the most recent rank for that species in New York is actually "S4" (Steven Young, New York Natural Heritage Program, Personal Communication, 2001).

Newfoundland

The Natureserve website reports the Newfoundland S-rank of *R. capillacea* to be "SR" (Natureserve 2001) However, the species has recently been re-ranked to S1S2 (S. Blaney, personal communication).

Michigan

The Natureserve website reports the rank for *R. capillacea* in Michigan as "S?" (Natureserve 2001). This species is present but not tracked in Michigan, and the Botany Associate Program Leader thinks that this taxon is "probably an S4" (E. Choberka, personal communication).

Ohio

The Natureserve website reports the rank for *R. capillacea* in Ohio as "SR" (Natureserve 2001). The species is frequent in the proper habitats in Ohio. Chief botanist for the Ohio

Department of Natural Resources states "I would rank it an SR4. The species is secure in Ohio, in my opinion." (A. Cusick, personal communication).

Texas

This species was discovered in Texas in 1990 (Jones and Jones 1990), which is by far the southernmost occurrence of the species. It is not listed as a rare species in that state.

Wisconsin

The ABI Natureserve website reports the rank for Wisconsin as "SR" (Natureserve, 2001). Wisconsin has not evaluated the species' abundance comprehensively, however a botanist with the Wisconsin Department of Natural Resources estimates that the species is "on the rare side of S4." (K. Westad, personal communication).

3. An Explanation of Conservation Ranks Used by the New England Plant Conservation Program (after Brumback and Mehrhoff et al. 1996)

Division 1 = Globally rare taxa occurring in New England.

Division 2 = Regionally Rare taxa (fewer than 20 occurrences seen since 1970 within New England).

Division 3 = Locally Rare taxa (these taxa may be common part of New England, but have one or more occurrences of biological, ecological, or possible genetic significance).

Division 4 = Historic taxa (taxa that once existed in New England, but that have not been seen since 1970).

Division Indeterminate = Indeterminate Taxa (taxa that are under review for inclusion in one of the above divisions, but issues of taxonomy, nomenclature, or status in the wild are not completely understood.

4. An Explanation of Conservation Ranks Used by The Nature Conservancy and Natureserve

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis — that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction — i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks (the lower the number, the "higher" the rank, and therefore the conservation priority). On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups; thus, G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have made for more than 20 years. An X rank is utilized for sites that 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.