New England Plant Conservation Program

Cyperus houghtonii Torrey
Houghton's Flat Sedge

Conservation and Research Plan for New England

Prepared by:
Michael Lew-Smith
Ecologist/Botanist
Arrowwood Environmental
950 Bert White Road
Huntington ,Vermont 05462

For:

New England Wild Flower Society
180 Hemenway Road
Framingham, MA 01701
508/877-7630
e-mail: conserve@newfs.org • website: www.newfs.org

Approved, Regional Advisory Council, May 2003

SUMMARY

Houghton's flat sedge (*Cyperus houghtonii* Torrey) is a perennial herb in the sedge family (Cyperaceae). It is known from northeastern North America west to Manitoba, Minnesota and Illinois, and is uncommon throughout its range except in Wisconsin and Michigan. *Cyperus houghtonii* is considered a Division 2 species in *Flora Conservanda,* which is a designation given to plants that are regionally rare. It is Globally ranked G4, which indicates that it is apparently secure throughout its range but may be locally rare. There are 39 total occurrences in New England: 2 in Maine, 7 in New Hampshire, 18 in Vermont and 12 in Massachusetts; 17 total are currently considered extant. This species is considered historic in Maine and is listed as Threatened in New Hampshire and Vermont and Endangered in Massachusetts.

Throughout its range, *C. houghtonii* is found primarily on sandy, nutrient-poor soils, or soils that are shallow to bedrock. This species appears to be associated with some form of habitat disturbance. Historically, the major disturbance was most likely brought about by fire and, to a lesser extent, shifting sands. While some of the known occurrences are associated with fire, most of the current occurrences occupy habitats disturbed by human activities. The most significant threats to this species in New England are loss of habitat due to development and a lack of suitable disturbance regime such as fire.

There are three objectives for conserving this species in New England: 1) conserve the two largest known populations that exist in naturally-occurring (non-ruderal) communities, 2) survey likely natural habitat to discover at least five new occurrences each containing at least 300 individuals, and 3) protect six occurrences in ruderal habitats. The actions that must be taken to meet these objectives include conducting: regular surveys of known occurrences; searches for new populations; research on species biology and ecology; habitat and site management; and landowner education.

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.

This document should be cited as follows:

Lew-Smith, Michael. 2003. *Cyperus houghtonii* Torrey (Houghton's Flat Sedge) Conservation and Research Plan for New England. New England Wild Flower Society, Framingham, Massachusetts, USA.

I. BACKGROUND

INTRODUCTION

Houghton's flat sedge (*Cyperus houghtonii* Torrey) is a perennial herb in the sedge family (Cyperaceae). In the Midwestern United States, it is most often associated with jack pine (*Pinus banksiana*). In the Eastern United States, it is commonly associated with pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*), where it colonizes disturbed habitats and sites that are shallow-to-bedrock. It is a shade-intolerant species and appears to be associated with some form of disturbance. This disturbance can take the form of fire, wave- or current-action, or a wide variety of human-caused disturbances that open the canopy and scarify the soil.

This species is considered historic in Maine, Threatened in New Hampshire and Vermont and Endangered in Massachusetts. It is uncommon throughout its range in North America except in Wisconsin and perhaps Michigan. The main threats to this species are loss of habitat from development and the lack of a disturbance regime that favors this species.

The goal of this conservation plan is to update the current status of this species in New England, consolidate information known about this taxon, provide goals to conserve this species and specific steps to achieve those goals. There are three objectives for conserving this species in New England: 1) conserve the two largest known populations that exist in naturally occurring (non-ruderal) communities, 2) survey likely natural habitat to discover at least five new occurrences each containing at least 300 individuals, and 3) protect six occurrences in ruderal habitats. The actions that must be taken to meet these objectives include conducting: regular surveys of known occurrences; searches for new populations; research on species biology and ecology; habitat and site management; and landowner education.

DESCRIPTION

The following description is taken from taxonomic treatments by Gleason and Cronquist (1991), Fernald (1950), Voss (1972), Mohlenbrock (2001), and Tucker et al. (2002). *Cyperus houghtonii* is a long-lived perennial bearing a short rhizome and a corm-like tuber. It grows 10-100 cm tall and has smooth stems that are 0.5-1.5 mm thick below the terminal inflorescence.

The leaves are basally disposed and seldom reach the inflorescence, except in cases where smaller, secondary culms sprout from the base. The glabrous leaves are 2-4 mm wide and are usually smooth-margined. There are 2-5 involucral leaves (leaves directly subtending the inflorescence) that are also smooth and are divergently ascending or spreading.

The inflorescence consists of 1-2 sessile spikes and 2-5 rays each composed of 5-15 spikelets. The spikelets are linear and flattened, measure 0.5-2.2 cm long, and are arranged into ascending hemispherical heads. The scales are rotund and obtuse with a mucronate or mucronulate tip. They measure 2-2.5 mm long and 1-1.5 mm wide, have many nerves and are stramineous to reddish brown. The achenes are trigonous (three sided), rounded at the base, and truncate above with nearly concave faces. They measure 1.0-1.8 mm long and 0.8-1.2 mm wide and are dark brown.

Cyperus houghtonii closely resembles *Cyperus filiculmis*, with which it is often found growing. *Cyperus filiculmis* tends to have a more tightly hemispherical head as opposed to a more loose arrangement of spikelets in *C. houghtonii* (though still roughly hemispherical). *Cyperus filiculmis* also has narrower achenes (usually 1/2 as wide as long versus 2/3 as wide as long in *C. houghtonii*). The scales in *C. filiculmis* lack a mucronate tip, whereas *C. houghtonii* scales have a very slight (0.5 mm long) mucronate tip. The involucral bracts in *C. filiculmis* have scabrous margins and tend to be more recurved or spreading than in *C. houghtonii*. Lastly, the achenes of *C. filiculmis* are black whereas *C. houghtonii* achenes are dark brown.

Cyperus houghtonii also closely resembles *C. schweinitzii*. The achenes in *C. schweinitzii* are longer (2.2-3.3 mm long as opposed to 1.6-2.0 mm in *C. houghtonii*) and lighter-colored. The culms of *C schweinitzii* are scabrous and 1-2.5 mm thick. The culms of *C. houghtonii* are smooth and usually under 1 mm thick. The leaves of *C. schweinitzii* have scabrous margins and tend to be wider than those of *C. houghtonii*. Finally, the scales of *C. schweinitzii* are longer (3-4 mm long as opposed to 2-3 mm) and have a more prominent mucronate tip.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Cyperus houghtonii belongs to the Cyperaceae. *Cyperus* is the second largest genus in this large family, with approximately 600 species worldwide. Other species of *Cyperus* have been used for making paper (*Cyperus papyrus*), mats (*Cyperus malacopsis*), perfume (*Cyperus longus*), and for eating (*Cyperus esculentus*) (Chant 1993). There are 96 species of *Cyperus* in North America and approximately 19 species in New England.

Some authors, most notably Kukenthal (1936), split the genus into six subgenera. These subgenera are distinguished based on the number of stigmas and the nature of the rachilla. According to this classification, which was also used by Fernald (1950), *C. houghtonii* belonged to the *Mariscus* subgenus and section *Laxiglumi.* More recently, Tucker et. al (2002) recognized only five subgenera (though no sections) based on the number of stigmas, nature of the rachilla and arrangement of the achenes and spikelets. Under this classification, *C. houghtonii* is placed in the subgenus *Cyperus*. This subgenus consists of 350-400 species world-wide and includes both upland and wetland species.

Cyperus houghtonii was named for its discoverer Douglass Houghton, who was an explorer and botanist in the 19th century. He first collected this species on August 4, 1831 in Lake of the Isles in Sawyer County, Wisconsin while he was "on the first Schoolcraft expedition to the source of the Mississippi River" (Voss 1972). This species was named by John Torrey in 1836.

Mariscus houghtonii (Torr.) T. Koyama is the only published synonym for this species (Koyama 1974).

Two morphologically similar species, *C. filiculmis spp. macilentus* and *C. schweinitzii* are known to hybridize where they are sympatric (Marcks 1972). Based on cytological and chromatographic studies of these species, Marcks (1972) has proposed that *C. houghtonii* arose as a stabilized hybrid between these two species.

There is some evidence that hybridization still occurs between these three closely related species. Voss (1972) has documented specimens that he has interpreted as intermediate between *C. houghtonii* and *C. schweinitzii* as well as specimens intermediate between *C. houghtonii* and *C. filiculmis*. Further work needs to be done to determine the extent of hybridization and fertility of the hybrids.

SPECIES BIOLOGY

Like all members of the Cyperaceae, *Cyperus houghtonii* flowers are wind-pollinated (Cronquist 1968). Its flowers are perfect (containing both stamen and pistil) and consist of a perianth that is reduced to scales. It is unknown if self-pollination occurs in *C. houghtonii.* Vegetative reproduction probably occurs via rhizomes. The extent of vegetative reproduction in this or closely related species has not been studied. There are no known (or reported) herbivores, parasites or pathogens of *C. houghtonii*. Mycorrhizal associations have not been investigated. The significance of this symbiosis is probably negligible given that mycorrhizal colonization of plants in the Cyperaceae is generally low or non-existent (Trappe 1987).

Cyperus houghtonii begins flowering in July in New England. The achenes develop in late July and early August and generally dehisce by late-September to mid-October (personal observation). The best time to identify this species in the field is late summer and early fall, after achenes have developed.

There is no published work done on the dispersal of the seeds of *Cyperus houghtonii* or its closely related species. Many members of the Cyperaceae are thought to disperse directly by falling from the inflorescence (van der Pijl 1972). *Cyperus houghtonii* is often found in sandy habitats. The same forces that move sand in these habitats, such as wind or colluvial forces, may also be responsible for dispersing seeds, at least a short distance (personal observation).

Field observations indicate that *C. houghtonii* is a fairly prolific producer of seeds. Germination tests of this species have been conducted by William Brumback (New England Wild Flower Society, personal communication,). There have been eight separate collections of seed from seven different sites in New England. Germination results have generally been rather poor, with 0% germination common. This includes fresh seeds, dried seeds, seeds receiving cold stratification, and seeds placed in a solar greenhouse. The germination rate of seeds that were placed outside to over-winter was highly variable. Some tests resulted in 5% germination, whereas other yielded nearly 50% germination. This over-wintering treatment was clearly the most promising method of breaking the dormancy of these seeds. Brumback (personal communication) has noted that the seeds have a hard outer coat and scarification may help increase the germination results. This hard seed coat may also allow the seeds to withstand desiccation and persist in the seed bank for long periods of time.

Baskin and Baskin (1971a) have studied the germination of *Cyperus inflexus* (synonym: *Cyperus squarrosus*). *Cyperus inflexus* is an annual that colonizes disturbed, open, sandy habitat such as river banks and lake shores. They found that the seed dormancy of this species could be broken by stratification and scarification. They also found that exposure to light was essential for the germination of this species and that none of the other treatments that they tested could substitute for the light requirement. The light treatment, however, was only effective after stratification and scarification. They hypothesized that since this species favors open, sandy habitats, the requirement for light may ensure that suitable habitat is present for germination (Baskin and Baskin 1971b). While there are many differences between *C. inflexus* and *C. houghtonii*, they both occupy habitats that are open, sandy and disturbed and therefore may have similar germination requirements.

HABITAT/ECOLOGY

Physical Environment

Throughout its range, *C. houghtonii* is found primarily on sandy, nutrient-poor soils. In eastern North America, it has also been found on shallow soils over bedrock. These soils are of various textures but, like the sandy soils, tend to be droughty. *Cyperus houghtonii* is known to be found most abundantly in areas of full sunlight (personal observation). It is rarely found in areas of limited shade. The species presumably cannot tolerate full shade and the author knows of no accounts of this species being reported in full shade. Because of its shade-intolerance, *C. houghtonii* is usually relegated to the edges of forested communities or within woodland communities that have more open canopies. Other ecological variables such as aspect, slope and elevation seem to be variable and not limiting to the species' distribution within the communities in which it is found.

Habitats and Associated Species

In the Midwestern United States, *Cyperus houghtonii* is most commonly found in sandy habitats often associated with jack pine (*Pinus banksiana*). These habitats are historically fire-dependent ecosystems (Welby Smith, Minnesota Department of Natural Resources, personal communication). It is also found in open, sandy, disturbed areas such as blowouts and lakeshores (Craig Anderson, Wisconsin Natural Heritage Inventory, personal communication). Along the Great Lakes, it is associated with older and historic sand dunes and appears to be absent from current dunes (Ed Voss, University of Michigan Herbarium, personal communication). There are no known occurrences of *C. houghtonii* on sand dunes outside of this region.

Cyperus houghtonii is also known to occur along the sandy shores of lakes or rivers that are exposed to regular scouring by waves or flood waters or the sloughing of sand on erosional river bluffs. There are only a few historic occurrences of *C. houghtonii* in these habitats in the New England, none of them known to be extant.

Many historic populations of this species in the eastern United States have occurred along railroad beds and railroad rights-of-way. These sites were historically (and in some cases, currently) kept open by the use of herbicides. This prevents the sites from being shaded out by larger trees and shrubs. The effects of the herbicides on *C. houghtonii*, however, are unknown. Railroad beds were also historically the sites of many fires that may have created suitable habitat. The frequency of fires at these sites in modern times has, however, decreased dramatically. For these reasons, railroad beds and rights-of-way may be ephemeral habitats for this species.

In Massachusetts, *C. houghtonii* is also found on exposed mountain summits with soils that are shallow to bedrock. These sites are often dominated by pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*). Other associates include: lowbush blueberry (*Vaccinium angustifolium*); poverty grass (*Danthonia spicata*); little bluestem (*Schizachyrium scoparium*); and gray goldenrod (*Solidago nemoralis*). In West Virginia and Virginia, it occurs in similar habitats (Paul Harmon, West Virginia Natural Heritage Program and John Townsend, Virginia Division of Natural Heritage, personal communication). At least two of these occurrences (locational data is unclear for one occurrence) exist in communities that are likely to depend on fire. Associated species include table mountain pine (*Pinus pungens*), scrub oak, mountain laurel (*Kalmia latifolia*), blueberries (*Vaccinium* spp.), and huckleberry (*Gaylussacia baccata*).

In Vermont, *Cyperus houghtonii* tends to occur on the edge of Pine-Oak-Heath Sandplain Forest Communities or in areas formerly occupied by these communities. This community is found predominately along Lake Champlain where glacial river deltas have deposited large amounts of sand. These communities were historically fire-driven ecosystems. This species may have benefited from the local disturbance created by fire and colonized the more open and edge habitats associated with this community. Species associated with *C. houghtonii* in this habitat include: tick-trefoil (*Desmodium canadense*); pinweed (*Lechea intermedia*); stiff aster (*Aster linearifolius*); bush-clover

(*Lespedeza capitata*); umbrella sedge (*Cyperus filiculmis*); sweetfern (*Comptonia peregrina*); pitch pine (*Pinus rigida*); low bush blueberry (*Vaccinium angustifolium*); sand sedge (*Bulbostylis capillaris*); and sandbur (*Cenchrus longispinus*).

Temporal Dynamics and Fluctuations

Some occurrences of this species in the northeast may experience widely fluctuating population levels from year to year (Hunt et al. 1995). At a site in Vermont (VT .008 [Colchester]), the population appears to fluctuate from a low of 34 individuals in 1994 to a high of 175 individuals in 2002. The population at VT .001 (Essex) has shown a difference of about 150 individuals from 1998 to 1999. At another site in Massachusetts (MA .012 [Montgomery]), the population consisted of 300 individuals in 2000. In 2002, no plants of this species could be found. Finally, MA .010 (Lancaster) consisted of nearly 1,000 individuals when surveyed in 1991. In other years (such as 2002 when the author conducted a survey of the site), only 2 individuals were found.

The exact causes of these fluctuations are unknown. Some of these differences may possibly be explained by surveyor error. Hunt et al. (1995), however surveyed the same site (MA .010 [Lancaster]) by the same methods in 1991 and 1993 and reported large population fluctuations. Likewise, VT .001 (Essex) has had consistent surveys done through the years. Field observations suggest that factors such as time since recent disturbance and amount of precipitation may be causative factors, but more research needs to be conducted to elucidate these apparent trends.

Disturbance Relationships

One of the major ecological adaptations driving the local distribution of this species is its dependence on some form of soil disturbance. Some forms of disturbance have been linked with increasing species diversity in some communities (Connell 1978) and maintaining populations of "disturbance-adapted" species (Willig and Walker 1999). The frequency and severity of disturbance have been shown to be important factors in ecology of disturbed areas (Pickett and White 1985). These factors also appear to be important for the growth and survival of *Cyperus houghtonii.* The severity of disturbance at a site (depth and intensity of scarification of the soil, for example) must be intermediate to severe (personal observation).

The frequency of disturbance is also important. Field observations suggest that if a site is disturbed too frequently, *C. houghtonii* will generally be extirpated from the site. If the site is not disturbed frequently enough, shrubs and trees will grow up, creating shade that makes the site inhospitable for *C. houghtonii*. A disturbance regime that is intermediate in frequency and with intermediate to high severity seems to favor the establishment and spread of this species (personal observation).

Fire appears to be the dominant natural disturbance for many *C. houghtonii* occurrences throughout its range. In nearly every state in which it occurs, *C. houghtonii* is found in fire-dependent habitats. Fire also appears to play an important role in two of the largest occurrences in New England. One (MA .012 [Montgomery]) occurs in a Pitch Pine-Dry Oak Woodland Community on a dry rocky summit with shallow soils and a sparse canopy of (*Quercus ilicifolia*) and pitch pine (*Pinus rigida*). The other occurs on a sandy esker near the edge of a oak-hickory forest community that is burned regularly (MA .010 [Lancaster]).

The historical occurrence of fire in these communities in New England has been well-studied (Patterson and Sassaman 1988, Motzkin et al. 1996, Parshall and Foster 2002). Paleoecological data suggest that, prior to European settlement, fire in these communities was common (Motzkin et al. 1996). The frequency of fire in these (and other) communities, however, has increased in the last 300 years (Parshall and Foster 2002). The most significant increase occurred during the years of early European settlement when burning was frequently used to clear land for agriculture. The effects of this increased fire regime and changing land use on the populations of *Cyperus houghtonii* are not known. While an increase in fire frequency may have benefited the species, converting habitat into agricultural land may have been detrimental to some populations.

Unfortunately, there are no published accounts of the effect of fire on this species. Field observations suggest that a fire of the right intensity and frequency can disturb the soil in such a manner that is advantageous for the germination and establishment of this species. Fire may also reduce competition from other species that would otherwise shade out this species. Steve Young (New York Natural Heritage Program, personal communication) reports that on Long Island, this species was found infrequently along roads in pine barrens. After a severe fire burned hundreds of acres, *C. houghtonii* was found in the thousands. In New England, there are a number of records of *C. houghtonii* appearing the year after a fire (MA .009 [Mt, Washington], MA .010 [Lancaster], MA .012 [Montgomery], MA .002 [Alford] and MA .001 [Holyoke]). In some cases, these populations are not found the second or third year after the fire. The brief period of plant growth could be attributed to only a brief reduction in post-fire competition or from the lack of suitable germination conditions without fire.

For the majority of the occurrences of this species in the New England, the natural disturbance regime favored by *C. houghtonii* has been replaced by a human-caused disturbance regime. There are a wide variety of human activities that can create habitat for this species including: road construction and maintenance; development activity; logging; maintenance of railroad beds; vehicular and foot traffic; sand and gravel mining and power line maintenance. Only those sites that occur on sandy soils and have the appropriate disturbance regimes will create habitat suitable to *C. houghtonii*.

THREATS TO TAXON

The threats to *C. houghtonii* fall into two general categories: habitat destruction by development, and a lack of disturbance regime. While these two factors are linked, it is useful to discuss them individually.

Threats from Development

Residential and commercial development is a common cause of habitat destruction for this species. Of the 17 non-historic occurrences recognized for New England, six have been eliminated or are threatened by development, including NH .001 (Cheshire), NH .006 (Concord), VT .008 (Colchester), VT .011 (Colchester), VT .015 (Colchester), and VT .021 (Colchester).

There is also a significant amount of potential habitat that is regularly destroyed by development. The natural habitat of this species is on well-drained, sandy soils. These sites are often chosen for commercial and residential development because of their low frost action, well-drained nature and suitability for septic systems. Motzkin et al. (1999) have estimated that all of the remaining Pitch Pine-Scrub Oak communities in New England are threatened by development. The populations in Vermont are experiencing the most immediate threat due to development. This is largely due to the fact that the sandplain areas that harbor the majority of the occurrences in Vermont are located in northern Chittenden County. This part of the state is experiencing tremendous development pressure as the city of Burlington expands.

Threats from Lack of Disturbance Regime

Since the long-term survival of *C. houghtonii* seems to be linked to some level of disturbance, maintenance of that disturbance regime may be crucial to its survival. Sites that now lack a disturbance regime become inhospitable to this species either because shrubs and trees colonize the site and shade out *C. houghtonii* or because the site lacks conditions favorable for seed germination brought about by disturbance.

Some of the largest populations of this species in New England occur on sites that are affected by fire. There are many sites in this region that have had fires suppressed. Fire suppression in New England in the last half of the twentieth century has been well documented (Motzkin et al. 1999). This suppression of fire often leads to plant succession and a change in the character of the communities historically shaped by fire. In this regard, lack of fire may be largely responsible for the lack of suitable, open habitat for *C. houghtonii* in many areas of New England. Motzin et al. (1999), however, suggest that prescribed burns are unlikely to maintain Pitch Pine-Scrub Oak communities in their current or historical state because most of these fires are such low intensity. Limited field observations from MA .012 (Lancaster) suggest that frequent, low-intensity spring burns

may be beneficial for *C. houghtonii*. Much more research, however, needs to be conducted to determine the effects of fire on this species.

For the occurrences of this species found associated with surface waters such as rivers, a disruption of the natural disturbance regime can occur when damming takes place. Some river sites are dependent on the erosional forces of flood waters to create local disturbance that *C. houghtonii* favors. When rivers are dammed, flow is often moderated and erosional forces eliminated. Since only a few historic occurrences are associated with rivers in New England, this threat is not as significant as the threat posed by fire suppression.

DISTRIBUTION AND STATUS

General Status

Cyperus houghtonii ranges from southern Quebec west to Manitoba and south to Illinois (Table 1). On the eastern seaboard, it occurs in New England and south to Virginia. It appears to be uncommon throughout its range except in Wisconsin and perhaps Michigan. It is Globally ranked as G4, which indicates that it is thought to be generally secure globally, though it may be locally rare. *Cyperus houghtonii* is thought to be regionally rare and is listed as a Division 2 species in *Flora Conservanda* (Brumback and Mehrhoff et al. 1996). There are 39 total occurrences in New England: two in Maine, seven in New Hampshire, 18 in Vermont, and 12 in Massachusetts. This species is considered historic in Maine and is listed as Threatened in New Hampshire and Vermont and Endangered in Massachusetts.

While *Cyperus houghtonii* is found in many states, it appears to be uncommon in most states with the exception of Wisconsin and Michigan. In Minnesota, it is currently unlisted, but its status may warrant closer attention (Smith, personal communication). In West Virginia and Virginia, it is known from three collections, all of which occur on exposed mountainous sites on soils that are shallow-to-bedrock (Harmon and Townsend, personal communication). There are only four occurrences in Maryland, where it is ranked S2 (Christopher Frye, Maryland Department of Natural Resources, personal communication). Tucker et al. (2002) in the *Flora of North America* lists *C. houghtonii* occurring in New Jersey. It has recently come to light that this is based on a mislabeled or mistranscribed herbarium specimen (Gordon Tucker, Eastern Illinois University, and David Snyder New Jersey Natural Heritage Program, personal communication). The specimen in question appears to be from New York. There are no known occurrences in New Jersey at this time.

Table 1. Occurrence and status of *Cyperus houghtonii* 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)
Vermont (S2, T); 12 extant, 5 historic and 1 extirpated occurrences	Michigan (S3)	Wisconsin (SR): not rare	Maine (SH): 2 historic occurrences
Massachusetts (S1, E): 4 extant, 6 historic and 2 extirpated occurrences	New York (S3)		North Carolina (SH)
New Hampshire (S1, T): 1 extant, 4 historic and 2 extirpated occurrences	Minnesota (S3)		Ohio (SX)
Illinois (S2, T)	Ontario (S3?)		Virginia (SH)
Indiana (S2)	Quebec (S3)		
Maryland (S1)	West Virginia (S?)		
Pennsylvania (S1)			
Manitoba (S2)			

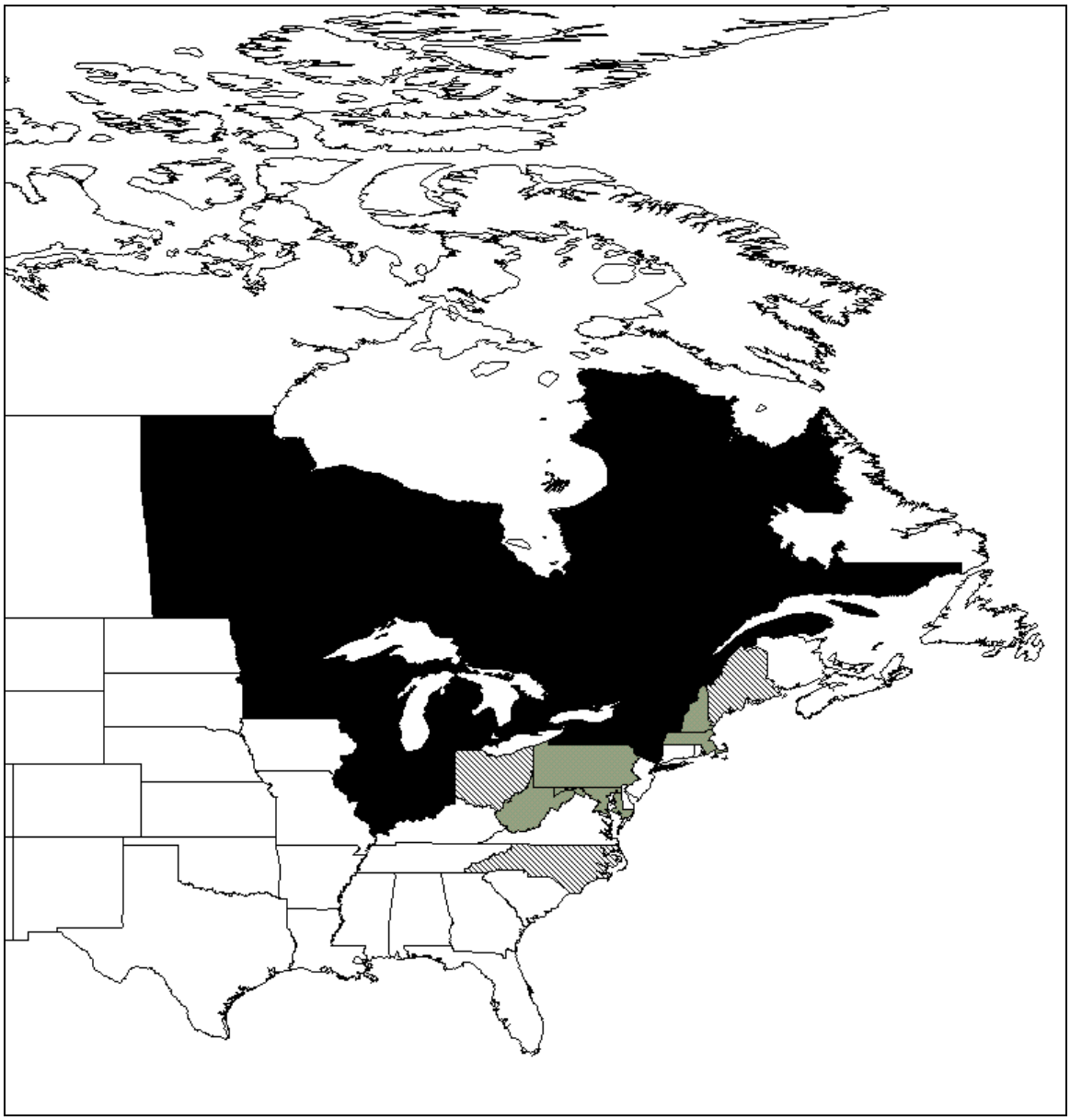

Figure 1. Occurrences of *Cyperus houghtonii* in North America. States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. Areas shaded in black have more than five confirmed occurrences. States with diagonal hatching is designated "historic," where the taxon no longer occurs. See Appendix for explanation of state ranks.

Status of All New England Occurrences – Current and Historical

Cyperus houghtonii was historically known from four of the six New England States, with a total of 39 known occurrences in New England; this includes extant, historic and extirpated populations (Figure 2, Figure3). This species has not been found in Connecticut or Rhode Island. There are 18 historic populations, three populations that are known to be extirpated, one population that has not been seen since 1989 (MA .001 [Holyoke]) and is ranked "F" by that state, and 17 extant populations. Of all occurrences, 26 have been surveyed in the last 12 years. Many of the historic sites lack good location information, making resurveying them difficult. Maine appears to have only two historic occurrences. New Hampshire has only one extant occurrence, five historic occurrences, and one presumed extirpated. Most of the sites for this species occur in Vermont and Massachusetts. Vermont has the highest number of occurrences of this species, with 12 extant, one extirpated, and five historic populations currently known. All of the extant sites occur in the sand plain habitat of Chittenden County. Nearly all are found in ruderal, or weedy, habitats. Whereas Massachusetts currently has only ten occurrences, four considered extant, it contains two of the largest and most stable populations in New England.

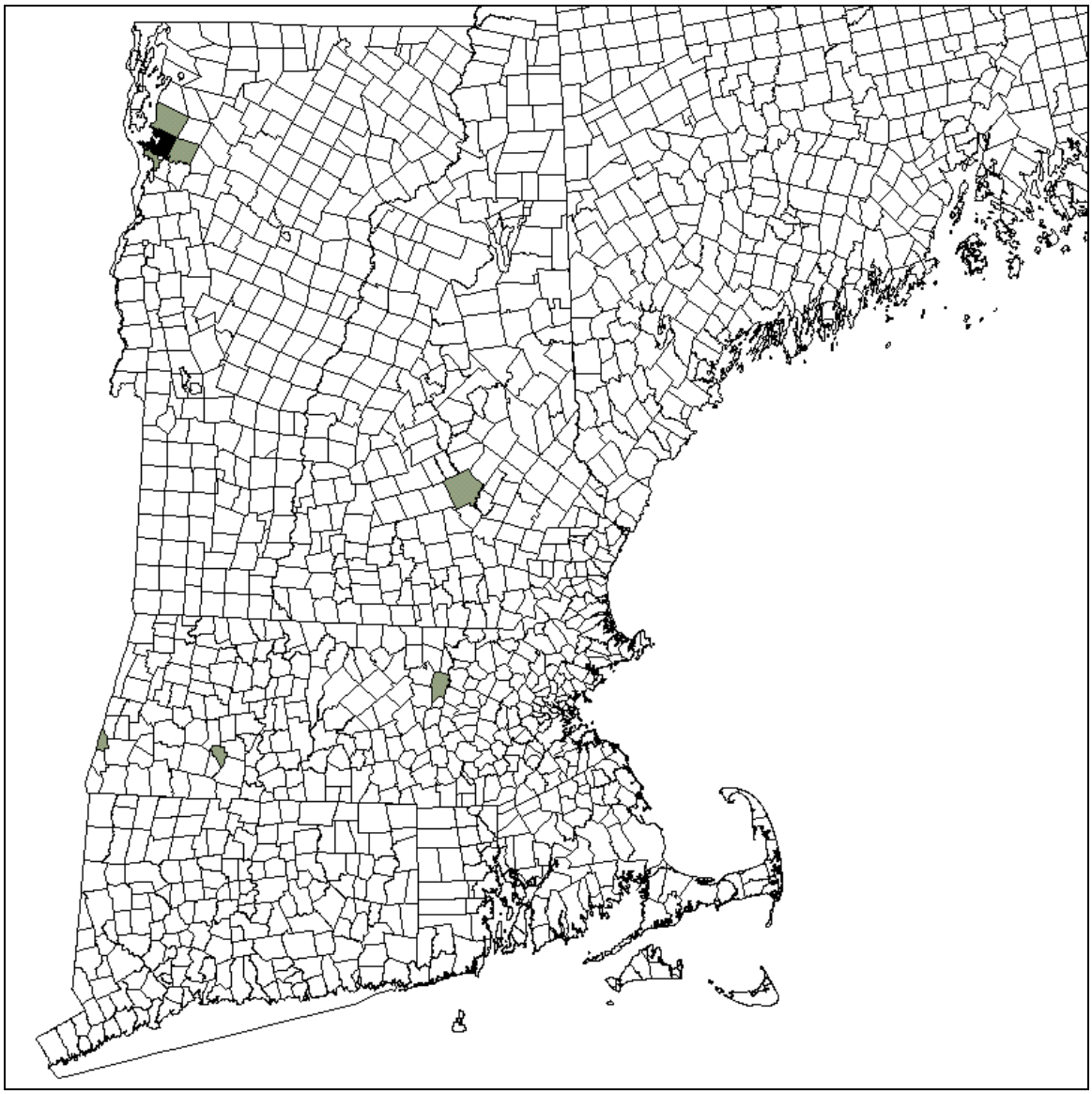

Figure 2. Extant occurrences of *Cyperus houghtonii* in New England. Town boundaries for New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon. Towns shaded in black have more than five confirmed occurrences.

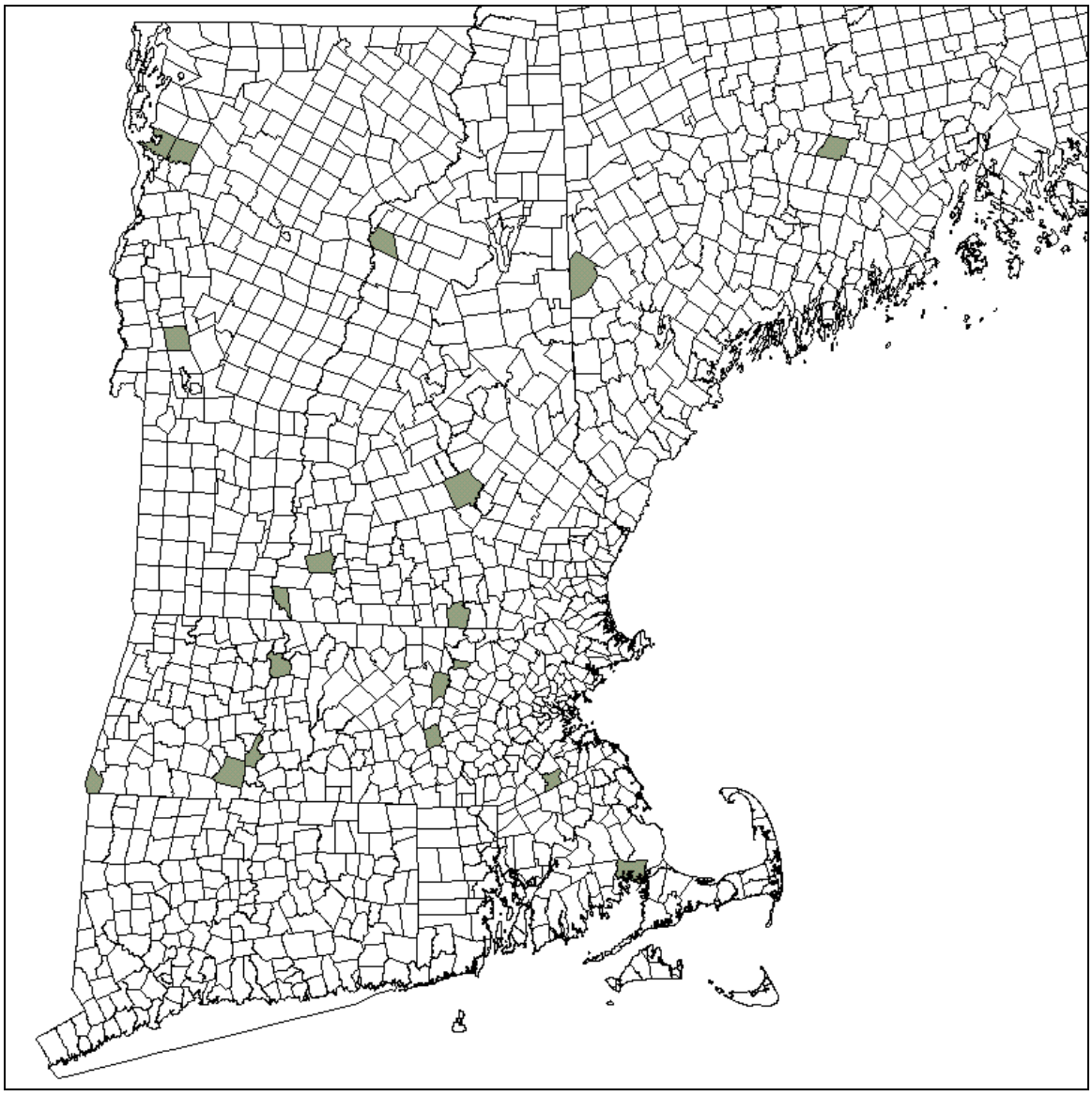

Figure 3. Historical occurrences of *Cyperus houghtonii* in New England. Towns shaded in gray have one to five historical records of the taxon.

Table 2. New England Occurrence Records for *Cyperus houghtonii.* Shaded occurrences are considered extant.			
State	**EO Number**	**County**	**Town**
ME	.001	Kennebec	Winslow
ME	.002	Oxford	Fryeburg
NH	.001	Cheshire	Hinsdale
NH	.002	Grafton	Bath
NH	.003	Hillsborough	Hollis
NH	.004	Cheshire	Keene
NH	**.005**	**Merrimack**	**Concord**
NH	.006	Merrimack	Concord
NH	.007	Cheshire	Hinsdale
VT	**.001**	**Chittenden**	**Essex**
VT	.002	Chittenden	Colchester
VT	.003	Chittenden	Essex
VT	.004	Rutland	Brandon
VT	.005	Rutland	Castleton
VT	.007	Rutland	Brandon
VT	**.008**	**Chittenden**	**Colchester**
VT	**.010**	**Chittenden**	**Colchester**
VT	**.011**	**Chittenden**	**Colchester**
VT	**.012**	**Chittenden**	**Essex**
VT	**.014**	**Chittenden**	**Milton**
VT	**.015**	**Chittenden**	**Colchester**
VT	.016	Chittenden	Colchester
VT	**.017**	**Chittenden**	**Burlington**
VT	**.019**	**Chittenden**	**Milton**
VT	**.020**	**Chittenden**	**Essex**
VT	**.021**	**Chittenden**	**Colchester**
VT	**.022**	**Chittenden**	**Colchester**
MA	.001	Hampden	Holyoke
MA	**.002**	**Berkshire**	**Alford**
MA	.003	Plymouth	Wareham
MA	.004	Worcester	Lancaster
MA	.005	Hampden	Westfield
MA	.006	Worcester	Shrewsbury
MA	.007	Norfolk	Stoughton
MA	.008	Franklin	Montague
MA	.009	Berkshire	Mt Washington
MA	**.010**	**Worcester**	**Lancaster**
MA	.011	Middlesex	Ayer
MA	**.012**	**Hampden**	**Montgomery**

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

In order to conserve *C. houghtonii* in New England, a wide variety of actions must be undertaken. Taking action to protect a species, however, must be done with the overall conservation objectives for the species in mind. There are three objectives for conserving this species in New England:

1) conserve the two largest known populations that exist in naturally occurring (non-ruderal) communities;
2) survey likely natural habitat to discover at least five new occurrences each containing at least 300 individuals; and
3) protect six occurrences in ruderal habitats.

Some of the largest and most stable populations in New England occur in ecosystems where the natural disturbance mechanism (usually fire) is still intact. There are currently three known populations where fire is the major disturbance factor (MA .002 [Alford], MA .010 [Lancaster], and MA .012 [Montgomery]). The occurrence in Alford (MA .002) only consisted of one individual and may not be a viable population. Since the remaining two occur in naturally functioning ecosystems and are the largest known populations in New England, neither of these populations must be lost. These populations potentially offer not only the largest single source of genetic diversity in New England but also an opportunity to conduct vital research on the biology and ecology of this species. In order for these sites to be conserved, a controlled burn program may need to be implemented.

Many field observations support the hypothesis that this species is somewhat ephemeral in nature. In many cases, *C. houghtonii* will appear the year following a fire and then disappear the second or third year. It is, therefore, highly likely that this species is under-collected in New England and that there are more populations that are currently not known. There are also many historic occurrences that need to be relocated. Though the amount of suitable habitat in New England may be quite high, the infrequency of fire limits the likelihood of this species occurring in many of these habitats. The addition of five stable populations in New England is a reasonable expectation given these factors. Three hundred individuals at each site was chosen because field observations suggest that when this species occupies a site, the numbers of individuals present can be quite high. Higher population numbers may be beneficial because they have been shown to be correlated with greater genetic fitness (Given 1994).

Most occurrences in New England rely on human disturbance for their habitat. Very few represent a stable population within a natural community. And yet, without the many small populations in these ruderal habitats, a lot of genetic diversity may be lost. It is, therefore, important to maintain the plants and habitats that exist under human

disturbance regimes. Of the 17 extant populations in New England, approximately 12 currently rely on human-caused disturbance regimes for their continued presence at the site. As many of these 12 sites as possible must be conserved. Determining specifically how many populations would be adequate to preserve genetic variability in this region is a difficult prospect because this species has not received much attention in the academic literature. Ideally, all of these 12 sites would remain suitable for *C. houghtonii*. The reality of the current land use situation and social climate, however, may not allow that. Three Vermont populations (VT .008 [Colchester], VT .021 [Colchester] and VT .011 [Colchester]) are in the path of the Chittenden County Circumferential Highway. This highway is likely to be built in the next five years and these populations lost. This includes two of the sites with the highest population numbers in Vermont (VT .008 [Colchester] and VT .011 [Colchester]). In addition, three more (VT .015 [Colchester], VT .014 [Milton], and VT .017 [Burlington]) are not likely to persist because of development pressure or succession. There are, therefore, six occurrences in ruderal habitats that could realistically be conserved (NH .005 [Concord], VT .001 [Essex], VT .010 [Colchester], VT .012 [Essex], VT .020 [Essex], and VT .022 [Colchester]). For the long-term stability of this species in New England, none of these six populations must be lost.

III. LITERATURE CITED

Baskin, J. M. and C. C. Baskin. 1971a. Germination of *Cyperus inflexus* Muhl. *Botanical Gazette* 132: 3-9.

Baskin, J. M. and C. C. Baskin. 1971b. The possible ecological significance of the light requirement for germination in *Cyperus inflexus*. *Bulletin of the Torrey Botanical Club* 98: 25-33.

Brumback W. E., L. J. Mehrhoff, R. W. Enser, S. C. Gawler, R. G. Popp, P. Somers, D. D. Sperduto, W. D. Countryman, and C. B. Hellquist. 1996. *Flora Conservanda*: New England. The New England Plant Conservation Program (NEPCoP) list of plants in need of conservation. *Rhodora* 98: 233-361.

Chant, S.R. 1993. Cyperales. Pages 292-293 in V. H. Heywood (Editor), *Flowering Plants of the World.* Oxford University Press. New York, New York, USA.

Connell, J. H. 1978. Diversity in tropical rain forests and coral reefs. *Science* 199: 1302-1310.

Cronquist, A. 1968. *The Evolution and Classification of Flowering Plants.* Houghton Mifflin. New York, New York, USA.

Fernald, M. L. 1950. *Gray's Manual of Botany*. American Book Company, New York, USA.

Given, D. R. 1994. *Principles and Practice of Plant Conservation*. Timber Press. Portland, Oregon, USA.

Gleason, H. A. and A. Cronquist. 1991. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. Second Edition. New York Botanical Garden, Bronx, New York, USA.

Hunt, D. H., K. B. Searcy, R. E. Zaremba, and R. C. Lombardi. 1995. The vascular plants of Fort Devens, Massachusetts. *Rhodora* 97: 208-244.

Koyama, T. 1974. New combinations relevant to the Cyperaceae tribe Cypereae of Tropical America. *Phytologia* 29: 73-75.

Kukenthal, G. 1936. Cyperaceae-Scirpoideae-Cypereae. *Das Pflanzenir* 20: 1-671.

Marcks, B. G. 1972. *Population Studies in North American* Cyperus *Section* Laxiglumi (Cyperaceae). Ph.D. Thesis. University of Wisconsin, Madison, Wisconsin, USA.

Mohlenbrock, R. H. 2001. *Sedges: Cyperus to Scleria*. Southern Illinois University Press. Carbondale, Illinois, USA.

Motzkin, G, D. Foster, A. Allen, J. Harrod, and R. Boone. 1996. Controlling site to evaluate history: vegetation patterns of a New England sand plain. *Ecological Monographs* 66: 345-365.

Motzkin, G., W. A. Patterson III, and D. R. Foster. 1999. A historical perspective on pitch pine-scrub oak communities in the Connecticut Valley of Massachusetts. *Ecosystems* 2: 255-273.

NatureServe: An online encyclopedia of life [web application]. 2001. Version 1.6. Arlington, Virginia, USA. Available at: http://www.natureserve.org (Accessed: 2002).

Parshall, T. and D. R. Foster. 2002. Fire on the New England landscape: regional and temporal variation, cultural and environmental controls. *Journal of Biogeography* 29: 1305-1317.

Patterson, W. A. III and K. E. Sassaman. 1988. Indian fires in the prehistory of New England. Pages 107-135 in G. P. Nicholas (Editor), *Holocene Human Ecology in Northeastern North America*. Plenum Publishing. New York, New York, USA.

Pickett, S. T. A. and P. S. White. 1985. Patch dynamics: a synthesis. Pages 371-384 in S. T. A Pickett and P. S. White (Editors), *The Ecology of Natural Disturbance and Patch Dynamics.* Academic Press. New York, New York, USA.

Trappe, J. M. 1987. Phylogenetic and ecologic aspects of mycotrophy in the angiosperms from an evolutionary standpoint. Pages 137-155 in G. R. Safir (Editor), *Ecophysiology of VA Mycorrhizal Plants.* CRC Press, Boca Raton, Florida, USA.

Tucker, G. R., B. G. Marcks and J. R. Carter. 2002. *Cyperus*. Pages 141-193 in Flora of North America Editorial Committee (Editors), *Flora of North America North of Mexico*. *Volume 23 Magnoliophyta: Commelinidae (in part): Cyperaceae.* Oxford University Press. New York, New York, USA.

van der Pijl, L. 1972. *Principles of Dispersal in Higher Plants.* Second Edition. Springer-Verlag. Berlin, Germany.

Voss. E. G. 1972. *Michigan Flora. Part I. Gymnosperms and Monocots.* Cranbrook Institute of Science and University of Michigan Herbarium. Bloomfield Hills, Michigan, USA.

Willig, M. R. and L. R. Walker. 1999. Disturbance in terrestrial ecosystems: salient themes, synthesis and future directions. Pages 747-764 In L. R. Walker (Editor), *Ecosystems of the World Volume 16: Ecosystems of Disturbed Ground*. Elsevier Press. New York, New York, USA.

IV. APPENDICES

---

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.