New England Plant Conservation Program

Piptatherum canadense (Poiret) Dorn
Canada Ricegrass

Conservation and Research Plan
for New England

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SUMMARY

Piptatherum canadense (Poiret) Dorn (Poaceae) is a perennial grass that is broadly distributed from the Canadian Maritime Provinces to the Alberta-British Columbia border and extends southward into northern New England and the northern Great Lakes States. Although it is widely distributed in forested regions of northern North America, the species is apparently nowhere common, and it is ranked as rare in 12 of the 15 states or provinces in which it is known to occur. It is considered to have been extirpated from Prince Edward Island. In New England, *P. canadense* occurs only in Maine and New Hampshire, with most of the extant and historic occurrences in Washington and Hancock counties of Maine. It is ranked S2 (rare) and listed as a Special Concern species in Maine, which hosts eight extant populations. In New Hampshire, where there are two extant populations, the species is listed as Endangered and ranked S1 (very rare). Three extant populations are known from northern New York, where *P. canadense* is ranked S1S2 and is listed as Threatened. This grass appears to be most common in central Quebec and central Ontario, but there are only 23 and 18 documented extant occurrences, respectively.

The species has recently been placed in the genus *Piptatherum*, and many botanists are more familiar with the name *Oryzopsis canadensis*. *Piptatherum canadense* grows in open areas in dry (or occasionally moist), sandy or very rocky, nutrient-poor soils. It occurs most frequently in openings in fire-prone coniferous forests or ericaceous shrub heaths; it is also known from rocky lakeshores as well as talus and exposed bedrock of high-mountain slopes. Disturbances that periodically create open canopy and bare soil conditions are very important characteristics of the species' habitat.

Major threats to the persistence of *Piptatherum canadense* in New England include succession, disruption of natural disturbance regimes, physical damage to road- and trail-side populations, and conversion of habitat to commercial blueberry fields. Interestingly, some of the same factors that pose threats also help to create appropriate habitat conditions. Road maintenance activities and traffic serve to suspend succession and maintain open soil, and management of blueberry fields by fire helps to maintain appropriate habitat at the edge of commercial production fields. Changes in management practices, however, can alter those factors from being beneficial to posing threats.

Conservation objectives for *Piptatherum canadense* in New England are to maintain a minimum of eleven occurrences (all currently known populations) and strive to increase or maintain minimum population size to the greater of 20 plants or the current population size. Necessary conservation actions include discussions with landowners and managers; monitoring; research on seed-banking, reproductive ecology, population biology, and impacts of various disturbance regimes; habitat and site management to maintain disturbance regimes and limit impacts of pedestrian and vehicular traffic; and searches to relocate historic occurrences and look for new ones.

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

Piptatherum canadense (Poiret) Dorn is a perennial grass (Family Poaceae) that occurs from the Canadian Maritime Provinces across central Canada to the Alberta-British Columbia border and extends southward into northern portions of New England, New York, and the Great Lakes States; disjunct populations occur in West Virginia. This conservation plan is intended to present what is known about the species' distribution, biology, and habitat requirements, to elucidate the present and potential threats to the species persistence in New England, and to recommend conservation actions that can ameliorate those threats and help to secure viability of the species in New England.

Piptatherum canadense grows most often in dry, nutrient-poor soils that are sandy or rocky, where the vegetation is sparse or has openings created by frequent disturbance. The species is also known from moist peaty and seepy rocky habitats. Disturbances that contribute to suitable habitat conditions include fire, cryoturbation (disturbance of soil by freeze-thaw action), ice scour, and mechanical disturbances that both bare the soil and remove tree and shrub canopies. Although habitat appears to be abundant in many parts of the species range, *Piptatherum canadense* is not known to be particularly common in any part of its range, and most of the known populations are relatively small (often under 100 plants, apparently not in the 1000s of plants). The grass is ranked very rare or rare in 12 of the 15 states or provinces where it is documented to occur, and it is apparently uncommon in the three remaining political divisions. It is presumed to have been extirpated from one province.

Piptatherum canadense is recognizable by its narrow, involute (or nearly so) leaf blades, its open panicle, and its large florets that have persistent, twisted and bent awns. The lemma is hard and dull-brown, and the awn is terminal. *Piptatherum canadense* is closely related to and closely resembles *P. pungens,* but the two are easily distinguished by the long awn and the more open panicle of *Piptatherum canadense*. In New England, *P. canadense* flowers in mid-June to late-July; seed maturation and dispersal appear to occur rapidly after the onset of anthesis. No reports were found in the literature about either seed dispersal or seed-bank characteristics of this grass or others that are closely related. Little is known about the reproductive ecology or population biology of either *P. canadense* or *P. pungens;* no scientific papers documenting details of the species' biology were located during the preparation of the plan.

In New England, *Piptatherum canadense* is known only from Maine and New Hampshire. The regional conservation status of the taxon in New England is listed as "Division 4: Historic Taxa" (Brumback and Mehrhoff et al. 1996), but since the publication of that list it has been relocated in both states in which it had historically been documented. In Maine, eight extant and ten historic occurrences have been recorded; in New Hampshire, two extant occurrences, plus one presumed to be extant are known; one occurrence is historic. Most species occurrences in the region are in Washington County

in Downeast Maine, and most of them are in or on the edges of blueberry (*Vaccinium*) heath vegetation. The species is listed as "Endangered" in New Hampshire. Four of the eleven extant populations are on public lands (including that presumed to be extant), with an additional population in a Special Value Area on lands protected by a Forest Legacy easement; a state agency is responsible for enforcement of the easement.

The major threats to *Piptatherum canadense* are 1) succession to closed forest or shrub canopies and, related to this, disruption of natural disturbance regimes; 2) physical damage to populations that are alongside roads or trails; and 3) conversion of habitat to commercial blueberry fields. It is interesting to note that some of the same factors that potentially threaten populations may also help to create appropriate habitat conditions. For example, roadsides are usually the last places where tree and shrub succession leads to closed canopies, and thus edges of roads provide appropriate open canopy and bare soil conditions; changes in road use or maintenance practices, however, can lead to eradication of populations.

Conservation objectives for *Piptatherum canadense* in New England are to maintain a minimum of eleven occurrences (all currently known populations) and strive to increase or maintain minimum population size to the greater of 20 plants per occurrence or the current population size. Downeast Maine is suggested as a focal area for conserving *P. canadense* in New England, but it should not be the only location for its conservation. Conservation actions that will help meet the objectives include the following: discussions with landowners and managers; monitoring; *ex-situ* activities, especially regarding seed-banking capabilities; species biology research, especially regarding reproductive ecology, population biology, and impacts of various disturbance regimes; habitat and site management, both to maintain appropriate disturbance regimes and to keep people from physically damaging plants in frequently accessed areas; and searches to relocate historic occurrences and look for new ones.

Conservation planning for *P. canadense* in New England is important because so many of the populations are small, so little is known about the species, the grass is rare throughout most of its range, and contemporary use and management of sites and landscapes has dramatically altered the presettlement disturbance regimes to which the species was adapted. This conservation plan is presented with the hope that it will engender conservation actions and scientific research that will contribute to the survival of *Piptatherum canadense* in New England and the greater extent of its range.

DESCRIPTION

Piptatherum canadense (Poiret) Dorn is a loosely tufted, 30-80 (-90) cm-tall, perennial grass (Fernald 1950, Hitchcock 1950, Gleason and Cronquist 1991). Leaf blades are narrow, 1-2 mm, and are flat to involute; the membranous ligule measures 1.5-3 mm long (Fernald 1950, Hitchcock 1950, Voss 1972, Dore and MacNeil 1980, Seymour 1982, Gleason and Cronquist 1991). Flowering and fruiting culms are as long as or somewhat longer than the leaves, which are sparse above the middle of the culm.

The panicle is open (8-15 cm wide), with 5-10 cm-long, slender, flexuous branches that are widely spreading to somewhat ascending. Spikelets are one-flowered and loosely clustered towards the distal ends of panicle branches; thus, the inflorescence has a few-flowered appearance. Glumes are equal in length, 3.5-5 mm long, thin-herbaceous, and elliptic-obovate; glumes slightly exceed the lemmas. Lemmas are hardened (indurate) at maturity, dull brownish in color, 2.5-4 mm long, and have a moderately sparse, appressed, short pubescence (appressed-pilose). Lemmas have a terminal awn which measures 6-11 (-20) mm, and has both a crook in the basal half and a twist or coil. The palea is nearly fully included in the lemma. Dispersing fruits disarticulate above the glumes. Late-season plants are recognizable by the narrow to involute leaves and the open inflorescence, which retains the thin-herbaceous, tan glumes.

Piptatherum canadense is very similar to, but rather easily distinguished from, closely related *P. pungens.* Both species are loosely tufted grasses with narrow, more or less involute leaves, and spikelets that are smaller (3.5-5 mm) than the other closely related sympatric species. Both species also grow in dry, nutrient poor-soils in habitats that are often described as "barrens," and they may grow together or in close proximity. The three most apparent differences between the species are in awn length, plant height and panicle characteristics. *Piptatherum canadense* has a very apparent 6-10 mm-long, twisted awn, whereas *P. pungens* has an awn either less than 2 mm long or early-deciduous or lacking. Differences that are especially useful if flowers or fruits are lacking are that *P. canadense* is a taller plant and its panicle is slightly longer-branched and clearly more open than the narrow, ascending panicle of *P. pungens.* The other two similar northeastern North American species, *Oryzopsis asperifolia* and *Piptatherum racemosum*, both have much broader leaves and substantially larger spikelets than *P. canadense.* The former has leaves that are all basal or nearly so; the latter has a shiny black lemma. *Oryzopsis asperifolia* does occur in some of the same habitats as *P. canadense. Piptatherum racemosum* most often occurs in nutrient-rich, calcareous woods throughout its range. In the Midwest, however, *P. racemosum* is occasionally found on wooded dunes and less frequently with jack pine and oak (Voss 1972).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

The grass *Piptatherum canadense* is a member of the tribe *Stipeae*, a cosmopolitan group that includes approximately 500 species. Characteristics of the tribe are a single floret per spikelet, no rachilla extension, glumes that usually extend well beyond the lemma apex, a well developed callus, a lemma that is usually stiff or hard, and a terminal, usually articulated awn (Barkworth 1993). Although the tribe's position within Poaceae had been questioned in the past (Barkworth 1981), recent phylogenetic work has placed the Stipeae tribe squarely within the subfamily Pooideae (Grass Phylogeny Working Group 2001). Pooideae is comprised of C_3 grasses of boreal and cool temperate regions and tropical high mountains (Grass Phylogeny Working Group, no date).

Relationships within the *Stipeae* have long been questioned (Parodi 1944, Kam and Maze 1974, both cited in Barkworth 1993). Although generic limits of *Oryzopsis* and *Piptatherum* have been a part of the controversy, recent molecular and morphological/ anatomical analyses have suggested that the species of the *Piptatherum/Oryzopsis* complex, with members from America, Europe, and Asia, are basal to the *Stipeae* tribe (Jacobs et al. 2000). Setting generic limits based on such analyses, Barkworth (1981, 1982, 1993) and Jacobs et al. (2000) have concluded that only one species in North America, and perhaps globally, belongs in the genus *Oryzopsis.* The newest treatment thus leaves *Oryzopsis asperifolia* as monotypic and places the other New England species that were traditionally in *Oryzopsis* into *Piptatherum* (Barkworth et al. 2003). The new combinations are thus *Piptatherum canadense, P. pungens,* and *P. racemosum.*

Piptatherum canadense (Poiret) Dorn is a new combination, published on page 377 of *Vascular Plants of Wyoming*, Third edition (Dorn 2001). The numerous synonyms for *Piptatherum canadense* are *Oryzopsis canadensis* (Poiret) Torrey, *O. juncea* Britton, Sterns and Poggenburg, *O. macounii* (Scribner) Beal, *Stipa canadensis* Poiret, *Stipa juncea* Michaux, *S. macounii* Scribner, *Urachne canadensis* (Poiret) Torrey. The basionym is *Stipa canadensis* Poiret, published in 1806.

The species that is most similar to *Piptatherum canadense* based on anatomy, morphology, and habitat preferences is *Piptatherum pungens.* Barkworth (1993) states, "Morphologically *O. canadensis* [*P. canadense*] and *O. pungens* [*P. pungens*] are quite similar, differing chiefly in the length and persistence of their awns…." The close relationship of the two species based on morphological/anatomical characteristics is also supported by nuclear rDNA analyses (Jacobs et al. 2000). *Piptatherum pungens* has a slightly broader western and southern distribution than does *P. canadense.* The former occurs from the mid-Atlantic coast northward and across to western British Columbia; the latter, as is discussed in more detail below, extends only as far west as the Alberta-British Columbia border and reaches its southern range limit in northern New England.

SPECIES BIOLOGY

Piptatherum canadense flowers in New England from mid-June to mid- or late-July (based on Seymour (1982) and Maine and New Hampshire Element Occurrence data). Fruit maturation and dispersal appear to occur rapidly, within several weeks of anthesis. Fecundity is apparently high, as most spikelets appear to produce fruits that disperse. As with most grasses, the species is wind pollinated. No vegetative reproduction is noted in the literature (Fernald 1950, Hitchcock 1950, Voss 1972, Dore and McNeil 1980, Seymour 1982, Gleason and Cronquist 1991); the loosely caespitose growth habit with individuals scattered or few together suggests that there is either no vegetative reproduction or that it is a very limited and not a prolific means of reproduction.

Seed dormancy and germination characteristics are not known. Since *P. canadense* appears to be well adapted to fire and other relatively frequent disturbances which create the bare soil that the grass apparently needs to establish and persist (Blaney, Atlantic Canada Conservation Data Centre, personal communication; Gilman, consulting botanist, personal communication; Hunt, consulting ecologist, personal communication; Jenkins, consulting botanist, personal communication), it is probable that the species can lie dormant in a seed bank.

Neither herbivory, nor parasitism, are documented in the literature. Gilman, (personal communication) reported that ergot (*Claviceps purpurea*) is known from *Oryzopsis* hosts. None of the field forms filed with the New Hampshire, Maine, or New York Natural Heritage Programs (or their equivalents in those states) indicated that observers had noticed any damage to individuals in the observed populations. Endophytic infection by *Balansia*, an ascomycete fungus, is reported for one species of *Oryzopsis* and infection by the ascomycete *Atkinsonella* is reported in *Stipa;* it is not known whether these relationships are parasitic or mutualistic but photosynthetic and reproductive performance is known to have been altered by endophytic fungal infection (Chapman 1996).

Interestingly, *P. canadense* does not seem to often form large populations, and it is not documented to occur with any regularity in the abundant, apparently suitable habitat throughout most of its range. The grass is widely distributed but apparently nowhere common. Oldham (Ontario Natural Heritage Information Centre, personal communication) estimates from his observations that larger populations of the species are in the "high dozens to low hundreds, not in the thousands," but in New York, two populations were documented as having thousands of individuals.

HABITAT/ECOLOGY

The words that are most frequently used to describe *Piptatherum canadense* habitat, both in flora manuals (Marie-Victorin 1935, Fernald 1950, Hitchcock 1950, Voss 1972, Scoggan 1978, Seymour 1982, Gleason and Cronquist 1991) and in Element Occurrence descriptions, are "dry," "sandy," "open," "rocky," "barrens," "acidic," "nutrient-poor," and "peaty"; "talus," and "moist" are less often used. Although not mentioned in the literature, periodic disturbance appears to greatly benefit the species (personal observation; Blaney, Gilman, Hunt, Jenkins, personal communications).

In New England and northern New York – the southern extents of the species range – *Piptatherum canadense* grows most often in open, frequently disturbed, acidic, sandy habitats, with ericaceous shrubs and open-canopy pine or spruce forest. The southernmost habitats are openings in dry, recently burned, or otherwise disturbed woods, or shrub heaths. Populations are known from eskers with open forest, edges of blueberry (*Vaccinium*) fields, pitch pine (*Pinus rigida*) plains, a river shore, and high-mountain slopes with much bare rock and talus. Northward, the species is found in sandy or peaty heath barrens, jack pine (*Pinus banksiana*) plains, and various habitats along the

shores of Lake Superior and the lower St. Lawrence River, including but perhaps not limited to rocky shores. In Newfoundland, several populations are known from seepy talus slopes. In addition to sites being open, acidic, and usually dry, frequent disturbance, whether by fire, clear-cutting, dirt-road maintenance, ice scour, downslope movement of talus, or frost-heaving is a common element that ties together the habitats in New England and New York.

Piptatherum canadense typically grows in New England as scattered individuals or in small groups. Associate species include *Vaccinium angustifolium, Kalmia latifolia, Comptonia peregrina, Danthonia spicata, Pteridium aquilinum* and trees such as *Abies balsamea* and *Picea rubens,* or *Pinus strobus* and *Pinus resinosa,* or *Pinus rigida* and *Quercus ilicifolia.* Natural heritage program data indicated that in only one vegetation type in New England or New York does the grass constitute a substantial proportion of the vegetation. New York's Northern Appalachian Ecoregion variant of the "successional northern sandplain grassland" natural community is described as having 25-50% cover of "sandplain" grasses, predominantly *P. canadense* and *Deschampsia flexuosa* (Hunt 1998). Hunt (1998) mentions that fire may be an important part of the disturbance regime, and notes that infrequent large-scale anthropogenic fires may be necessary for maintaining some high-quality occurrences of the natural community.

THREATS TO TAXON

Despite its broad geographic distribution, *Piptatherum canadense* is rare in New England due to specificity of habitat, especially with regard to soil conditions and disturbance regime. It is also rare due to small population size at almost every occurrence. As such, it faces a number of threats. The need for frequent disturbances that create bare-soil areas under open tree- and shrub-canopy conditions renders nearly all populations susceptible to the threat of tree- or shrub-canopy closure due to succession. Natural disturbance regimes, including interactions of spruce-budworm cycles and fire, have been altered by forest management, timber extraction, pest control activities, and blueberry cultivation. Disruption of natural disturbance regimes, especially natural fire cycles, is a threat to some populations (NH .003 [Conway], and perhaps ME .011 [T40 MD] and .015 [Cherryfield]). On the other hand, management of many of the sites in New England has promoted fire (for either commercial blueberry production (ME .012 [T24 MD BPP], .013 T25 MD BPP], and perhaps .014 [T18MD BPP]) or wildlife habitat management (ME new3) [Steuben]), and that has apparently benefited the species.

Several of the populations in New England occur beside roads (ME .011 [T40 MD], .012 [T24 MD BPP], .014 [T18MD BPP], NH .003 [Conway]). Road maintenance and traffic patterns at those sites (i.e., low use, but enough currently or in the past so that roads are still openings in the woods) appear to have benefited the populations by halting canopy closure and maintaining areas of open soil. Conversely, changes in road management practices or traffic patterns pose a potential threat to those populations. Total or near lack of traffic on small woods roads could enable trees and shrubs to crowd

out *Piptatherum canadense* at such sites. Increased traffic or widening of such roads could negatively impact populations by physical smothering or eradication of plants, or it could allow *P. canadense* to spread into some of the newly bared ground. Because of the disturbance requirements of the species and our lack of knowledge of its seed-banking and dispersal characteristics, it is difficult to predict the effects of those impacts on the local populations. Physical damage to the plants is also a potential threat to populations close to areas of frequent human activity, such as hiking trails (NH .004 [Chatham]) and river access areas (ME .015 [Cherryfield]).

Many of the New England populations are in Downeast Maine, especially Washington County, where commercial blueberry production is a major economic activity with impacts on substantial acreage of potential *Piptatherum canadense* habitat. Conversion of lands to blueberry fields could have negative or positive impacts on the species. A regime of frequent fire management may be beneficial to the grass, but other potential blueberry field management practices, especially herbicide application, could threaten rare plants at sites. Most herbicides applied are likely broad-leaf specific, however, and would thus purportedly not harm the grass (Gilman, personal communication). Very frequent and/or very hot fires could be detrimental to populations, but there is no information available about fire interval or intensity and their positive or negative influences on *Piptatherum canadense*. Gilman (personal communication) suggested that blueberry-field prescribed fires are not very hot.

Threats to the taxon in other parts of its range have not been thoroughly investigated. It would appear that populations in the northernmost part of the range (e.g., Central Ontario and Quebec; areas around Hudson's Bay and Great Slave Lake) are less threatened because disturbances, be they natural fires or clearcutting, occur frequently (Oldham, personal communication). Populations on the shores of Lake Superior are likewise probably not under much threat, as those areas do not have much human recreation pressure and, with their poor soils and frequent disturbance by wind, fire, or even ice, naturally remain open. Similarly, Newfoundland populations on talus slopes and tablelands of Gros Morne and other mountains are also probably not subject to much threat. Populations in New York are clearly threatened by forest succession (Hunt, personal communication, Jenkins, personal communication); one population has experienced a documented decline over the past 30 years as a formerly burned area has succeeded to forest.

DISTRIBUTION AND STATUS

General Status

Piptatherum canadense occurs from Newfoundland to the Alberta-British Columbia border, from a northern location at Great Slave Lake to southern locations in northern New Hampshire and the northern Adirondack Mountains; disjunct populations occur in West Virginia (Figure 1). The Global Heritage Status Rank is G5; the National

Heritage Status Rank for the United States is N2, and for Canada is N4N5 (NatureServe Explorer 2003).

Botanical collections suggest that the species is nowhere exceptionally common. In fact, *P. canadense* is rare in most of the states and provinces in which it occurs, including Maine, New Hampshire, New York, Michigan, West Virginia, Wisconsin, Manitoba, New Brunswick, Newfoundland, Nova Scotia, and perhaps Alberta (Table 1). It occurs most frequently in Ontario and Quebec, where it is known from the eastern shores of central Hudson's Bay southward to the St. Lawrence River and the shores of Lake Superior. It is also more common than elsewhere in Michigan's Upper Peninsula and northern Lower Peninsula and in central Saskatchewan. *Piptatherum canadense* is considered to have been extirpated from Prince Edward Island.

Several pieces of inconsistent information need to be addressed. The Alberta Natural Heritage Information Centre has documentation for many fewer occurrences than are marked on the recent *P. canadense* map on the Grass Manual on the Web (Barkworth et al. 2003). Two other inconsistencies noted are Hitchcock's (1950) listing of the species as occurring in Minnesota and Wyoming. Hartman (Rocky Mountain Herbarium, personal communication) reported that in Wyoming the species has not been located; Wyoming botanists have not searched herbaria to determine the source of Hitchcock's information. For Minnesota, the grass is listed in neither the Annotated Checklist of the Flora of Minnesota (Cholewa 2002), nor in Vascular Plants of Minnesota (Minnesota Department of Natural Resources 2002). Additionally, NatureServe's website lists *P. canadense* as S1 in Virginia and S? in South Carolina; botanists have uncovered no records of the grass in those states. Finally, the regional conservation status of the taxon in New England is listed as "Division 4: Historic Taxa" (Brumback and Mehrhoff et al. 1996), but since the publication of that list it has been relocated in both states from which it was historically known.

Flint (1877), in "Observations upon the distribution of plants in New Hampshire and Vermont," wrongly concluded that *Piptatherum canadense* was part of the more southern Alleghanian flora based on occurrences in the pitch and red pine (*Pinus resinosa*)-white oak (*Quercus alba*) forests on high terraces at the mouths of the Lower Ammonoosuc and Wells rivers. There is no record of those occurrences in the contemporary record, and Flint's observations may be referring to misidentified *Piptatherum pungens.* Regardless, *P. canadense* is clearly part of a northern, not an Alleghanian, flora.

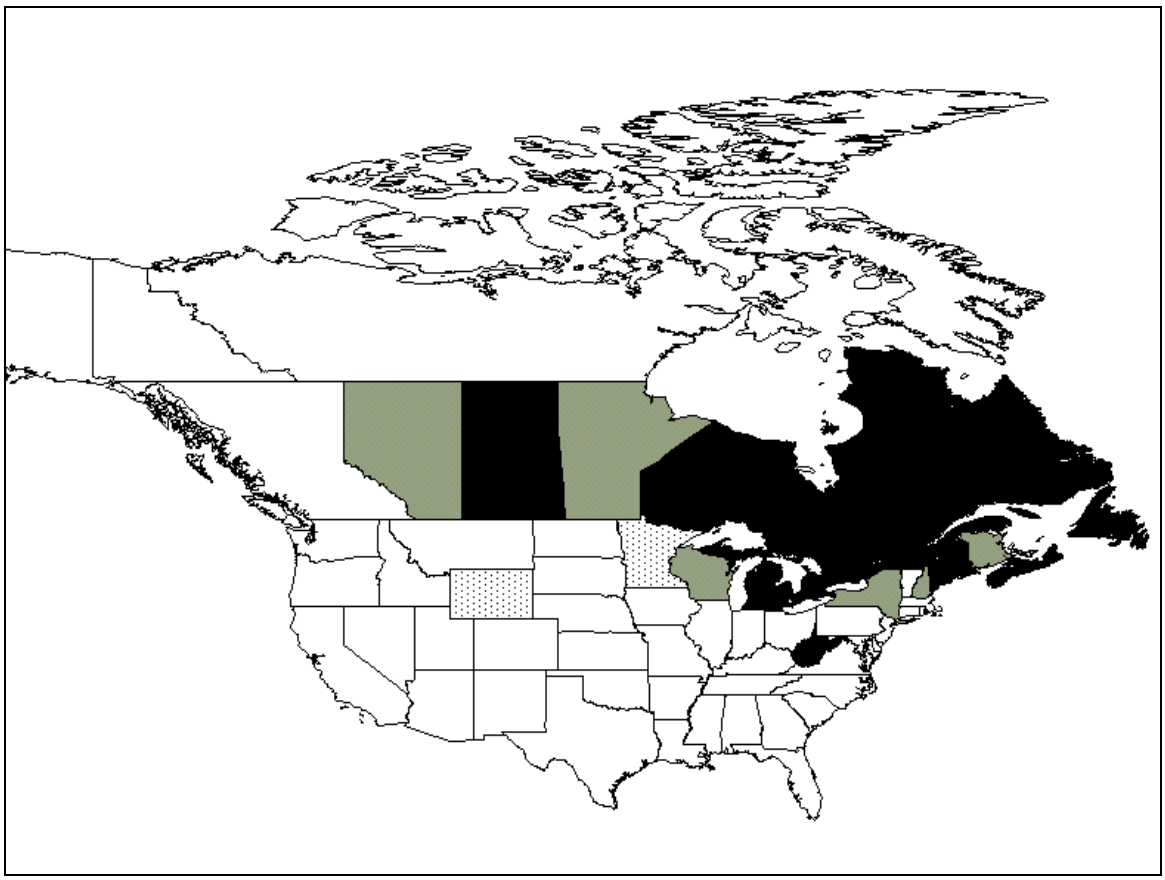

Figure 1. Occurrences of *Piptatherum canadense* in North America. States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. The province (Prince Edward Island) with diagonal hatching is designated "historic," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but not necessarily verified). See Appendix for explanation of state ranks.

Table 1. Occurrence and status of *Piptatherum canadense* 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)**
Maine (S2, SC): 8 extant and 10 historic occurrences	Ontario (S4): At least 18 occurrences (Dore and McNeill 1980), "but in a relatively poorly botanized region" (Oldham, personal communication)	Minnesota (SR): Not listed in either Cholewa (2002) or Minnesota Department of Natural Resources (2002)	Prince Edward Island (SH): 1 historic occurrence
New Hampshire (S1, E): 3 extant occurrences and 1 historic	Labrador (S?): no records in the database of the Atlantic Canada Conservation Data Centre, but a report of *P. pungens* from western Labrador is likely *P. canadense* (Djan-Chekar, Newfoundland and Labrador Inland Fish and Wildlife Division, personal communication)	Quebec (SR): 23 occurrences (Dore and McNeill 1980)	
New York (S1S2, E): 3 extant occurrences and 1 historic		Wyoming (SR): despite an active program of collecting in the past 25 years, there is no record of the species, although it is reported from WY in Hitchcock (1950) (Hartman, personal communication)	
Michigan (S2, T): 21 occurrences, 6 of which have not been observed since the 1960s			
West Virginia (S1): 6 extant occurrences (5 of which are on the same mountain)			
Wisconsin (S1, SC): 4 extant and 2 historic occurrences			

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OCCURS & LISTED (AS S1, S2, OR T &E)	**OCCURS & NOT LISTED (AS S1, S2, OR T & E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
Alberta (S1, "May be at Risk" (status as reported by Rintoul, Alberta Natural Heritage Information Centre, personal communication)): 1 extant, 2 historic, and 3 extirpated occurrences			
Manitoba (S1): 2 extant and 2 historic occurrences			
New Brunswick (S2): 5 extant and 4 historic occurrences			
Newfoundland (S2): 6 extant and 9 historic occurrences			
Nova Scotia (S2): 6 extant and 9 historic occurrences			
Saskatchewan (S2): 20 occurrences distributed throughout southern part of province; most recent observations were 2 in the 1980s and 6 in 1972-73			

Status of All New England Occurrences — Current and Historical

In New England, there are 22 occurrences of *Piptatherum canadense*, of which ten are extant, one is presumed to be extant, and 11 are historic (Table 2). Eight of the extant and 10 of the historic occurrences are in Maine, while in New Hampshire there are two extant occurrences, one occurrence presumed to be extant, and a single historic occurrence.

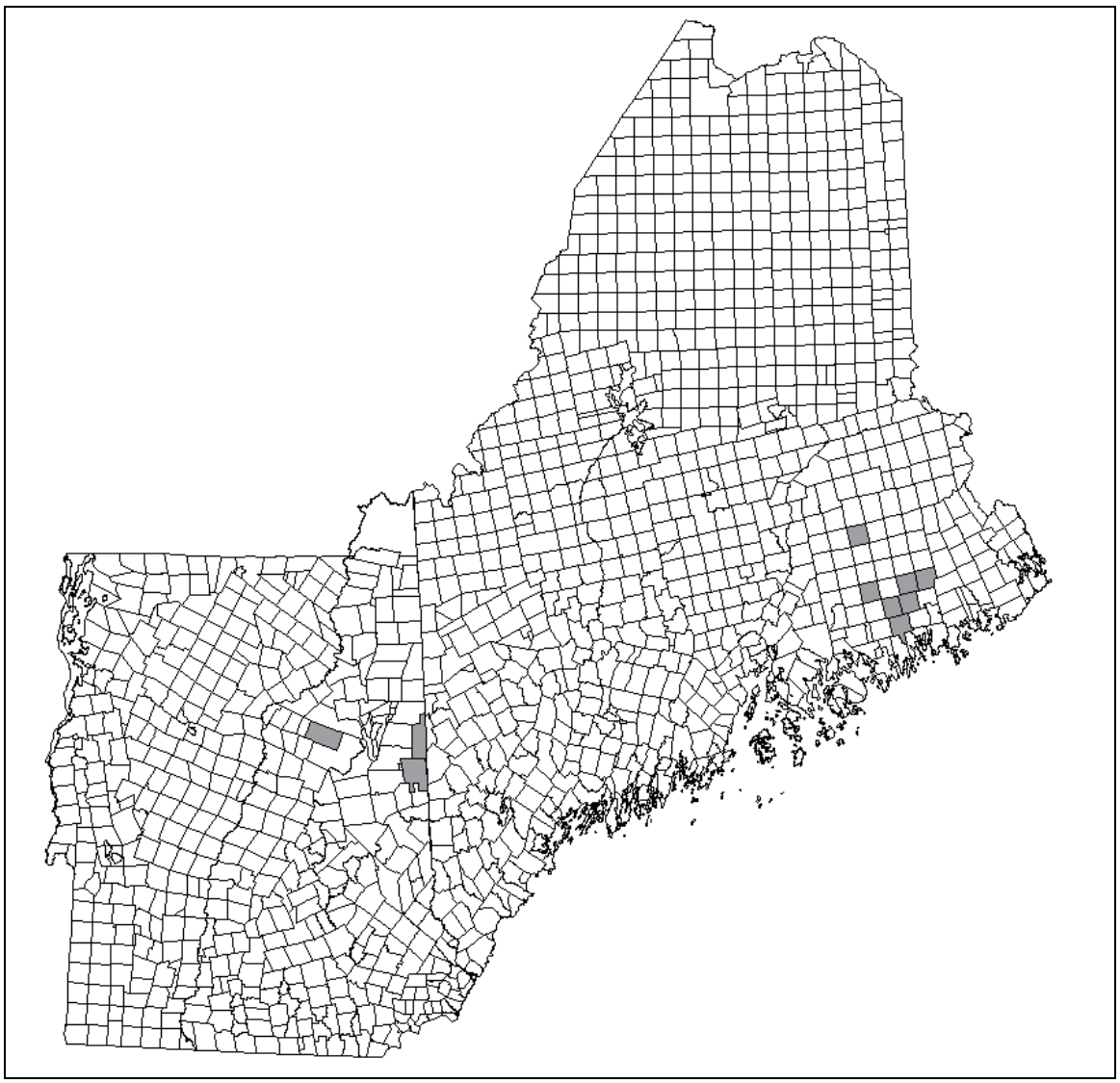

Figure 2. Extant occurrences of *Piptatherum canadense* in New England. Town boundaries for northern New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon.

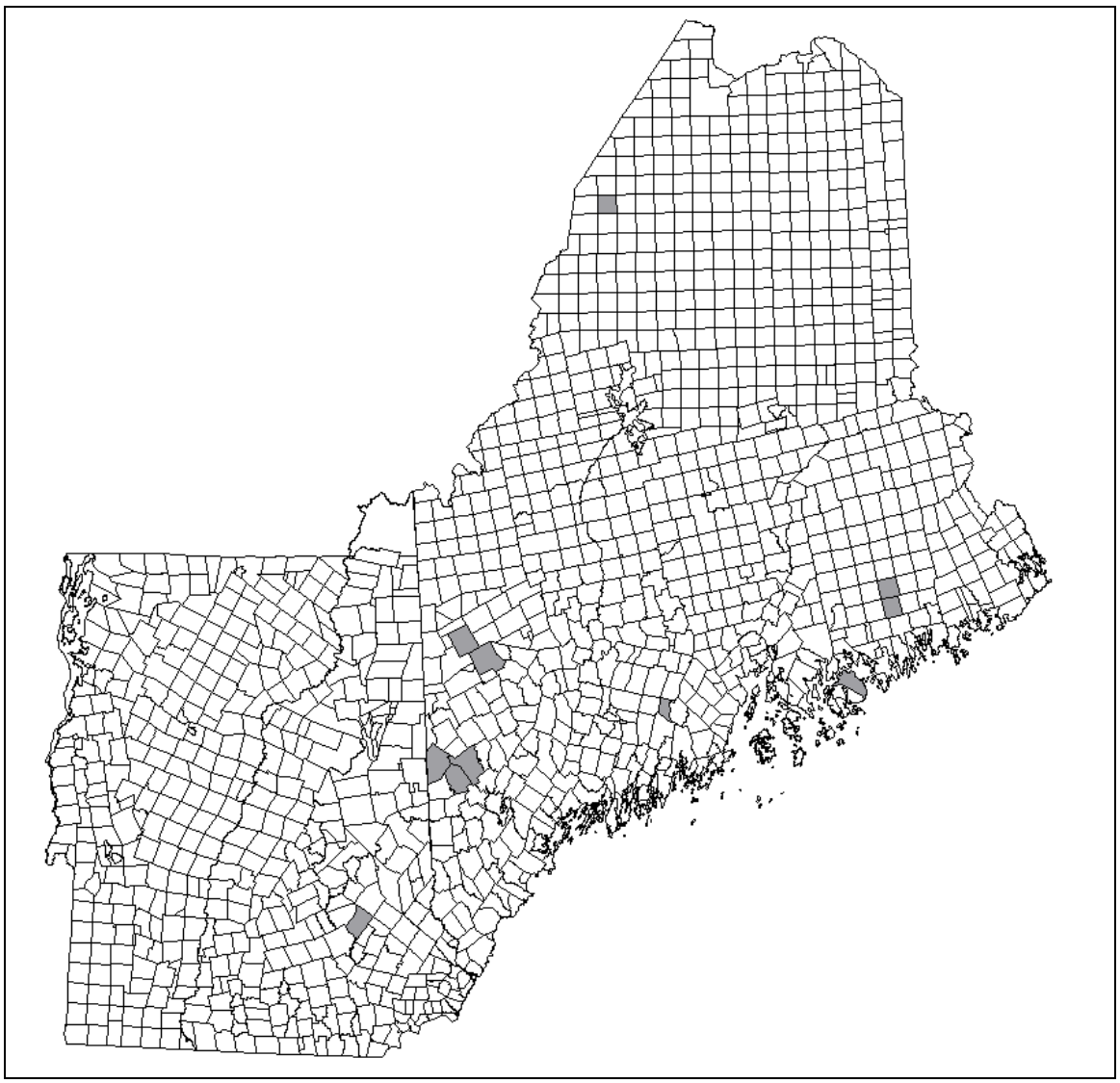

Figure 3. Historical occurrences of *Piptatherum canadense* in New England. Towns shaded in gray have one to five historical records of the taxon.

Table 2. New England Occurrence Records for *Piptatherum canadense.* Shaded occurrences are considered extant.			
State	**EO #**	**County**	**Town**
ME	.001	Washington	Beddington
ME	.002	Oxford/ Cumberland	Fryeburg/ Bridgton/ Denmark
ME	.003	Knox	Isle au Haut
ME	.004	Hancock	Bar Harbor
ME	.005	Aroostook	T11 R16 WELS
ME	.006	Oxford	Andover
ME	.007	Oxford	Rumford
ME	.008	Lincoln	Somerville
ME	.009	Washington	Deblois
ME	.010	Hancock	Bar Harbor
ME	**.011**	**Hancock**	**T40 MD**
ME	**.012**	**Washington**	**T24 MD BPP**
ME	**.013**	**Washington**	**T25 MD BPP**
ME	**.014**	**Washington**	**T18 MD BPP Deblois**
ME	**.015**	**Washington**	**Cherryfield**
ME	**new1**	**Washington**	**T22 MD**
ME	**new2**	**Washington**	**T30 MD**
ME	**new3**	**Washington**	**Steuben**
NH	.001	Merrimack	Loudon
NH	**.002**	**Grafton**	**Franconia**
NH	**.003**	**Carroll**	**Conway**
NH	**.004**	**Carroll**	**Chatham**

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Eleven extant occurrences of *Piptatherum canadense* are known from New England: eight in Maine and three in New Hampshire. The bulk of the populations are in Downeast Maine. There are also 12 historic occurrences, ten of which are from Maine. The species is not known to occur presently or to have occurred historically in any of the other New England states. Several of the extant populations occur on public lands, a situation that may make conservation management for the species easier to implement. It is also likely that there are undiscovered populations in Downeast Maine (Blaney, personal communication).

The overall conservation objective for *Piptatherum canadense* in New England is to maintain a minimum of eleven occurrences, the number of populations currently known. It seems likely, based on the recent trend of locating new populations, that there are more occurrences in Maine that have not yet been documented, and conservation of more than eleven occurrences may be practicable. Nevertheless, the apparently transient nature of some of the populations suggests that conserving every known occurrence may not be congruent with the species' population biology. The conservation objective of maintaining at least eleven occurrences may in fact be met by conservation of some known occurrences, some that are not yet known, and some that are relocated historic occurrences. The conservation objective for New Hampshire is to maintain all of the known occurrences (NH .002 [Franconia], NH .003 [Conway], NH .004 [Chatham]). The conservation objective for Maine is to maintain a minimum of eight occurrences, be they known extant occurrences, relocated historic occurrences, or newly discovered occurrences. All occurrences on lands that are public or are protected by conservation easements (ME .011 [T40 MD], ME .015 [Cherryfield], ME new3 [Steuben]) should be priorities for conservation.

Downeast Maine (especially Washington County) is the current stronghold for the species in New England, and that region should be a focal area for conservation of the species. Nevertheless, conservation in New Hampshire is also important. The extant populations in New Hampshire comprise 75% of all recorded occurrences in that state. Conservation of the three populations will provide for 1) conservation of the general historic range of the species across New England, 2) conservation of the genetic diversity that may exist due to isolation of those populations from the Maine ones (and from each other), and 3) conservation of the two mountain occurrences known to be extant in the region, which may be of importance to genetic diversity of the species in New England and throughout its range.

Population size is also an important consideration in planning for species conservation, because it influences the resilience of a population to ecological threats, stochastic events, and genetic threats including inbreeding depression (Brown 1989, Brown and Briggs 1991, both cited in Neel et al. 2001). Gene flow and subsequently

outcrossing rates are generally very high in wind-pollinated species (Govindaraju 1988, cited in Silvertown and Doust 1993), and in such species selection may act, both during and after seed maturation, against selfed individuals and against homozygotes derived from selfing and consanguineous matings (Neel et al. 2001). Changes in levels of inbreeding may not be detectable for many generations (Neel et al. 2001). Thus, even though little is known about genetic diversity or breeding systems within (or among) populations of *Piptatherum canadense,* plant conservation genetics research and theory suggest that it is important to maintain large populations.

Therefore, an additional conservation objective is to increase population sizes at occurrences that have fewer than 20 individuals (ME .012 [T24 MD BPP], ME .013 T25 [MD BPP], ME .014 [T18 MD BPP Deblois], ME new 2 [T30 MD], perhaps ME new 1 [T22 MD], and NH .002 [Franconia]). There are no hard facts or research results to rely upon for setting population-size goals, but since many populations in the eastern Canadian provinces and about one-half of the populations in New England consist of over 20 individuals, a population size of 20 would seem to be a bare-bones minimum objective for occurrences that currently have fewer individuals; population sizes of 50 to 100 individuals would certainly be preferable over the bare-bones minimum. *Piptatherum canadense* population sizes may vary considerably over time in response to disturbance; such a pattern has been suggested for ME new2 (T30 MD) by Gilman (personal communication). Thus, it may be appropriate to strive for an average population size over a time period; it is difficult, however, to understand the appropriate time-scale for measuring population size of this species. Fluctuations in population size and area are related to the extent of appropriate habitat, frequency of disturbance, and intensity of disturbance. It is not known if declines to very small population sizes hinder recovery to larger numbers when conditions permit population increases.

Disturbance regimes should be manipulated to increase population spatial extent and population size at sites listed above. Habitat management is recommended as the primary method for increasing population sizes; however, fire and mechanical disturbance should be done cautiously, and should be conducted as replicated experiments. Research findings from these management trials should be used to inform further steps. Future research may suggest that active augmentation is warranted for very small populations, but until any research findings are obtained, that approach is not recommended here.

The population size objective for those occurrences that currently have more than 20 plants (ME .011 [T40 MD], ME .015 [Cherryfield], ME new3 [Steuben], NH .003 [Conway], and NH .004 [Chatham]) is to maintain population sizes at or above current numbers. The range in the most recent population counts for those occurrences is 20+ to 317. Habitat management is the strategy recommended for maintaining population size.

Since we know nothing about the genetic or seed-banking characteristics of *Piptatherum canadense,* these guidelines for minimum population size or maximum time interval between disturbances are provisional. Population monitoring and empirical research would provide much needed information about the ability of *P. canadense* to

either regenerate from a seed bank or persist in vegetative form through a disturbance, and would give a better indication of an appropriate minimum size per population. Conservation genetics research would inform minimum size with regard to homozygosity, inbreeding depression, and fitness in small populations. The objective of maintaining all eleven populations at a population-size minimum of at least 20 individuals has been chosen in the hope that the populations would produce enough viable seeds with which to regenerate plants and maintain genetic diversity after disturbance.

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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.