New England Plant Conservation Program

Scleria pauciflora Muhlenberg ex Willdenow var. *caroliniana* Alph. Wood
and
Scleria pauciflora Muhlenberg ex Willdenow var. *pauciflora*

Few-flowered nut-rush

Conservation and Research Plan for New England

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SUMMARY

Scleria pauciflora Muhlenberg ex Willdenow (few-flowered nut-rush) is a widespread perennial in the Cyperaceae. There are two varieties: *S. pauciflora* Muhlenberg ex Willdenow var. *caroliniana* Alph.Wood and *S. pauciflora* Muhlenberg ex Willdenow var. *pauciflora.* Both varieties are rare in New England, where they are at the northern edge of their ranges. Both of these varieties are the subject of this plan.

Scleria pauciflora var. *caroliniana* is known from 26 states. It is rare in seven states and known historically from one state. In New England, *S. pauciflora* var. *caroliniana* has been collected at: 12 sites in Massachusetts (all supporting extant populations), where it is listed as S1; at four sites in Rhode Island (three with extant populations), where it is listed as S1; and at four sites in Connecticut (one with an extant population), where it is listed as S1. *Scleria pauciflora* var. *pauciflora* is known from 20 states and is listed as rare in two states and known only from one historical record in New Hampshire, where it is listed as SH. There is one extant population in Massachusetts, where it is listed as S1. *Scleria pauciflora* is listed in *Flora Conservanda* as a Division 2 species, globally secure, but regionally rare. All but one of the extant populations in New England have been discovered in the past 22 years; most have not been surveyed in detail. The Massachusetts populations are primarily on property owned by conservation organizations. One of the Rhode Island sites is owned by the U. S. Fish and Wildlife Service. Population sizes range from a few plants to over 5000 plants at one population scattered over many hectares.

Scleria pauciflora sensu lato occurs in a range of habitat types, including pine flatwoods in the Southeast, pine barrens, and damp grasslands in the Mid-Atlantic region, and cedar glades in Alabama, Arkansas, Tennessee, and Virginia. It is also known from serpentine barrens. In New England, *S. pauciflora* occurs in maritime grasslands and damp areas in pine barrens. It frequently occurs with other regionally rare species. *Scleria pauciflora* is taxonomically distinct and easily distinguishable from other *Scleria* species in New England. It is wind-pollinated, seeds readily into areas with soil disturbances, and can grow from root fragments. It responds favorably to fire management and some types of mowing. Threats to the species include habitat loss, excessive physical disturbance, and fire suppression.

The conservation objectives for *Scleria pauciflora* var. *caroliniana* in New England are to protect 12 occurrences in Massachusetts and two occurrences in both Rhode Island and Connecticut. It will be necessary to locate additional populations to achieve this objective. The conservation objectives for *S. pauciflora* var. *pauciflora* are to search for new populations and, if they can be located, to protect two populations in both New Hampshire and Massachusetts. Each population should support at least 100 individuals in a natural community setting. All populations should be monitored for population level, habitat extent, management effects, and associated species to develop a better model of habitat use. Research should be conducted on life cycle events including flowering, germination, plant longevity, and the response of plants to a range of management techniques. Seeds should be collected from a range of populations and maintained in an *ex situ* conservation seed bank. No reintroductions are recommended at this time.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Because they contain sensitive information, full plans 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

INTRODUCTION

Scleria pauciflora Muhlenberg ex Willdenow (few-flowered nut-rush) is a widespread, herbaceous perennial in the Cyperaceae, one of three species of *Scleria* known from New England. Until the 1980's, there were only four historical records for *S. pauciflora* var. *caroliniana* in New England, three in Connecticut and one in Massachusetts. There is one record for *S. pauciflora* var. *pauciflora* in New Hampshire. During the past 20 years, two of these populations have been relocated and 13 additional sites have been located for *S. pauciflora* var. *caroliniana* and one site for *S. pauciflora* var. *pauciflora*. Populations vary from only a few plants to over 5000 plants. This conservation plan is written to review the current information about these occurrences in New England and the basic information available on the taxonomy, biology, and ecology of *S. pauciflora*. There is a review of threats and an assessment of the need for conservation action. Recommendations are made concerning conservation goals for the species and activities required to secure *S. pauciflora* in New England.

Scleria pauciflora var. *caroliniana* is known from 26 states (NatureServe 2004). It is rare in seven states and known historically from one state. In New England, *S. pauciflora* var. *caroliniana* has been collected at: 12 sites in Massachusetts (all supporting extant populations), where it is listed as S1; at four sites in Rhode Island (three with extant populations), where it is listed as S1; and at four sites in Connecticut (one with an extant population), where it is listed as an S1. *Scleria pauciflora* var. *pauciflora* is known from 20 states and is listed as rare in two states and known only from historical records in New Hampshire. It was collected once in New Hampshire, where it is listed as SH. There is one extant population in Massachusetts, where it is listed at S1. *Scleria pauciflora* is listed in *Flora Conservanda* as a Division 2 species, globally secure, but regionally rare (Brumback and Mehrhoff et al. 1996).

Scleria pauciflora var. *pauciflora* and *S. pauciflora* var. *caroliniana* are known to interbreed and there are numerous intermediate forms (Fairey 1967, Reznicek et al. 2002). Because the two varieties appear to occupy similar habitat and should require similar conservation actions, they are discussed together throughout this plan. Because *S. pauciflora* var. *pauciflora* is the rarer of the two, all references directly to this variety are noted to variety. All other references to *S. pauciflora* are either general to the species or refer to *S. pauciflora* var. *caroliniana*. Nomenclature follows Mitchell and Tucker (1997). *Scleria pauciflora* is listed as G5 and each of the varieties are listed as T5 (NatureServe 2004).

In the Southeast, both varieties of *Scleria pauciflora* occur in sandy, open areas and long-leaf pine savannahs (Radford et al. 1968). In the Mid-Atlantic States, it occurs in dry ground in pine barrens (Stone 1973), barrens and open woodlands (Rhodes and Klein 1993), and serpentine grasslands (Brooks 1987). It can also be abundant in limestone glades (Baskin et al.1995). In the Midwest, it is found in open prairies on

sandy soil (Steyermark 1975). In the Northeast, *Scleria pauciflora* is found in maritime grasslands and dry to wet sandy openings on glacial till or outwash.

Like all sedges, *Scleria pauciflora* is wind-pollinated and probably self-compatible (Fairey 1967). It produces very few seeds. It flowers most prolifically after disturbances (personal observation). *Scleria pauciflora* responds favorably to fires (Oosting and Humphreys 1940, Clinton and Vose 2000), and appears to flourish with at least some types of mowing (Hedge et al. 1999). It seeds into open, sandy areas and is often found in locations that have recently burned. Threats to current populations include succession, inappropriate management, and genetic isolation leading to possible inbreeding depression.

The conservation objectives for *Scleria pauciflora* var. *caroliniana* in New England are to protect 12 occurrences in Massachusetts and two occurrences in both Rhode Island and Connecticut. It will be necessary to locate new populations to achieve this objective. The conservation objectives for *S. pauciflora* var. *pauciflora* are to search for new populations and, if they can be located, to protect two populations in both New Hampshire and Massachusetts. Each population should be at least 100 plants (genets) in a natural community setting. All occurrences should be monitored for the number of plants, habitat extent, management effects, and associated species to develop a better understanding of habitat use. Research should be conducted to clarify important life cycle events, including timing of germination, longevity of plants, flowering frequency, and responses of the species to different types of management. Seeds should be collected from a range of populations and maintained in an *ex situ* conservation seed bank. No introductions or reintroductions are recommended at this time.

DESCRIPTION

The genus name, *Scleria*, is derived from the Greek word *scleros*, meaning hard. An alternative name for the genus is stone-rush. The term "pauciflora" refers to the few flowers on each culm. Common names for *Scleria pauciflora* include: few-flowered nut-rush, papillose nut-rush, papillose nut-sedge, and Carolina whipgrass.

The following description is mainly adapted from Core (1936), Fernald (1950), Fairey (1967), and Reznicek et al. (2002). *Scleria pauciflora* is a slender, cespitose perennial with a short, branched, knotty rhizome. The nodes on the rhizome are close together and there are numerous fibrous roots. The number of leaves is variable and probably related to plant health (personal observation). Leaves can be dense and numerous to sparse, with blades 20-50 cm long and 2-5 mm wide. Plants form small clumps that are 10-50 cm in diameter. Most plants in New England are 15-25 cm in diameter and 10-25 cm tall with numerous leaves (personal observation). The inflorescence is solitary and sessile, subtended by a leafy bract 2-5 cm long. A second, lower, short-peduncled inflorescence may often be present. Scales are ovate. The achene is white and subglobose, 1-2 mm tall (sometimes up to 5 mm), with an apiculate summit. The surface of the achene is covered with horizontally arranged, wart-like structures.

The base of the achene is subtended by a disk called a hypogynium. The hypogynium is ornamented with six rounded tubercles, a diagnostic characteristic for the species.

The hairiness of *Scleria pauciflora* is variable and characterizes the separation of the two varieties (Reznicek et al. 2002). *Scleria pauciflora* var. *caroliniana* has spreading, villose-ciliate hairs that are 0.5-1 mm long. Plants can shine with dew in the morning sun. *Scleria pauciflora* var. *pauciflora* is glabrous or sparsely hairy with hairs less than 0.4 mm long.

When it is in flower or fruit, *Scleria pauciflora* is not difficult to identify (personal observation). It generally has bluish-green leaves and is clearly cespitose. It looks somewhat similar to the more bluish individuals of *Schizachyrium scoparium* and can superficially look like a *Sisyrinchium.* All three of these species can occur together. When individuals of *Scleria pauciflora* are healthy and large, such as during the first year or two after a fire, the culms can be very dense and appear to radiate out from a central point at about a 60-75 degree angle. Plants can be found alone or in a colony with scattered individuals. In the early spring, as leaves emerge, it is possible to see fertile culms still attached on the ground at the base of the plant.

There are two other species of *Scleria* in New England: *S. triglomerata* and *S. reticularis*. Both are considered to be rare in all New England states where they occur. *Scleria triglomerata* is a much larger plant with sparse, bright yellowish-green leaves arranged at a 20-35 degree angle from the ground. The achenes are large and shiny white with no surface detail. *Scleria triglomerata* co-occurs with *S. pauciflora* at three sites in New England and one site in New York. The two species are so different in appearance that misidentification is not an issue. *Scleria reticularis* is an annual which occurs on coastal plain pond bottoms and along pond shores. It has wavy reticulations on its achene. *Scleria reticularis* usually occurs in large populations and is not cespitose. It is also not likely to be confused with *S. pauciflora*. A comparison of characters for these three species of *Scleria* appears in Table 1. *Scleria minor* is known from Eastern Long Island in New York, but has never seen documented in New England. It is very similar to *S. triglomerata* except with narrower leaves and smaller achenes.

Table 1. Field characters distinguishing *Scleria* species in New England			
Character	**Species**		
	Scleria pauciflora	***Scleria triglomerata***	***Scleria reticularis***
Leaf width	1-2.5 mm	3-9 mm	1-3.5 mm
Culm length	20-50 cm	40-100 cm	15-50 cm
Angle of culms	60-75 degrees	20-35 degrees	60-90 degrees
Achene size	1-2.5 mm	2-3 mm	1.5-2 mm
Achene surface features	Papillate-verrucose	Smooth and shining	Reticulate network of lines and fine hairs
Hypogynium form	With six distinct tubercles	Continuous, without distinct lobes	With three oblong lobes
Annual or perennial	Perennial	Perennial	Annual
Habitat	Dry to damp grasslands	Damp grasslands	Upper shores of coastal plain ponds

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Scleria pauciflora is divided into two varieties (Reznicek et al. 2002). Synonyms for *S. pauciflora* var. *pauciflora* include *S. oakesiana* Robbins, *S. pauciflora* var. *effusa* Clarke, and *S. ciliata* var. *pauciflora* Kukenth. Synonyms for *S. pauciflora* var. *caroliniana* include *S. caroliniana* Willdenow, *S. pauciflora* var. *kansana* Fern., and *S. ciliata* Michx. var. *glabra* (Chapman) Fairey. *Scleria pauciflora* has at times been combined with *S. ciliata,* with which it shares many features (Fairey 1967). *Scleria curtissii* Britt. has been grouped with *S. pauciflora* as a variety under *S. pauciflora* var. *curtissii* (Britt.) Fairey. The *Flora of North America* treatment of *Scleria* includes *S. curtissii* as a full species (Reznicek et al. 2002). Gleason and Cronquist (1963) considered *S. pauciflora* a questionable species and thought it probably a variant of *S. ciliata*. *Scleria ciliata* is currently also considered to be a separate and distinct species (Reznicek et al. 2002). Whatever the disposition of these *Scleria* populations in New England, they are equally rare in the Northeast and appear to be globally secure with a center of distribution in the Southeast.

The two varieties of *Scleria pauciflora* are known to interbreed (Fairey 1967). There are numerous intermediate entities of *Scleria pauciflora,* particularly in the Southeast. There are no known intermediates of the two *Scleria pauciflora* varieties in the Northeast. With the exception of two collections in New England, one extant in Massachusetts and one historical in New Hampshire, all documented occurrences of *S. pauciflora* in New England are *S. pauciflora* var. *caroliniana.*

SPECIES BIOLOGY

Scleria pauciflora is a perennial with a short rhizome and fibrous roots. It is capable of withstanding fire (Oosting and Humphreys 1940, Clinton and Vose 2000) and at least moderate levels of other types of disturbance. Populations of *Scleria pauciflora* probably persist for many years, as suggested by the longevity of one population in Massachusetts, MA .004 (Uxbridge). A specimen was collected at this site in 1846. This site burned in 1984 and plants were seen in 1989, after not being known from the site for 143 years. It is probable that either remnant plants were stimulated by the fire and subsequently became evident to surveyors or that seeds in the soil seed bank were released from dormancy and germinated. This site has not continuously been a grassland through the intervening years between 1846 and 1989.

Scleria pauciflora, as its name suggests, produces few flowers and few seeds. Each culm typically produces only a few fruits (personal observation). During a typical year, plants may support 3-10 fertile culms and numerous sterile culms. Only after a disturbance, such as fire, do plants produce a large number of flowering culms. It is likely that *S. pauciflora* relies primarily on the long life of individual plants to sustain populations.

The seed coat of *Scleria pauciflora* is hard, as the genus name indicates, and probably absorbs water poorly. Seeds may require long periods of saturation or physical abrasion to germinate, resulting in long periods of dormancy. Germination studies at Garden in the Woods in Framingham, Massachusetts indicate that *S. pauciflora* requires a cold treatment and that the variability in the hardness of the seed coat may affect germination time (Bill Brumback, New England Wild Flower Society, personal communication). It is unclear in this study if there were additional seeds that remained viable, but did not germinate after two years. In a study of old-field succession in North Carolina, *S. pauciflora* appeared in one experimental clearing of a 112-year-old pine forest (Oosting and Humphreys 1940). This study suggests that *S. pauciflora* had been present in soil seed bank from a period before the forest canopy closed. It seems likely that seeds of *S. pauciflora* do not generally germinate quickly and that variable seed coat thickness is an adaptive strategy that has developed over time to insure a seed bank that can respond to variable site conditions. Fire may stimulate germination.

Individuals of *Scleria pauciflora* are hardy. In one investigation led by Carol Knapp on Martha's Vineyard (MA .001 [Edgartown]), transplanted individuals died back to the rhizome almost immediately. Within one week, there were new leaves present. Two Mid-western studies include *S. pauciflora* as a species that does well after fire (Hedge et al. 1999, Clinton and Vose 2000). Several populations in New England and New York were first found after prescribed burns were conducted at the site (MA .010 [Nantucket], MA .017 [Falmouth], and the Hempstead Plains on Long Island). *Scleria pauciflora* also survives mowing (Hedge et al. 1999), although it is unclear if mowing is a reliable management technique. One of the Long Island sites is found along a transmission line right-of-way that has been managed for many years with brush hogging and rotary mowers. The large contiguous populations at MA .001 (Edgartown) and .003

(West Tisbury) are along a fire break that has been managed aggressively with mowers, brush hogs, and bulldozers. *Scleria pauciflora* can also survive light grazing by cattle (Buechner 1944).

Scleria pauciflora has unisexual flowers, but plants are monoecious. Male and female flowers are restricted to different spikelets on a plant (Reznicek et al. 2002). Flowers are wind-pollinated and probably self-compatible. Outcrossing is probably favored because male flowers do not develop synchronously with female flowers on a culm. Male flowers are also generally lower on the plant (Fairey 1967).

Most mature culms produce only one to four fruits (personal observation). Fruits are held on the plant until mid to late fall. Plants are identifiable from late June through October with fruits most evident from late July through September.

HABITAT/ECOLOGY

In the Southeast, *Scleria pauciflora* occurs in sandy, open areas and long-leaf pine savannahs (Radford et al. 1968). In Alabama, *Scleria pauciflora* occurs in limestone glades (Baskin et al. 1995). In the Mid-Atlantic States, it occurs in dry ground in pine barrens (Stone 1973) and open woodlands (Rhodes and Klein 1993). *Scleria pauciflora* is listed as a frequent plant in serpentine grasslands (Brooks 1987). Many of these sites have a percent cover of vegetation between 60 and 90%. In Maryland, it occurs in seasonally wet, sandy soils bordering bogs (Brown and Brown 1984). In the Midwest, it is found in open prairies in acid soils of sandstone and chert and in upland prairies (Steyermark 1975). It has been noted that *S. pauciflora* var. *caroliniana* occurrences may be found in more disturbed sites than *Scleria pauciflora* var. *pauciflora* (Reznicek et al. 2002). At several New England occurrences of *S. pauciflora* var. *caroliniana* (MA .010 [Nantucket], MA .011 [Nantucket], and MA .018 [Nantucket]), high velocity winds and salt spray may maintain habitat.

In New York, *Scleria pauciflora* is found in maritime grasslands and sandy areas in pine barrens. *Scleria pauciflora* was collected numerous times at many locations in the Hempstead Plains grassland. Cain et al. (1937) described *S. pauciflora* as a characteristic species of the "*Andropogonetum Hempsteadi*." In one of their descriptive plots with 150 quadrat samples, *S. pauciflora* had a frequency of 14%, indicating widespread distribution of the species. Conard (1935) described that "over many square miles (of the Hempstead Plains) *S. pauciflora* shows its tiny white bony achenes…" Now, despite being reduced to only 43 disturbed acres, the Hempstead Plains still supports three patches of *S. pauciflora*. One of these patches is associated with *Agalinis acuta*, which is federally listed as Endangered. The substrate for *Scleria pauciflora* is often evidently damp in New York, but there are occurrences which appear to be dry grasslands as well. There are three other extant occurrences in New York outside the Hempstead Plains. The dominant species occurring with *S. pauciflora* var. *caroliniana* include: *Schizachyrium scoparium, Lespedeza* spp., *Panicum virgatum, Sisyrinchium arenicola, Aletris farinosa, Trichostema dichotomum, Lechea* spp., *Viola fimbriatula,*

Polygala nuttallii, Eupatorium hyssopifolium, Solidago nemoralis, and *Euthamia tenuifolia* (personal observation). The vegetation percent cover in New York is usually only 50-70% or less, with bare patches. One New York population appeared in a fire break through pine barrens following the massive Summer 1995 pine barrens fire (personal observation). The hot fire had burned most of the organic layer. *Scleria* appeared as seedlings in small wet areas in a bulldozed fire break. Plants were small and in groups in tire tracks and other depressions. These appeared to be first-year plants that had germinated after the fire and were in flower during the summer following the fire. They were small by comparison to others seen on Long Island, but they all had flowers and fruits. During periods with frequent fires, *Scleria pauciflora* may have increased in abundance. Disturbances associated with human activities may have provided some appropriate habitat for *S. pauciflora.*

In New England, *Scleria pauciflora* var. *caroliniana* occurs in maritime grasslands, pine barrens, and borders of disturbed areas in glacial outwash deposits. *Scleria pauciflora* var. *caroliniana* occurs with *Schizachyrium scoparium, Carex pensylvanica, Linum intercursum, Sisyrinchium arenicola, Aletris farinosa, Polygala nuttallii, Baptisia tinctoria, Hudsonia ericoides, Lechea minor, Viola pedata, Hieracium venosum, Potentilla canadensis, Helianthemum* spp., *Bartonia virginica, Solidago odora, S. puberula, Aster solidagineus, A. patens,* and *A. spectabilis.* The one site for *S. pauciflora* var. *pauciflora* in New England occurs on a sandy bluff, probably an esker, bordering a small river. Plants are growing with *Carex pensylvanica, Aster solidagineus,* and *Quercus prinoides.*

Scleria pauciflora often occurs with other rare species and has often been located during surveys for other species or during conservation management activity. Among these rare species in New England and New York are: *Scleria triglomerata* (four sites), *Aletris farinosa* (four sites), *Platanthera ciliaris* (two sites), *Malaxis bayardii* (one site), *Linum intercursum* (four sites), *Polygala nuttallii* (four sites), *Corema conradii* (two sites), *Polygala cruciata* (one site), *Helianthemum dumosum* (one site), *Agalinis acuta* (four sites, one of which is introduced), *Aster solidagineus* (three sites), and *Prenanthes serpentaria* (one site). It will be useful to survey the locations of occurrences of many of these species to discover additional populations of *S. pauciflora.*

THREATS TO TAXON

Direct Conversion of Habitat

The main threat to *Scleria pauciflora* is the direct loss of habitat to development into residential or commercial uses. Many of the sites that support *S. pauciflora* are in parts of New England where open land is limited and development pressure is high. Martha's Vineyard, Nantucket, and Cape Cod are all rapidly losing both open grassy areas as well as border areas, such as roadsides and airport margins, dominated by native species. Many roadsides, airports, cemeteries, and recreational areas, that currently support *S. pauciflora* or may support appropriate habitat for *S. pauciflora,* are being more

actively managed than in the past and are losing their character as habitat for native species, including *S. pauciflora*.

Succession, Fire Suppression, and the Loss of Natural Disturbance Regimes

At many of the sites owned by conservation organizations with *Scleria pauciflora,* habitat is being lost to succession. Martha's Vineyard, Nantucket, and Cape Cod sites will all need active management, if they are to support *S. pauciflora* in the long term. Some management at the Massachusetts sites has maintained or created habitat for *S. pauciflora* as part of either general site activity, such as maintenance of fire breaks (MA .001 [Edgartown] and MA .003 [West Tisbury]), or building demolition (MA .018 [Nantucket]), or management for other species (MA .010 [Nantucket] and MA .017 [Falmouth]). Fire management at several sites (MA .010 [Nantucket] and MA .017 [Falmouth]) has enhanced habitat for *S. pauciflora.* Because these sites are not specifically managed for *S. pauciflora*, there may arise a time when succession is not limited by management or when *S. pauciflora* is inadvertently lost to random acts at the site.

Physical Disturbance

Most of the current sites for *Scleria pauciflora* have been subject to some identifiable disturbance caused by humans in the past 20 years. Prescribed fire, wildfires, brush hogging, bulldozers, disking, mowing, and sand mining have all created or maintained the habitat that *S. pauciflora* now occupies in New England. Many of these disturbances are likely to continue, but do not necessarily favor the maintenance of *Scleria*, particularly if all plants and seeds are eliminated during a period of disturbance. It will be necessary to identify sites and focus management specifically on *S. pauciflora* to secure the species in New England long term. With more information on effective management techniques, it should be possible to maintain and enhance populations at many of the currently occupied sites.

Fragmentation

Many of the currently occupied *Scleria pauciflora* sites in New England are small, isolated patches of natural communities that were once more widespread in New England. Martha's Vineyard, Nantucket, and Cape Cod all supported extensive areas that were probably appropriate habitat for *S. pauciflora*. As current sites have become even more isolated from one another over time, populations will have less opportunity to expand or exchange genes. Inbreeding depression could be the result of this isolation leading to populations less adapted to changing conditions.

DISTRIBUTION AND STATUS

General Status

Scleria pauciflora var. *caroliniana* is known from Massachusetts west to Michigan and Kansas south to Florida and Texas. Within this range, it is not known from Pennsylvania, and West Virginia. It is listed as S1 or S2 in seven states, all at the northern edge of its range. It is ranked SH in Maryland and listed as SR or S? in 19 states.

The range of *Scleria pauciflora* var. *pauciflora* is similar to *S. pauciflora* var. *caroliniana* except that the range of *S. pauciflora* var. *pauciflora* extends into New Hampshire and Ontario Province in Canada. It is not known from New York, Indiana, West Virginia, Alabama, Mississippi, Louisiana, Delaware, or the District of Columbia. Neither variety is known from Vermont or Maine. *Scleria pauciflora* var. *pauciflora* is listed as SH in New Hampshire and is listed in Massachusetts as S1.

Figures 1 and 2 and Tables 2 and 3 show the distribution and status of *S. pauciflora* var. *caroliniana* and *S. pauciflora* var. *pauciflora*, respectively. Data on the North American distribution and status of the taxon are available from NatureServe (2004). Information on the distribution of the two varieties of *S. pauciflora* also appears in Reznicek et al. (2002) and differs significantly from the information reported in NatureServe. Some of the data in Reznicek et al. (2002) need additional assessment (Tony Reznicek, University of Michigan Herbarium, personal communication). Data concerning county distribution within states were obtained from the PLANTS National Database (USDA, NRCS 2004).

Status of All New England Occurrences — Current and Historical

Scleria pauciflora is currently extant at 16 sites in New England. *Scleria pauciflora* var. *caroliniana* is currently known to occur at eleven sites in Massachusetts, three sites in Rhode Island, and one site in Connecticut. The only site for *S. pauciflora* var. *pauciflora* currently considered to be extant in New England is in Massachusetts.

Survey work specifically for *Scleria pauciflora* has not been conducted in any of the New England states. All known occurrences were located opportunistically, during surveys for other species, or during general vegetation monitoring. Surveys focused on *S. pauciflora*, designed to locate new populations, would likely result in the discovery of new sites. There are no records or known habitat for *S. pauciflora* in Vermont (Bob Popp, Vermont Nongame and Natural Heritage Program, personal communication) or in Maine (Don Cameron, Maine Natural Areas Program, personal communication).

Table 2. Occurrence and status of *Scleria pauciflora* var. *caroliniana* 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)
Connecticut (S1, E): one extant population, 3 historic populations	District of Columbia (S?)	Alabama (SR)	Maryland (SH)
Illinois (S1): 1 county	North Carolina (S?)	Arkansas (SR)	
Kentucky (S1): 1 county		Delaware (SR)	
Massachusetts (S1, E): 11 populations		Florida (SR)	
New York (S1, E)		Georgia (SR)	
New Jersey (S2)		Indiana (SR)	
Rhode Island (S1,T): three extant population- one historic population		Kansas (SR)	
		Louisiana (SR)	
		Mississippi (SR)	
		Missouri (SR): 17 counties	
		Ohio (SR)	
		Oklahoma (SR)	
		Pennsylvania (SR)	
		South Carolina (SR)	
		Tennessee (SR)	
		Texas (SR)	
		Virginia (SR)	

Table 3. Occurrence and status of *Scleria pauciflora* var. *pauciflora* 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)
Massachusetts (S1): one extant population	Kentucky (S?): 12 counties	Arkansas (SR)	New Hampshire (SH)
New Jersey (S1)	North Carolina (S?)	Florida (SR)	
		Georgia (SR)	
		Illinois (SR): 6 counties	
		Kansas (SR)	
		Maryland (SR)	
		Missouri (SR): 21 counties	
		Ohio (SR)	
		Oklahoma (SR)	
		Pennsylvania (SR)	
		South Carolina (SR)	
		Tennessee (SR)	
		Texas (SR)	
		Virginia (SR)	
		Ontario (SR)	

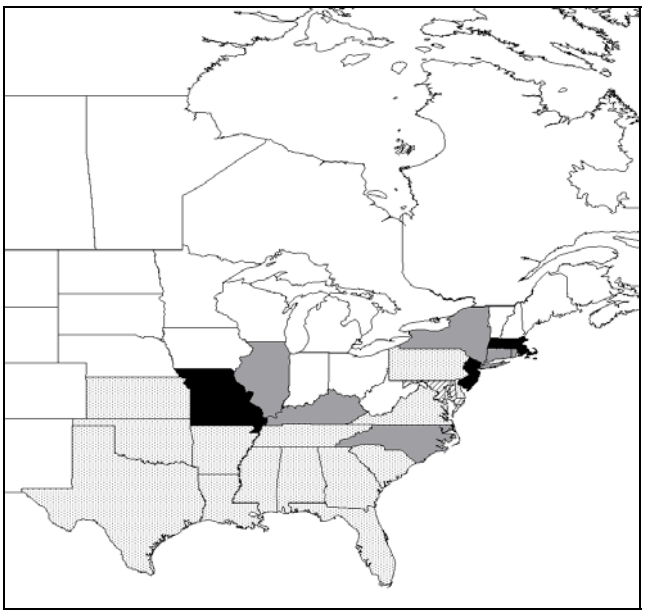

Figure 1. Occurrences of *Scleria pauciflora* var. *caroliniana* in North America. States shaded in gray have one to five (or an unspecified number of) extant occurrences. States shaded in black have more than five extant occurrences. The state with diagonal hatching (Maryland) is designated "historic" or "presumed extirpated," where the taxon no longer occurs. The states with stippling are ranked "SR" (status "reported" but not tracked), with no additional information on species abundance. See Appendix for explanation of state ranks.

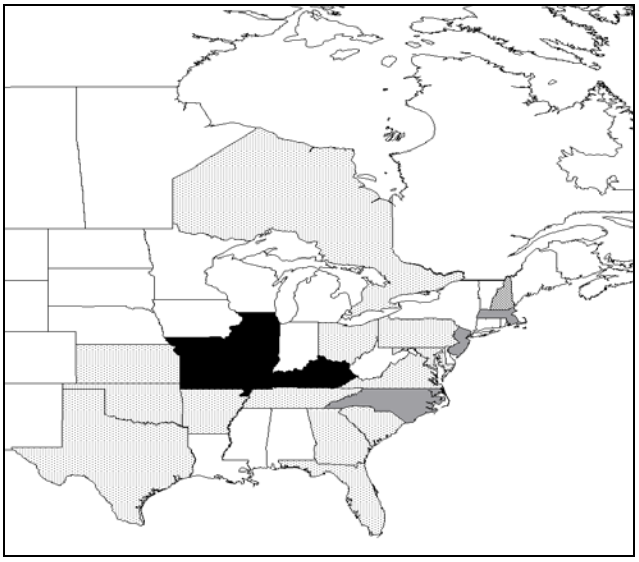

Figure 2. Occurrences of *Scleria pauciflora* var. *pauciflora* in North America. Shading is coded as in Figure 1.

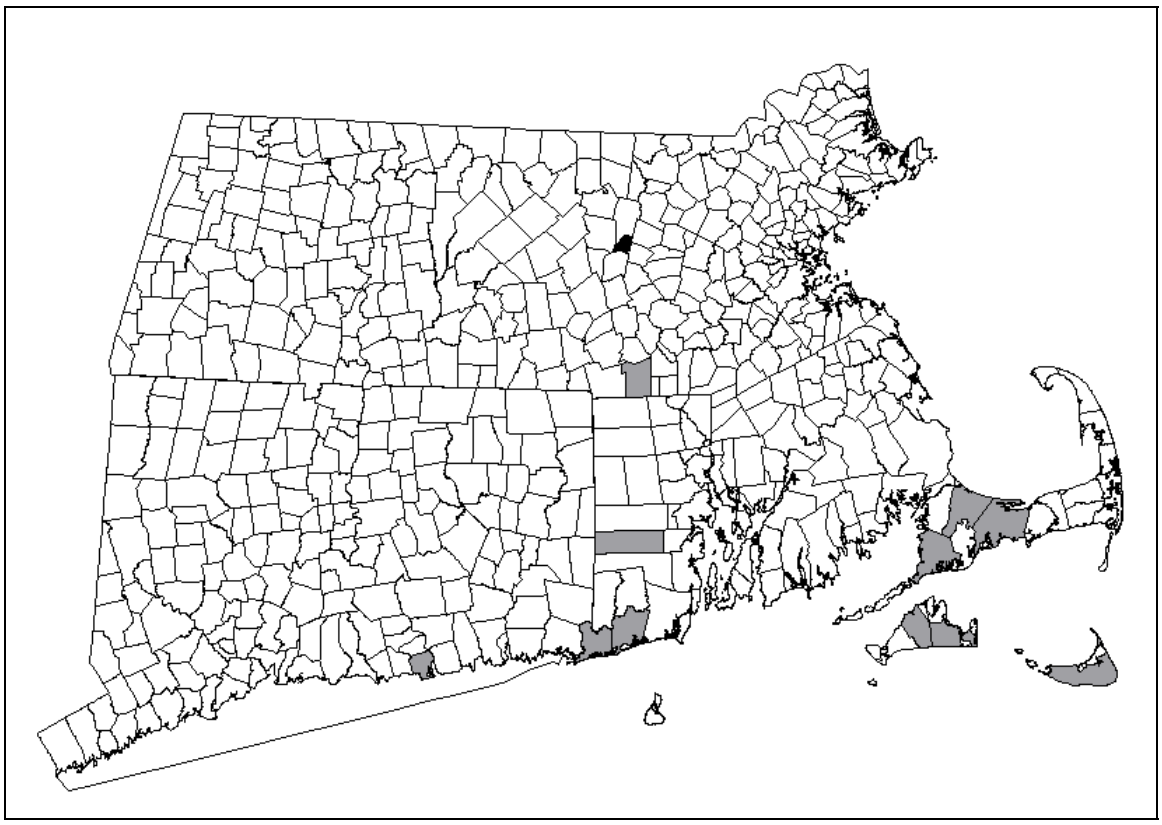

Figure 3. Extant occurrences of *Scleria pauciflora* in New England. Town boundaries for southern New England states are shown. Towns shaded in gray have one to five confirmed, extant occurrences of *S. pauciflora* var. *caroliniana*. The town shaded in black (Clinton, Massachusetts) has one confirmed occurrence of *S. pauciflora* var. *pauciflora*.

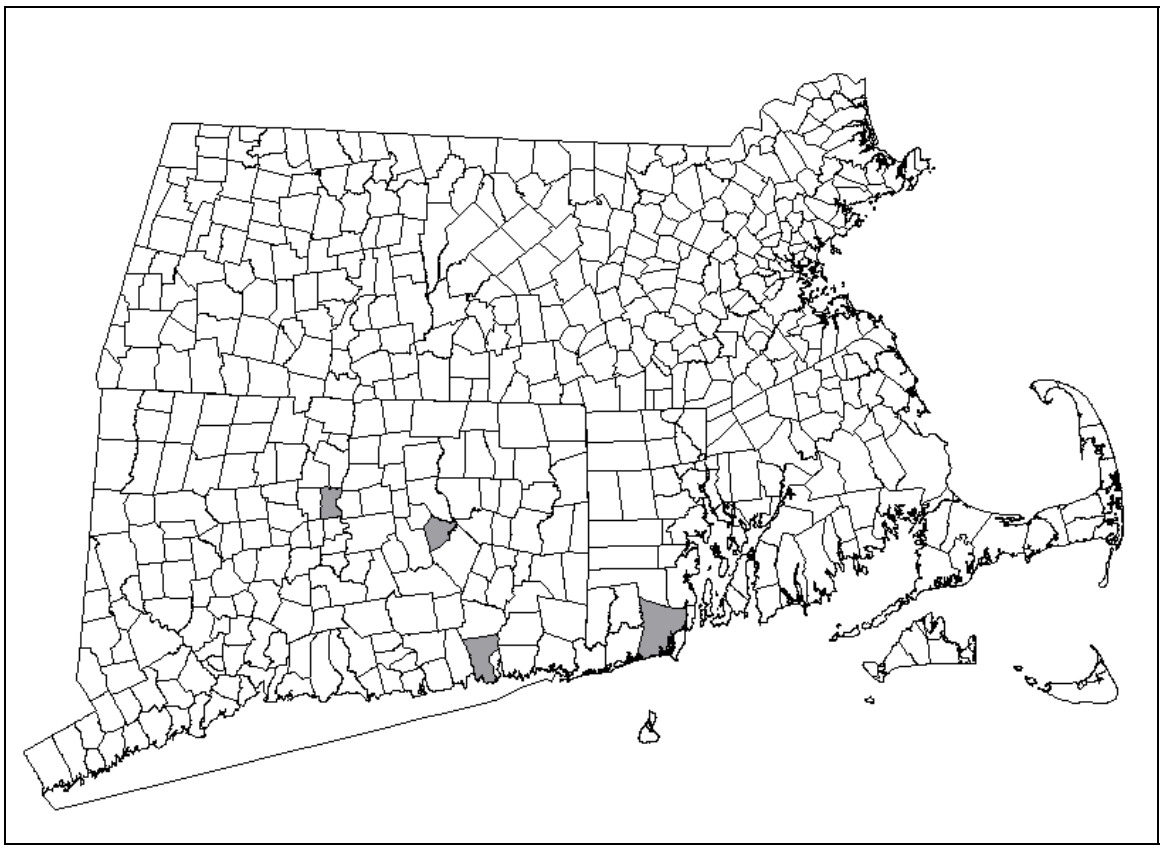

Figure 4. Historical occurrences of *Scleria pauciflora* in New England. Towns shaded in gray have one to five historical records of *S. pauciflora* var. *caroliniana*. Although a single New England record of var. *pauciflora* is recorded from New Hampshire, the town of the collection is unknown, so that state is not shown.

Table 4. New England Occurrence Records for both varieties of *Scleria pauciflora.*
Unless otherwise noted, occurrences are *S. pauciflora* var. *caroliniana*.
Shaded occurrences are considered extant.

State	EO #	County	Town
NH	No #	Cheshire	Unknown
MA	**.001**	**Dukes**	**Edgartown**
MA	**.002**	**Nantucket**	**Nantucket**
MA	**.003**	**Dukes**	**West Tisbury**
MA	**.004**	**Worcester**	**Uxbridge**
MA	**.005**	**Barnstable**	**Barnstable**
MA	**.006**	**Worcester**	**Clinton**
MA	**.010**	**Nantucket**	**Nantucket**
MA	**.012**	**Nantucket**	**Nantucket**
MA	**.015**	**Dukes**	**Edgartown**
MA	**.016**	**Barnstable**	**Sandwich**
MA	**.017**	**Barnstable**	**Falmouth**
MA	**.018**	**Nantucket**	**Nantucket**
RI	.001	Washington	South Kingstown
RI	**.002**	**Washington**	**Westerly**
RI	**.003**	**Washington**	**Charlestown**
RI	**.004**	**Kent**	**West Greenwich**
CT	.001	Tolland	Columbia
CT	.002	New London	Waterford
CT	**.003**	**Middlesex**	**Old Saybrook**
CT	no #	Hartford	Hartford

II. CONSERVATION

CONSERVATION OBJECTIVES FOR *SCLERIA PAUCIFLORA* IN NEW ENGLAND

The primary conservation objectives for *Scleria pauciflora* var. *caroliniana* in New England are to protect 12 occurrences in Massachusetts and two occurrences in both Rhode Island and Connecticut. It will be necessary to locate additional occurrences to meet this objective. The best possibility for effective conservation of *S. pauciflora* var. *caroliniana* is in southeastern Massachusetts, where ten of the fifteen extant populations are located. All of these sites have been found in the past 22 years. It is likely that there are additional populations of *S. pauciflora* var. *caroliniana* that will be found in Massachusetts and even that some of these populations will be associated with sites that are already owned and managed for biological conservation. There is also potential habitat for *S. pauciflora* var. *caroliniana* in Rhode Island and Connecticut.

The primary conservation objectives for *S. pauciflora* var. *pauciflora* are to search for new populations and, if they can be located, to protect two populations in both New Hampshire and Massachusetts. The possibilities for locating new occurrences of *S. pauciflora* var. *pauciflora* are uncertain. In New Hampshire, the one historical specimen has not been seen recently. Appropriate habitat should be surveyed for possible remnant populations. The one population in Massachusetts of *Scleria pauciflora* var. *pauciflora* has not been seen for many years and will need to be relocated.

Each occurrence should be managed to maintain a population of at least 100 plants. The minimum viable population size for *Scleria pauciflora* is not known anywhere within its range. One Massachusetts population (MA .001 [Edgartown]) supports over 5000 plants. Several other populations have over 100 plants. One population (MA .004 [Uxbridge]) has been known for 143 years and supported “fewer than 10 culms” when it was relocated, suggesting that populations may persist at very low numbers. Setting a population goal of 100 plants may be possible given the ability of the species to respond to management, and may offer greater genetic diversity than smaller population sizes and buffer the species from random disturbances that may eliminate plants.

A second objective is to understand the rarity and conservation needs of both varieties of *Scleria pauciflora* better, by conducting site and population monitoring and population biology studies. More information is needed to answer the following questions. Under what conditions does *S. pauciflora* germinate in the field? Do individual plants live very long? Do plants respond favorably to mowing? Do plants flower every year? Is the amount of flowering a response to disturbance? Can reproductive output be increased with management? What types of disturbances, such as fire and mowing, increase plant vigor? Does the time of year of the disturbance matter to plant vigor?

A third objective is to improve an *ex situ* seed bank to preserve the genome of both varieties of *Scleria pauciflora* in New England. If all natural populations are lost, seeds will be needed to supply material for future studies and reintroduction efforts, if called for in future iterations of this plan. Seeds from one New England population have been collected, but were not stored for long-term use. With only 16 populations scattered at four general locations, it is desirable to collect material from all of these regions for conservation. Special attention should be paid to the one extant *Scleria pauciflora* var. *pauciflora* population in New England. Seed from all sites should be kept separately to distinguish genetic differences among regional populations.

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IV. APPENDICES

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

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

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

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

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

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

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

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

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EOs have received such ranks in all states, and ranks are not necessarily consistent among states as yet.