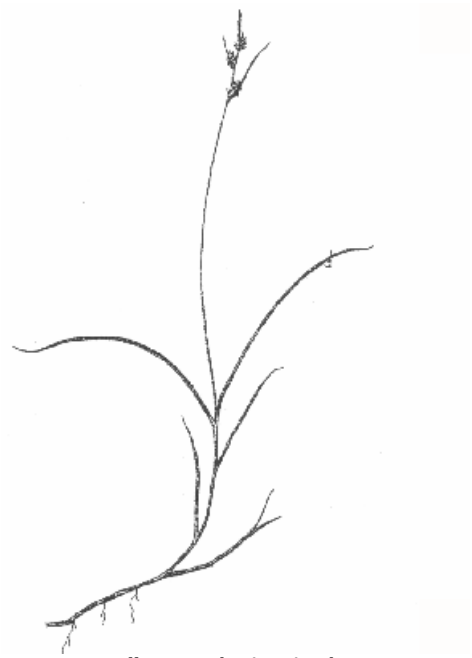
Conservation Assessment for New England Sedge (Carex novae-angliae Schwein.)



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USDA Forest Service, Eastern Region
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This document is undergoing peer review, comments welcome

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

Carex novae-angliae Schwein. (New England sedge) is designated as a Regional Forester Sensitive Species in the Eastern Region of the U.S. Forest Service on the Hiawatha National Forest in Michigan and on the Superior National Forest in Minnesota. *Carex novae-angliae* is documented, but not listed on the Chequamegon-Nicolet National Forest in Wisconsin, the White Mountain National Forest in New Hampshire, and the Green Mountain National Forest in Vermont. The purpose of this document is to provide the background information necessary to prepare a Conservation Strategy which will include management actions to conserve the species.

Carex novae-angliae (New England sedge), as its common name suggests, primarily occurs in New England and areas bordering New England in Canada and New York. Disjunct populations also occur in Pennsylvania, West Virginia, Wisconsin, Minnesota and Michigan (Reznicek & Crins 1993). The species occurs in hardwood forests or mixed forests of hardwoods and conifers. *C. novae-angliae* is often located in shade or partial shade near intermediate disturbances such as tree tips or old logging roads (Reznicek & Crins 1993). *C. novae-angliae* is ranked by the Natural Heritage Network as "secure globally" (G5) (NatureServe 2000). States at the edge of its range, however, have only a few known populations each, some which have not been re-located for many decades.

C. novae-angliae has a small terminal spike that is staminate and two to three relatively short lateral spikes that are pistillate (Gleason & Cronquist 1991, Reznicek & Crins 1993). Achenes are trigonous with a deciduous style; each style has three stigmas. Perigynia are minutely pubescent, obovoid, have a bidentate beak, and have two distinct nerves. The lowest bract is longer than the inflorescence; and leaves are glabrous. Unlike a few other related *Carex* species, no pistillate spikes develop below the middle of the stem or basally in *C. novae-angliae*; and spikes of the inflorescence are not overlapping (Gleason & Cronquist 1991, Reznicek & Crins 1993).

Like many *Carex* species, *C. novae-angliae* is probably self-compatible and wind-pollinated (Catling *et al.* 1990; Reznicek & Crins 1993). Species such as *C. novae-angliae* that have a tufted growth form may have a shorter life span than other rhizomatous species. Seeds of *C. novae-angliae*, like many herbs of temperate forests, are most likely dispersed by ants (Handel 1978, Gaddy 1986). Ants are believed to disperse seeds into unoccupied locations where seedlings have little competition (Handel 1978, Vellend *et al*. 1999). Subsequently, ant-dispersal may be an important factor that influences the distribution and abundance of this species.

Although *C. novae-angliae* is dependent on occasional intermediate disturbances, large disturbances, such as clear-cut tree harvests, could be detrimental to populations (Reznicek & Crins 1993). Germination may depend on the moisture or cool temperatures that exist in small forest gaps. In addition, *C. novae-angliae* may not be able to compete with aggressive species that tend to establish in large canopy openings (Reznicek & Crins 1993).

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Herbarium and Heritage Data: We appreciate the sharing of occurrence information for this species from Heritage personnel both in the United States and Canada, along with the helpful assistance of Herbarium personnel. See Contacts section at end of report for a complete list.

Editorial Committee

- We thank Jan Schultz, of the Hiawatha National Forest, for her suggestions and patience through revisions.

- Also appreciated was the editorial assistance of the following contract employees working with the Hiawatha National Forest: Beverly Braden, contract botanist.

Literature Search

- We thank Laura Hutchinson of the North Central Research Library for performing initial species inquires and sending us relevant research articles.

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NOMENCLATURE AND TAXONOMY

The *Carex* genus contains about 2000 species (Reznicek 1990). Basic characteristics of the genus include narrow grass-like leaves that are three-ranked, triangular stems, and closed sheaths (Gleason & Cronquist 1991). Flowers do not have perianths and occur on spikes* that are bisexual or unisexual (Gleason & Cronquist 1991). Each flower is subtended by a scale; and pistillate flowers are within a sac-like scale called the perigynium. Other characteristics often used in distinguishing species include the shape of the achene, the number of stigmas, and the number of spikes. Often in technical field guides, this large and difficult genus is broken into smaller taxonomical categories called "sections." *C. novae-angliae* Schwein. (New England Sedge) is grouped within section *Acrocystis* of the Cyperaceae family (Table 1).

Table 1. Current taxonomic placement and nomenclature of *Carex novae-angliae* (Crins & Rettig 2002)

Family:	Cyperaceae
Genus:	*Carex*
Subgenus:	*Carex*
Section:	*Acrocystis* Dumort.
Synonymous section:	*Montanae* Fries
Scientific name:	*Carex novae-angliae* Schwein.
Common name:	New England sedge
USDA Symbol:	CANO4

DESCRIPTION OF SPECIES

Carex novae-angliae and other species of section *Acrocystis* Dumort. (synonymous with section *Montanae* Fries) have at least a few unisexual spikes per culm, three deciduous stigmas per pistillate flower, trigonous achenes, and pubescent perigynia (Crins & Rettig 2002). *C. novae-angliae* has a small terminal spike (< 20 mm long) that is staminate and two to three relatively short lateral spikes (each < 7 mm long) that are pistillate (Gleason & Cronquist 1991, Reznicek & Crins 1993, Crins & Rettig 2002, Fig 1.). Perigynia are obovoid (longer than wide), have a bidentate beak, and have two distinct nerves. The lowest bract is longer than the inflorescence; and leaves are glabrous and less than 2 mm wide (Gleason & Cronquist 1991, Reznicek & Crins 1993, Crins & Rettig 2002). Refer to Table 2 for more details regarding technical characteristics of *C. novae-angliae*.

A few characteristics often distinguish *C. novae-angliae* from closely related species (i.e. those within section *Acrocystis*). No pistillate spikes develop below the middle of the stem or basally in *C. novae-angliae* as they do in a few related *Carex* species (including *C. rossii*, *C. deflexa*, and *C. umbellata* in eastern North America) (Reznicek & Crins 1993). Spikes of the inflorescence are not overlapping in *C. novae-angliae* like they are in other related species including *C. albicans* and *C. deflexa* (Reznicek & Crins 1993). *Carex pensylvanica*, *C.*

* Technically the spikes are spikelets, as they are part of a compound inflorescence. Literature, however, generally uses the term 'spike' when describing inflorescence of *Carices*.

communis, and *C. lucorum* have broader leaves and longer staminate spikes than *C. novae-angliae*. In addition, these three species have perigynia whose bodies are nearly as wide as long, while *C. novae-angliae* has perigynium bodies that are longer than wide (Reznicek & Crins 1993).

Table 2. Technical Characteristics of *Carex novae-angliae* Schwein. (New England Sedge). References for descriptions: Mackenzie 1940, Robertson 1984, Gleason & Cronquist 1991, Crins & Rettig 2002.

General:	**Perennial**, **loosely cespitose, short rhizomes**[1]; **chromosome count 2n = 30**.
Culms:	**Flowering culms** 5-40 cm tall, slender, usually shorter than leaves, triangular with 2-3 ribs per side, base reddish-purple, old leaves at base. **Vegetative culms** with leaves originating near top, lower leaves reduced to scales, leaves longer than on fertile culms.
Leaves:	One to many, originating from the lower third of flowering culms, 0.5-15 cm long, 0.75-2.0 mm broad, thin, light-green, mostly glabrous, scabrous on margins and towards tip, short ligule, tight sheaths.
Inflorescence:	**Terminal spike** is staminate (4-16 mm long), with a short peduncle; The 2-3 **lateral spikes** are pistillate (3-6 mm long), with 3-10 flowers each, and at least the lowest spike has a short peduncle; All spikes are borne above the middle of the stem, not overlapping, with the lowest spikes 7-25 mm apart (Fig 1a); Lowest **bract** longer than inflorescence.
Pistillate flowers:	**Perigynia** green, brown or straw-colored; minutely pubescent, 2.2-2.7 mm long; two ribs, obovoid, longer than wide, trigonous, stipitate, beak 0.3 - 0.5 mm, bidentate (Fig. 1b). **Pistillate scales** shorter to equal in length with the perigynium, with three nerves, green midrib, orbicular with mucronate tip, margins are hyaline, pale-brown, or reddish-brown (Fig. 1c). **Stigmas** three. **Achenes** nearly filling the perigynium, approximately 1.5 mm long, pale brown, obovate, trigonous, deciduous style.

[1] A few sources suggest that *C. novae-angliae* can have long rhizomes (Gleason & Cronquist 1991, Magee & Ahles 2001). Reznicek (pers. comm. 2003) indicates that this is "simply a mistake." According to Reznicek, herbarium samples may appear to have long rhizomes as a result of pulling a portion of stems from a mat of *C. novae-angliae*.

Fig. 1. ***Carex novae-angliae*** with a magnified: A. inflorescence, B. perigynium, and C. pistillate scale (Illustration by Ann Anisko from "The Plants of Pennsylvania: An Illustrated Manual," edited by Ann Fowler Rhoads and Timothy A. Block. Copyright ©2000 University of Pennsylvania Press. Reprinted with permission of the publisher).

LIFE HISTORY

Little is known specifically about the life history of *C. novae-angliae*. Life history traits of other *Carex* species, however, are probably similar and may aid in understanding this species. This section is a compilation of what is known about *C. novae-angliae* and what is known about *Carex* species in general.

Sexual Reproduction

C. novae-angliae is monoecious with a terminal staminate spike and multiple pistillate spikes on each fertile culm. Like most *Carex* species, one would expect that *C. novae-angliae* is self-compatible and wind-pollinated (Catling *et al.* 1990, Reznicek & Crins 1993). Given the small size of the staminate spike and the close proximity of the staminate and pistillate spikes, Reznicek and Crins (1993) predict that the species tends to be autogamous (self-pollinating). Mature spikes may be found between late June and early August (MNFI 1985; Reznicek & Crins 1993). Research suggests that *Carex* species, like other plants that have rhizomatous (clonal) growth, tend to establish new seedlings infrequently (Schütz 2000).

Schütz (2000) and Schütz and Rave (1999) researched seed germination of European *Carex* species. Although these species are from a different continent, the biology of European species is probably similar to North American species. Schütz (2000) found that *Carex* species have primary dormancy, in which ripe seeds are dormant until the dormancy mechanism is broken. To be released from dormancy, the seeds of many *Carex* species must go through cold stratification. In a study of 32 temperate *Carex* species, Schütz and Rave (1999) determined that 70-80% of species had increased germination rates after a period of

cold stratification. This dormancy mechanism prevents seeds from germinating in the summer when competition from other plants would make their establishment difficult (Schütz 2000). Schütz (2000) indicates that in the spring, germination is initiated when a combination of specific conditions occur including relatively high temperatures, daily fluctuations in temperatures, and light exposure. The seeds of many *Carex* species are believed to go through annual dormancy cycles (Schütz 2000). If seeds do not germinate in the spring, the seeds may become secondarily dormant as the temperature rises (Schütz 2000). Each year cold winter temperatures may release the seeds from dormancy (Schütz 2000). *Carex novae-angliae* may differ from the majority of *Carex* species in regards to seed dormancy; *C. communis*, a related species (within the same taxonomic section), has been cited as germinating without cold stratification (Bond 1999, cited in Vellend *et al.* 1999).

Carex novae-angliae, like other *Carex* species, may have a persistent seed bank (Reznicek & Crins 1993). Schütz (2000) indicates that most *Carex* species have persistent seed banks. Results from many studies have shown that viable *Carex* seeds tend to occur in deep soil layers, suggesting that the seeds can persist for decades in the soil (McGraw *et al*. 1991, Hendry *et al*. 1995, Schütz 2000). C*arex rugosperma*, a related species, was well represented in the seed bank examined in southern Michigan (Scheiner 1988). Moreover, many forest species that are dependent on occasional disturbances, as is *C. novae-angliae*, have persistent seed banks (Granström 1982, Eriksson 1989).

The capacity of *C. novae-angliae* to have a persistent seed bank, however, is uncertain. The fact that the related *C. communis* can germinate without cold stratification suggests that seeds of that species probably are not dormant when they are ripe (Bond 1999, cited in Vellend *et al.* 1999). One would expect that *Carex* species with persistent seed banks tend to have dormant seeds immediately after dispersal.

Research has shown that in some *Carex* species, primary induction of flowering shoots (development of floral primordia) begins in the fall and overwinters, while secondary induction (culm elongation and inflorescence development) tends to occur in the spring and summer (Bernard 1990, Heide 1997). Heide (1997) determined that a combination of temperature and photoperiod (daylight length) conditions during a primary induction period affect the percent of plants that flower and the number of culms per plant that flower during a secondary induction period. Such research suggests that a combination of the photoperiod and temperatures in the fall influences the numbers of flowering culms in the spring. Shoots die after fruiting which is often within a year of development (Bernard 1990, Heide 1997). In arctic and alpine habitats that have short growing seasons, flowering shoots may take multiple years to develop, depending on the conditions (Alexeev 1988).

Asexual Reproduction

In addition to sexual reproduction, *Carex novae-angliae* reproduces asexually by vegetative or "clonal" growth (Mackenzie 1940, Gleason & Cronquist 1991). Many *Carex* species have long rhizomes that may make it difficult to distinguish genets (genetically distinct individuals) and allow genets to essentially move by growing new rhizomes. *Carex novae-angliae* has short rhizomes that restrict each genet to persisting in a single tiller clump (Reznicek and Crins 1993). This type of growth form has been called "phalanx."

Carex genets may take years to mature and tend to be long-lived (Alexeev 1988, Bernard 1990). In fact, a genet could theoretically live hundreds of years (Bernard 1990). Species with the phalanx growth form, such as *C. novae-angliae*, are thought to have a shorter lifespan than *Carex* species with long-rhizomes (Alexeev 1988; Eriksson 1989). Nevertheless, species with this growth form have been documented as living at least ten to twenty years (Bernard 1990).

Ecology

Fungi (including arbuscular mycorrhizal, ectomycorrhizal, and dark septate fungi) have been found in association with the roots of certain *Carex* species (Miller *et al.* 1999). The fungi may have a mutualistic relationship with these *Carex* species, as such an association has been found in many other plant groups. This relationship, however, is probably not obligate, since fungi have been found seasonally or in only a portion of populations of a given species (Miller *et al.* 1999). In a study of 23 *Carex* species in Illinois, 16 had arbuscular fungi present in the roots (Miller *et al.* 1999). From that study, Miller *et al.* found that *Carex* species occurring in alkaline conditions were more often associated with arbuscular mycorrhizal fungi than those occurring in acidic conditions. Species of wet habitats were less likely to have an arbuscular mycorrhizal association (Miller *et al.* 1999).

Symbiotic fungi associations have not been studied in *C. novae-anglia*e; however, the tendency for *C. novae-angliae* to occur in acidic soils may make it less likely to have a symbiotic relationship with arbuscular fungi (Miller *et al.* 1999). Roots of *C. novae-angliae* could be associated with other types of fungi. For example, Miller *et al*. (1999) commonly found a dark septate fungal infection in one of the eight locations that a species related to *C. novae-anglia* (*C. pensylvanica*) was sampled.

Dispersal

Seeds of many species of herbs in temperate forests are dispersed by ants (Handel 1978, Gaddy 1986). *Carex communis*, *C. umbellata*, and *C. nigromarginata* are within the same section as *C. novae-angliae* (*Acrocystis*) and have been shown to be dispersed by ants (Handel 1978, Gaddy 1986). Most seeds that are dispersed by ants, however, including these three *Carex* species, have an "elaiosome" or "caruncle" that ants consume after they move the seeds (Handel 1978). Technical identification manuals do not indicate the presence of a caruncle or elaiosome on *C. novae-angliae*. Crins (pers. comm. 2003) indicates that if *C. novae-angliae* has an elaiosome, it is very small. An experimental study could determine if ants disperse *C. novae-angliae* seeds (see “Research and Monitoring” section). The adaptive strategy of ant dispersal is discussed in the "Population Biology and Viability" section.

Most pollen from wind-pollinated herbs disperses short distances (Levin & Kerster 1974). With distance from the pollen source, pollination decreases rapidly. In almost any wind-pollinated species, the majority of pollen lands within 50 m of the source (Levin & Kerster 1974). *Carex novae-angliae* may have very limited pollen dispersal given that the structure of the inflorescence seems to promote self-pollinations (Reznicek and Crins 1993). Handel (1976, cited in Handel 1985) determined that the woodland sedge, *Carex platyphylla*, has very limited pollen dispersal. A very small amount of pollen was deposited beyond 20 cm from the parental culms of this species.

HABITAT

Range-wide

Information from technical field manuals (Appendix 1) and herbarium labels (Appendix 2) indicate that *C. novae-angliae* occurs in hardwood forests (Magee & Ahles 1999, Ball & White 1982), in mixed hardwood-conifer forests (Reznicek and Crins 1993; MNFI 2002), and occasionally in spruce-hemlock forests (Crins & Rettig 2002). In Newfoundland populations occur in balsam fir forests that are stunted by the wind (tuckamores) along the coast (Robertson 1984). *Carex novae-angliae* tends to grow in forests dominated by *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), and *Tsuga canadensis* (eastern hemlock) (Reznicek & Crins 1993). Other tree species that are commonly present include: *Betula alleghaniensis* (yellow birch), *Acer rubrum* (red maple), *Ostrya virginiana* (ironwood), *Pinus strobus* (white pine), *Ulmus americana* (white elm), *Abies balsamea* (balsam fir), and *Betula papyifera* (white birch) (Reznicek and Crins 1993).

Soil moisture tends to vary from dry-mesic to wet-mesic in areas in which *C. novae-angliae* occurs (Ball & White 1982, Reznicek & Crins 1993). The microsite is usually cool and humid with evidence of a past mild to intermediate disturbance such as a tree fall or logging track (Reznicek & Crins 1993). The canopy is usually intact, although more light may penetrate the understory than in undisturbed areas. *C. novae-angliae* occurs in soils "ranging from acidic sands to acidic sandy loams" (Reznicek and Crins 1993).

National Forests

Hiawatha National Forest, Michigan
On the Hiawatha National Forest, two occurrences of *C. novae-angliae* are located in hardwood forests and hardwood/conifer mixed forests (Reznicek & Crins 1993, MNFI 2002). Plants occur along old logging roads and in natural forest openings.

Trees associated with sites include: *Acer saccharum, Fagus grandifolia, Tsuga canadensis, Acer rubrum, Prunus serotina, Betula alleghaniensis, Populus tremuloides, Pinus strobus, Prunus pensylvanica,* and *Abies balsamea* (MNFI 2002, Jan Schultz 1987, Appendix 2). Associated shrubs include: *Rubus strigosus, Lonicera canadensis, Rubus alleghaniensis, Diervilla lonicera,* and *Sambucus pubens*. Associated herbs include: *Maianthemum canadense, Mitchella repens, Lycopodium lucidulum, Trientalis borealis, Clintonia borealis, Streptopus roseus, Carex* spp., *Pteridium aquilinum, Oxalis acetosella, Aralia nudicaulis, Panicum* spp., *Coptis groenlandica,* and *Dryopteris carthusiana*.

Chequamegon-Nicolet National Forest, Wisconsin
One population, last located in 1963, occurs near an old campsite on the Chequamegon-Nicolet National Forest (Wisconsin State Herbarium 2002). Trees associated with the site include *Picea mariana, Abies balsamea,* and *Populus tremuloides* (Wisconsin State Herbarium 2002; Appendix 2).

Superior National Forest, Minnesota
C. novae-angliae was recently located less than three miles from the Superior National Forest. The plants grow on level ground in about twenty acres of relatively moist upland habitat. The population (the only one in Minnesota) occurs in a forest of scattered *Fraxinus nigra* (black

ash) and *Populus tremuloides* (quaking aspen). At least one old fire-scarred white pine (*Pinus strobus*) stump occurs in the area. Shrubs are dominated by tall and thick *Corylus cornuta* (beaked hazelnut) with occasional *Alnus incana* (speckled-alder), *Prunus virginiana* (choke-cherry), and *Amelanchier* species (serviceberry). Associated herbs include: *Carex intumescens, C. arctata, C. pedunculata, Allium tricoccum, Thalictrum dasycarpum, Actaea rubra, Viola pubescens, Athyrium angustum, Trillium cernuum,* and *Ribes hirtellum*.

Acer saccharum (sugar maple) and *Betula papyrifera* (paper birch) forest occurs on an adjacent south-facing slope. Mixed forest (aspen, birch, spruce and fir) is also adjacent to the stand.

DISTRIBUTION AND ABUNDANCE

Range-wide Distribution

As displayed in Figure 2, *C. novae-angliae* is most common in New England, parts of New York State, Maritime Provinces of Canada, and southern areas of Quebec and Ontario (Reznicek & Crins 1993). Disjunct occurrences are distributed in Minnesota, New Jersey, Pennsylvania, West Virginia, Wisconsin and the Upper Peninsula of Michigan (Reznicek & Crins 1993, NatureServe 2001). Plants recently located in South Carolina resemble *C. novae-angliae* (Crins & Rettig 2002). Reznicek (pers. comm. 2003) indicates that it is “quite certain” that these plants are not *C. novae-angliae*.

Carex novae-angliae occurs primarily in areas that were glaciated (Reznicek and Crins 1993). The exceptions to this are populations in West Virginia and Pennsylvania. Reznicek and Crins (1993) expect that the species was not previously distributed much beyond its current range, as remnant populations would probably persist in the "apparently suitable" habitat in the mountains to the southwest. Possibly the calcareous soils of the Great Lakes region were a barrier to the species expanding its range to the west (Reznicek & Crins 1993). Reznicek & Crins (1993) expect that the species migrated to Wisconsin and Michigan relatively recently.

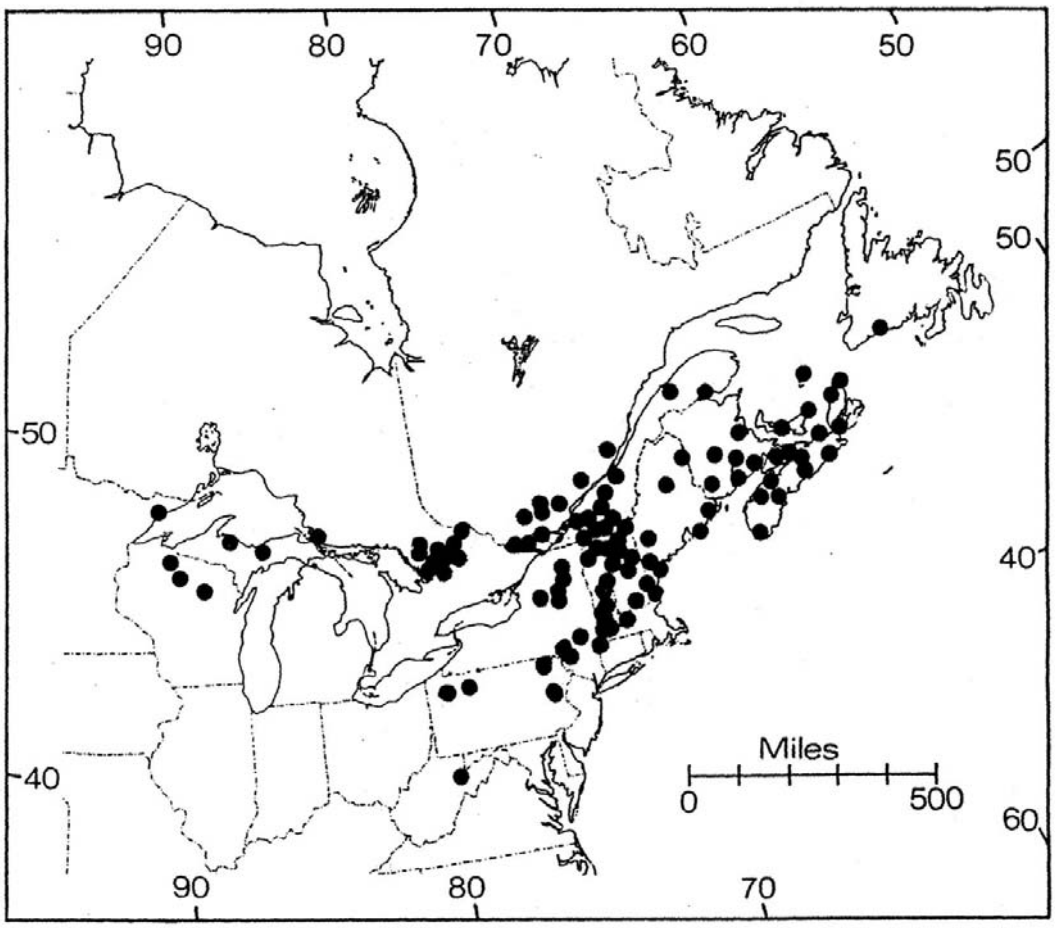

Fig. 2. Distribution of *Carex novae-angliae* from herbarium records examined by Reznicek and Crins (1993). Two recently discovered populations were added to their map (Lake County, Minnesota and near Lake Superior in Ontario).

Region-wide Distribution

The Eastern Region of the U.S. Forest Service covers a substantial portion of the entire range of *C. novae-angliae*. Canadian provinces bordering the northeastern U.S. are the only other locations with occurrences of this species. Table 3 gives distribution and abundance information regarding *C. novae-angliae* within states of the U.S. Forest Service's Eastern Region along with information on the neighboring Canadian provinces.

Carex novae-angliae is documented on four national forests in the Eastern region of the U.S. Forest Service including: the Hiawatha National Forest in Michigan, the Superior National Forest in Minnesota, the Green Mountain National Forest in Vermont, and the White Mountain National Forest in New Hampshire (USDA Forest Service 2003). Herbarium records reveal that an occurrence was documented on the Nicolet-Chequamegon National Forest in 1963 (University of Wisconsin Herbarium 2002). The Allegheny National Forest in Pennsylvania and Monongahela National Forest in West Virginia occur in the vicinity of documented occurrences of *C. novae-angliae* (Reznicek & Crins 1993, Cusick 1996).

Table 3. Abundance and distribution of *C. novae-angliae* in some Canadian Provinces and U.S. States that it occurs.

State/Province	Distribution and Abundance
United States	
Connecticut	According to PLANTS database (2001), one county had occurrences of the species. The Connecticut Department of Environmental Protection (2002) indicates that the species is probably extirpated from the state.
Maine	Twenty-one of the 23 counties have occurrences (PLANTS 2001). Nineteen occurrences are listed in the University of Maine database (2000).
Massachusetts	Seven of the fourteen counties have occurrences (PLANTS 2001).
Michigan	Three element occurrences are known in the Upper Peninsula (Reznicek & Crins 1993, Appendix 1). Two of the occurrences are on the **Hiawatha National Forest**. Each occurrence is made up of multiple populations. One occurrence is scattered in parts of two USGS sections.
Minnesota	One recently discovered occurrence is located within three miles of the **Superior National Forest** (Michael Lee pers. com. 2003).
New Hampshire	Eight of the ten counties have occurrences (PLANTS 2001).
New York	"A substantial area of occurrence in ... the Adirondack and Catskill uplands of New York" (Reznicek & Crins 1993). Disjunct populations occur adjacent to Pennsylvania in high altitudes of the Allegheny Plateau (Reznicek & Crins 1993).
Pennsylvania	"locally frequent" (Rhoads & Block 2000). "...occurs disjunctly in the Pocono Plateau of Pennsylvania and the higher parts of the Allegheny Plateau in northwestern Pennsylvania" (Reznicek & Crins 1993).
Vermont	Eight of fourteen counties have occurrences (PLANTS 2001). Listed as “occasional” in the state (Jenkins 1988, cited in Grove & Burbank 2000).
West Virginia	Two known occurrences are located in the Canaan Valley at ca. 1,000 m. altitude (Cusick 1996, Appendix).
Wisconsin	Two occurrences are documented in northern Wisconsin (University of Wisconsin Herbarium 2002, Appendix 2). One of the occurrences is located on the **Chequamegon-Nicolet National Forest**.

State/Province	Distribution and Abundance
Canada	

New Brunswick	"Common in the southern half of the Province and rare northward" (Hinds 1986).
Newfoundland	"Rare ... [in] southern and southwestern Newfoundland" (Robertson 1984).
Ontario	"Wide ranging in Ontario, however, it is restricted to deciduous forest habitats on the Canadian Shield" (Ball & White 1987). "...A substantial area of occurrence in ... upland areas of eastern Ontario (primarily the Algonquin Dome)" (Reznicek & Crins 1993).
Quebec	"...a substantial area of occurrence in Quebec, just north of New England..." (Reznicek & Crins 1993).

RANGEWIDE STATUS

The Nature Conservancy's Ranking

Rangewide status can be assessed by a ranking system developed by The Nature Conservancy, NatureServe, and the Natural Heritage Network (NatureServe Explorer 2001). This ranking system uses information on species that are tracked by The Nature Conservancy and Natural Heritage Programs throughout the world. The ranking that a species receives indicates the species vulnerability to extirpation and is based on many factors such as the number of occurrences, the quality of the occurrences, and their rate of decline. The global ranking (G-rank) gives the status of a species throughout its range. Each country where the species occurs has a national ranking (N-rank) that indicates the species vulnerability within that country. If the species occurs within the boundaries of provinces, states, or other divisions within a country, the species is given a subnational ranking (S-rank) for that area (NatureServe Explorer 2001).

The number or letter following G, N, or S is the ranking of current vulnerability of the species within the given geographical boundary (Nature Serve Explorer 2001). Numeral ratings range from 1 to 5. The more vulnerable a species is to extirpation within the given geographical boundary, the lower the numeral rating. If a letter or punctuation follows the G, N, or S, the current status has not been determined; the letter indicates what is known about the species (Nature Serve Explorer 2001).

Carex novae-angliae has a global rank of "G5" indicating that it is "secure" throughout most of its range (Nature Serve Explorer 2001). This species, however, has not been ranked in the United States "N?" (31 July 1993). The status of *C. novae-angliae* is "critically imperiled" in Michigan and Connecticut (S1), and ranked as “historical” in Wisconsin (SH, Table 4). The species is ranked as "reported" (SR) or "unranked" (S?) in the nine other states in which it occurs (Table 4, NatureServe Explorer 2001). In Canada, the National Heritage Status of *C. novae-angliae* is "unranked" [N? (08 Aug. 1993)]. *Carex novae-angliae* is ranked as "vulnerable" in Ontario (S3) and “reported” in Quebec (SR). According to the Atlantic Canada Conservation Data Centre (2003), *C. novae-angliae* is ranked as “secure” (S5) in Prince Edward Island, Nova Scotia, and New Brunswick, and is ranked as ranging between “critically imperiled” and “imperiled (S1S2) in Newfoundland Island.

Table 4. Subnational rank (S) of *C. novae-angliae* in the U.S. states and Canadian provinces that it occurs as listed by NatureServe (2001) except for where noted. (S1 = critically imperiled, S2 = imperiled, S3= vulnerable, S4 = apparently secure, S5 = secure, SH= historical occurrences, SR= reported, S?= unranked).

U. S. State	Subnational Rank	Canadian Province	Subnational Rank
Connecticut	S1	New Brunswick	S5*
Maine	SR	Newfoundland Island	S1S2*
Massachusetts	SR	Nova Scotia	S5*
Michigan	S1	Ontario	S3
Minnesota	S?**	Prince Edward Island	S5* (S4)
New Hampshire	SR	Quebec	SR
New Jersey	S?		
New York	SR		
Pennsylvania	S?		
Vermont	SR		
West Virginia	SR		
Wisconsin	SH***		

* Atlantic Canada Conservation Data Centre (2003).
** *C. novae-angliae* in Minnesota has no S-rank given by NatureServe or the Minnesota Natural Heritage Program, however a population has been discovered recently (Michael Lee pers. comm. 2003).
*** Wisconsin Bureau of Endangered Resources (2003).

Ranking by States and the U.S. Forest Service

Carex novae-angliae is listed as "threatened" in Michigan with three occurrences in the Upper Peninsula (MNFI 2002); and it is listed as a "special concern" species in Wisconsin with two populations that have not been re-located for over 20 years (Wisconsin Bureau of Endangered Resources 2003). *Carex novae-angliae* is proposed to be listed as "endangered" in Minnesota (Michael Lee, pers. comm. 2003), and it may be extirpated from Connecticut where it is listed as a "special concern" species (Connecticut Department of Environmental Protection 2002). The Eastern Region (Region 9) of the U.S. Forest Service has listed *C. novae-angliae* as a Regional Forester Sensitive Species on the Hiawatha National Forest in Michigan and on the Superior National Forest in Minnesota (USDA Forest Service 2003). The Chequamegon-Nicolet National Forest in Wisconsin may also consider listing the species (Steven Spickerman 2002).

POPULATION BIOLOGY AND VIABILITY

The population biology and viability of *C. novae-angliae* have not been studied; however other species within the same genus or with a similar growth form may share some common characteristics. In other *Carex* species, the numbers of flowering culms per genet may fluctuate from one year to the next depending on conditions during the fall such as temperatures and photoperiod (Heide 1997). *Carex* species that grow rhizomatously tend to reproduce sexually infrequently (Eriksson 1989) and be long-lived (Bernard 1990). *C. novae-angliae* has a phalanx or tufted growth form. Species with the phalanx growth form tend to have shorter life spans than other clonal species ("Life History" section). Nevertheless, some

Carex species with this growth form have been shown to live at least 10 or 20 years (Bernard 1990).

A community of forest herbs is dependent on intermediate disturbances such as tree tips and blow downs in order to obtain enough light for germination and/or sexual reproduction (Hughes *et al.* 1988, Barret & Helenurm 1986, Kudow *et al.* 1999). From habitat descriptions, *C. novae-angliae* apparently is adapted to this niche within the hardwood and hardwood-conifer mixed forests. Such species occur in patches scattered throughout the forest. In areas of closed canopy these species tend to grow primarily asexually through rhizomatous growth (Hughes *et al.* 1988, Kudow *et al.* 1999). In mildly disturbed areas, where light penetrates the canopy, rhizomatous growth tends to increase in addition to the numbers of germinating seeds and emergent seedlings (Hughes *et al.* 1988, Kudow *et al.* 1999).

Many *Carex* species that occur in temperate forests are not dominant species of the plant community (Vellend *et al*. 1999). Even when they are infrequent in the forest community, *Carex* species may be able to establish in random openings by having persistent seed banks. A group of perennial herbs, including many *Carex* species, is dependent on random gap-openings within temperate forests and have persistent seed banks (see "Life History" section). Persistent seed banks allow species to establish in locations even if the species is not part of the current vegetation. Persistent seed banks may also allow a genetically diverse set of seedlings to emerge as disturbances such as tree tips could potentially uncover viable seeds produced decades prior to the disturbance. One should note, however, that persistent seed banks have not been examined specifically in *C. novae-angliae*.

Seed dispersal by ants may be another manner that may influence the distribution and abundance of *Carex* species. Handel (1978) showed that the ant-dispersed species, *C. pedunculata*, is a weak competitor compared to two *Carex* species that do not have seeds that are ant-dispersed. In a study of the microhabitats of four *Carex* species in a Quebec old growth forest, Vellend *et al*. (1999) found that *C. communis*, a species within the same section as *C. novae-angliae* (*Acrocystis*), was located in a relatively broad range of environmental conditions. Vellend *et al*. (2000) hypothesized that the fact that this species was the only ant-dispersed species, may have allowed the species to be so widely distributed throughout the forest. Handel (1978) and Vellend *et al.* (1999) suggested that ants may disperse seeds to locations that have low levels of plant competition. If *C. novae-angliae* is dispersed by ants, it may be dispersed throughout forests in a similar manner (see “Dispersal” section). Reznicek and Crins (1993) observed various populations of *C. novae-angliae* in New England, Ontario, and Michigan. They noted that the species usually occurs in discreet clumps or patches with few aggressive or competitive species in the vicinity. Possibly *C. novae-angliae* is a poor competitor, like *C. pedunculata*, and ant-dispersal of seeds allows this species to establish in areas with less competitive conditions. Handel (1978) and Vellend *et al*. (2000) hypothesized that species that have ant-dispersed seeds may share other characteristics such as the ability to germinate immediately after dispersal, relatively short lifespans, and a faster initial growth rate.

C. novae-angliae may be adapted to grow in forest gaps for a combination of reasons. Possibly the moisture and cool temperatures of the forest are required for germination, establishment, or long-term persistence. Forest gaps may have less competitive conditions

than undisturbed forests or large openings. Noting that *C. novae-angliae* was typically located in areas with little competition, Reznicek and Crins (1993) hypothesized that the species may not be capable of persisting in large canopy openings due to the establishment of very competitive weedy species that occur following such a disturbance. Likewise, shade tolerant species such as *Acer saccharum* seedlings may out-compete *C. novae-angliae* in well shaded hardwood stands (Reznicek & Crins 1993).

POTENTIAL THREATS

Carex novae-angliae is not in danger of extirpation in the near future as it is described as "frequent" in New England (Seymour 1982) and is listed as "secure globally" (G5) by the Natural Heritage Network (NatureServe Explorer 2001). The species, however, has some vulnerability given that it may be extirpated from the New England State of Connecticut. The species may be vulnerable if not threatened in Michigan, Minnesota, Wisconsin, and West Virginia where only a few scattered and disjunct populations are known to occur.

Logging may be the greatest threat to *C. novae-angliae* in Wisconsin, Minnesota and Michigan. Although this species is dependent on occasional medium or small disturbances, large disturbances could be detrimental to *C. novae-angliae*. The species does not occur in the open "except occasionally in very cool, sheltered microsites in the northern coastal portions of its range" (Reznicek & Crins 1993). Possibly the germination requirements are dependent on the moisture or cool temperatures that exist in small forest gaps. The species "does not seem to co-exist with strong competitors" (Reznicek & Crins 1993), and as a result may not be able to establish or persist in large openings or heavy shade. Reznicek and Crins (1993) indicate in their discussion of *C. novae-angliae* that after a large canopy opening "the increased light would probably result in a short term flush of heavy fruiting." Such an effect is probably what was found in the Hiawatha National Forest in 1988. In areas that had trees thinned, *C. novae-angliae* had a five-fold increase in the number of fertile culms per square meter compared to before thinning in 1987 (Schultz 1988). The long-term persistence of these plants may depend on the amount of canopy that was removed. If competitive species were able to establish, one would expect that *C. novae-angliae* would be excluded from the logged area (Reznicek & Crins 1993).

Reznicek and Crins (1993) suggest that severe disturbances that remove substantial canopy such as clear-cut harvests should be avoided in areas that *C. novae-angliae* occurs. If tree harvests are proposed, they made the following recommendations:

1. The degree of canopy removal and soil scarification should be limited as much as possible.

2. Cutting and skidding should be restricted to the winter if possible. If cutting must occur in the summer, it should only occur after fruit has dispersed (late July at the earliest).

3. Roads, skid trails and landings should be planned in areas that *C. novae-angliae* does not occur.

4. An area in which *C. novae-angliae* occurs should not be disturbed for three to five years after a tree harvest to allow the species to recover from the disturbance.

5. The logged area should not be seeded with a cover crop, as such species are often very competitive and may prevent the persistence of *C. novae-angliae*.

6. After a management activity, *C. novae-angliae* should be monitored to determine its persistence.

LAND OWNERSHIP AND EXISTING HABITAT PROTECTION

Two element occurrences of *C. novae-angliae* are located on the Hiawatha National Forest in Michigan. If timber harvests are planned in areas in which these populations occur, steps will be taken to minimize the impact to populations due to the species' listing as a Regional Forester Sensitive Species. The population recently found in Minnesota occurs on county land. When Minnesota lists the species as "endangered," as has been proposed (Michael Lee, pers. comm. 2003), the population be protected to some degree from logging activities. One of the two populations in Wisconsin occurs on the Chequamegon-Nicolet National Forest. The Chequamegon-Nicolet National Forest may consider listing this species as a Regional Forester Sensitive Species in the future (Steven Spickerman pers. comm. 2002).

RESEARCH AND MONITORING

Existing Surveys, Monitoring, and Research

The Hiawatha National Forest surveys for *C. novae-angliae* prior to timber sales. Given that this species occurs in mature forests, such surveys may locate additional populations and aid in their protection.

The Hiawatha National Forest established permanent quadrats to monitor a population of *C. novae-angliae* (Schultz 1988). Seven quadrats were placed in an area that was logged and seven quadrats were placed in an area that was not logged. The numbers of flowering culms per quadrat and percent cover of each species within the quadrats were recorded prior to logging in 1987 and after logging in 1988 and 1989. On average, number of flowering culms per quadrat increased from 63 before logging to nearly 300 after logging (Schultz 1988). The percent cover of *C. novae angliae* did not change significantly after logging.

Reznicek and Crins (1993) verified the range of *C. novae-angliae* by reviewing herbarium specimens. They also made an identification key for species of the *Acrocystis* section in

Michigan and visited populations throughout the species range. Reznicek and Crins (1993), in addition, made a detailed description of the species habitat from summarizing habitat descriptions.

Survey Protocol

1. The permanent quadrats that were established on the Hiawatha National Forest in 1987 should be re-visited in order to determine if thinning the forest where *C. novae-angliae* occurs was detrimental or beneficial to the population. The data gathered for the first two years following the harvest indicated that *C. novae-angliae* initially had an increase in reproductive output. Reznicek and Crins (1993) hypothesized that such an effect might be temporary following the creation of a large canopy opening. The number of flowering culms per quadrat and percent cover of *C. novae-angliae* in areas that had been logged 15 years ago compared to the same data from quadrats that had not been logged may indicate if the species has been able to sustain the initial reproductive output. If canopy openings increased air temperatures and/or decreased humidity in the forest, *C. novae-angliae* patches in the thinned areas may have been negatively affected. If competitive species have established throughout the thinned area, *C. novae-angliae* may also have been negatively affected. The percent cover of *C. novae-angliae* and other plants within quadrats may reveal if many competitive species have been introduced into the plant community during the fifteen years following the logging. Such surveys may indicate how sensitive *C. novae-angliae* is to tree harvests.

2. The one occurrence of *C. novae-angliae* that was last observed in 1963 on the Chequamegon-Nicolet National Forest should be located. Botanists on the Forest have not searched for the known population as they were unaware of the herbarium voucher prior to this Conservation Assessment. Since the species, like many *Carex* species, is quite inconspicuous and easily confused, a search specifically targeting the known location of the species would be an important first step in determining the status of the species on the Chequamegon-Nicolet National Forest. Such a search should be performed by botanists familiar with the species.

3. The Hiawatha, Superior and Chequamegon-Nicolet National Forests should identify potential *C. novae-angliae* habitat and target the species when the habitat is surveyed. Such surveys might be implemented in connection with management projects or surveys for other species. The Superior and Chequamegon-Nicolet National Forests might consider surveying likely *C. novae-angliae* habitat as a project in itself. Both of these forests have not included *C. novae-angliae* in plant surveys until recently as the presence of the species was not considered. Unknown populations may occur on these national forests given that *Carex* species are quite inconspicuous and may be overlooked even by botanists when the species is not targeted.

Research Priorities

1. Any well developed study of *C. novae-angliae* would improve the knowledge base of this species. One could monitor plots within populations to better understand the persistence of plants and the establishment and development of new plants. Species-specific information could be gathered in conjunction with detailed descriptions of the habitat such as the structure of the associated plant community and abiotic conditions such as light penetration, soil type,

soil moisture, and air temperatures. Such information may suggest the competitive abilities and disturbance requirements of *C. novae-angliae*.

2. Given that the primary range of *C. novae-angliae* is in New England, a search in local herbaria to determine if and where populations occur on National Forests in the region would reasonable. Ray Angelo (pers. comm. 2002), the Curator of Vascular Plants for the New England Botanical Club, indicated in an e-mail that "the New England collections which include those of the Harvard University Herbaria and the New England Botanical Club contain two folders of *Carex novae-angliae* specimens from New Hampshire and Vermont." One might expect, given this information, that this species might be somewhat common on the White Mountain and Green Mountain National Forests. Herbaria in the vicinity of Allegheny National Forests in Pennsylvania and Monongahela National Forest in West Virginia could also be searched to determine if local *C. novae-angliae* populations occur on these National Forests. Each of these National Forests is within the same county as documented occurrences of the species (Cusick 1996, April Moore pers. comm.. 2002).

3. Seed-dispersal is an important factor in understanding the ecology and population biology of any species. A simple study could be carried out using similar methodology as Handel (1978) to determine if ants take *C. novae-angliae* seeds to their nests. Handel placed a few ants and ten seeds from two *Carex* species (a test species and a control species) in a petri dish. The control species was previously shown to not be dispersed by ants. If the ants were interested in seeds of the test species, the ants carried the seeds to their nests within half an hour. The seeds of species that were determined to not be dispersed by ants were rarely moved. Such a study could be carried out in a lab with a captive ant colony.

4. One could determine if *C. novae-angliae* seeds have a dormancy mechanism like many *Carex* species, or if seeds can germinate immediately after dispersal like some species with ant-dispersed seeds. This could be done by sampling ripe seeds in the summer and following methodology of other germination studies of *Carex* species such as Schütz and Rave (1999).

5. A study of the seed bank in forests that *C. novae-angliae* occurs in may indicate if this species has a persistent seed bank as Reznicek and Crins predict (1993). Such a study would probably be carried out in concert with a larger study of the community of plants with persistent seed banks. Methods could follow those of other seed bank studies such as Scheiner (1988) or McGraw *et al.* (1991). In areas in which *C. novae-angliae* occurs, soil could be sampled along a transect. Soil would be sieved to remove large objects such as rocks and sticks, and placed in germination trays in a greenhouse. Methods to maximize the numbers of seeds that germinate would be used such as keeping trays moist, daily fluctuations in temperatures, having light and dark cycles (such as 20 hours of light and 4 hours of dark each day). Seedlings would be grown at least until they could be identified.

6. A study using molecular-techniques could investigate the genetic structure of *C. novae-angliae* populations. One could use techniques of researchers such as Jonsson *et al.* (1996) and Vellend and Waterway (1999), who have studied the genetic structure of other *Carex* species. By sampling plants from populations throughout the species range, one could determine if disjunct populations in Minnesota, Wisconsin, West Virginia, and Michigan are genetically isolated from other populations. In addition such a study would indicate genetic diversity of this species.

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APPENDIX 1

Habitat descriptions of *Carex novae-angliae* from technical field guides.

North America "Woodlands" (Mackenzie 1940).
"Moist to mesic sites, in shade or partial shade under mixed deciduous forests, occasionally under spruce-hemlock canopies; 100-1000 m" (Crins & Rettig 2002).

Canada: "Woodlands and damp slopes..." (Scoggan).

New Brunswick: "Open, dryish woodlands" (Hinds 1986).

Newfoundland: "...in open balsam fir tuckamore in coastal plains. " (Robertson 1984).

Ontario: "Mesic to wet-mesic hardwood forests" (Ball & White 1982).

Acer saccharum (sugar maple) is a dominant tree species in all 6 occurrences listed from Georgian Bay area (Appendix). Other tree species present, sometimes as dominant species, include: *Acer rubrum* (red maple), *Ostrya virginiana* (ironwood), *Betula alleghaniensis* (yellow birch), *Pinus strobus* (white pine), and *Ulmus americana* (American elm).

Species of saplings and seedlings include: *Acer saccharum*, *Abies balsamea*, *Fraxinus pennsylvanica*, *Prunus serotina*, *Ostrya virginiana*, *Alnus rugosa*, *Tsuga canadensis*, *Tilia americana*, *Quercus rubra*, *Fagus grandifolia*, and *Thuja occidentalis*.

Herbs: *Pteridium aquilinum*, *Maianthemum canadense*, and *Solidago rugosa* were each found in 5 of the 6 occurrences.

United States

Eastern U.S. "Moist woods" (Gleason & Cronquist 1991).

New England: "Moist deciduous woods" (Magee & Ahles 1999, p. 261).
"Woods, moist or dry" (Seymour 1982).

Michigan: The three known occurrences are located in forests dominated by hardwoods or a mix of conifers and hardwoods. Populations occur in small to intermediate disturbances (Reznicek & Crins 1993).

Minnesota	Located within 5 miles of Lake Superior along a river. Sparse canopy of *Fraxinus nigra* (black ash) and *Populus tremuloides* (quaking aspen) with thick, tall underbrush of predominately *Corylus cornuta*. Occurring on level ground in about 20 acres of relatively moist upland habitat (Michael Lee pers. comm. 2003, Appendix).
Pennsylvania:	"Wet woods and thickets" (Rhoads & Block 2000, p. 737)
West Virginia:	"Crevices of flat, exposed sandstone rocks... ca. 1,100 m..Sandstone knob." (Cusick 1996).

APPENDIX 2
Element Occurrences of Carex novae-angliae
This appendix lists element occurrences of *Carex novae-angliae* in four U.S. states (Michigan, Minnesota, Wisconsin, and West Virginia) and Ontario Canada. Descriptions are in alphabetical order by U.S. state and then Canadian province.

Michigan

Location:	Chippewa County, Michigan
Year(s) Observed:	June 1996
Land owner:	Hiawatha National Forest
Habitat:	"Northern hardwoods with spring seeps and vernal ponds along two levels of Great Lakes' relict shorelines." Dominant trees: *Acer saccharum*, *Fagus grandifolia*, and *Prunus serotina*.
Source:	Michigan Natural Features Inventory 2002.

Location:	Marquette County, Michigan
Year(s) Observed:	July 1990
Habitat:	"Growing on high hills ...in mixed balsam-aspen-maple woods."
Source:	Reznicek & Crins 1993

Location:	Schoolcraft County, Michigan
Year(s) Observed:	June 1986, July 1987, July 1990
Landowner:	Hiawatha National Forest
Habitat:	Occurring along roads and within openings of Hemlock-hardwoods in areas of two neighboring USGS sections. One of the sections had a selective tree harvest in 1987. Herbarium label descriptions (Reznicek & Crins 1993): "Locally common along old logging trail in Hemlock-hardwoods..." (1986). "Growing along old trail, in old mixed woods, in semi-shade" (1986). "Growing in disturbed sand at edge of logging road" (1987). "Mesic second-growth hardwoods with hemlock and white pine. ..timber sale area." On high ground along two Forest Service roads. (1990).
Associated species: (from quadrat measurements by the Hiawatha National Forest, 1987 &1988)	Trees: *Acer rubrum, Prunus serotina, Betula alleghaniensis, Acer saccharum, Prunus pensylvanica, Fagus grandifolia, Pinus strobus*. Shrubs: *Rubus strigosus, Lonicera canadensis, Rubus alleghaniensis, Diervilla lonicera, Sambucus pubens.* Herbs: *Maianthemum canadense, Mitchella repens, Lycopodium lucidulum, Trientalis borealis, Clintonia borealis, Streptopus roseus, Carex spp., Pteridium aquilinum, Oxalis acetosella, Carex aurea, Aralia nudicaulis, Carex arctata, Panicum spp., Carex intumescens, Coptis groenlandica, Dryopteris spinulosa.*
Source:	Reznicek & Crins 1993

Minnesota

Location	Lake County
Year(s) Observed:	2001
Ownership:	County
Population size:	"Occasional, forming small carpets"
Habitat:	In forest with widely scattered trees (*Fraxinus nigra* and *Populus tremuloides*) with thick, tall underbrush of predominately *Corylus cornuta*. At least one old fire-scarred *Pinus strobus* (white pine) stump noticed in the area. Occurring on level ground in about 20 acres of relatively wet-mesic upland habitat (possibly semi-terrestrial). Sugar maple forest occurs on 100-foot, south-facing slope (moderately steep), that is adjacent to level area plants were found. Aspen-birch-spruce-fir forest is adjacent on other side in broad terrace below.
Associated species:	Trees: Sparse canopy of *Fraxinus nigra* and *Populus tremuloides*. Shrubs: *Corylus cornuta* with *Alnus incana*, *Prunus virginiana*, and *Amelanchier* sp. Herbs: *Carex intumescens, C. arctata, C. pedunculata, Allium tricoccum, Thalictrum dasycarpum, Actaea rubra, Viola pubescens, Athyrium angustum, Trillium cernuum, Ribes hirtellum*.
Source:	Michael Lee, County Biological Survey, pers. comm. 2002

West Virginia

Location:	Tucker County, West Virginia
Year(s) Observed:	June 1947
Altitude:	900-1200 m.
Habitat:	"Sandstone knob."
Source:	Cusick 1996

Location:	West Virginia
Year(s) Observed:	May 1991
Altitude:	1,199 m.
Habitat:	"Crevices of flat, exposed sandstone rocks"
Source:	Cusick 1996

Wisconsin

Location	Ashland, Wisconsin
Year(s) Observed:	July 1963 (The Curator of the University of Wisconsin-Madison Herbarium, Ted Cochrane, indicated that this population has been reported to be relocated in addition to a third Wisconsin population, however a voucher specimen was not given to the herbarium.)

Habitat:	"Old campsite."
Associated species:	*Picea mariana, Abies balsamea, Populus tremuloides,* and *Luzula acuminata*.
Source:	University of Green Bay Herbarium

Location:	Price County, Wisconsin
Year(s) Observed:	June 1915
Habitat:	"Moist shaded ground white tinged sedge; in stools."
Source:	Milwaukee Public Museum Herbarium.

Ontario, CANADA

Location:	Georgian Bay, Ontario
Year(s) Observed:	20 September 1992
Slope:	Gradual
Soil:	Mesic loam
Dominant species:	*Acer saccharum* with *Acer rubrum*, *Betula alleghaniensis*, and *Ulmus americana*.
Understory species:	*Pteridium aquilinum*, *Solidago rugosa*, *Acer saccharum* seedlings and saplings, *Maianthemum canadense*.
Source:	Reznicek & Crins 1993 (record 1)

Location:	Georgian Bay, Ontario
Year(s) Observed:	20 September 1992
Slope:	Level
Soil:	Mesic loam
Dominant tree species:	*Acer saccharum*, *Betula alleghaniensis*, *Acer rubrum*.
Understory species:	Saplings of *Abies balsamea*, *Fraxinus pennsylvanica*, *Pteridium aquilinum*, *Solidago rugosa*, *Acer saccharum* seedlings, *Maianthemum canadense*.
Source:	Reznicek & Crins 1993 (record 2)

Location:	Georgian Bay, Ontario
Year(s) Observed:	20 September 1992
Slope:	Gentle south-facing slope
Soil:	Wet mesic loam
Habitat:	"Along trail."
Dominant tree species:	*Acer rubrum* and *Acer saccharum*.
Understory species:	Seedlings of *Prunus serotina*, *Tilia americana*, *Abies balsamea*, and *Acer rubrum*; *Acer saccharum* saplings, *Pteridium aquilinum*, *Solidago rugosa*, *Acer saccharum* seedlings, *Maianthemum canadense*.
Source:	Reznicek & Crins 1993 (record 3)

Location:	Georgian Bay, Ontario
Year(s) Observed:	20 September 1992
Slope:	Level

Soil:	Mesic thin loam over gneiss.
Habitat:	"Bed of old track, +/- open canopy, partial shade."
Dominant tree species:	*Acer saccharum* with *Acer rubrum*, and *Ostrya virginiana*.
Associated Species:	*Dryopteris intermedia, Hieracium vulgatum, Maianthemum canadense, Danthonia spicata, Carex arctata, Poa nemoralis,* and seedlings of *Prunus serotina, Acer rubrum, Ostrya virginiana,* and *Quercus rubra*.
Source:	Reznicek & Crins 1993 (record 4)

Location:	Georgian Bay, Ontario
Year(s) Observed:	20 September 1992
Slope:	Level
Soil:	Mesic loam
Habitat:	"Knoll, closed canopy."
Dominant tree species:	*Acer saccharum*, *Acer rubrum*, and *Ostrya virginiana*.
Associated Species:	*Aster macrophyllus*, Seedlings of *Fraxinus pennsylvanica*, *Solidago rugosa*, *Pteridium aquilinum*.
Source:	Reznicek & Crins 1993 (record 5)

Location:	Georgian Bay, Ontario
Year(s) Observed:	20 September 1992
Slope:	Level
Soil:	Dry mesic sandy loam
Habitat:	"Sun flecks."
Forest Classification:	*Pinus strobus, Ostrya virginiana*, and *Acer saccharum*.
Associated Species	Saplings and seedlings of *Acer saccharum*, *Fagus grandifolia, Abies balsamea, Thuja occidentalis, Ostrya virginiana*, and *Tsuga canadensis*; *Fraxinus pennsylvanica*; *Maianthemum canadense*; *Solidago rugosa*; and *Pteridium aquilinum.*
Source:	Reznicek & Crins 1993 (record 6)

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