New England Plant Conservation Program

Sporobolus compositus (Poiret) Merrill var. *compositus* Tall Dropseed

Conservation and Research Plan for New England

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SUMMARY

Sporobolus compositus (Poiret) Merrill var. *compositus*, commonly known as tall dropseed, is a perennial member of the grass family (Poaceae) that is rare in New England (Division 2 in *Flora Conservanda*), but common in the prairie country of the central United States. For many years, the species was known as *S. asper*. *Sporobolus compositus* includes three accepted varieties, two of which occur in New England. The taxon forms discrete tufts 60-120 cm tall. Its panicles typically stay partially or fully ensheathed when flowering in the fall, and the species can be easy to overlook for this reason. The flowers tend to self-pollinate. Both fire and grazing are known to stimulate reproduction, though excess of either will have the opposite effect. It is a grass that is easy to propagate by seed and is used in prairie restoration.

In the plains country of central North America *S. compositus* var. *compositus* favors dry positions in various prairie communities. It has ruderal tendencies throughout its range, growing in disturbed, often sandy soil along roads and railroads. It also occurs rarely in prairie fen wetlands. In New England, the species favors coastal sandy habitats, dry limestone outcrops, and roadsides of sandy or limy soils.

There are a total of 83 *S. compositus* var. *compositus* occurrences in New England (most are in Connecticut), of which 42 are extant. The apparent loss of populations may suggest species decline or simply that the species has been overlooked. The species appears to be expanding in the marble belt of western Connecticut. Shading by invading woody plants, competition by invasives, development (roadside or other), and changes in roadside maintenance practices are threats to the species. Conservation action to date includes field surveys, and seed collection at one site in Vermont. Many of the extant roadside occurrences, plus several in other habitats, are on public land.

In Vermont, the conservation objective for *Sporobolus compositus* var. *compositus* is to maintain three occurrences with populations ranging from 50 to 350 genets with at least 50% of genets fruiting. In Massachusetts, where most of the 16 occurrences are historical, no objective for number of occurrences can be set until more field survey is done. Likewise, in Rhode Island, where all four occurrences are historical, more field survey is needed before an objective can be set. In Connecticut, the conservation objective is to maintain 35 occurrences with populations ranging from 50 to 100,000 genets with at least 75% of genets fruiting. Of these 35, thirteen occurrences are identified as higher priority for conservation. Given the large number of occurrences documented in this plan, *Sporobolus compositus* var. *compositus* should be changed from a Division 2 to a Division 3 species in *Flora Conservanda.* Since the provenance of some New England occurrences has been questioned, a primary general conservation action for the species is to do research on the origins of the region's populations. In addition to relocating historical occurrences, conservation actions include landowner education, monitoring surveys, conservation easements, and management which keeps habitats open, such as cutting woody plants or possibly controlled burning.

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

The focus of this conservation and research plan is *Sporobolus compositus* (Poiret) Merrill var. *compositus*, or tall dropseed, a perennial grass (Poaceae) native to North America. This species name is synonymous with *Sporobolus asper* var. *asper*, a name that is most frequently found in the literature (Kartesz and Gandhi 1995). The purpose of the plan is twofold: 1) to provide background information on the species in general, including its description, taxonomy, biology, ecology, threats and distribution; and 2) to provide information on the conservation of the species specifically in New England, including its status, conservation actions to date, and proposed conservation actions.

As with many, if not most, of the conservation plans for rare plants in New England being written for the New England Plant Conservation Program (NEPCoP), background information on *S. compositus* var. *compositus* comes from disparate sources. While no monograph has pulled together all the biological and ecological information about the species, Riggins (1977) has written an important taxonomic treatment for the *Sporobolus asper* complex, including what is now *Sporobolus compositus* var. *compositus*. Her work delineated the taxa in this complex, which include three varieties and one separate species. While this plan deals with just the nominative variety, *S. compositus* var. *compositus,* it is likely somewhat corrupted by information about other varieties due to taxonomic confusion and omission of varieties in the literature. In this plan, the assumption is that references to *S. asper* are synonymous with *S. compositus* var. *compositus,* particularly in the northern and eastern part of the complex's range.

With its center of distribution in Kansas, Missouri, Nebraska and Iowa, *Sporobolus compositus* var. *compositus* is principally a tall- and mixed-grass prairie species (citations provided in appropriate sections below). Adapted to the open country of central North America, with that landscape's attendant ecological processes of fire and grazing, the species in forested Eastern North America shows a spotty distribution, relegated to natural and artificial openings often associated with coastal sands or roadsides. In New England, the species is distributed primarily along the Connecticut and Massachusetts coasts, and in the carbonate belt running along the western side of the region. In western New England, it is most frequently associated with limestone-type bedrock outcrops in open roadside rights-of-way and other places.

As a Division 2 taxon in *Flora* Conservanda (Brumback and Mehrhoff et al. 1996), *Sporobolus compositus* var. *compositus* is a rare species in New England as a whole. It has been known from the region since 1833. Although many new occurrences have been found in Connecticut in recent years, the species is exceedingly rare in the northern New England states and still primarily known from historical occurrences in

Massachusetts and Rhode Island. Some occurrences in Massachusetts and Connecticut are thought to be introduced.

In the center of its range, the species has undoubtedly undergone major decline as a result of the widespread conversion of prairie into agricultural lands. In New England, the species is threatened in a variety of ways, including development (both commercial/housing and roads), competition by native and invasive species, and changes in highway roadside maintenance practices. Disturbance, such as trampling associated with recreation, can be damaging to the species; however, the species appears to tolerate, if not thrive, with some disturbance.

Because the status of *Sporobolus compositus* var. *compositus* varies widely from state to state in New England, no single set of conservation objectives can be set for the region as a whole. In Massachusetts and Rhode Island, most occurrences are historical. Given that the species is easily overlooked, more survey work needs to be done in these states before conservation objectives on the number of occurrences can be set. In Vermont, maintenance of the three verified occurrences is an objective. In contrast, maintenance of Connecticut's 35 extant occurrences is an objective, though 13 of these 35 are chosen as a higher conservation priority.

Because the provenance of some New England occurrences has been questioned, research is needed to establish the origin(s) of New England populations. At the same time, more survey work, both *de novo* and of historical occurrences, is needed in order to establish the status of the species in Massachusetts and Rhode Island. Other important conservation actions include landowner education and site management to control competing woody plant and/or invasive species.

DESCRIPTION

Sporobolus compositus var. *compositus* is a medium-sized perennial grass that grows in relatively small, discrete tufts. In the prairie of central North America it is not considered a sod-former (Bruner 1931). The rather stout culms range from 2-4 millimeters in diameter at the first node (Riggins 1977) and from 60-120 centimeters tall (Hitchcock 1971). In the autumn, culms and sheaths can be subtly colorful with tones ranging from light green to salmon (Engstrom, personal observation). Leaves are thin, starting with a width of only 1-4 mm at departure from the sheath, then tapering to a long, fine-wiry, scabrous point (Hitchcock 1971). In the description for *Sporobolus compositus* inclusive of all its varieties, Peterson et al. (2003) describes leaf blade width ranging from 1.5-10 mm. The leaves broadly arch or curl (Engstrom, personal observation), ranging from roughly 5-70 cm in length (Peterson et al. 2003). Sheaths are glabrous, strongly overlapping, and more or less pubescent or pilose at their summits (Hitchcock 1937). While blade pubescence is common, pubescence of the sheath is rare.

Flowering culms have 2-6 contracted panicles ranging from 9-53 cm long. Panicles are frequently included in sheaths (Riggins 1977). The panicle ensheathment is

very typical for the species, and is possibly one reason the species is overlooked. Most inflorescences were completely or near completely ensheathed during various September and October surveys of the species in Vermont and Connecticut (Engstrom, personal observation). In January 2003, a survey of one Vermont occurrence showed that about 75% of 30 fruiting culms sticking out of the snow had 50-100% of their fruiting panicles out of sheaths while the remaining 25% had less than 50% of their panicles exposed. This survey came after an earlier survey (October 9, 2002) of the same population where most panicles were hidden.

Spikelets are single-flowered, 3-6 mm long, with the glumes shorter than or equaling the palea and lemma. Palea and lemma are glabrous and roughly the same length. The lemma has a single nerve. The grain is rounded and 1-1.8 mm long, with its width a little more than half that of its length. The seed coat (pericarp) is gelatinous when moistened (Riggins 1977). At maturity, the endosperm is an amber color (Colbry 1957; Engstrom, personal observation). The chromosome number for *Sporobolus compositus* var. *compositus* is 2*n*=54 (Riggins 1977).

During the winter in the prairie of central North America, *S. compositus* var. *compositus* turns whitish (Bruner 1931, Weaver and Fitzpatrick 1934). Standing out against other darker prairie grasses, it is referred to as 'flag grass' (Steyermark 1977). In mid-winter in Vermont, plants are a light tan color (Engstrom, personal observation).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Sporobolus compositus (Poiret) Merrill var. *compositus* is the currently accepted name in *Flora of North America North of Mexico* (Peterson et al. 2003) and the Catalogue of New World Grasses (2001). Common names for the species include tall dropseed (Gleason and Cronquist 1991) or meadow dropseed (Gould 1975). Because of the old species epithet "*asper*," it is sometimes referred to as rough dropseed. Synonyms listed in the *Catalogue of New World Grasses* include: *Agrostis aspera* Michx., *A. composita* Poir., *Agrostis involuta* Muhl., *Agrostis longifolia* Torr., *Muhlenbergia aspera* Trin. ex Kunth, *Muhlenbergia composita* Trin. ex Kunth, *Sporobolus asper* (Michx.) Kunth var. *asper* , *S. longifolius* (Torr.) Alp. Wood, *S. pilosus* Vasey; *Vilfa asper* P. Beauv., *V. composita* (Poir.) P. Beauv., and *V. longifolius* (Torr.) Torr. It was long known as *Sporobolus asper* (Michx.) Kunth until a recent application of naming rules produced the currently accepted *Sporobolus compositus* var. *compositus* (Kartesz and Gandhi 1995). Throughout this plan *S. compositus* var. *compositus* will be used to refer to *Sporobolus asper* found in the literature.

Sporobolus compositus var. *compositus* is a member of the grass family (Poaceae). It is in the Chloridoideae subfamily and the Cynodonteae tribe (Catalogue of New World Grasses 2001). The genus name *Sporobolus* is derived from Greek *spora* (seed) and *ballein* (to throw), referring to freely detaching grains (Fernald 1950). A characteristic of all *Sporobolus* is that the spikelets disarticulate above the glumes).

Besides the nominative, there are two other accepted varieties of *Sporobolus compositus*: *S. compositus* var. *drummondii* (Trin.) Kartesz and Gandhi and *S. compositus* var. *macer*(Trin.) Kartesz and Gandhi. *Sporobolus clandestinus* (Biehler) Hitchcock has been considered a variety of *S. compositus* but is currently retained as a separate species (Riggins 1977, Peterson et al. 2003). A biosystematic study of the *Sporobolus asper* complex by Riggins (1977) was the primary work for defining the infraspecific taxa of what is now *S. compositus*. According to Riggins, both *S. compositus* var. *drummondii* and *S. compositus* var. *macer* are largely confined to Texas and states adjacent to the east and north of Texas. *Sporobolus clandestinus* has more of a south-central United States and southeastern coastal plain distribution, but in New England does overlap with *Sporobolus compositus* var. *compositus* in coastal Connecticut and Massachusetts. The recent annotation by P. M. Peterson of United States National Herbarium of the lone Maine *S. compositus* specimen to *S. compositus* var. *drummondii* represents a major disjunct for the taxon (Arthur Haines, independent botanist, personal communication). *Sporobolus compositus* var. *macer* is basically separated from the others by its rhizomatous habit, and *S. compositus* var. *drummondii* is separated from the others by its skinny culms and sparsely flowered panicles (Riggins 1977). *Sporobolus clandestinus* is readily separated from the *S. compositus* varieties by its pubescent lemma.

There was no specific mention of hybridization for *Sporobolus compositus* var. *compositus* in the literature reviewed. This is to be expected since the species is mostly self-fertilized (Riggins 1977).

SPECIES BIOLOGY

Lacking rhizomes or stolons, reproduction in *Sporobolus compositus* var. *compositus* is predominantly sexual. While most grasses are wind-pollinated, *S. compositus* var. *compositus* is unusual in that its panicles are mostly ensheathed during flowering; hence, it is self-fertilized (Riggins 1977). Field and garden observations of the species by Riggins show that while cross-pollination is possible, it is probably infrequent. Even if panicles are exserted, cross-pollination can be prevented by florets remaining closed, filaments partially or completely failing to exsert, or pollen of one floret falling on other florets of the same plant. She observed all of these selfing situations, as well as cross-pollination, occurring on a single panicle. She also confirmed that reproduction is not apomictic, i.e. asexual.

Sporobolus compositus var. *compositus* flowers late in the growing season, primarily from August to October (Fernald 1950, Great Plains Flora Association 1986, Haines, unpublished data). During field work in mid September 2002, most plants observed had immature fruit (Engstrom, personal observation).

In the literature, seed set in *S. compositus* var. *compositus* is described as high, although no numbers are given (Riggins 1977). Natural seed dispersal mechanisms are unknown. A few ensheathed fruiting panicles observed in the winter appeared to have been picked open by birds (Engstrom, personal observation). Whether the seed could

stay viable after passing through a bird's digestive system is questionable. Artificial means of dispersal might include seeds, attached to stems or separate, transported via trains, motor vehicles, or roadside mowing equipment. *Sporobolus compositus* var. *compositus* seed might be intentionally or unintentionally part of seed mixes used for stabilizing soil after disturbance associated with highway construction projects.

In most studies, *Sporobolus compositus* var. *compositus* shows high germination rates. In a study of germination rates among prairie plants, *S. compositus* var. *compositus* had one of the higher germination rates, although this varied somewhat between years and seasons (Blake 1935). Results of this study showed highest rates (91%) in the spring (April) of the sixth year. While a cooling pretreatment was used for fresh seed, seed greater than six months old showed healthy germination when left in room temperature water for two to three weeks (Riggins 1977). Seed germination has also been tested using New England seeds (William Brumback, New England Wild Flower Society, personal communication). After drying the seed for a month, test sowings were done at NEWFS in December 2000. Germination trials used a pretreatment of moist-cold. Four trials using 25-50 seeds/trial yielded 2, 12, 28 and 36% germination success rates. There is probably more propagation information for *Sporobolus compositus* var. *compositus* because commercial seed sources exist (Natural Resources Conservation Service 1996).

In addition to its high potential for seed set and germination, seedlings of *Sporobolus compositus* var. *compositus* have been described as forming "rather dense clumps and produce flower stalks the first year" (Weaver and Fitzpatrick 1934: 183). These vigorous reproductive/growth characteristics combined might aid the long-term viability of the species.

According to Gould and Shaw (1983), all the members of the Chloridoideae subfamily, including *Sporobolus*, have the C_4, or Kranz, photosynthetic pathway. This chemical pathway allows plants to utilize carbon dioxide more efficiently. Kranz grasses are adapted to hotter, drier, sunnier conditions than counterpart C_3 species. *Sporobolus compositus* var. *compositus* is known as a drought-resistant species (Steyermark 1977). The species was shown to increase in abundance (number of stems) after some of the most extreme drought conditions in the "true-prairie" vegetation of eastern Nebraska (Robertson 1939). Even its seedlings are drought-resistant in comparison with other prairie grasses (Mueller and Weaver 1942). No literature provided information on the species' light requirements. However, it is very clear from the numerous floras and herbarium label data that the species nearly always occurs in the open, presumably out of need for abundant sunlight. Only one flora (Yatskievych 1999) mentioned a forest setting ("dry upland forest"). All the New England occurrence data presented in this plan, including twelve occurrences visited by the author (Engstrom, personal observation) indicate the species is intolerant of shade.

HABITAT/ECOLOGY

While the species' habitat varies throughout its range, *Sporobolus compositus* var. *compositus* should be considered primarily a prairie species of the central plains of North America. A comparison of the range map of *Sporobolus compositus* (Barkworth et al. 2000), which does not separate out the varieties, and a grassland types map (Sims and Risser 2000) shows a good overlap with much of the tall-grass and mixed-grass prairies, but the species is relatively infrequent in the shortgrass prairie that dominates the southwestern third of the Great Plains region. This distribution corresponds ecologically with the more mesic portion of the Great Plains, i.e. the more eastern plains. North of the Missouri River, deposits associated with late Wisconsian glaciation are the parent materials of the flat and rolling plains landscape. These include till, outwash, lake bottom sediments and loess. South of the Missouri River, the soils are derived from sandstone and shale, with extensive aeolian sands and loess soils found in Nebraska and Kansas. Fine sands and clays dominate the southern plains. Mollisols are the soils largely associated with the tallgrass and mixed grass prairies. Mollisols are a major soil group (order) characterized by a well-developed topsoil layer, where organic matter is mixed with mineral soil. The vegetation of these prairies is largely free of woody plants and dominated by grasses (Sims and Risser 2000).

Within the tallgrass prairie of eastern Nebraska and adjacent states (i.e., the most mesic portion of the Great Plains), *Sporobolus compositus* var. *compositus* is most abundant in the driest uplands where vegetation is less dense (Weaver and Fitzpatrick 1934). It is widely distributed, yet it is a minor component of the grasslands in terms of cover. In these prairie lands, it has a "semi-ruderal" (=somewhat weedy) habit, occurring in habitats where there is disturbance, such as banks along roadsides, grazed prairies, along trails, and on dry, sparsely vegetated ridges.

In the more mesic portions of the "mixed grass" prairie of west-central Kansas, *S. compositus* var. *compositus* is considered a dominant, along with *Andropogon gerardii*, *Pascopyrum smithii*, and *Bouteloua curtipendula* in the big bluestem habitat type, and it becomes a species of secondary importance in the drier little bluestem (*Schizachyrium scoparium*) habitat type (Sims and Risser 2000). The mixed grass prairie described here is considered ecotonal between the drier short grass prairie and the moister tall-grass prairie. The species composition of the various habitats within this prairie zone shifts according to climate fluctuations (drought) and disturbances (grazing and fire).

Sporobolus compositus var. *compositus* is a species described in a variety of plant associations of the Great Plains and adjacent savannah regions of interior North America. In Kuchler's (1964) map of potential natural vegetation of the United States, the species (as *S. asper*) is mentioned as an "other species" in Bluestem-Grama Prairie (*Andropogon-Bouteloua*), Blackland prairie (*Andropogon-Stipa*), and Cross Timbers (*Quercus-Sporobolus*) plant associations. The following descriptions excerpted from floras in the central and western portion of the species' range give an indication of the variety of habitats in which the species can be found:

- "Prairies, roadsides and a variety of other habitats" (Great Plains Flora Association 1986: 1226, referring to the Great Plains region)

- "Dry, often sandy, soil" (Mohlenbrock 1973: 278, referring to Illinois)

- "Upland prairies, glades, tops of bluffs, savannahs, and dry upland forests, rarely banks of streams and margins of saline seeps; also pastures, oldfields, roadsides, and railroads" (Yatskievych 1999:730-731, referring to Missouri)

- "...frequent in grasslands, borders of woods and road right-of-ways" (Gould 1975: 304, referring to Texas)

- "dry soil, often where sandy, prairies to foothills; e. Wash and Ore" (Hitchcock and Cronquist 1973: 670)

The habitats given for the species in floras covering northeastern United States and adjacent Canada provide very generalized descriptions: "Dry open soil" (Fernald 1950) and "Dry or sandy soil, especially on prairies, sometimes on beaches" (Gleason and Cronquist 1991). In this northeastern part of its range, which has a moister climate than the prairies in central North America, the species generally occupies some of the driest habitats in the landscape, i.e. well-drained sands, and limestone and trap rock uplands. More detailed habitat descriptions for this region are provided below.

In Wisconsin, *Sporobolus compositus* var. *compositus* was thought to be adventive, being found primarily along railroads and roadsides (Fassett 1951). Now it is known to occur in the most xeric, and a few mesic, prairies of southwestern Wisconsin (Cochrane and Iltis 2000). The dry and dry-mesic prairies of Wisconsin are described as predominantly steep, southwest-facing slopes with thin, organic-rich loess soils over limestone and other bedrock types (Curtis 1959). These sites have very calcareous soils with pH values rarely less than 8.0 and calcium values of 5000 ppm or greater.

Moving further east, out of the prairie country, *Sporobolus compositus* var. *compositus* becomes rarer, occupying ruderal as well as natural habitats. In Ontario, most occurrences appear adventive because they are found growing along roadsides and railroads (Reznicek 1984). However, the species also occurs in natural habitats, such as prairie relicts found in extreme southern Ontario, prairie-like areas on top of the limestone escarpment at Niagara Gorge, and along the Ottawa River (Dore and McNeil 1980, Reznicek 1984). It also occurs in perched prairie fen, a globally rare wetland natural community in Ontario (Ontario Natural Heritage Information Centre 1996). Described as "clearly native here" the *Sporobolus compositus* var. *compositus* is associated with a remarkable variety of species in this rare fen habitat, including elements from Great Lakes Coastal Meadow Marshes, relictual northern and western species, prairie species, and fen species. These unusual fens develop on calcareous sand and gravel slopes fed by groundwater discharge. Unlike typical fens with peat soils, these prairie fens have mineral or muck soils.

In the Michigan flora, *Sporobolus compositus* var. *compositus* is presumed adventive along railroads (Voss 1972), although more recent literature might show it native elsewhere. A 1933 specimen from along a railroad in Kalamazoo County is thought to have been the first documented occurrence of the species in Michigan (Hermann 1936). In New York, label data from 19 specimens of *Sporobolus compositus* var. *compositus* at the New York State Museum in Albany (Charles Sheviak, New York State Museum, personal communication) show the species to be found most frequently along railroads and on seashores, either on sand beaches or on borders of salt marshes. A few other New York specimens were collected in the open talus below a cliff and in a cedar glade. Of special note is one Brainerd specimen at the Pringle Herbarium in Burlington, Vermont, from Westport Bay, Essex County, New York. No habitat is provided on the label. Coincidentally, this historical occurrence (188[1?]) is immediately west across Lake Champlain from one of the Vermont occurrences. In Quebec *Sporobolus compositus* var. *compositus* was first documented in 1943 growing on a rocky shore along the St. Lawrence River near Montreal (Rouleau 1945). This island site is known for its primitive (i.e., undisturbed) flora. Here, the species grows with two other rare Quebec plants: *Verbena simplex* and *Scutellaria parvula*.

Habitat described for *Sporobolus compositus* var. *compositus* in Virginia include both a sandy beach on the coast (York County) and a sand bank along the York River, New Kent County (Fernald 1940). In the Tennessee "barrens," *Sporobolus compositus* var. *compositus*, along with other mid-tall grass prairie species such as *Schizachyrium scoparium*, *Sorghastrum nutans*, *Andropogon gerardii*, and *Bouteloua curtipendula*, is a dominant of mesic to xeric sites (DeSelm 1989). These barrens are small openings in the oak-dominated forest matrix. They have a variety of substrates including shallow to bedrock limestone, chert, or sandstone soils, as well as some clayey and loess soils. While the present vegetation is largely a product of recent (post European settlement) land use practices, these barrens are thought to have been naturally maintained by periodic drought, fire, and grazing.

In New England *Sporobolus compositus* var. *compositus* occurs in a variety of habitats, including coastal beaches and outcrops, roadsides (both sandy and other soils), railroad rights-of-way, waste ground, sandy fields, marble outcrop openings, quarried limestone areas, and dolomite outcrops along Lake Champlain. These are described in detail in the section on New England occurrences. The habitat conditions common to the New England occurrences include open (sunny) locations with dry, and often disturbed, soil.

It has been suggested that *S. compositus* var. *compositus*, along with other prairie plants, migrated into New England from the midwest during a xerothermic period after the last great ice age (Mehrhoff 1997). It is perhaps noteworthy that other common prairie plants, such as *Schizachyrium scoparium*, *Andropogon gerardii*, and *Sorghastrum nutans*, are frequently associated with *S. compositus* var. *compositus* in New England. Rarely associated with *S. compositus* var. *compositus* is another prairie species: *Solidago rigida*.

Primary ecological processes associated with prairie vegetation include grazing, fire, and drought (Sims and Risser 2000). Because *Sporobolus compositus* var. *compositus* is primarily a species of the prairie, these processes have likely influenced the species' evolution. Adaptations of many grasses to these processes include disproportionally large underground parts; early spring structural development (when moisture is most available); closing stomata and curling leaves during drought; C_4 photosynthetic pathways that contribute to efficient use of water; seeds that can germinate in relatively dry soils; and basal meristems. Compared to forested or other terrestrial ecosystems, grasslands have a large proportion of materials and energy flowing through grazing pathways. This is especially true in the prairies where ungulates such as bison were an important part of the ecosystem.

There is a substantial literature on the fire ecology of grasslands. Summaries of this literature include Wright and Bailey (1980) and Collins and Wallace (1990). It is now recognized that Native Americans widely used fire, as well as accidentally ignited fires, in the central North American grasslands and woodlands (Higgins 1986, Ladd 1991), and even in southern New England (Russell 1983). These human-ignited fires are in addition to fires ignited by lightning-strikes, which are relatively frequent in the northern Great Plains (Higgins 1986). Regardless of ignition source, grasslands are fire-prone for several reasons. In the central North American prairie, drought, high temperatures, and strong winds are ideal conditions for fire. Furthermore, grasses produce fine fuels that dry out quickly and burn readily.

It is generally acknowledged that fire stimulates grassland production (Glenn-Lewin et al. 1990). The immediate effects on the grasses, however, are generally restricted to one or two years. Fire also has the important effect of killing or decreasing woody vegetation, thereby reducing competition for light by a potentially taller plant. Using both flower stalk production and total biomass metrics, dominant tall grass prairie species, including *Sporobolus compositus* var. *compositus*, showed significant increases in productivity in burned versus unburned plots in tallgrass prairie in Kansas (Hurlbert 1988). Comparing a variety of treatments, this study showed that any mechanism that warmed soil temperatures, increased surface light intensity, or increased nitrogen availability increased grass productivity. Fire is a good mechanism to achieve these conditions, but human clipping of most aboveground biomass was found to be as effective in most cases. In a contrasting study in a remnant tallgrass prairie in Oklahoma, *Sporobolus compositus* var. *compositus* (not a dominant in the study plots) was found to do better when left unburned versus when burned (Collins 1987). *Andropogon gerardii* and *Sorghastrum nutans* — the dominants in these plots — were more productive after burning.

Sporobolus compositus var. *compositus* is generally acknowledged to increase in abundance/cover when grazed (Weaver and Fitzpatrick 1934, Steyermark 1977), yet some studies show that it has little effect on the species (Collins 1987). Observations by others are that *S. asper* var. *pilosus* (a synonym of *Sporobolus compositus* var. *compositus*) decreases with grazing, while *Sporobolus compositus* var. *hookeri* increases

with grazing (Dyksterhuis 1948). It is noted that *Sporobolus compositus* is considered fair forage for livestock, but poor for wildlife (Stubbendick et al. 1982). Whether bison are considered "wildlife" in this reference is unclear. Its relative impalatability might be a reason for the species increasing after grazing.

While no direct references were found, *Sporobolus compositus* var. *compositus* appears to be salt-tolerant given its presence in seashore habitats (both outcrops and sand beaches) in New England and Virginia, and its frequent presences in roadsides in northern climates where salt is used regularly for clearing roads of snow and ice in the winter. While a rare occurrence, the species' presence in saline seeps in Missouri is an additional indication of its salt tolerance (Yatskievych 1999).

THREATS TO TAXON

At first glance, it might appear as though *Sporobolus compositus* var. *compositus* is not a threatened species. It has ruderal tendencies and there is evidence that the species is extending its range in the northeastern and western portions of the United States (see "Distribution and Status" section following). From an historical perspective, however, the species has likely undergone a massive decline in population. In the heart of its range out in the prairie states, habitat destruction through conversion to agriculture was, and probably still is, the biggest threat to *Sporobolus compositus* var. *compositus*. On the ecosystem level, the prairies, particularly the tallgrass prairie, and the prairie-forest border (savannah) ecoregions of central North America have nearly disappeared, with loss figures generally ranging from 90 to 99+% (Noss et al. 1995).

In the tallgrass prairie and prairie-forest border of the eastern Great Plains, as well as in barrens, glades and openings in the eastern United States, shading through succession by woody plants is a threat to *Sporobolus compositus* var. *compositus* and other sun-loving grasses. Fire suppression, as well as development that fragments landscapes, allow plant succession to go unchecked.

In New England, and likely through many other areas within its range, the species is impacted directly by increased development. One of the New England occurrences appears to have been extirpated and another largely destroyed due to commercial and residential development, respectively; while another appears imminently threatened by golf course development. Since many of the New England populations occur on roadsides, road width expansion would likely destroy many plants. Changes in roadside maintenance practices could negatively impact many occurrences in New England. For example, roadsides not mowed would lead to woody plant succession that would shade out *Sporobolus compositus* var. *compositus*. Or, if roadsides were consistently mowed during or immediately preceding flowering, the likely curtailment of sexual reproduction might lead to extirpations. Invasive species, present and coming, could undoubtedly pose a major risk to *S. compositus* var. *compositus*, in both natural and artificial habitats. As detailed in the occurrence descriptions below, invasives *Lonicera morrowii* and *Centaurea maculosa* are documented at two occurrences each. The honeysuckle appears

to threaten the existence of at least one of these occurrences. *Vincetoxicum nigrum* is found in the immediate vicinity of another occurrence.

Other threats to *Sporobolus compositus* var. *compositus* in New England include trampling, ATV traffic, herbiciding, and mowing. Not only can these activities directly impact *S. compositus* var. *compositus*, they can also indirectly impact the species by creating soil disturbance that favors weedy species that could outcompete the *S. compositus* var. *compositus*. In contrast, these activities can also create conditions that promote the species. The literature, including the data from New England occurrences, suggests that *S. compositus* var. *compositus* is often found in disturbed habitats, and maintains itself, if not increases, under grazing, fire, and related activities that temporarily decrease aboveground biomass.

DISTRIBUTION AND STATUS

General Status

Sporobolus compositus var. *compositus* is a G5T5 species that is widespread in North America, currently being reported from 42 continental U.S.A. states, and six Canadian provinces (Table 1, Figure 1). The distribution and status shown in this figure are derived from NatureServe Explorer (2002), Kartesz and Meacham (2001) and Peterson et al. (2003). The species is missing from Maine, New Hampshire, South Carolina, Florida, California, Nevada, Alaska and Hawaii. It is also reported from Mexico (Catalogue of New World Grasses 2001). Using a combination of distribution maps found in Riggins (1977), Manual on the Web (Barkworth et al. 2000), and the *Flora of North America North of Mexico* (Peterson et al. 2003), a more detailed description of the species distribution can be created. Though based on the same sources, the maps in the Manual on the Web and the *Flora of North America North of Mexico* might differ slightly due to 2002 editing for the latter work (Barkworth 2003). While Riggins' map is based on *S. asper* var. *asper* specimens, the Manual on the Web and the *Flora of North America North of Mexico* map is for the distribution of *S. compositus*, including all varieties. This is a problem. For this description the northern and western outliers shown on the Manual on the Web map are presumed to be *S. compositus* var. *compositus*, since that is the variety which Riggins shows has the most northerly distribution.

To the north, *S. compositus* var. *compositus* outliers range from southern New Brunswick west to southern Quebec (Montreal area), northern Wisconsin (Bayfield County), southern Manitoba (Winnipeg vicinity), and southern British Columbia. It reaches its northern-most point at roughly 50° north latitude in Manitoba and British Columbia. In the western United States (i.e. west of the 100th parallel) it occurs very scarcely, appearing in central Washington, central Idaho, southeast Montana, northern Utah, eastern Arizona and in scattered portions of New Mexico and Colorado. To the south, Riggins shows *S. compositus* var. *compositus* as far south as 28° north latitude, or southern coastal Texas (Aransas County). In the East, it is virtually absent in the

southeastern United States and uncommon in the northeastern United States, most occurrences being coastal, ranging from Virginia to Massachusetts.

While the range of *Sporobolus compositus* var. *compositus* includes the majority of the lower 48 states, plus adjacent Canada, the heart of its distribution is the central Great Plains and adjacent prairie-forest border region. From a biogeographical standpoint this would include the following ecoregions (The Nature Conservancy 2001):

- Central Tallgrass Prairie
- Central Mixed Grass Prairie
- Osage Plain/Flint Hills Prairie
- Ozarks
- Crosstimbers and Southern Tallgrass Prairie
- Prairie-Forest Border (southern portions only)
- Northern Mixed Grass and Tallgrass Prairies (southern portions only)

What this distribution shows is how limited the species becomes in the moist, forested regions of eastern United States and adjacent Canada, and how it gradually disappears in the drier climates of the shortgrass prairie and desert to the west of the prairie lands. In the broadest of ecological terms it is an ecotonal species occupying the parklands and moist end of the prairie lands between the drier shortgrass prairie to the west and the moister forest country to the east.

The status of *Sporobolus compositus* var. *compositus* in various states and provinces of North America is presented in Table 1 (NatureServe Explorer 2001). The statuses shown in the table partly corroborate what one might expect from a prairie species, i.e. becoming rare in eastern, western, northern states where the climate/vegetation becomes untenable. Without more effort to learn the real status in the numerous states where the species is only reported ("SR"), the table is of limited use at this point. It is suspected that the species might be rare in many other states, but state Natural Heritage Programs are reluctant to assign ranks to the species because of its ruderal habit, or because of a lack of knowledge. For example, in Massachusetts where most occurrences are in ruderal situations, it is unclear whether any occurrences are native (Paul Somers, Massachusetts Natural Heritage and Endangered Species Program, personal communication), and in Rhode Island the species was not "on the radar screen" until being evaluated for *Flora Conservanda* (Rick Enser, Rhode Island Natural Heritage Program, personal communication). There is also the problem of detectability. Since the panicles are rarely exserted from their sheaths until late in the season, if at all, the species can be easily overlooked. This was remarked upon by two seasoned botanists (Reznicek 1984; Peter Zika in Vermont Nongame and Natural Heritage Program, unpublished data). Zika made this observation on his field form while surveying one Vermont occurrence: "I have stood on this point ca. 25 times in the last two years and not noticed this species before! Very inconspicuous."

What this table does not include is the extreme decline the species has undoubtedly undergone in the prairie states. In these states that are biogeographically

central to the species, the landscape has essentially been converted to agricultural fields. In major tallgrass prairie states, such as Illinois and Iowa, less than two-tenths of one percent of the original prairie – which once covered millions of acres – remains (Whitney 1994), and in adjacent states scant more prairie remains. While the species in these states is generally not threatened, it has undeniably undergone a huge population decline.

Table 1. Occurrence, status, and distribution notes of *Sporobolus compositus* var. *compositus* in the United States and Canada based on information from Natural Heritage Programs and other sources.

OCCURS and LISTED (AS S1, S2, OR T and E)	OCCURS and NOT LISTED (AS S1, S2, OR T and E)	OCCURRENCE REPORTED OR UNVERIFIED	HISTORIC (LIKELY EXTIRPATED)
British Columbia (S1)	Massachusetts (Watch list): 3 extant,13 historical. Native?	Alabama (SR)	Rhode Island (SH): 4 historical
Manitoba (S1)	Connecticut (S3S4): 35 extant, 24 historical	Arizona (SR)	Delaware (SH)
Quebec (S1): Roleau 1945	West Virginia (S?)	Arkansas (SR)	Saskatchewan: Extirpated/Historic (Kartesz and Meacham 2001)
Ontario (S1S2): see Oldham 1999		Colorado (SR)	Montana (SH)
New Brunswick (S1) Extirpated ? (Hinds 1986)		Georgia (SR)	
Idaho (S1)		Illinois (SR)	
Maryland (S1)		Indiana (SR)	
New Jersey (S2)		Iowa (SR)	
Vermont (S1, E): 4 extant occurrences		Kansas (SR)	
Virginia (S1S2)		Kentucky (SR)	
Wyoming (S1)		Louisiana (SR)	
		Michigan (SR)	
		Minnesota (SR)	
		Mississippi (SR)	
		Missouri (SR)	
		Nebraska (SR)	
		New Mexico (SR)	
		New York (SR)	
		North Carolina (SR)	
		North Dakota (SR)	
		Ohio (SR)	
		Oklahoma (SR)	

Table 1. Occurrence, status, and distribution notes of *Sporobolus compositus* var. *compositus* in the United States and Canada based on information from Natural Heritage Programs and other sources.			
OCCURS and LISTED (AS S1, S2, OR T and E)	**OCCURS and NOT LISTED (AS S1, S2, OR T and E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
		Oregon (SR)	
		Pennsylvania (SR)	
		South Dakota (SR)	
		Tennessee (SR)	
		Texas (SR)	
		Utah (SR)	
		Washington (SR)	
		Wisconsin (SR)	
		Mexico (SR): Catalogue New World Grasses 2001	

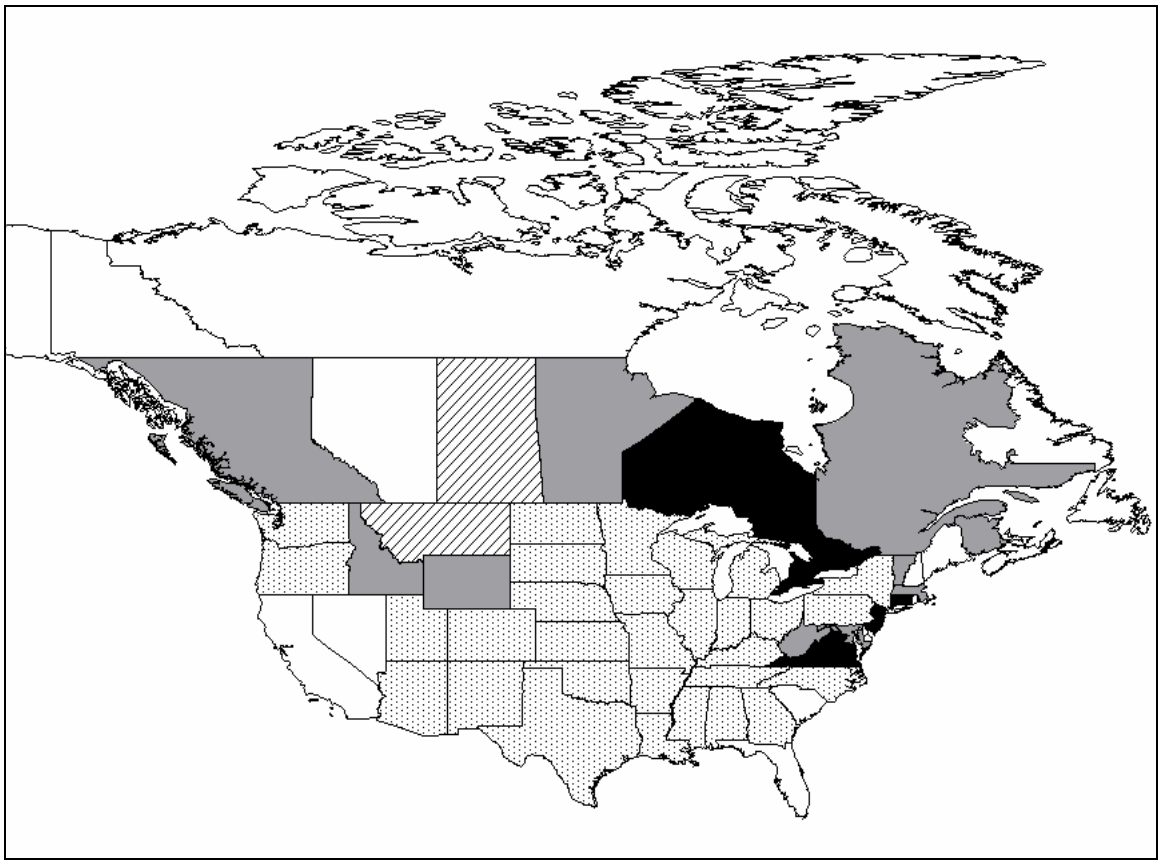

Figure 1. Occurrences of *Sporobolus compositus* var. *compositus* in North America. States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. Areas shaded in black have more than five confirmed occurrences. Areas with diagonal hatching are designated "historic," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but without additional information). See Appendix for explanation of state ranks.

Status of all New England Occurrences -- Current and Historical

According to NEPCoP, *Sporobolus compositus* var. *compositus* is a Division 2, or regionally rare, taxon in New England (Brumback and Mehrhoff et al. 1996). Since the publication of *Flora Conservanda,* the status and distribution of the species has changed in Maine and Connecticut. In Maine, *Sporobolus compositus* var. *compositus* can no longer be considered a part of the state's flora because the specimen from Wade, Aroostook County, which was originally determined as *Sporobolus asper* (Rawinski et al. 1989), has been subsequently determined as *Sporobolus compositus* var. *drummondii* by P. M. Peterson of United States National Herbarium (Arthur Haines, personal communication). Having *Sporobolus compositus* of any variety is odd enough for northern Maine, but to have var. *drummondii* occur there is highly unusual because the distribution for var. *drummondii* is primarily Texas up to Kansas and Missouri (Riggins 1977).

In addition to the status change in Maine, the most significant change since *Flora Conservanda* is the number of extant occurrences in Connecticut. While in 1996 there were only five extant occurrences for *Sporobolus compositus* var. *compositus* in Connecticut, now there are 35. These Connecticut occurrences, along with the four occurrences in Vermont and three in Massachusetts, brings the total extant occurrences in New England to 42, over twice the 20-occurrence limit of a Division 2 taxon.

Table 2 summarizes the occurrence data for *Sporobolus compositus* var. *compositus* for all of New England. Figures 2 and 3 show the current and historical distribution for the species in New England.

Using Table 2 data, there are 42 extant, 39 historical, and two believed extirpated occurrences, for a total of 83 occurrences in New England. The large number of historical occurrences is equivocal. First, with one notable exception, nobody has attempted to relocate these historical occurrences. Second, efforts to relocate them would be difficult because locational data on herbarium labels, especially old ones, is vague or absent altogether. The one exception to this is VT .002 (Charlotte) which was documented by a Pringle specimen in 1877, then relocated in 2000 after several attempts at rediscovery.

The dates for these New England occurrences range from 1833 to 2002. The 1833 occurrence is an Oakes collection (MA .007 [Ipswich]). After that early date, there are numerous collections from 1871-1900, and even more in the first half of the 20th century. While there are few to no extant occurrences in Massachusetts and Rhode Island, Connecticut has seen a huge surge of occurrence discoveries in the last five years, made largely by one person.

Occurrences range widely in population size, from a handful of plants to an estimated 100,000-500,000 (CT .025 [Brookfield]). A tally of population sizes (genets) for 27 occurrences with figures available breaks down as follows:

- 1-10 genets = 6
- 11-100 genets = 12
- 101-1000 genets = 7
- 1001- 10,000 genets = 1
- 10,000+ genets = 1.

While anything but precise, these figures show that the populations are generally quite vigorous, even in the few Vermont populations. Population trends are unclear since so few occurrences have been surveyed more than once. Those that have been revisited have data that is not clearly comparable, since return visits are usually by different people who might look in slightly different places. Be that as it may, of eight occurrences that have multiple surveys, two showed increases, three showed decreases, and three were about the same.

Table 2. New England Occurrence Records for *Sporobolus compositus* var. *compositus*. Shaded occurrences are considered extant.			
State	**EO #**	**County**	**Town**
VT	**.001**	**Addison**	**Ferrisburgh**
VT	**.002**	**Chittenden**	**Charlotte**
VT	**.003**	**Chittenden**	**Colchester**
VT	**.004**	**Bennington**	**Pownal**
MA	**.001**	**Berkshire**	**Great Barrington**
MA	**[2]**	**Berkshire**	**Stockbridge**
MA	[3]	Bristol	New Bedford City
MA	[4]	Bristol	Westport
MA	**[5]**	**Bristol**	**Westport**
MA	[6]	Essex	Danvers
MA	[7]	Essex	Ipswich
MA	[8]	Middlesex	Medford
MA	[9]	Middlesex	Somerville
MA	[10]	Norfolk	Milton
MA	[11]	Norfolk	Quincy
MA	[12]	Plymouth	Duxbury
MA	[13]	Plymouth	Hingham
MA	[14]	Plymouth	Kingston
MA	[15]	Suffolk	Boston
MA	[16]	Suffolk	Boston
RI	.001	Kent	Warwick
RI	.002	Providence	Providence
RI	.003	Newport	Tiverton
RI	.004	Kent	Warwick
CT	**.001**	**Litchfield**	**Kent**
CT	**.002**	**Litchfield**	**New Milford**
CT	**.003**	**New Haven**	**Branford, Guilford**
CT	**.004**	**Litchfield**	**New Milford**
CT	**.005**	**New Haven**	**Branford**
CT	.006	Litchfield	Salisbury
CT	.007	New Haven	New Haven
CT	.008	New Haven	Milford
CT	.009	New London	Groton
CT	.010	Fairfield	Brookfield
CT	.011	Fairfield	Bridgeport
CT	.012	Fairfield	Greenwich
CT	.013	Fairfield	Fairfield
CT	.014	Fairfield	Norwalk
CT	.015	New Haven	Oxford
CT	.016	New Haven	Wallingford
CT	**.017**	**Litchfield**	**Kent**
CT	.018	New Haven	East Haven
CT	.019	Middlesex	Old Saybrook

Table 2. New England Occurrence Records for *Sporobolus compositus* var. *compositus*. Shaded occurrences are considered extant.			
State	**EO #**	**County**	**Town**
CT	.020	Litchfield	Salisbury
CT	.021	Hartford	Southington
CT	.022	Hartford	Hartford
CT	.023	Litchfield	New Milford
CT	**.024**	**Fairfield**	**Bridgeport**
CT	**.025**	**Fairfield**	**Brookfield**
CT	**.026**	**Litchfield**	**New Milford**
CT	**.027**	**New Haven**	**Guilford**
CT	**.028**	**New Haven**	**Guilford**
CT	**.029**	**New Haven**	**Branford**
CT	**.030**	**New Haven**	**Branford**
CT	**.031**	**Litchfield**	**Cornwall**
CT	**.032**	**New Haven**	**New Haven**
CT	**.033**	**New Haven**	**Guilford**
CT	**.034**	**Litchfield**	**North Canaan**
CT	**.035**	**Litchfield**	**Canaan**
CT	**.036**	**Litchfield**	**Canaan**
CT	**.037**	**Litchfield**	**Salisbury**
CT	**.038**	**Litchfield**	**Canaan**
CT	**.039**	**Litchfield**	**Canaan**
CT	**.040**	**Litchfield**	**Canaan**
CT	**.041**	**New Haven**	**Southbury**
CT	**.042**	**New Haven**	**Branford**
CT	**.043**	**Fairfield**	**Danbury**
CT	**.044**	**Fairfield**	**Bethel**
CT	**.045**	**Hartford**	**Southington**
CT	**.046**	**Litchfield**	**Salisbury**
CT	**.047**	**Fairfield**	**Brookfield**
CT	**.048**	**Fairfield**	**Brookfield**
CT	**.049**	**Fairfield**	**Sherman**
CT	**[50]**	**New Haven**	**Branford**
CT	**[51]**	**New Haven**	**New Haven**
CT	**[52]**	**New Haven**	**New Haven**
CT	**[53]**	**New Haven**	**Branford**
CT	[54]	New Haven	New Haven
CT	[55]	New Haven	Milford
CT	[56]	New Haven	Hamden
CT	[57]	New London	Norwich
CT	[58]	Hartford	Farmington
CT	[59]	New Haven	Southbury

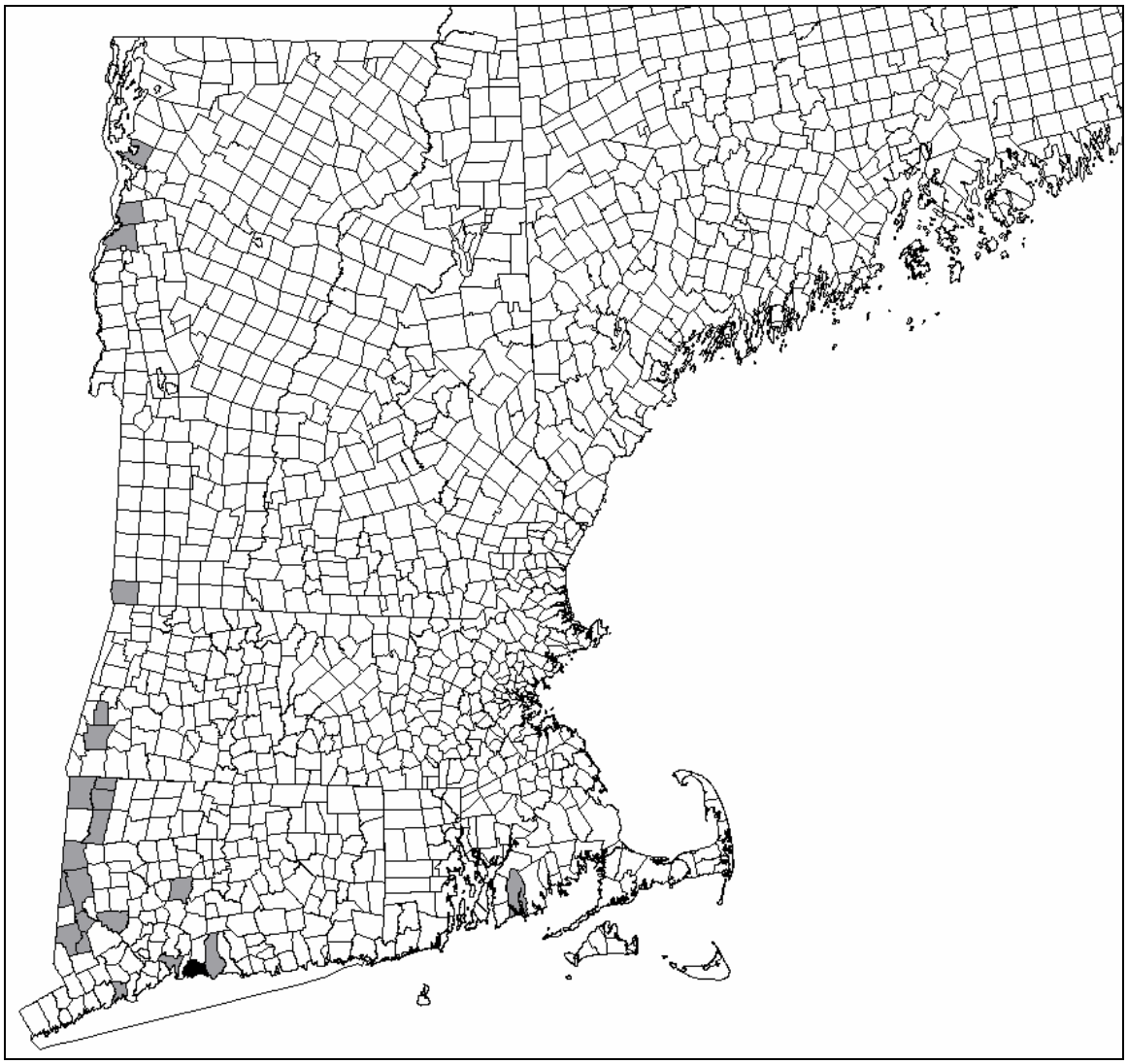

Figure 2. Extant occurrences of *Sporobolus compositus* var. *compositus* in New England. Town boundaries for New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon; towns shaded in black have more than five confirmed occurrences.

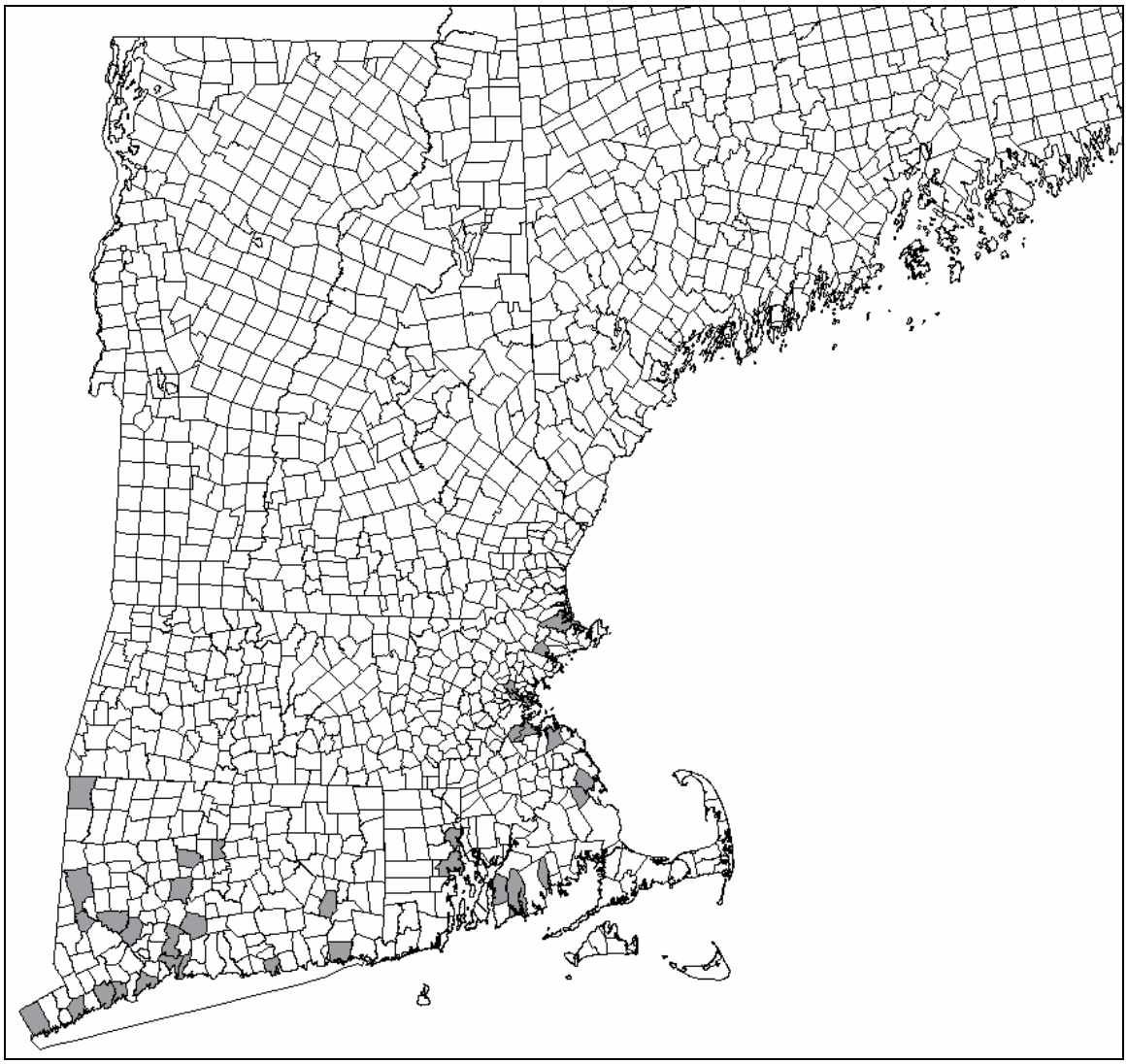

Figure 3. Historical occurrences of *Sporobolus compositus* var. *compositus* in New England. Towns shaded in gray have one to five historical records of the taxon.

Figures 2 and 3, combined with some physiographic and habitat data, indicate some definite distribution patterns of *Sporobolus compositus* var. *compositus* in New England. First the species has a coastal affinity, ranging from Greenwich in Fairfield County, Connecticut, all the way to Ipswich, Essex County, Massachusetts. A notable gap for the species along the coast is Cape Cod (Barnstable County, Massachusetts). Along the coast, the species is most frequently associated with dry, sandy, open habitat, such as beaches, oldfields, and roadsides. Along the coast in Connecticut, it also occurs on seashore outcrops, both granitic and basalt (trap rock), and in waste ground of former industrial complexes. In Massachusetts (.005[Westport]) there is an extant population on and around a huge granite boulder in a tidal river marsh. In this unusual setting, the species is growing out of rock cracks filled with shell fragments deposited by gulls that have dropped live bivalves on the rock to get at the internal edible animal parts.

Another distribution pattern is very clearly associated with calcareous bedrock formations that run north-south along the western side of New England. Starting at CT .044 (Bethel), most interior occurrences follow the Stockbridge marble belt; this belt goes north through Massachusetts to the Vermont border, at which point the formation name changes but the carbonate bedrock continues on through the Vermont Valley and Champlain Valley to the St. Lawrence Valley (Doll 1961; Zen 1983; Rodgers 1985). Most of the numerous western Connecticut occurrences, including the largest populations of *Sporobolus compositus* var. *compositus* in New England, are associated with marble outcrops, or sandy soils over marble bedrock, in this carbonate belt. In the Salisbury-Canaan area of far northwestern Connecticut, there are at least five occurrences clustered in a four square-mile area of the marble district. The two occurrences in western Massachusetts (.001 [Great Barrington] and [.002][Stockbridge]) sit in the marble belt, though their habitats were described as “dry sandy soil along ... road” and “along RR near old RR station.” In Vermont, all four occurrences are on carbonate bedrock: one in a limestone quarry (.004 [Pownal]) and the other three on dolomite or limestone outcrops along the shore of Lake Champlain. The many occurrences along Route 7, which runs straight up the carbonate valley from Connecticut to Quebec, coincides with the many marble outcrops the road cuts through on its way north. The Housatonic River and the railroad also provide easy arteries of dispersal to the north through this same carbonate belt.

Excepting the carbonate belt, few *Sporobolus compositus* var. *compositus* occurrences reach interior New England. Only in Connecticut as far north as Hartford (CT .022) are there interior occurrences outside the lime belt. Habitats noted for these interior Connecticut occurrences (Hartford County) include roadside and dry fields (CT .021[Southington]), and a dry power line right-of-way meadow on trap soil (CT .045 [Southington]). The species also occurs in trap soil in a subacidic rocky summit/outcrop community in New Haven (CT [51][New Haven]). A dry-mesic bottomland meadow (CT .047[Brookfield]) is one of the most unusual habitats for *Sporobolus compositus* var. *compositus* in New England.

A striking curiosity is the almost complete lack of occurrences in the Connecticut River Valley. This is surprising because the Connecticut River is the largest river valley

in New England and would seem a natural dispersal path for a species amenable to sandy disturbed habitats. Like the carbonate belt to the west, the Connecticut Valley has a major highway and railroad running its length. Lacking limestone, however, the Connecticut Valley appears to not function as a migration corridor for the species.

The carbonate belt and coastal distributional patterns are based on positive information, i.e., data from known locations. The patterns appear to be real and tied to some physiographic features. However, the negative information (i.e., areas where it has not been documented) can be interpreted in a few ways. First, it can be assumed that the species really does not occur there, even though botanists have looked for it. Or, conversely, it might be there, but no one has found it yet or looked for it in these other places. While the latter seems unlikely given the long history of botanical exploration in New England, the idea should be considered given the species somewhat cryptic character (ensheathed inflorescences) and the relatively few people with the skills to identify the species. The substantial number of historical occurrences of the species in Massachusetts and Rhode Island compared to the dearth of extant occurrences in these states suggests that the species may be overlooked.

The data also show that *Sporobolus compositus* var. *compositus* occurs mostly at low elevations, roughly 90% being found at elevations under 152 meters and many of these under nine meters. The highest elevation for the species is approximately 274 meters (CT .040 [Canaan]). Some of the species most frequently associated with *Sporobolus compositus* var. *compositus* in New England are other warm-season grasses, such as *Tridens flavus*, *Schizachyrium scoparium*, *Andropogon gerardii*, and *Sporobolus vaginiflorus* as well as a host of weedy grasses, like *Poa compressa*, *Festuca ovina*, *Elytrigia repens*, and *Festuca elatior*. Some of the more frequently associated herbs are *Plantago lanceolata*, *Centaurea maculosa*, and *Verbascum thapsus*. A few associated calciphiles are *Quercus muhlenbergii* and *Pellaea atropurpurea*. A few unusual associates are *Aristida purpurascens, Solidago sempervirens, S. rigida, Liatris scariiosa* var. *novae-angliae, Shepherdia canadensis,* and *Thuja occidentalis*.

Ownership of occurrence sites is both public and private. A surprisingly large number of occurrences are wholly or partially within highway rights-of-way. A few threats frequently mentioned with respect to the occurrences are changes of highway maintenance practices, invasive species, competition and shading, and development.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Research for this plan suggests that there is insufficient information on *Sporobolus compositus* var. *compositus* in New England to set a single target figure for the number of occurrences in the region as a whole. Furthermore, there is a great disparity in the number of occurrences between Vermont and Connecticut. Therefore, conservation objectives for the taxon in New England are presented state-by-state.

The conservation objectives for *Sporobolus compositus* var. *compositus* in Vermont are to maintain three occurrences, including individual occurrences with 350, 250, and 50 genets. At each occurrence, at least 50% of the genets should be fruiting. A reported fourth occurrence (VT .004 [Pownal]) needs to be verified. These objectives are based on information from the verified occurrences in the state. The target number of genets per occurrence is based on a slightly higher figure (rounded up to the next fifty) than the highest number of genets recorded for each occurrence. The target of 50% fruiting individuals per occurrence is a rough average of observed fruiting productivity for these occurrences.

In Massachusetts, no target figure for number of occurrences should be set until more field work is done. Both surveys in appropriate habitat where the species was historically known (oftentimes just a town is known), as well as *de novo* surveys, should be conducted in order to understand the real status of the species in the state. While the paucity of extant occurrences (three) compared to historical (thirteen) occurrences could be interpreted as decline, it is the author's opinion that the species is under-surveyed and under-reported. Given insufficient information, the first conservation objective for *Sporobolus compositus* var. *compositus* in the state must be to make dedicated searches for the species, especially in areas where it is historically known. The fact that the species is easy to overlook combined with the availability of suitable, non-specialized habitat, especially in coastal regions where it was historically reported, suggests that the species might be more common than reported. The fact that two new occurrences were discovered in Connecticut in one day during field work for this plan lends support to the notion that the species is under reported.

The conservation objective for Rhode Island is the same as for Massachusetts. Dedicated searches for *Sporobolus compositus* var. *compositus* need to be made first in areas where specimens have been historically collected. Secondarily, *de novo* searches should be made in suitable habitat (coastal sandy fields).

In Connecticut, the conservation objective is to maintain the 35 extant occurrences. Thirteen of these 35 occurrences are proposed as higher priority for conservation actions. These higher-priority occurrences are chosen partly to reflect the species' geographic extent and the diversity of habitats where the species is found in the state. Additionally, occurrences found in more natural (even though sometimes

disturbed) habitats were chosen to receive a higher priority for conservation actions. The reasoning behind this prioritization is that in most cases the natural habitats have other conservation values that are worth protecting, such as rare species or natural communities, in addition to the *Sporobolus compositus* var. *compositus*. In contrast, roadside habitats that are of obvious artificial origin and usually dominated by non-native species, usually lack other conservation values and are problematic for protection. The 22 occurrences of lower conservation priority are mostly at sites of less conservation value. They are located in artificial habitats, or in replicate habitats of the higher priority occurrences.

The goal for number of genets per occurrence of these priority Connecticut occurrences is distributed as follows:

- Seven occurrences with at least 50 genets
- One occurrence with at least 100 genets
- One occurrence with at least 150 genets
- One occurrence with at least 300 genets
- Two occurrences with at least 1000 genets
- One occurrence with at least 100,000 genets

Furthermore, flowering genets should comprise at least 75% of the total genets of each occurrence. The target number of genets per occurrence is based on a slightly higher figure (rounded up to the next fifty) than the highest number of genets recorded for each occurrence, or the highest figure when a range was given for number of genets at a site. The target of a minimum 75% fruiting individuals per occurrence appears to be an obtainable fruiting rate since 70% was the lowest percentage reported for these occurrences. One hundred percent fruiting rate was not uncommon, though this may be high. Time constraints, especially when surveying large populations, likely leads to vegetative genets, especially small ones, being missed.

The rationale for these objectives is predicated upon the belief that *Sporobolus compositus* var. *compositus* is native in New England, even though the species acts as a ruderal in many instances. Even in the center of its range in the Great Plains, it is often weedy in habit. So, it is not surprising that it would exhibit such tendencies at the edge of its range, particularly in a region dominated by forest vegetation. Furthermore, the species also grows in natural environments in New England, particularly in seashore habitats (both on outcrops and beaches/edges of estuaries) and on dry limestone (marble, dolomite) outcrops. The occurrences on limestone outcrops along Lake Champlain in Vermont appear very natural, both because of the relatively few alien species co-occurring with the *S. compositus* var. *compositus* at these sites, and because of the remarkable similarity these sites have to one another. Rare waif introductions in such similar but separated habitats (but not elsewhere) seems very unlikely. The species' persistence at one of these limestone lakeshore sites for 125 years is additional evidence of it being native in Vermont.

This being said, it is also plausible that some populations, especially along railroads, some highways, and in waste ground, are adventive. *Sporobolus compositus* var. *compositus* could be transported by trains and vehicles along these human travel corridors. It is also possible that some plants get established through seed mix used in highway landscape work. The *Sporobolus compositus* var. *compositus* seed could be intentionally included in a warm-season grass mix, or accidentally included in a conservation seed mix. A number of botanists, both in New England (Sorrie and Somers 1999, Moorhead on Connecticut field forms, Weatherbee – see MA [2] Stockbridge) and in other northern states and provinces (Fassett 1951, Voss 1972, Reznicek 1984) have suggested that at least some populations are not native.

There has been no genetic research, however, into the origins of New England plants. Hence, the assumption made in this plan is that the species is native throughout New England. Given the large number of occurrences in the region, there must be prioritization among the occurrences for conservation action. Sites where the species occurs in natural habitats should be given priority for conservation action. Natural communities supporting *Sporobolus compositus* var. *compositus*, as well as other rare species, can potentially benefit from the conservation actions and protection associated with the *Sporobolus compositus* var. *compositus*.

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IV. APPENDICES

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1. **Unpublished Data References**

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

1. Unpublished Data References

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Department of Environmental Protection
79 Elm Street
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Massachusetts Natural Heritage and Endangered Species Program (MANHESP)
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Vermont Nongame and Natural Heritage Program
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Waterbury, VT 05671-0501 USA

2. 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.